Dale Raymond Corson
This book captures some significant markers in the life and times of Dale Raymond Corson and his imprint upon Cornell University. His is a unique and remarkable journey.

This story is told through three videos — 1) “Dale Corson: Cornell’s Good Fortune”, 2) an overview by two of Cornell’s most distinguished faculty members, Walter LaFeber and M. H. Abrams, and 3) a wide-ranging interview of Dale Corson by another former chair of the Department of Physics, Kurt Gottfried—and through this book, a collection of historical documents and speeches by Corson and by many friends. This book assembles numerous noteworthy documents and the transcripts of “The Corson Symposium: A Strategy for a Great Research University.” Enhancing this book are numerous photographs, including two collections by the late Sol Goldberg, archival images from University Photography, the Division of Rare and Manuscript Collections, and George Gull.

The documents reprinted here provide insight into a renaissance in engineering and in biology at Cornell. They include thoughtful essays on issues of contemporary importance — essays about the future of higher education in general and at Cornell in particular. They illuminate the remarkable career of a brilliant, yet kind and humble man who provided able and insightful leadership for Cornell and for the nation. Corson’s leadership was marked by a profound respect for those whom he led by being an astute and thoughtful listener — a concept he articulated as his principle of fences and bases.

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This book and the DVD were produced by

J. Robert Cooke

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Note: Some supplementary materials may be found in the ROM section of the companion DVD. This book and the videos on the DVD may be viewed online (in reduced image size) at http://ecommons.library.cornell.edu/handle/1813/3613. Additional supplementary resources may be placed at this eCommons@Cornell digital repository address as they become available.
# CONTENTS

*Editor's note: Click on a “Contents” entry to turn to that item.*

| Frontispiece: Photograph of Dale Raymond Corson | i |
| Preface | ii |
| Contents | iii |
| Photographs provided by Dale Corson | 1 |
| Pittsburg (an autobiographical article about his early years) | 4 |
| Dale Corson's Significant Scientific Papers | 17 |
| Engineering at Cornell | 19 |
| The Next Ten to Twenty Years in Engineering Education at Cornell University | 19 |
| Biology at Cornell | 36 |
| Report of the External Committee on Biology at Cornell | 36 |
| Report of the President's Committee on Biological Sciences | 45 |
| Biology at Cornell: Critiques of the Report | 58 |
| Establishment of the Division of Biological Sciences | 64 |
| Letters: Cornell Alumni News | 68 |
| Goldberg Photographs | 72 |
| Corson Investiture Photo Album, Vol 1 | 72 |
| Executive Staff Photo Tribute, Vol 2 | 96 |
| Remarks at Dinner Honoring President and Mrs. Corson | 119 |
| Cornell Alumni News: July 1977 Issue | 124 |
| A Salute to President Corson | 125 |
| Hail and Farewell | 131 |
| Corson Looks Back | 138 |
| A Sundial for the Quad | 144 |
| The Sun Rises in Maine | 153 |
| Remarks by Stuart M. Brown, Jr. at the Dedication of Corson–Mudd Hall | 157 |
| Some Corson Papers | 160 |
| A Report To The Trustees of Cornell University | 161 |
| DuBridge Symposium: The War Years | 237 |
| Where Has Science Been and Where Is It Going? | 244 |
| Whither The Research University? | 253 |
| The High Cost of Quality | 263 |
| Summary of U.S. Papers and Commentary | 271 |
| Multidisciplinary Programs in Universities | 275 |
| The High Cost of Higher Education: Did We Make a Mistake? | 281 |
Audio and Video Content

Editor's Note: From within Adobe Reader 6 (or a more recent version), the following audio (aac) and video (mp4) segments may be played using the QuickTime Player (or equivalent) with play-back controls available. Click on a topic below to turn to that item and the link to that audio or video resource. These files are also accessible in the DVD-ROM of disc 1.

*Item, book page, [mm:ss]*

The Corson Symposium  296  
Gala Banquet Tributes  297  
- Frank Press, former President of U.S. National Academy of Sciences  300  [07:34]  
- Robert L. Sproull, President Emeritus, University of Rochester  302  [05:31]  
- Jean Gortzig, former Development Associate Vice President, Cornell University  304  [06:39]  
- J. Robert Cooke, Dean of the Cornell University Faculty  306  [03:44]  
- Cornell Glee Club Serenade  312  [08:20]  

Response  
- Dale R. Corson, President Emeritus, Cornell University  308  [26:46]  

Luncheon Tribute  
- Frank H. T. Rhodes, President Emeritus, Cornell University  316  [07:49]  

Symposium Lectures  318  
- Welcome by Robert C. Richardson, Vice Provost for Research, Cornell University  321  [03:31]  
- Hunter R. Rawlings III, President, Cornell University  322  [46:37]  
- John Brademas, President Emeritus, New York University  328  [40:01]  
- Vernon J. Ehlers, U.S. House of Representative (Michigan)  335  [42:06]  
- Charlotte V. Kuh, Executive Director, Office of Scientific and Engineering Personnel, NRC  343  [42:58]  
- Joe B. Wyatt, Chancellor, Vanderbilt University  349  [35:32]  
- Fred Plum, Professor of Neuroscience, Weill Medical College of Cornell University  355  [36:58]  
- Donald P. Greenberg, Professor of Computer Graphics, Cornell University  360  [40:35]  
- Frank H.T. Rhodes, President Emeritus, Cornell University  369  [35:05]  
- Ronald G. Ehrenberg, Ives Professor of Industrial and Labor Relations and Economics, CU  380  [49:12]  
- Donald F. Holcomb, Professor Emeritus of Physics, Cornell University  387  [28:37]  
- Steven D. Tanksley, Liberty Hyde Bailey Professor of Plant Breeding, Cornell University  395  [17:14]  
- Joseph M. Ballantyne, Professor of Electrical Engineering, Cornell University  399  [15:29]  

Hall of Fame Induction, Cornell Center for Materials Research  408  
- Remarks by Neil Ashcroft  408  [04:08]  
- Response by Dale Corson  410  [23:55]  

Campus Unrest  416  [01:04:05]
Videos on DVD and Online  <http://ecommons.library.cornell.edu/handle/1813/62>

Sol Goldberg's Photo Album of the Corson Investiture, Vol 1  72  [03:05]
Dale Corson: Cornell’s Good Fortune – Edward Hershey and David H. Rose  303  [19:46]
The Corson Legacy – An Overview Walter LaFeber and M.H. Abrams  disc 1  [33:14]
Campus Unrest – A lecture by Dale Corson given at Kendal at Ithaca on May 31, 2007  416 [01:04:05]
A Conversation with Dale R. Corson – Interviewed by Kurt Gottfried disc 2  [01:59:37]
Dale and Nellie Corson celebrate their 70th Wedding Anniversary
June 17, 2008
Dale’s commitment to education began at an early age. On September 13, 1921, at age 7, he heads to school, riding “Frolic”. [The aunt who introduced him to photography made this photo.]
Dale and the Chair of the Cornell University Board of Trustees, Austin H. Kiplinger
Preface

The first nine years of my life were spent on a farm in Kansas. The piece here is something I wrote for our children to give some feeling for what life was like in that setting where I rode my pony 2 1/2 miles to a one-room school.

Dale R. Corson

Ed.: For a photo of Dale riding the pony to school, see page 2.
PITTSBURG

A little while ago a friend of mine, whose profession is city planning, gave me a 55-page, slick paper booklet entitled: “A Report to the City of Pittsburg, Kansas” and sub-titled: “A Framework for Urban Design and Historic Preservation”. It is a study done for Pittsburg by the College of Architecture and Design of Kansas State University at Manhattan.

The booklet is of interest only to those who live in Pittsburg – and to me, because I was born in Pittsburg and lived there until I was nine years old. To be precise, I was born, on April 5, 1914, on a farm six miles west and a quarter mile south of Fourth and Broadway – the central reference point in the town.

The booklet is full of maps but only two street names are shown: Fourth and Broadway. It is easy for me to find the corner of Tenth and Locust, just a block below the Missouri Pacific tracks and a block east of Broadway, where my paternal grandfather, Robert Corson, lived with my two maiden aunts, Julia and Mary, at 1001 North Locust. I can also find Chestnut Street in the southwest part of town where my maternal grandparents, Bettie and Robert Hill, lived at 504 South Chestnut. I can find Chestnut because there is a jog in it just below Fourth, and I can find 504 because it was a block straight west of Lakeside Park, where I often went to play when I visited my grandparents – and where I caught my first fish, perhaps an inch long, probably using a worm for bait on a bent pin.

My memory for the names of other streets was nearly completely blank so I wrote to the Chamber of Commerce in Pittsburg for a map which they sent me. It has the names of all the streets, but it neglects some landmarks such as Lakeside Park, and Lincoln Park where we went every Fourth of July to see the fireworks. The parks must still be there because the planning booklet shows them in its discussion of recreational areas in the city.

The Chamber of Commerce map recalls many familiar streets and places. There were relatives on both sides of the family living in Pittsburg and we visited them frequently. When I was old enough to remember, various features of the town imprinted themselves on my memory – the Frisco tracks, for example, on second Street, which my Sister Margaret Lois crossed when she climbed out of the car (a 1917 Buick touring car) parked on Broadway somewhere around Fourth. She was no more than a year and a half old and walked down Broadway and across the tracks before anyone realized she was missing. When she was discovered missing, those in the car set out in all directions to search for her. I found her, across the tracks.

Pittsburg is a town in extreme southeastern Kansas, almost on the Missouri border and only a few miles from Oklahoma. I remember it with a population of perhaps 10,000, and the K State booklet says it is now (or was in 1980) 20,000. It is in a mining area, with soft coal near the surface (which led to a great deal of strip mining) and with zinc and lead deposits. After mining, wheat and corn farming provided the principal economic base for the area.

My memory has been supplemented by information in the booklet which has also supplied some historical perspective I never had before. Pittsburg was founded in 1876 and was named after Pittsburgh, Pennsylvania. It was established to support the coal mining and shipping industry – railroads came to that part of the country in the last quarter of the 19th century. The first coal mine shaft
Steam engines disassembled.

My Uncle Ira ran an automobile repair shop, a “garage”, on Third Street just east of Broadway. I liked visiting that and seeing automobile engines disassembled.

Making the ice cream required breaking the ice into small pieces by placing large pieces in a “gunny” sack (“bag” was a word unfamiliar to me until I moved away from Kansas and “burlap” was a word that came into my consciousness much later) and placing it on the ground to be beaten with the flat side of an ax. That was often my job. I also had my turns at turning the handle on the ice cream maker (I do not remember its proper name). I also remember mixing the ice with salt to make it colder. I also remember “packing” the central container with the ice cream, once the paddle had been removed and licked by any children that happened to be about, with newspapers to insulate it while the ice cream froze solid.

My Uncle Ira ran an automobile repair shop, a “garage”, on Third Street just east of Broadway. I liked visiting that and seeing automobile engines disassembled.
THE FARM

The farm six miles west and a quarter mile south was the farm which my grandfather must have acquired, perhaps through a homesteading procedure, when he first moved to Kansas in, I think, 1884. My father, Harry Raymond Corson, was born in the same house. I do not know who really owned the farm. It was 160 acres, I think, devoted to corn and wheat farming with a small herd of cattle and their requisite pasture land. Now, I think the farm was oddly located in the “section” (a section is a square mile). Since there are 640 acres in a section, it would be natural for the farm plot to be in one of the corners of the section. It was not, however. Our land began a quarter mile south of the section line which was the extension of Fourth Street, running east-west. The farm extended half a mile to the west to a north-south railroad track. I do not know which railroad. Perhaps there were only 80 acres.

The house was one story on the back, the west side, and two stories on the front, which faced the road. The back contained the kitchen and possibly a dining room. There must have been a dining room adjacent to the kitchen because I can remember an occasion, before I reached the age of reason, when I was in the house alone, seeking to entertain myself. There was a kitchen cabinet with a flour storage bin which tipped out. I tipped it out, walked in it and walked into the adjacent room to my mother’s piano, climbed up to walk across the key board and back to the flour bin. I do not know if I remember the incident because of the act itself or because of what happened to me because of the act.

On the front, downstairs, was a “front room”. I was aware of the word “parlor” but that was considered a “stuckup” word, one that city people might use. I think I was unfamiliar with the words “living room” until I was in high school or college. Not much living was done in the front room. It was for company. Ordinary activities took place in the kitchen. There were probably two bedrooms upstairs. I can remember sleeping there in the winter in a feather bed with a hot iron wrapped in a cloth for warmth.

There were two sources of heat in the house – the kitchen “range”, ordinarily called the “kitchen stove”, and a coal stove in the front room. The kitchen stove, used in the winter, was coal-burning. In the summer a New Perfection, four burner, kerosene stove was used for cooking. The kerosene was held in a glass container, holding perhaps two gallons, resting upside down on its support at the end of the stove. I remember wondering why the kerosene did not leak out.

Every house I lived in until I finished college was heated in winter with a coal stove, decorated with nickel-plated narrow skirts designed both to keep people from getting too close to the stove and to provide a bit of ornateness to relieve the stark lines of the cylindrical stove. The nickel plate had to be polished and the stove “blacked” at appropriate intervals. There was a small window of “ising glass” (thin sheets of mica) in the door of the stove to permit viewing the state of the fire within. The coal “bucket” had one side extended into kind of chute to make “pouring” coal into the stove easier. A small coal shovel always rested in the bucket or near it adjacent to the stove. I first heard the work “scuttle” much later. Every spring the front room stove was dismantled and stored somewhere for the summer. I can remember removing the bolts from the nickel-plated rings in order to dismantle them.

Ironing clothes was accomplished with flat irons, usually with detachable handles, heated on the kitchen stove. Clothes were washed in round galvanized washtubs holding several gallons. Water was heated on the kitchen stove and the clothes were rubbed on the washboard, which often had a glass, corrugated surface, with a small recessed shelf across the top to hold the soap. The really dirty clothes were boiled in a “boiler” on the stove. The boiler was an oblong copper tub, rounded on the ends, perhaps 30 inches long, 12 inches wide and 18 inches deep. It often developed leaks, usually at the joint where the sides joined the bottom. I had my first soldering lesson helping my father fix leaks in the boiler, using a feather to spread the acid flux over the joint to be soldered and using a large copper soldering iron, heated how I do not now know. The clothes were either “wring out” by hand or put through a hand operated wringer. They were hung to dry on an outdoor clothes line, always of heavy wire. Rope clothes line entered my life much later. The clothes line was always dirty and it was often my job to wipe it clean with a wet cloth before the clothes were fastened on the line with wooden clothes pins.

Slack clothes lines were a constant problem and I do not remember the arrangement of poles and trees to which the line was fastened, but I do remember the frustration of trying to keep the line tight enough to hold several wet sheets and all the other clothes.

A DeLaval cream separator stood in the kitchen. I think I was in high school before I realized the word was not “DeLavalve”. I had a similar trouble with the word “granite”. There were enameled cooking pans (usually with pieces of enamel chipped off) which were called “granite” pans. I knew the expression “take it for granted” but it was a long time before I realized that the expression was not “take it for granite”.

The separator was a centrifuge device, rotated at high rpm by turning a crank. This required hard work because of the high gear ratio to make the rotating chamber go fast enough to separate the cream from the milk. The cream, being lighter, came off from a spout from the inner part of the rotating chamber while the milk came off through another spout from the outer region. It was often my job to turn the crank.

The telephone was in the kitchen. It was a hand-cranked model, as all telephones, at least in the country, were then and it was mounted on the wall. There was a small sloping shelf for writing notes. The mouthpiece into which one talked was at the end of an extension several inches long and could be tilted up and down. The “receiver” was perhaps five inches long and was held to the ear.
Everyone for miles around was on the same line, and everyone knew everyone else's business as a result of “listening in”. I remember one episode from the spring of 1919 when my mother, my father and I were all in bed with the flu. My father went from his bed to call the doctor in town but the line, as always, was busy. He heard one woman tell another that she had just put her beans on to cook. After trying repeatedly, over what seemed a lengthy period, my father finally said, “Lady, I can smell your beans burning”. That got him the line.

There was always a churn for making butter somewhere in the kitchen. I remember two kinds. One was a vertical ceramic container, maybe 10 inches in diameter and three feet tall, with a plunger of some type which one moved up and down in the cream to make the butter. The other kind was larger and must have been made of wood, with a horizontal paddle wheel, turned by a crank on the side. I always looked forward to drinking the buttermilk, with small pieces of butter floating in it.

Immediately outside the side door on the north side of the house were two or three large mulberry trees with a terrible mess of mulberries on the ground when they ripened and fell off the trees. A swing wide enough for two or three people was suspended between two of the trees.

A few yards northwest from the house was a “smoke house”. This is a place where meat (pork in this case) was hung and smoked, with a smoky fire on the floor, to preserve the meat. I think that salt may have been rubbed into the meat before it was smoked. On the back of the smoke house was a small room where coal was stored. I can remember playing in the coal storage room with a set of small pulleys and string to lift small loads to high places. My mother must have liked that enterprise.

The barn was perhaps 25 yards north from the house and set back farther from the road than the house. It was large enough to house a dozen cows and several horses. There was a hay “loft” above. I remember the beautifully polished and worn wood where the horses rubbed their necks when they ate from the manger in front of the stalls.

There were always pigs but I do not remember where they were housed. It was often my job to “slop” the pigs. There were always chickens also but I do not remember where the hen house was or the fenced chicken yard. I do remember collecting the eggs every day, and I remember catching chickens for cooking using a long wire with a hook on the end. When I was old enough I was assigned the task of cutting the chickens’ heads off with an ax or hatchet. My grandmother had a different way of killing chickens — she wrung their necks.

A barbed wire fence enclosed everything and there was a gate of some sort where the barnyard was entered from the road. It had to be opened and closed every time someone went through. Not far inside the gate was a well that I remember clearly. It had a concrete top with a square hole, perhaps a foot on a side, in the middle for access to the water. Around the edge were vertical boards, probably 1X4s, constituting a fence. They were set into the concrete of the top. The concrete top was made by my father and my maternal grandfather when I was a small child. I remember playing in the sand pile that was awaiting the mixing of the concrete. I remember being reprimanded for pouring sand over the wheel of a wagon standing nearby.

It was probably in the summer of 1964 or 65 that Bruce, Richard, Janet and I drove to Kansas. Nellie was already there visiting her mother in Caldwell. We were ahead of schedule so we went via Pittsburg and looked up some of the places I have mentioned here. The farmhouse had been torn down soon after we moved away in 1923, but I told the children I would show them the well cover I thought they were. My initials were not there but there was a date indicating the time of construction — when I was two years old. Probably many other things I think I remember clearly now, at age 75, are subject to similar inaccuracies.

Back of the house several yards was a lane running south parallel to the road and leading to pastures and wheat and cornfields. I was often sent to bring the cows or the horses to the barn. One time, while my father was away somewhere, one of the horses was missing. My mother sent me to look for it and I found it in an abandoned, unfenced well near the far end of the lane. Somehow the horse had fallen in backwards, with its head up. There was no way it could get itself out. I ran to the house and reported the situation. My mother telephoned neighbors and they rigged a tripod arrangement with a block and tackle with which they hoisted the horse out of the well, unhurt.

That lane imprinted itself on my memory because of the horse and well incident and for other reasons. It was where, on occasion, we found dead chickens, killed presumably by coyotes. Once there was a rumor that a gray wolf was roaming the countryside and my mother was substantially agitated. She communicated fear to me, at least. One day, sure enough, the wolf came loping along the field on the other side of the road. My mother brought the .22 caliber rifle and positioned herself to defend everything, while the wolf went its merry way. I can remember thinking that she did not know one end of the rifle from the other.

In dry times everything was dust and in wet times everything was mud. There was one occasion when I was perhaps four years old and had a new pair of rubber boots. I put them to the test by walking into a plowed field across the road and some distance down it so that I was out of sight of the house. I became completely mired in the mud, unable to move. Someone came walking along the road and asked if I needed help and I said “No. I’m OK”. I do not know how long it took me to extricate myself. I may have stepped out of the boots and walked home barefoot.
I can still feel the dust in the road, during dry periods, between my barefoot toes. The feeling is described at the beginning of *The Grapes of Wrath* with Tom Joad squirting the Oklahoma dust between his toes.

One strong memory I have of farm life is the hard work. My father was usually up by five every morning and, as I recall it, did the chores before breakfast. The chores consisted of milking the cows, all done by hand of course, feeding all the animals and getting ready for the day’s work. In winter the chores were done by the light of a kerosene lantern. All our artificial light was by kerosene lanterns or lamps. I never lived with electricity until we moved to town when I was nine years old, in the fall of 1923. My maternal grandparents did get electricity some time before then, probably after 1920, and I remember bare electric bulbs there. One time my father decided to try gasoline lamps, and I can remember coming into the living room with a brilliant light and thinking it was a miracle. My mother would not have it, however — too dangerous. I think we probably tried it just one night.

I began to help with the chores early — feeding the chickens, gathering the eggs and eventually helping with the milking. I think I must have had some competence at milking by the time I was nine. One common event at milking time was sending a stream of milk at an attentive cat, skilled in drinking in that manner. I remember at least trying that with the cats, of whom there were always several around.

The big event of the year was threshing. My childhood days preceded the advent of the combine so the wheat harvest was a two-tiered event. First came the reaping (I never knew that word then) when the wheat was cut by a horse drawn “binder” which not only cut the grain but bound it into sheaves (I did not know that word either) and threw them out on the ground. The binder was always followed by some men on foot who stacked the sheaves into “shocks” — little pyramids with a couple of sheaves placed horizontally across the top to provide a kind of roof to keep some of the rain from penetrating the shock.

Wheat cutting probably occurred in late June or around the first of July and threshing probably did not come until some time later, depending on the weather and the threshing machine schedule. One machine served a large district, going from one farm to another. It was common for the rather large threshing crews to accompany the machine as it moved about, one farmer helping all his neighbors. Every farmer had one or two hired hands and it was customary to hire others for the harvest.

The threshing machine was pulled about the countryside and was powered in the threshing operation by a steam engine placed some distance away from the thresher, with the two connected by a long leather belt. When the belt broke, it was always a crisis. If it rained while the operation was going on there was danger of losing part of the crop; and since everyone wanted to do his threshing at the same time, there was always a premium on finishing quickly.

The thresher was placed where the straw stack was to be located and the wheat brought to the machine by horse–drawn wagons. I do not remember how the binder twine around the sheaves was cut. Someone surely had to do that by hand although all I remember was men pitching the sheaves into the machine with pitchforks.

The straw was blown out of the machine through a long pipe, ten or twelve inches in diameter, which could be guided to different positions to build the stack properly. The wheat came out a different, and smaller pipe, into horse–drawn wagons. I do not know where it was stored. It may have been taken directly to the mill to be ground into flour. The mill was called an “elevator” and there was one only a few miles from where we lived. I can remember riding there on a wagon, but I do not associate it with the threshing operation.

One characteristic feature of the operation was chaff — from the straw. One breathed that dust, and it found its way into one’s clothes against sweaty skin — a miserable experience. It was always hot at harvest time and I remember taking lemonade to the men.

Cooking for the threshers was always an enormous amount of work, and all the neighbor women gathered wherever the work was going on to help. My Aunt Julia always came from town to help. I do not remember my Aunt Mary ever coming, however. I know that my mother dreaded that period. It was dawn to dusk work. The big meal was at noon. Big tables were set up out of doors, and the main dish was fried chicken — big mounds of it with mashed potatoes and thick, white gravy. I do not know what else was served, other than lemonade. I have no memory of supper in the evening. Perhaps everyone went home, and only the local family and the local hired hands remained overnight.

I remember one hired hand in particular. He was a high school student in town and he came for threshing only, probably. All the hired hands slept in the hay loft over the barn. This particular boy’s name was Reginald (not exactly a Kansas farm name — maybe that is one of the reasons I remember him) Carter. It must have been his first time away from home because he had to check in with his mother every night by telephone. She did not think much of his sleeping in the hay. I can still hear him saying: “Aw Mom, I wasn’t born just yesterday.” One year in the early 1970s I received an honorary degree from the College of Emporia, where we went to college, and the commencement speaker was a distinguished educator from Hawaii — named Reginald Carter. He also had attended the College of Emporia but a few years before us.

At a dinner the night before Commencement I recited the threshing story but I do not think he was amused. Another memory of the harvest was the smell of the steam engine — a mixture of steam, coal smoke and oil. I also remember the pile of cinders from the boiler — the engines burned coal.
Getting up early in the morning became a natural part of my life. One time I went into town to stay at my Grandfather's house with my aunts, Julia and Mary. My Grandfather was not there — he may have been off staying with another of his many children. My aunts stayed in bed until nine o'clock in the morning, and it seemed absolutely immoral to me.

Another part of the farm routine I remember was “putting up” the hay. The hay was cut with a mower — a two wheeled machine-drawn by two horses. It had a long sickle bar cutter extending out to one side. The sickle bar folded to a vertical position when not in use. The cut hay cured on the ground for a few days before it could be stacked or before it could be put in the barn. This put a big premium on the weather. If rain fell on the hay it could not be stored so it was necessary to find a succession of dry days to cut and store hay. There were no weather predictions in those days — at least no reliable ones. It was a matter of looking at the sky and guessing.

Once the hay was cut and cured it was raked into windrows with a rake whose name I cannot remember. It was about ten feet wide with a series of curved steel tines pointing in the forward direction, with a three-foot-in-diameter steel wheel at each end. The rake picked up the hay in its path and pulled it along until the operator, riding on a seat directly over the curved tines, pulled a trip lever that raised the tines and dropped the hay. By going back and forth across the field, all the hay could be gathered in long windrows. When the entire field had been raked and covered with windrows, a “bull” rake (I have no idea where the name came from) was used to go down the windrows gathering up the hay and carrying it to the stack or to the wagon that carried it to the barn. The bull rake was 20 feet wide, probably, with a set of long straight teeth riding on the ground and extending several feet to the front. The teeth must have been about 2X2 size (i.e. two inches by two inches in cross section) and pointed at the front ends. The rake was pulled by two horses, one on each side, so that the horses were separated by the width of the rake.

I was never allowed to operate the dump rake, if that might have been its name. The seat right over the curved tines was considered too dangerous a place for a child. I did operate the bull rake, however, at least in my last summer on the farm. That would have been the summer of 1922 when I was eight years old. I remember standing on the seat, balancing myself with the reins to the horses, so that I could see over the pile of hay in the rake.

If the hay was to be stacked, the bull rake pushed it to the stack where men with pitch forks threw it on to the stack, and another man arranged it into a neat stack form — sometimes round and tapering to the top but more often oblong and rounded at the top.

If it was to go to the hayloft in the barn, a wagon with a hay bed carried it there. There a hay “hook” on the end of a rope came to the ground from a large door in the end of the hay loft. The hook was a tongs arrangement, where the two arms could be held apart with a suitable small rope running over a pulley system, while the hook was lowered over a pile of hay. The tongs then closed on the pile, and someone pulling on the rope attached to the hook drew it up into the barn. I think the pulling may have been done ordinarily by a horse pulling the rope at the other end of the barn. The hook, with its load of hay, moved along a rail in the top of the hayloft until it reached the place the man in the loft wanted it dropped. There someone pulled the small trip rope and dropped the hay on the floor of the loft. From there someone pitched it into its proper storage spot with a pitchfork.

If the hay was wet when it was stored, there was a danger of spontaneous combustion — always a worry.

Another farm operation was bringing in the corn — I do not remember the proper name for the operation. A team of horses pulled a wagon along a row of corn — always in the late fall, at least in my memory. The side of the wagon away from the cornrow had a side extended upward to serve as a backboard for the ears of corn thrown into the wagon. A man, wearing a kind of glove fitted with a pointed hook that was used to remove the “shucks” from the ear of corn, walked along the row. I learned the word “husk” a long time later. A skilled man could pull the ear of corn from the stalk, remove the shucks in a couple of quick motions and throw the ear into the wagon, all in few seconds. The horses, if they were properly trained, pulled the wagon along parallel to the row at the proper rate.

I remember going with my father on these occasions. It must have been before I started school; otherwise, I would have been in school at that time of year. I remember one frosty November morning, riding to the field in the wagon, while my father taught me to spell "thanksgiving."

There had to have been hired "hands" still around at that time of year, at least in the fall of 1918, when I was four years old. World War I was much on everyone's mind, especially since I had two uncles who were in France. On November 11, just as my father and at least one helper finished unloading a load of corn and were heading back to the field my mother heard on the party line telephone that an armistice had been signed. She must have explained to me what that meant because I ran out to the barn, pursuing the wagon and yelling, "The war is over". They did not hear me.

There were actually two farms in my first nine years. Sometime, probably in 1917, we moved half a mile north to another farm, known as the Geyer or Geier (or something like that) farm. We lived there until 1922, probably, and then moved back to the original place. I can only guess the reasons for the moves. The second house was smaller — only four rooms. I think the farm was larger, however, and I guess that my father was looking for more acres to plant in wheat. Those years '17 certainly and probably '16 and '18 as well — were booming years. Wheat was selling for two dollars a bushel, equal to something like fifty dollars a bushel now instead of the actual four dollars.
My parents bought a car — a 1917 Buick open touring car. My father bought a new tractor a three-wheeled Allis Chalmers — and other new equipment as well. By 1923 the bubble had burst, and all the equipment, including the car, was gone. My parents were never prosperous again, ever. The move back to the original place came after the fall. This was the recession of 1921 or 22.

I remember that 1917 Buick well. I have no idea what it cost. Model T Fords sold for a few hundred dollars. The Buick would have cost more. The sound of the engine idling always reminded me of a sewing machine. There were two switches on the dashboard (it was called): one for the ignition and one for the lights. They were round disks, maybe an inch in diameter, with raised solid triangles pointing upward.

There was no such thing as a sedan then — only touring cars and roadsters, the latter one-seaters. Nellie remembers her family resisting sedans when they appeared on the market because there would be no fresh air. When it rained one stopped the car, removed the "side curtain" from under the seat and attached them with fasteners to the supports that held the top. Some cars had tops that could be folded down, and I think the Buick may have had that too.

My mother learned to drive, and I remember going to Pittsburg to shop for groceries with her. I believe the grocery store was Ozbun's on West Fourth. Flour came in 100 pound bags — the store was too far away to shop often. I presume other staples were purchased in comparable quantities. On one trip to town, after visiting my grandparents, we returned home via Chestnut north to West Fourth. My mother made the turn to the left rather abruptly. I was thrown against the door, which came open, and I continued north, landing on the brick pavement on my forehead. My mother, shocked at what had happened, picked me up and put me back in the car. We continued home, I with a severe headache, but I recovered. She turned corners more cautiously after that.

Once in 1917, my Uncle Hubert, who was in an Army training camp, sent word that he would be passing through Girard (a town a few miles away) at some estimated time which must have been only an hour or so away. I had been ill with something or other, and I was bundled into the back seat and completely covered, as I remember it, with a "lap robe". Since the time was short my father drove at breakneck speed — 35 miles an hour — over my mother's objection. We made it in time and my mother and grandmother remained on the station side of the tracks and my father carried me to the other side so that some of us would see Uncle Hubert. Why they thought he would be anywhere other than the station side I do not know. In any case my mother and grandmother saw him. That was the last time they saw him until he returned from France, sometime in 1919 probably.

We made several trips in that car. We went to Kansas City for my Uncle Dick's wedding on June 17, 1917. I learned the date from Uncle Dick's obituary which my sister Lois sent me when he died a few years ago. I think we made another trip to Kansas City after the end of WW I. It was on that trip that I saw my first airplane. There were no paved roads and when it rained travel often became impossible. I remember staying overnight in a hotel, perhaps in Ft. Scott, on one of those trips. My father sometimes rescued motorists from muddy ditches with a team of horses. I think he may have charged $5 for that service — an exorbitant fee.

One year we made a trip over into Missouri to visit my mother's aunt (Ethel) and her husband on a large farm, or ranch as it was called (1200 acres). On the way there we stopped to look at an eclipse of the sun through photographic negatives. We later moved to that ranch for a few months.

We made a trip to Emporia to visit some friends of my father's named Cross. Cornell's first Dean of Students (after separate deanships for men and women) was Patricia Cross and she was related to that Emporia family — perhaps a niece. I doubt if my parents were thinking of moving to Emporia at that point because times were still good and they still had the Buick.

None of these trips was more than 150 or 160 miles, and that was the farthest from home I ever traveled until I was a junior in college.

I have a particularly vivid memory of the Allis Chalmers tractor and for good reason. It was at the old place half a mile south of the Geier place, and I was there with my father one day when he was showing it to someone. He was demonstrating the operation of the various levers while I sat on top of one of the five-foot diameter (probably) rear wheels. I had my hands on the power take-off wheel. That was operated by a clutch controlled by one of the levers by the driver's seat. My father pulled that lever just as I had my left hand in the space between the brake pad and the wheel. The brake began to squeeze my hand, and I yelled but he did not hear me. He continued to pull the lever, and the brake continued to squeeze and crush my left hand. The middle, ring and little fingers were rather badly injured, the ring finger particularly. It was split open, and I do not know what injury the bone suffered. Nor do I know how many stitches were required to sew it up. My father put me in the car and drove the half mile home at high speed, for what purpose I do not know. My mother said she could hear me yelling from a quarter of a mile away. We immediately set off for town and the doctor. I have no memory of what he did to repair the damage.

The finger was stiff and unbending for a few years. My parents regretted most that I would be unable to learn to play the piano with the stiff finger. I was probably about five when the accident happened. The finger gradually became usable and by the time I moved to Emporia when I was nine I was able to take piano lessons. My inability to play the piano now is not attributable to the injured finger. It has never caused any trouble although it is somewhat disfigured.

I had one other accident as a child. I stepped on a scythe and cut my bare foot badly. For some reason I was trying to cut some high grass, barefoot, with the scythe when my mother called me to lunch. I dropped the scythe and went to lunch. I do not know why I
was allowed to use a sharp tool barefooted. When I came out after lunch, I did not see the scythe in the high grass and stepped on it, cutting a long gash diagonally across the bottom of my foot. I remember sitting in the kitchen with my mother catching the blood in a "wash pan", a shallow vessel used for washing hands. Again another dash to the doctor in town. I have no idea how many stitches were required, but the gash must have been at least three or four inches long.

There was not much health or dental care in those days. I saw the doctor on the occasion of those accidents, and I must have seen him other times as well. I remember his name: Dr. Charles Montee. He once had a party for all the children he treated and I went, probably against My wishes. He served rare and strange food, such as rattlesnake and possum. I had possum — oily meat. I remember nothing else about the party. My father consulted the doctor by telephone during the flu epidemic in 1919, probably, and when my sister was born at home in 1921 the doctor came for the delivery.

I was taken to a dentist when my baby teeth were first replaced by permanent teeth but I did not see a dentist again until I was in college by which time crooked teeth and periodontia were well established.

There was not a great deal of entertainment in those days. There was an occasional movie. Someplace along the way I became a cowboy movie fan, but that may not have been until after I moved to town. After I acquired a Shetland pony in 1921 when I started to school, I tried all the cowboy and Indian tricks such as hanging over one side of the pony and "shooting" under her neck. I must have seen cowboy movies by then.

There were occasional "socials" or "ice cream socials" at schools or churches. At these affairs the women, preferably unmarried ones, made box lunches that were auctioned to the highest bidders. The tactics were for the unmarried men to try to associate a particular box with a favorite girl and bid up that box. I do not know where the proceeds went.

At home, groups, usually relatives, would sometimes gather around the piano, probably on a Sunday evening, and sing hymns while my mother played the piano. I have no idea how she learned to play, but she played well, although she seldom did it. After I took piano lessons I learned to respect her ability to sight read pieces with four sharps or four flats. She treasured her piano, and we must still have had it after we moved to Emporia. I suspect it was sold to raise money. We moved from the family farm west of Pittsburg to Aunt Ethel's and Uncle Tommy's ranch near Nevada, Missouri in the early spring of 1923 with all the household goods, those that were not sold at auction, in horse-drawn wagons. The wagon with the piano turned over in the mud in the barnyard, spilling everything to the ground. My mother was beside herself. I do not know if it damaged the piano or not.

Other than my mother's occasional piano playing there was no music at all until Christmas in one of the prosperous years. My father ordered a phonograph of the Edison type with cylinders rather than the customary disks. I went with him in the Buick to pick it up just before Christmas, and he would not tell me what it was. It was probably unwrapped the night before Christmas, and it was a great machine. I can remember little of the music available. Most vivid were the songs of Harry Lauder: "It's nice to get up in the morning but it's nicer to lie in bed". A few years ago Nellie and I stopped to visit a crofter's house/museum in Scotland and there was a phonograph playing Harry Lauder songs.

There was always a Christmas tree but there were never many presents. I usually received some type of book, and I can remember two presents, in two different years probably. One was a small wooden sled, made by my father or my grandfather, and other was a toy kitchen made of pressed "tin" complete with tiny pots and pans and a fireplace.

A now long forgotten practice was serenading newlyweds with a "chivaree" or, more properly, I think, a "charivari". This consisted of the entire countryside gathering, at a predetermined time, at the home of the newlyweds and making large amounts of noise, including the firing of blank shotgun shells. I remember preparing these shells prior to the event by removing the shot and stuffing the shells, with the gunpowder charge intact, with paper. My parents reported that they had escaped this serenade when they were married, on October 10, 1910, by slipping out of the house into an adjoining cornfield. Driving in Italy in 1958 we went through the village of Charavari, and I took a photograph of the road sign.

In the summer, making ice cream on Sunday was a common pastime. I have already related my part in that activity. Relatives from town often came to those affairs. I suspect my mother spent a great deal of time preparing food for those occasions. There would have been fried chicken, and I do not know what else. If it were late in the summer there would have been lots of corn, more often than not straight out of the corn field. Sometimes we had a few short rows of sweet corn as well. I remember being sent to the field to get the corn. I was instructed to pull back the husks (shucks) to be sure there were no worms and that the kernels were well-formed.

Planting corn and wheat were exercises I participated in. Corn was planted with a "corn planter." A long wire with "knots" at regular intervals was stretched from one end of the field to the other. I have no idea how such a wire was managed without tangling, but I was sent to one end and instructed how to secure the end of the wire while my father did the other end. The wire passed through a mechanism on the "planter" which consisted of a long box, holding the seed corn at right angles to the cornrows to be planted. When the "knot" passed through the mechanism, it tripped the device and dropped a few kernels of corn through a tube with a small plow-like end which deposited the kernels below the surface of the ground. Several rows were planted simultaneously. When the end of the field was reached, the wire had to be set over by the width of the planter and the operation repeated going the other way. At first this was all done with horses, but later I think the tractor was used.
Wheat was planted in somewhat the same way with a “drill” except the grain was fed continuously as I remember it, with no trip mechanism. Sometimes the wheat was “winter” wheat and was planted in the fall. Sometimes it was planted in the spring.

I had few playmates. The only ones I recall were the Stoneking boys who lived on West Fourth, about a quarter mile east of the intersection with our road — so they were about half a mile away. I remember going to their house and they coming to mine. The only other children I ever saw were relatives, and I think they were mostly older than I. There were the Oertles who were somehow related to my maternal grandfather. They had one boy, Robert, who was my age and another, Malcolm, who was older. They were city boys and much wiser in the ways of the world than I. I sometimes went there to stay overnight. I remember one baseball game in their backyard when, looking the other way, I ran into the guy wire for a power pole which took all the skin off my left arm. A railroad track ran past their house and also past my maternal grandparents and I could walk from one place to the other along the tracks.

Every year we went to the Fourth of July celebration in Lincoln Park which was near where the Oertles lived. I must have usually gone to the park with Robert Oertle — Malcolm was always with the girls. Robert was also interested in girls, and he wanted to go off with them rather than stay with me. Most of what I remember from those affairs was driving home late at night. One time there had been a severe thunderstorm, and we had to remove tree limbs from the road before we reached home. Another time we came on an accident where a car had struck three cows and killed them — with blood all over the road.

My parents attended, at least occasionally, the Methodist Church in Buelah that was probably about three and a half miles away. I remember riding my pony there after I started to school, to go to Sunday School. Someplace I have a photograph of me, all dressed up, sitting on the pony ready to go to Sunday School.

I always had a dog and his name was always Shep. He was my primary playmate. My grandmother liked to tell a story about the dog chasing a rabbit through the yard with me following at a considerable distance yelling something like “bar-eek, bar-eek”. I hunted rabbits with the dog, and later, when I made rabbit traps, I had a “string” of two or three traps. The dog went with me each morning to check the traps. I think we may have eaten the rabbits, and I think the skins could be sold in town. The traps were always approached cautiously lest they contained a skunk. There is also a photograph of me pulling my “wagon” (metal, I believe) with the dog sitting in it and a cornfield in the background.

Rabbits and squirrels made up part of our diet. My father often hunted with a .22 caliber rifle. He sometimes shot at squirrel nests in trees without knowing what was in them — sometimes successfully. He also went duck hunting with a shotgun. I learned the differences among a 10 gauge, a 12 gauge and a 410 gauge. Sometimes he caught ducks by baiting a fish hook with corn and securing it at the edge of a pond.

One year there was an infestation of chinch (I think I called them “cinch”) bugs — great hordes of them eating everything in their path, particularly the corn as I remember it. My father consulted the local county agent, my first experience with the extension service. I think waiting for the passage of time and the passage of the insects was all there was to do about it. I presume the crop was lost that year. It must have been about the time of the post-war recession because we still lived on the Geier place.

On another occasion some disease ran rampant through the herd of COWS. Many died, on their back with their feet in the air. That probably indicates what the disease was but I do not know its identity. Those had to be trying times and probably contributed to my father’s decision to give up farming. I know that my mother never liked it, and I am sure she was ready to move to town. Life was not any easier there, however.

Racial, ethnic and religious prejudice and bigotry were widespread among all the people I knew. Partly it was World War I and a strong prejudice against Germans, partly it was related to the large middle and southern European ethnic groups that populated the coal-mining regions and partly it was just there. I remember my mother or father stopping to pick up a woman hitchhiker on the way to town one day, and she addressed me as “hon.” I thought she was calling me “hun”, about as bad an epithet as one could imagine, and I refused to talk to her.

The central and southern Europeans in the coal mines lived apart, had totally foreign customs and spoke little or no English. They were known as Hunks or Wops or Dagoe. Negroes were always “niggers”. There were few Jews around but the few there were suffered much prejudice. Even Catholics were suspect. Some believed that they were out to conquer the world and that they had weapons stored in their churches ready for the revolution — much like the prejudice against the Soviets in more recent times.

The man who owned the Geier farm (I think he owned it, at least my father paid the rent to him) was German. His name was something like Jules Maskerod or Maskyerod (it does not sound German) but he lived an isolated life. No one trusted him. I believe that German language instruction was removed from the Kansas school curriculum until a number of years after the war.

The Buelah cemetery was 1 3/4 miles north of the Geier place, and I sometime went there with my father. I think that he kept the grass cut. I remember being there one day and, in exploring the fences, I found a tree with a big hole in it. I reached an arm in to see what was there, and at about the limit of my reach I encountered something soft and warm — baby birds? Baby squirrels? I did not stay around long enough to find out.
In the summer of 1991 Nellie and I stopped at the cemetery to see if I could find my grandfather’s grave. I am virtually certain that he is buried there, but there is no stone. We did find the grave of two of father’s sisters and their husbands — McIlraths and Roesers. A woman was cutting the grass and she said her father was the caretaker in charge. She went home to get a plot of the graves but that showed nothing. After we returned home I wrote him a letter, asking about my grandfather but he never replied. I should try him again.

In 1991 we drove by the old family homestead south of Fourth Street where it is now the site a huge rock quarry, and all signs of the farm are gone. I had thought that the well cover might have still been there. We drove north the half mile to the Geier place and the house had burned. Nothing is left in that area to attract my interest again.

**PLEASANT VALLEY SCHOOL — DISTRICT 78**

I started to school in the fall of 1921 — September 12 to be precise — when I was seven years old. My parents waited to start me in school until they thought I could get there on my own. By the time I started I had already learned to read. At least to some degree.

There were a few children’s books around, and I had a folding double-tripod kind of desk with a blackboard and a scroll with words and pictures. I had mastered that and some of the books. I remember saying that if I kept on getting smarter I would not have to go to school.

I remember the date because my sister, Margaret Lois, was born early in the morning of my second day at school, and her birthday is September 13.

On the first day my father took me to school in the car, found out from the teacher what books and supplies I needed and went into town to get them. The school was 3/4 mile north of the Geier place where we were living at the time and 1 1/4 miles east. Sometime in the summer of 1921 he bought a Shetland pony, named Frolic, for me to ride to school. I do not know just when he got it or where he got it, but I remember him driving slowly into the yard with the pony tied behind the car. I must have had time to get used to Frolic before school started because I think I started riding her almost from the second day of school. There was a shed for horses behind the one-room school, and I must have unsaddled her and tied her in her stall before school started. I do not remember if other children rode horses or not, but I do remember that the teacher came in a horse and buggy and her horse was also tied in the shed.

The school had one room. There was a little porch (stoop maybe it was called) where the teacher stood to ring the hand-held school bell to summon the pupils. There was some form of coat room at the back of the room adjacent to the door. There were a series of hooks along the wall for coats. The desks, with folding seats, were lined up on either side of a central aisle, with larger seats at the back and smaller ones in front. I was assigned one of the small seats in the right front row. Some of the seats were wide enough for two children, I think, but there were so few children that doubling up was probably not necessary. My desk had generations of names carved into the top, and it was too rough to write on. There was an ink well in the upper right corner and a shelf under the desk top for books.

The room was heated in cold weather by a coal stove in the very center of the room. The coal “bucket” sat adjacent to the stove, and pencils were always sharpened over the bucket. Some children were expert at sharpening pencils with a pocketknife — they drew the knife toward their bodies and could exercise a degree of control over the cutting process. My parents would not let me do that — I always had to sharpen my pencils by pushing the knife away from my body and my pencils were always badly sharpened.

The front of the room was covered with black boards with a chalk and eraser tray at the bottom. One day when it was raining too much to go outside for recess, we were playing some kind of tag game; and I accidentally hit my forehead on the chalk tray and cut a gash in it. It was bad enough that the teacher thought I should go home, and one of the older children took me home in the teacher’s buggy with my pony tied behind.

The teacher was a young woman named Hallie M. Dick with her hair braided and coiled on her head. After we moved away she married someone named Colegrove who came from a family my parents knew and sometimes visited. When I graduated from college I sent her a notice, and she wrote back saying, “Now that you have graduated from high school what are you going to do?”

There could not have been more than about ten pupils, spread over eight grades. Four of the children were from the Burns family and lived on west Fourth Street half a mile or so east of our road. The oldest was Hazel, whom I also remember with her hair coiled on top of her head. She was particularly friendly with me, and I remember her looking out for me whenever I had any trouble with older pupils. The next in line in Burns family was John who was a big farm boy — much bigger than anyone else in school. He must have been in 7th or 8th grade. Next was Wilse, perhaps in 5th grade. He was much smaller than John; but he was more assertive and aggressive than anyone else, and the teacher had a rough time with him. The fourth Burns was starting in first grade along with me, but I do not remember his name.

In the summer of 1964 when I drove through the area with Bruce, Richard and Janet, the mailbox in front of the large Burns farm house (they were prosperous farmers) had “John Burns” on it. When Nellie and I drove by in the summer of 1991, the mailbox said “Wilse Burns”. 
There was a girl named Thelma in third grade, perhaps, but I do not remember her last name nor do I remember any of the others. After we moved to Northview Road in Ithaca I had a photograph of the whole school, probably assembled in front of the building because there was a sign saying “Pleasant Valley, District 78”. I have lost that photograph although it must surely be in the house somewhere.

I also had a report card from my first year. It was blue and had four pages, i.e., it was a card about five inches high by six inches or eight inches wide folded down the middle of the long dimension. The front had a picture of an oak tree and the statement, “Great oaks from little acorns grow.” Some place on the card there was another statement, “Boys who smoke cigarettes need not worry about their future; they have none.”

The card had eight or ten subjects or items with boxes where numerical grades were entered each month. On the back of the card were lines for parents’ signatures, indicating they had seen the grades. In each case my father had signed the card: H.R. Corson.

Among the items graded were arithmetic, reading, orthography (which was writing, I think), spelling (although it seems to me that there was another word for that), tardiness, deportment and some others. On thinking about it I think “orthography” must have been spelling and writing was “penmanship.” Somewhere was a place for a brief teacher’s comment. She noted, “Dale is making good progress”, or something like that in some of the months. For at least one month I think there was some comment about “deportment” although I do not know what that was about. I think the grades were all in the 90s.

Teaching was conducted by calling grade groups, where there were grades, to the front of the room to recite, sitting in chairs by the teacher’s desk or standing at the blackboard, in whatever the subject was. There was no way for the other pupils to ignore what was going on in the front of the room except by dedicated concentration — something not many were capable of. The result was that I did a great deal of learning by listening to the higher grades “recite.” The result was that I was already doing fifth or sixth grade work in March 1923, after less than two years of school, when we moved away. By the time I had finished the spring 1923 term at a similar school near the “ranch” at Harwood, Missouri (where the teacher was Fred Atkinson) and had begun the fall term of 1923 I was officially in the sixth grade. When we moved to Emporia probably in October, 1923, I was put back in the top half of the fifth grade; it may have been called 5A. I later made up that half year I was set back.

I did OK in the fifth grade at Walnut school in Emporia except in penmanship and fractions. The first report cards there had “P” in those subjects, and neither my parents nor I knew what that meant. I remember suggesting that it meant “perfect,” but they would not buy that. It was something of a shock to find that it meant “poor.” I made up the fraction deficiency without much trouble, but I never did make up the penmanship deficiency. We were taught the “Palmer Method”, and it was too much for me. I can remember some of the pupils, particularly some of the girls, making perfect successions of circles with the pen pointing squarely over their right shoulders. Not only could I never make the circles or the required succession of slanting straight lines, I could not even keep the pen pointing over my shoulder.

One thing I did learn was the Gettysburg Address because it was inscribed in large characters above the blackboard in the front of the room, perfectly written by the Palmer Method I presume, and we had to copy it for penmanship practice.

But back to District 78. I have only one memory of what we did at recess and that is of a baseball game. I recall standing in the “field” somewhere near Hazel when someone hit the ball hard right at my head. It would have had to be one of the Page boys to hit it as hard as I remember it. I put up my hands to protect my face and the ball struck squarely in my open palms and I held on to it. Everyone cheered, particularly Hazel. That must have been the beginning of my athletic career.

We made our own baseballs out of twine (which we always called “string”) saved mostly from grocery packages, I think. There were no plastic bags then, and it was common to wrap food, meat for example, in heavy white paper and tie the packages with string. There was usually a large ball of string in the kitchen where every bit was wound on the ball after every trip to a store. The baseballs were made by winding the string tightly around a core of some sort until a sphere of the right diameter was attained. I do not remember how the end of the string was secured. I think that the short pieces were tied together to make one long continuous piece. After I moved to town and became much more sophisticated in the ways of the world, we wrapped our baseballs with black friction tape drawn as tightly as possible. In the country the balls made of string were uncovered, and I suppose they had to be rehabilitated at frequent intervals. Even the tape-covered balls had to be repaired because the bats tended to knock the tape loose.

I have a particularly vivid memory of the spring flowers in and around the schoolyard. The ones I remember were a variety of Trout Lily (although I never learned that name until many decades later) that we called by a name that had “Easter” in it — Easter something or other. I remember crawling through the fence across the road from the school at recess time to pick bouquets of those flowers.

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1 Editor’s note: This young man developed an insatiable appetite for learning and for service. In later life he was awarded honorary degrees from Columbia University, Hamilton College, Elmira College, Wilkes University, University of Rochester, and the College of Emporia. He also received a Berkeley Citation (to some extent the UC Berkeley Honorary Degree – they give no honorary degrees). There was an alumni award from the University of Kansas and a Certificate of Merit (second highest WW II civilian award) awarded by Harry Truman. There was also an Army Air Corps award for his World War II service. Probably the most significant awards were the Public Service Medal (the National Academy of Sciences’ most prestigious award) and the National Academy of Engineering Bueche Medal. Dale is one of two people to have received both these medals.
flowers. I have no idea what we did with them because I do not think they would have lasted until I reached home in the afternoon. I also have a memory of sitting at my desk, with the door at the back of the room open, and looking out at the pink patches of flowers. It is hard to see how that could have happened because I sat with my back to the door. In any case, the flowers made an impression on me.

In the visit to the area in 1964 we went to see the school, and it had long since disappeared under the big piles of rubble left by the strip mining which had defaced the countryside there.

In the summer of 1991 we also drove there for old times sake but again, mounds of overgrown rubble.
Preface
The most significant scientific papers by Dale Corson are listed herein.
Dale Corson’s Significant Scientific Papers

Selected Papers

- Magazine Discussion of Advances in Radar, *Radar*, November 15, 1944
- Dale R. Corson and Robert Wilson, “Particle and Quantum Counters”, *The Review of Scientific Instruments*, April 1948
- Dale Corson, “Multiple Scattering of Electrons in Nuclear Emulsions”, *The Physical Review*, November 1, 1951
- Dale Corson, “Radiation by Electrons in Large Orbits”, *The Physical Review*, June 1, 1953
- H.L. Davis and D.R. Corson, “Elastic Photoproduction of \( \pi^0 \) Mesons from Deuterium at 270 MEV”, *The Physical Review*, July 1, 1955
- W.S. Mc Donald, V.Z. Peterson and D.R. Corson, “Photo production of Neutral Pions from Hydrogen at Forward Angles from 240 to 480 MEV”, *The Physical Review*, July 15, 1957

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1. This is the definitive paper on the discovery of a new element in the Periodic Table.
2. The new element, Astatine, is named.
3. This 78-page report documents in detail the design and early operation of the 300 MEV synchrotron, Cornell’s first post WW II electron accelerator. Dale Corson was one of the major designers of this machine, one of the very first synchrotrons to operate successfully. The report is included in full on the DVD and on line as a scanned PDF.
4. The September 8, 2003 issue of Chemical and Engineering News is a commemorative issue that included one-page summaries documenting the circumstances surrounding the discovery of each of the chemical elements. Dale Corson was one of only a few of the discoverers still around to give a first hand account of the discovery, in this case, of Astatine.
Preface

In the discussion which follows I shall outline the problems of engineering education at Cornell as they appear to me after one year of responsibility as Dean of the College. I see clearly some of the steps which must be taken if the immediate problems are to be met. I see other areas where action is clearly indicated but where careful study is the first requirement. I see the financial burden which must be accepted if these problems are to be met in bold fashion during the next five to ten years. I see the degree to which this financial burden will extend into the indefinite future, but I see much less clearly the academic problems which will confront us beyond the ten-year period.

Dale R. Corson
Dean, College of Engineering
June 1960

Note: This paper provided the foundation for a successful grant proposal to the Ford Foundation that led to a major transformation of engineering education at Cornell.
A. Introduction

B. The Overall Situation
   1. Cornell’s role is to provide high-quality engineering education in a high-quality University setting.
   2. We have 1,850 high-quality undergraduate and 285 graduate students.
   3. We have 130 professors, an increasing number of whom conduct graduate education programs.
   4. Our physical plant is new and is still growing.

C. We Have Academic Problems in Several Areas.
   1. Graduate education must be expanded.
   2. Cornell must emphasize both engineering science and professional engineering.
   3. Students need more help in understanding the engineering profession.
   4. We must teach students to think.
   5. The non-technical portion of our curriculum requires consolidation.
   6. We must provide maximum opportunity for exceptional students.

D. How Do We Solve These Academic Problems?
   1. We must appoint at least ten senior professors.
   2. We must build more interdisciplinary research programs.
   3. We must raise our salary scale substantially.
   4. We must study our curriculum with the aim of making extensive revisions.
      a. The first two years should be common.
      b. We require a course sequence in engineering problems.
      c. We must institute honors programs.
      d. Instruction in computing techniques must be made available to all students.
      e. Civil engineering needs new emphasis.
      f. We must seek ways to promote interdisciplinary study.
5. We need expanded graduate fellowship resources.
6. Student selection methods must be examined carefully.
7. Reorganization of the engineering college must await curriculum developments.

E. What Will It Cost?
1. If recent trends are followed, the budget will double in ten years.
2. The immediate steps in section D above will add about $700,000 to our annual operating budget.
3. Follow-on programs will add a large but unknown amount to the annual budget, primarily in the graduate area.

F. What Are Cornell’s Financial Resources?
1. If recent trends are followed, income from tuition, endowment, and gifts will double in ten years.
2. Funds from existing sources can accomplish only a small part of section D above.
A. Introduction

In the discussion which follows I shall outline the problems of engineering education at Cornell as they appear to me after one year of responsibility as Dean of the College. I see clearly some of the steps which must be taken if the immediate problems are to be met. I see other areas where action is clearly indicated but where careful study is the first requirement. I see the financial burden which must be accepted if these problems are to be met in bold fashion during the next five to ten years. I see the degree to which this financial burden will extend into the indefinite future, but I see much less clearly the academic problems which will confront us beyond the ten-year period.

B. The Overall Situation

Every engineering school in the country is unique. It has a student body with its own characteristics and interests. It has a faculty oriented in its own particular direction. It has physical facilities adapted to a particular set of functions. And finally, the school has its own relationships to other units in the same college or university. Every engineering school must examine all these factors and decide how it can maximize the quality of its operation. The following paragraphs in this section discuss the overall complexion of Cornell’s College of Engineering in these regards.

1. Cornell’s Role is to Provide High-Quality Engineering Education in a High-Quality University Setting. Our purpose is to train students who will be solidly based in the principles of engineering science and engineering design and who are also at home in the humanities and social sciences; students who have the mental tools to deal with great technological problems and who are enlightened in areas of human affairs; students who understand the science and mathematics necessary to solve the most sophisticated engineering problem and who have the outlook to solve these problems with social, economic, and political insight. In short, our objective is a program of engineering education having the highest standards and traditions and from which will come substantial numbers of educational and industrial leaders.

There are few universities in the country in as good a position as Cornell to do this job. We have strong faculties in the College of Arts and Sciences, in the Graduate School of Business and Public Administration, in the School of Industrial and Labor Relations, in the College of Architecture, in the College of Agriculture, and in eight other specialized areas, as well as in the College of Engineering. Fifty percent of the instruction for engineering students is carried out in colleges other than Engineering. Our location in an isolated community insures the close association of students in daily life. Arts students and Engineering students live in the same dormitories and fraternity houses; Industrial and Labor Relations students and Engineering students eat at the same table; Agriculture students and Engineering students serve on the same student government committees. The nature of the community also insures close association of faculty members, socially as well as professionally. Students and faculty alike live in a truly university atmosphere.

Our five-year undergraduate engineering curriculum enables students to make the most of their opportunity. Not only does the five-year program allow students to follow advanced technical sequences of instruction, but it enables a student to take the equivalent of about one year of formal instruction in non-technical subjects.

In addition, the student is immersed in an atmosphere of public lectures, symposia, concerts, and other opportunities for informal education. Lecture series on such diverse topics as Cosmology, American Political Parties, Modern Art, the Role of Labor Unions, and the Molecular Basis of Life, to list a few recent series, are available to anyone who wishes to attend. Only in a University is it possible to find such informed discussion of such a variety of topics.
Our faculty has conducted high-quality undergraduate instruction since the early days of engineering education in this country. We have outstanding teachers, and our alumni make distinguished records. Since World War II, we have developed graduate engineering education to the point where some of our faculty are conducting distinguished programs in this area. The close association of the engineering college with strong graduate programs in the mathematics, physics and chemistry departments promotes interdisciplinary education.

Finally, we have a student body selected from among the most able young people in the country. Few colleges or universities have students with such great capacity for learning, and consequently, our curriculum can be comprehensive and far-reaching.

At Cornell we have the opportunity to make a unique contribution to engineering education in the United States.

2. We Have 1,850 High Quality Undergraduate and 285 Graduate Students. At present the undergraduate enrollment in engineering at Cornell totals approximately 1,850 (fall term figures). The graduate enrollment totals 285. During the past two years, the undergraduate enrollment has declined substantially, following the national pattern. The freshman enrollment in the fall of 1958 was down some 12% below the 1957 figures, and in the fall of 1959 it was down about 1.5% from 1958. In contrast, the graduate enrollment has increased about 15% per year during the last several years. It is interesting to note that the decline in numbers of undergraduate applicants has been accompanied by a rise in quality.

Future enrollment figures depend on a number of complicated factors. In the first place, it seems likely that the nation-wide increase in the college-age population will provide us with as many students as we can accommodate. The physical plant in the engineering college was designed for 2,400 undergraduates, but there are serious limitations in other parts of the university. At present, we could not go to such a large student body because the facilities of the College of Arts and Sciences for teaching physics, chemistry, mathematics, and English are limited. However, as facilities in that college expand, and as a greater number of students become available, it seems likely that our undergraduate enrollment will expand to the 2,400 figure. All things considered, I think that this expansion will take place gradually over the next 10 years, after which we shall probably hold enrollment constant.

The number of graduate students is quite another problem. An equilibrium graduate enrollment of 500 was used as a design figure for the new physical plant. However, with the growing interest in graduate education in engineering and with the growing national importance of this type of education, I believe it probable that we will exceed the projected 500 figure by a substantial margin. I think we could strain our facilities to accommodate 750 graduate students, and I estimate that we will reach this figure in the same period in which the undergraduate enrollment reaches 2,400.

The quality of the student body deserves comment. For the freshman class which entered in the fall of 1959, the median Scholastic Aptitude Test score in mathematical ability was 690, while the median verbal test score was 602. Thus, the average Cornell engineering college freshman during the current academic year stands in about the 97th percentile of American freshman college population as a whole in mathematical aptitude and in about the 85th percentile in verbal aptitude.

3. We Have 130 Professors, an Increasing Number of Whom Conduct Graduate Education Programs. At the present time, we have 130 professors, associate professors, and assistant professors. Thus we have approximately 14.5 undergraduate students per faculty member of professorial rank. Recognizing that approximately 50% of the instruction for engineering students is done outside the College of Engineering, we have about seven students per faculty member in courses given in the engineering college. In addition to the 130 professors, we employ five instructors and about 90 part-time teaching assistants.

Traditionally, Cornell’s College of Engineering has been predominately an undergraduate college, and our faculty includes a number of outstanding undergraduate teachers. The importance of graduate education was recognized from the beginning, however, and Cornell was strongly represented among the early American engineering doctorates. Since World War II, our graduate faculty has grown and we now have a sizeable body of professors conducting distinguished graduate programs. Our present engineering doctorate output is about 3% of the national total, placing us eighth or ninth in national standing.

One interesting feature of our faculty composition is the growing number of inter-departmental appointments. The director of our Radiophysics and Space Research Center holds a joint appointment in the School of Electrical Engineering and in the Department of Astronomy. Most members of the Engineering Physics faculty hold joint appointments in other departments – Physics, Electrical Engineering, Mathematics, Engineering Mechanics, and Metallurgy. The director of the School of Electrical Engineering is a member of the Department of Physics faculty. Several members of the Agricultural Engineering faculty are also members of the College of Engineering faculty. For the past few years, we have had a distinguished visiting professorship to which appointments have been made with inter-disciplinary activity as a main objective.

4. Our Physical Plant Is New and Is Still Growing. Few engineering schools have a physical plant equal to that of Cornell’s College of Engineering. We have about 600,000 square feet of space in eight major buildings, only one of which is pre-World War II. Of the existing programs, only Engineering Physics is badly housed. The problem there is critical, but its solution is tied to the future plans of the Department of Physics, which is part of the College of Arts and Sciences. Because of the many benefits of close association, the two Departments wish to remain in the same building although they are in different colleges and have different objectives.
Two new buildings are presently under way. Construction has begun on a building to house a nuclear power facility for the Department of Engineering Physics. This facility will include a low-power reactor capable of being pulsed to high power for brief periods, a zero-power critical assembly, and a gamma-ray irradiation facility. A new building of about 50,000 square feet for Metallurgical Engineering is in the final architectural design stage and construction will begin during the next several months.

Turning to the future, I foresee three different building demands. These are (a) a hydraulics laboratory or perhaps a general water-resources laboratory, (b) renovation of existing space to meet new requirements, and (c) space to house new research activities which will arise as new emphasis is placed on graduate education and as new interdisciplinary fields develop.

Hydraulic engineering facilities are available now in obsolete form. We have an unusual resource at Cornell in our natural surroundings, which provide us with a large water flow at a high head, so that a modern hydraulics laboratory can have unique characteristics. However, with all aspects of water resources of growing importance, and with related disciplines strongly represented in the College of Agriculture, a laboratory of broader scope is certain to be required before many years have passed.

Renovation of existing space to meet new demands will be a continuing requirement. For example, our Metallurgical Engineering program will move to a new building within two years, vacating space in the Chemical Engineering building, which will be used in expanded chemical engineering activities. Our Electrical Engineering building is beginning to overflow, just at a time when there is vigorous interest in a graduate electrical power engineering program. Fortunately, we have a High Voltage Laboratory, which has outlived its usefulness in high-voltage testing and which, for relatively minor cost, can be renovated to provide new research space whenever funds become available.

Graduate training and research in the power engineering field is a good example of an interdisciplinary program arising out of developments in a number of disciplines, no one of which is able to provide the space for a joint research effort. The power case is likely to involve Electrical Engineering, Aeronautical Engineering, Mechanical Engineering, and solid-state Physics. Another case is that of our already existing Radiophysics and Space Research Center, which involves Astronomy, Physics. Engineering Physics, Electrical Engineering, and Aeronautical Engineering, no one of which has adequate space to house the joint program which is developing. Still another case is that of our Materials Science Center, which has recently been created. This center will provide professional facilities for graduate training and research in the materials field, but again new space must be provided.

It is impossible to estimate the extent of these requirements for new space during the next ten to twenty years. However, extrapolating from the needs which are already apparent, it is clear that the total requirement will be substantial.

C. We Have Academic Problems In Several Areas

Starting from our present position, examining the demands which are being made on the engineering profession today, and guessing what the demands are likely to be during the next few decades, a number of academic problems appear which call for vigorous and imaginative action. These problems, as discussed below, are general in nature. I am not wise enough to see complete and specific solutions; only extensive study by many people can point the way.

In some cases, the directions in which we move as a college and as a university depend on outside influences. For example, the extent to which secondary-school education changes in the next decade or two will have a profound effect on our whole effort, including the educational goals we set for ourselves. Economic factors, such as inflation, will influence us greatly, quite aside from any educational considerations.

In the following paragraphs I shall attempt to outline some of the academic problems which I see from a 1960 point of view. As time goes on, it is inevitable that these problems will change in relative importance and that new problems will arise. It is also inevitable that as time goes on I shall see the problems more clearly.

1. Graduate Education Must Be Expanded. The greatest single step which the Cornell College of Engineering must take is in graduate education. The country faces such complex technological problems that no one trained only at the baccalaureate level can hope to cope with their purely technical aspects. In expanding the graduate program, the objective must be not only to admit more students, offer more courses, and provide more theses; the objective must also be to give the students the broad scientific and mathematical base required to work in broad areas; above all, the objective must be to train students in habits of thought, and to foster attitudes, which permit the student to tackle novel problems and to deal with them effectively.

There are two parts to effective graduate training. The first is training in the subject matter of fields of interest in the student’s area of specialization. The student must have insight into the mathematics and science on which his field is based. In these days of rapid technical development, with new disciplines arising rapidly, the need for a broad base is especially critical. The second part of an effective graduate program is research. The only way a student can learn to cope with difficult, novel problems is to be trained on difficult, novel problems. This research, which is such a vital part of successful graduate education, must be competitive with the best research in the field anywhere – industry, government, or university. The professor who directs the research must be capable of helping the student identify the significant areas of research in his field and he must help the student select an appropriate problem. The professor must himself solve difficult and novel problems.
When a student's graduate training is successful, his future work is not confined to the narrow field of his thesis study. The thesis study will serve to introduce the student to the technique of original thought, and the broad subject-matter training will enable him to transfer his thought processes and his research attitudes to any other problem in his general area.

Graduate education in engineering is increasingly characterized by interdisciplinary study and research. Electric power generation by magneto-hydrodynamic means, for example, cannot be undertaken by an electrical engineer used to thinking only in terms of rotating machinery. It requires insight into processes hitherto of interest primarily to physicists, and into high-temperature gas dynamics familiar to the aeronautical engineer and to the mechanical engineer, as well as into other problems which are more familiar to the electrical engineer.

The graduate program must be organized to promote such interdisciplinary training, and the organization of Cornell University is well suited to this end. Our graduate school does not recognize academic departments. It recognizes only fields and areas of intellectual activity. Responsibility for the direction of a student's graduate program rests with a special committee of faculty members chosen from the student's own field and from other fields, so interdisciplinary emphasis is a necessary feature of any graduate student's program.

It is also easy for us to organize interdisciplinary graduate research centers in which there is active cooperation among staff and students from several different fields. The Radiophysics and Space Research Center and the Materials Science Center, both organized during the last year, and both cutting across College of Engineering and College of Arts and Sciences lines, are examples of what we can do.

2. Cornell Must Emphasize Both Engineering Science and Professional Engineering. Although an increased and improved body of engineers with graduate training is essential for the progress of the profession, it is obvious that the great bulk of engineering work must continue to be handled by baccalaureate graduates. The requirements for competence at this level will surely advance in pace with the whole technological development.

Engineering schools have an urgent responsibility to shape and strengthen undergraduate education for the functions it must perform – to prepare students for graduate education, and to prepare students equally well, but perhaps in a different pattern, for direct entry into professional practice.

In the undergraduate area of engineering education at Cornell, there must be increased emphasis on science and mathematics. There are several reasons for this. One is that technological problems are becoming increasingly complex. An electrical engineer, for example, cannot design a low-noise amplifier using maser techniques without understanding the principles of solid state physics in considerable detail. Nor can the design problem be left to the physicist, because he does not understand the demands placed on the device by engineering considerations. A second reason is that technology is evolving so rapidly that engineers must work in fields which did not exist only a few years ago. Only when the engineer is solidly based in science and mathematics can he hope to learn the new field. Without this versatility, the country is doomed to an engineering work force of short-lived productivity.

We have some excellent engineering science programs at Cornell already. Our Engineering Physics is a strongly science-oriented engineering curriculum. It involves more physics than does the pure physics curriculum in Arts and Sciences. It also includes a minimum of four years of mathematics at a high level. Our Chemical and Metallurgical Engineering curriculum involves a great deal of chemistry. Some of our Electrical Engineering students study the same mathematics as do the Engineering Physics students. We must provide this kind of science and mathematics opportunity in our other engineering curricula.

At the same time that we expand the science and mathematics portions of our curriculum, we must place renewed emphasis on the more professional aspects of engineering. We must teach students the principles of design, and especially we must teach them to bring together the ideas and concepts of various disciplines, in order to develop systems of maximum effectiveness and utility. For example, an engineer who designs a system for the automatic assembly of electronic equipment must understand the interaction of mechanical, electrical, and economic factors in order to produce the optimum system.

This dual aspect of engineering education is one which we must have before us continually. There are endless examples of current engineering problems which cannot be solved without the use of science and mathematics at the most advanced level. At the same time, these problems require an engineer’s understanding of reliability, of maximum utility, of economic factors, and of overall design principles. Our job would be simpler if these scientifically-oriented engineering problems could be left to scientists. They cannot, however, because too many non-scientific considerations involving compromise and engineering judgment arise in translating a scientific idea into a useful product or system.

There are other large areas of engineering endeavor where advanced mathematics and science are not required. For example, a clever mechanical designer is indispensable wherever mechanical products are produced. Such a person needs a talent and a training which no amount of advanced mathematics and science can supply.

Some engineering schools can select one or the other of these aspects of engineering education and concentrate their effort. Cornell, because of its tradition, because of its size, because of the nature of its student body, and because of the availability of strong programs in the sciences and in business administration, for example, must excel in both the scientific and the professional
aspects of engineering education. We must find an efficient and an effective means of serving both these ends. In fact, this involves more than tradition or self-interest. The need for improving the scientific background of engineering education is becoming well-known and there is reasonable likelihood that major advances will be made in this direction over the next few years – we expect to contribute some of these ourselves. However, there is the attendant danger that engineering science will become the prestige label and that other areas of the professional spectrum will be serviced only by inferior educational operations, which in turn will be attractive only to inferior students. The broad responsibilities of the engineering profession are too important to our national welfare to hazard stagnation or decline in any segment. It is important that we strengthen the full range of educational preparation for the engineering profession.

Relatively few schools may be able to cover such an assignment, in terms of either resources or interests. We believe Cornell to be in a unique position to do so, and we believe it to be important that an institution such as Cornell be associated with educational developments across as much of the professional spectrum as possible.

3. Students Need More Help in Understanding: the Engineering Profession. I am disturbed by the attitudes of many engineering students at Cornell. These attitudes are, to a considerable extent, those of engineering students everywhere and of American undergraduates generally. This attitude manifests itself in an emphasis on grades rather than on understanding, in an emphasis on a well-paying job rather than on the mastery of a subject, in an attraction for the glamorous rather than for the important. The decline in interest in such an important field as civil engineering stems in part from this attitude. When the missile industry pays the highest salary, the students seek jobs in that industry, regardless of the relative importance or interest of the particular job.

Another manifestation of this problem is the high attrition among engineering students. A study made in 1957 by a committee of the American Society of Engineering Education showed that the ratio of graduates to enrolled freshmen in the same class was 0.42 in 152 accredited engineering colleges. In the 64 private institutions of this group the ratio was 0.55. At Cornell the ratio is about 0.53.

This whole problem is a complex one and probably has many causes. However, I believe that it arises in part because young people do not know what engineering is. In part, the trouble arises from the fact that engineering is a profession with no pre-professional training. Students have no opportunity to study at the college level for three or four years before undertaking professional work and thus have no opportunity to understand the field and to consolidate their own aims. They do not see the relationship between basic work in science, mathematics, and liberal studies and the glamorous, high-paying jobs which they associate with the engineering profession. They seem unable to become interested in a subject for its own sake. All too often their criterion of interest is, “Will it help me become a manager sooner?”

Students often become disillusioned with engineering in the early years of their training when they are faced with nothing but hard work in the basic disciplines on which the profession is founded. They do not have the vision to see the profession as a whole.

Combating these trends is one of the nation’s biggest problems if we are to continue to attract our share of the most able young people into engineering, and if we are to persuade them to work at the level at which they are capable. This effort must be carried out at the secondary-school level, as well as in the early college years. Students must be given an opportunity to see what the big engineering problems are. They must have an opportunity to spend part of their time from the beginning of their engineering education studying these questions, and they must be stimulated to work at a high level. The problems are challenging, and I am convinced that the most able students will be attracted to the field if given the opportunity to learn what the problems are.

4. We Must Teach Students to Think. We do three kinds of teaching at the undergraduate level.

a. We teach basic skills — in English composition, in mathematics at an elementary level, and in elementary foreign language, for example.

b. We teach students to understand concepts which have been developed by earlier generations. This is the major portion of our work, whether in history, mathematics, machine design, or any other field. Unfortunately, far too much of this type of teaching ends with the student being able only to repeat back to the professor that which the professor has said to the student.

c. Finally, we teach students to tackle new problems and to think original thoughts. This type of education is the particular province of the graduate school, but the graduate program is most successful when its roots extend into the undergraduate program.

Teaching students to think is not easy. The most skillful teachers are those who stimulate students in this direction, but the type of skill required is rare and it is difficult to develop. On the other hand, there are organizational ways of promoting the desired end. For the more able student, laboratories in which he works alone and in which he does “open ended” experiments are effective means of developing his ability to do independent and original work. Laboratory experiments of this type, having no fixed time set for their completion, allow the student to go as far as he can see worthwhile things to do. Such experiments can require the student to decide which measurements are appropriate, to devise his own scheme of making measurements, and to find his own way of analyzing his data.

We must encourage this type of educational process to the greatest possible extent.
5. The Non-Technical Portion of our Curriculum Requires Consolidation. At Cornell we have an extensive amount of non-technical subject matter in our engineering curriculum, and it forms a vital part of an engineer's education, but the program must be made more coherent. Students must "shop around" too much in order to find courses in the humanities and social sciences, for example, which happen to fit their schedules and which also fit their interests. We need sequences designed for engineering and science students — sequences which will permit the student to get a good view of the particular field and which will require him to study the field in significant depth. We have one such program now in the History of Science, which is a year-long sequence and which is designed to show the student the impact of science on civilization from the beginnings of science to the present time. We are starting another such program in Economics in which we expect to develop a sequence for technically-oriented students in their third or fourth year, making use of their mathematical training. We need the same kind of development in other areas. We need enough of these sequences so that each student is free to elect the particular field he wishes to study.

6. We Must Provide Maximum Opportunity for Exceptional Students. No matter how selective our admission procedure, we will always have a distribution of interest and ability among our students. The ones with the greatest ability and those with the greatest interest can go far beyond the level of work appropriate to the average student. We now recognize this fact in our elementary calculus and in our elementary physics instruction, where we offer the subject matter at three ascending levels. We must provide this opportunity at the advanced undergraduate level as well. We must provide means for the ablest students, who represent a great national asset, to follow less rigorously defined programs. We must provide opportunities which will stimulate the imagination and which will promote original thought. We must provide these opportunities for students interested in engineering design, as well as for students interested in engineering science. For all these students, we must provide short cuts to graduate study. Beginning next year, we will have a special pre-doctoral honors program available for Chemical Engineering students. This type of pre-graduate program must be extended to all fields of Engineering.

D. How Do We Solve These Academic Problems?

The problems discussed above represent areas in which Cornell must take vigorous action if it is to realize its full leadership potential in American engineering education. The purpose of this section is to point out some of the steps which we must take to solve these problems. Some of the steps are specific and well-defined. Others can become well-defined only after the general problem has had extensive study by many people.

1. We Must Appoint at Least Ten Senior Professors. The key to every problem outlined above lies in the number and quality of the faculty. For example, we cannot develop new areas of graduate instruction without faculty members who are competent in the new areas. There are two ways to build such a staff. The first is to appoint carefully selected young people and let them mature into leaders in the field; the second way is to appoint already recognized leaders in a few key areas and to build the remainder of the staff with young persons. The first way is less expensive, but it takes time to develop a growing program, and it is never certain that the young people will develop as planned. The second way is more expensive, but it is faster and it provides great leverage in attracting able young people. It is urgent that we attract more of the most able young people into academic positions, and this job is much easier when there are already outstanding people in the educational institutions.

At Cornell we have six named professorships plus one industry-supported one. The annual income for most of these professorships is in the $10,000 – $13,000 range, which is inadequate for present-day conditions. One of our chairs is a new one that is endowed with more than $500,000. We believe that we will receive other bequests of such a size in the future, but the number and the amounts are unknown.

We shall need ten or twelve senior professorships in the engineering college at Cornell during the next several years. The persons selected for these chairs must be old enough to have demonstrated their ability to be leaders in their respective fields, and they must be young enough to have many years of productive work ahead of them. The age bracket in which I expect to find such people is 35 to 45. The most likely source is in industry, although there are universities in which a number of outstanding people have been concentrated in particular fields, and these groups become good sources of leaders for new programs in other universities. For the greatest national educational health, the ablest people should not be concentrated in only a few institutions.

2. We Must Build More Interdisciplinary Research Programs. I have already pointed out that we must expand graduate education at Cornell and that it must be done on an interdisciplinary basis. During the current academic year, we have organized two graduate research centers. The first is the Radiophysics and Space Research Center, which was organized last fall, and the second is the Materials Science Center, which is in the process of organization at the moment, with financial help from the Advanced Research Projects Agency of the Department of Defense. The radiophysics center involves the Departments of Astronomy, Physics, and Engineering Physics, as well as the Schools of Electrical Engineering and Aeronautical Engineering. The Materials Science Center involves the Departments of Chemistry, Physics, Engineering Physics, Metallurgical Engineering, and Engineering Materials. In the case of both these Centers, the organization cuts across Arts College and Engineering College lines. These Centers are staffed by faculty members who have their academic homes in individual departments and who spend at least half of their time teaching either at the undergraduate or at the graduate level. These Centers provide facilities available to the members of the cooperating departments and they attract graduate students from all the disciplines involved.
A point of interest in connection with the Centers is the fact that Cornell’s faculty is a teaching faculty. We are not a research institute. Our primary emphasis in these research programs is on graduate training, and we propose to keep our future expansion in graduate work on the same basis.

We are in the early stages of forming an interdisciplinary power engineering research program. We expect to select an area of energy generation and conversion which is appropriate for university research and to seek support from appropriate sources, both industrial and governmental. We believe that the lack of student interest in the power field is a serious national problem, and we believe that the way to revive interest is through interesting and productive graduate programs. With the research effort directed by professors who also teach undergraduate courses, it is inevitable that interest will be carried over to undergraduates.

The next interdisciplinary program which I see is in nuclear technology. We already have a start with work in reactor controls systems, in reactor physics and in related chemical engineering problems. Our efforts here will carry over to the biological sciences through the use of some special isotope tracer techniques which our pulsed reactor will make possible.

3. We Must Raise Our Salary Scale Substantially. The whole salary structure at Cornell must be revised upward. One of our biggest problems and one of the biggest problems of the American technical education generally is that of competition with industry for able people. At present there are so many interesting industrial jobs at such high salaries that it is difficult indeed to attract young people into academic pursuits. Industrial research and development laboratories have evolved in directions that make them similar to university laboratories in many respects, so that no longer does the young person have to go to an academic institution to find an “academic” atmosphere. This, coupled with high salaries, attracts a high percentage of the able people to industry. It is common these days for a PhD graduate to take an industrial position at a salary which is greater than that of the professor who trained him. We even have occasional instances of undergraduates starting at $10,000 per year. It is difficult to maintain morale in the academic institution in the face of this competition.

Cornell’s salary scale is also distinctly inferior to that of the other private institutions, the larger state universities, and the principal institutes of technology. The March 1960 issue of the Bulletin of the American Association of University Professors summarizes 1959–60 salary data for 39 selected colleges and universities. The mean professor’s salary in 33 private institutions is $11,921; in five large North Central and Pacific state universities it is $12,055; in two institutions of technology in New England and on the Pacific coast it is $13,593 (some eleven- or twelve-month salaries are apparently included in this latter figure). The corresponding Cornell engineering college figure is $10,755. Over the last two years, the average professor’s salary increased 16% in the 33 private institutions and 7.1% in the five state universities. The corresponding Cornell Engineering figure is 9%.

A salary differential as large as this is a serious deterrent in attracting new staff. It also makes our staff especially susceptible to offers from other institutions and from industry. Our average salary for professors should be increased by $2000 immediately to put us in a favorable competitive position. Beyond this step increase, our annual rate of increase should also be improved.

4. We Must Study Our Curriculum With the Aim of Making Extensive Revisions. There are many areas where we must revise and reorient our curriculum in order to meet present-day demands on engineering education. We have discussed a number of these during the past year and we will be discussing more in the coming year. Before we can take intelligent action on the problems listed below, however, we must study them in an amount and with an intensity which, for the most part, we cannot support at present. We need to organize summer study groups. We need to visit other institutions. We need to free a number of our staff for full-time, academic-year studies. We need to bring people from other engineering colleges to help us with our studies.

a. The First Two Years Should Be Substantially Common. At the present time we require an entering freshman to select a field of engineering specialization when he applies for admission. Students are in no position to make this choice intelligently. With a common two-year curriculum, which we expect to adopt at the earliest possible moment, a student will enter the College of Engineering and not select his particular field until some time in his second year. In the meantime, he will follow a curriculum which is common and he will be helped in his selection of field through a suitable orientation program. The first two years, and in fact all our years, should be consolidated into fewer and more intensive courses.

b. We Require a Course Sequence in Engineering Problems. One of the biggest gaps in undergraduate engineering program generally is the lack of a sequence of formal courses which will let the student see engineering as a whole and which will let him understand the relationships and differences between science and engineering. This program should start in the first term of the freshman year and carry through the entire undergraduate curriculum. To be successful, such a sequence must involve the active participation of the student. Any effort to achieve the desired ends by a series of orientation lectures is doomed to failure.

The course sequence might be built on a series of subjects in which the student is required to solve problems involving important engineering questions. The problems would be posed at a level appropriate to the student’s sophistication in technical subject matter at the particular time. The questions studied might include water resources, air pollution, radioactive waste disposal, power generation, transportation, engineering problems arising out of urbanization of the nation, etc. In the first year the problems would involve only elementary mathematics and science. In later years sophisticated systems optimization studies could be included. The intent of such a sequence should be to develop an understanding of the great engineering problems we face and to promote
enthusiasm for the methods of solution. I believe that such a sequence could have considerable effect on attitudes toward the educational program throughout the undergraduate years.

c. We Must Institute Honors Programs. We must provide opportunity for the most able and the most interested students to do work beyond the scope of our normal program. In such an honors program we must provide the maximum opportunity for professionally oriented students whose formal education ends with the five-year baccalaureate degree or with the professional master’s degree, as well as for the engineering science-oriented student who proceeds directly to the doctorate. There are several ways to achieve these ends. We can divide students by ability in all our major required sequences as we now do in mathematics and physics. We can also provide flexibility in programs outside the common core. This flexibility could include designation of a major area of study, as for example design analysis, or controls systems. The particular combination of formal and informal study would be worked out by the student with his faculty advisor. A feature of the whole program might be a comprehensive qualifying examination at the end. The honors program can provide an effective bridge to graduate study.

The honors program should also include special courses or special laboratories designed to promote as much original work by the student as possible. For example, there could be an “open-ended” physics laboratory to accompany the upper-level physics lecture and recitation course. There could also be an “open-ended” material science laboratory for honors students in metallurgy, engineering physics, and related areas.

d. Instruction in Computing Techniques Must Be Made Available to All Students. It is clear that in the future large amounts of engineering design, as well as routine data processing, will be done with the aid of high speed digital computers. Consequently, every engineering student requires instruction in the use of such techniques. The form of this instruction, the degree to which the student needs to understand the electrical engineering of the computer, and the type of computing equipment he should have an opportunity to use while he is in school are all matters requiring careful consideration. We might reorient our differential equations instruction so that the students approach problems from the standpoint of difference equations which are amenable to numerical solution. Perhaps we should have small computers available in sufficient numbers for students to use in their normal engineering courses. Perhaps all the students need some opportunity to use a modern large high-speed computer. Perhaps our standard engineering courses should be redesigned to incorporate problems requiring machine solution.

e. Civil Engineering Needs New Emphasis. This is one of the critical problems in engineering education. As the population expands and as resources become limited, there will be more and more need for imaginative civil engineers. Yet student interest is declining rapidly. We must attack the problem vigorously in order to find a means to increase the number of able students who enter the field. Probably the best way is through the graduate program, where interesting and important work will inevitably create interest at the undergraduate level. It is also likely that a vigorous attack on the problem directly at the undergraduate level will pay dividends. This is a national problem, but the particular solution in any given school is apt to be unique. For example, at Cornell we have strong Latin American and Southeast Asian programs in Political Science as well as in Sociology and Anthropology. It is conceivable that these energetic programs could be expanded to include areas of interest to Civil Engineering. There has already been significant cooperative work of this type, where Civil Engineering worked with the Department of City Planning in the College of Architecture in some of the planning for Brasilia, the new capital of Brazil. The Civil Engineering part of this work involved locating the city in terms of soil conditions, type of drainage, etc., through air photo interpretation.

f. We Must Seek Ways to Promote Interdisciplinary Study. Engineers are required more and more to work on problems which bridge the traditional fields of engineering. Mechanical designs, for example, must often incorporate electronic controls; structural designs must often allow for the effects of high intensity radiation fields; electronic designs must often incorporate advanced techniques which come from solid-state physics. Furthermore, the pace of technology is so swift that an engineer may have to work in a field which did not exist only a few years earlier. Consequently, sequences of courses and programs of study which introduce the student to the techniques and outlooks of a variety of engineering disciplines are increasingly important.

We have studies of this type now, but we must have more. We could have design sequences with more or less equal emphasis on electrical, mechanical, and structural design. There are other similar areas. Our goal must be to train students in depth in the principles of engineering on a broad base.

The introduction to modern engineering problems proposed in section b. above is aimed in part toward developing in the student an awareness of the interdisciplinary nature of the profession.

g. We Need Expanded Graduate Fellowship Resources. As graduate study expands, we shall need increased fellowship support for students. We now award about $75,000 a year in graduate fellowships from general University funds and about $125,000 a year from funds restricted to Engineering College use. Thus we fall short by a factor of two in having sufficient funds even to award tuition scholarships to all our graduate students.

We should double our available funds immediately and we should seek further increased support as the number of graduate students expands.
6. **Student Selection Methods Must Be Examined Carefully.** Another big problem which we must study with every available means is the method of selecting students. At present we select on the basis of Scholastic Aptitude Test scores, Achievement Test scores, secondary school records, and recommendations. Our selection methods provide us with a student body highly competent in the areas measured by the Aptitude Tests. On the other hand, I am not convinced that we are selecting students with the most promise for doing original work or even with the most promise for the more routine aspects of engineering. Interest, determination, ability to succeed in the face of difficulties, and other relevant qualities are not well measured by present techniques. Nor do we measure the intangible talent for original work. There is danger that our selection system, and the consequent requirement to design curricula consistent with the students’ abilities, excludes students who could make major contributions to engineering.

This is a difficult problem with which to deal, but we must do our best. We must study the records of our most successful alumni to see if unusual success was indicated by any of the student’s qualities which were evident at the time of admission to the University. We must correlate success after graduation with pre-admission criteria. We must study every other aspect of admissions policy, with the goal of improving our ability to select students who will make significant contributions to the field.

7. **Reorganization of the Engineering College Must Await Curricular Developments.** In thinking about the ways in which our academic problems can be solved, we always think of the possibility of reorganizing the College. It is clear, for example, that the traditional disciplines of electrical engineering, mechanical engineering, etc., have less meaning now than they did 25 years ago, and it is also clear that they will have even less meaning ten years from now. However, if we abandon the present structure, it is not clear which alternative structure is best suited to our problem. If our future were clearly 100% in the engineering science direction, an appropriate reorganization would be easy to find. If our future were clearly 100% in the professional engineering direction, it would again be relatively easy to find a solution. But the nature of Cornell University as a whole, the type of student body we attract, and the interests of the staff all point in the direction of the combined program in engineering science and professional engineering.

One organizational way to handle such a dual program would be to develop a Department of Applied Science in which all the engineering science would be centered, and to concentrate the professional engineering in functional areas such as communication systems, electromechanical design, environmental engineering, etc. However, curricular matters are in such a state of flux, not only at Cornell but nationally as well, that it would be a mistake to make such a major change now. I am not convinced that such a reorganization – in which traditional subject-matter departments were wiped out in favor of new functional groupings – would be any more satisfactory than the present arrangement, provided that the proper modifications are made in the present arrangement. As an example, Metallurgy at Cornell must obviously be strengthened. More staff members with backgrounds in physical chemistry and solid state physics must be associated with the program. Through additions to the staff and through the close interdisciplinary cooperation which will prevail in the Materials Science Center, a strong and well-rounded program can be built. The key to success is people, not organization.

As another example, we should have a more coherent approach to instruction in design. One way to do this would be to form a grouping which would include all interested staff members in a new design department. The other way is to maintain, for the time being at least, our present subject-matter groups in Electrical Engineering, Mechanical Engineering, Civil Engineering, etc., and to organize an interdepartmental curriculum in design engineering which will include a carefully worked out sequence of engineering mechanics, mechanical design, structural design, electrical design, and electromechanical design. When a new aspect of design becomes important, such as nuclear reactor design, this topic can be added to the sequence without disrupting any existing organization. In the first way of solving the problem, a person or persons would have to be transferred from one organization to another.

It seems to me that the basic issue in these matters is the question of who should be the everyday associates of a faculty member. Our Engineering Physics faculty is a good example. In 1946 the Engineering College faced the problem of how to get more physics into the engineering program. Should it be done by distributing physicists throughout the 30 other schools or departments or should it be done by having a concentrated Department of Engineering Physics which then interacts in various joint programs with other departments? Cornell chose the latter course. Members of other faculties are also members of the Engineering Physics faculty. There are joint curricular programs, as, for example, in nuclear engineering. Engineering Physics students also do fifth-year projects with staff members in other departments. With this system, the individual Engineering Physics faculty member associates on a daily basis with others of similar background and interests. Furthermore, the Engineering Physics faculty is also in daily association with the Arts and Sciences Physics faculty. I am convinced that our Engineering Physics staff is more productive, and that more physics flows into the other engineering programs, than would be the case with a group of Engineering Physicists dispersed throughout the College.

We now face the need to make another quantum jump in the amount of engineering science in our curriculum, and we must decide how to do it, recognizing that today’s situation is quite different from that of 1946.

I am quite prepared to believe that as time goes on, new organizational groupings will be appropriate. Engineering at Cornell is a strong College which has a great deal of momentum, and it can make big changes in its structure successfully, whenever the faculty and administrative staff believe the changes to be sound and to be essential. We pioneered the five-year program, for example. We also pioneered the engineering science curriculum, as exemplified in our Engineering Physics case. It has been easy for us to
organize interdisciplinary centers of graduate instruction and research. We must maximize the cooperation among our schools and departments, and we must establish common standards and goals. The crystal ball is too cloudy, however, to warrant a major reorganization of the College in 1960.

E. What Will It Cost?

1. If Recent Trends are Followed the Budget Will Double in Ten Years. The accompanying table shows the cost of operating the Engineering College, with the exception of student aid, since 1952. The cost of student aid is analyzed for a single year, 1958-59. The cost of new buildings is excluded from this analysis.

Let me assume first that the College will continue to grow in the same pattern it has followed during the past eight years. Extrapolating the total expenditures according to the rate for this period, we see that there is a doubling time of ten years. This will provide for modest salary increases, for slow development of research activities, and for the addition of a few senior faculty members.

The pattern will not be the same, however, since we are already operating the Radiophysics and Space Research Center and we expect the Materials Science Center to be a going program during the coming academic year. These efforts will make substantial changes in both the expenditure and in the income figures. I cannot predict either the total cost or the net cost of these operations. They represent large increases in research staff. This will, of course, be offset by corresponding income. Tenure staff will be appointed, however, whose salaries will be recovered only in part. For example, in the Materials Science Center, we expect to add fifteen faculty members in engineering during the next ten years, and only 25% - 50% of their salaries will be recovered. On the other hand, they will be needed for teaching increased numbers of students, so that the remainder of the increased salary burden may be offset by increased tuition income.

2. The Immediate Steps in Section D Above Will Add About $700,000 to Our Annual Operating Budget. Let us examine the added cost of carrying out the programs outlined in Section D.

a. Senior Professors. Assuming that we will receive a few bequests endowing chairs during the next several years, I shall consider that only ten senior professorships will be required. Taking $500,000 as a standard professorship endowment figure, we shall need $5,000,000 for this purpose.

b. Salary Increases. Increasing our average full-professor salary by $2,000 will require an annual increase in expenditure of $130,000, since we have 65 professors. This corresponds to an endowment of $2,600,000.

Beyond this step increase, we must do everything possible to increase the rate of salary improvement. For the past eight years our full professors have averaged about 4.5% improvement per year. This should be 7.5% per year, which would correspond to a doubling time of ten years and would correspond to the rates of other private institutions. Thus we need, over and above our present resources, 3% per year for 65 professors at the proposed average salary of about $13,000. This represents an additional annual expense of about $25,000 at present, corresponding to an endowment of $500,000.

c. Studies. I believe that we should invest a minimum of 5% of our total faculty effort, on a continuing basis, in studying our academic problems and in working out solutions. This study can take the form of summer study groups and of academic-year study groups with faculty members made available on a full-time basis. In the beginning, perhaps even more effort should be invested. However, let us assume the equivalent of seven full-time faculty members. Some of these will be associate professors or assistant professors, so let us take an average salary of $10,000, to give a total of $70,000 per year, in order to replace the staff released for this purpose. To this should be added the salaries of visiting professors from other universities to assist us in our study efforts, travel expense for our staff to visit other universities, secretarial help, etc. A total of $100,000 per year can be invested profitably. Since this should be a continuing effort, it should be endowed — at a cost of $2,000,000.

d. Graduate Fellowships. Doubling the present graduate fellowship aid will cost $200,000 per year, corresponding to an endowment of $4,000,000.

e. Summary. The immediate program outlined in D above can be summarized as follows:

<table>
<thead>
<tr>
<th></th>
<th>Annual Costs</th>
<th>Required Endowment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Professors</td>
<td>$250,000</td>
<td>$5,000,000</td>
</tr>
<tr>
<td>Full Professor Salary Increases</td>
<td>130,000</td>
<td>2,600,000</td>
</tr>
<tr>
<td>Increased Salary Improvement Rate</td>
<td>25,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Academic Problem Studies</td>
<td>100,000</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Graduate Fellowships</td>
<td>200,000</td>
<td>4,000,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$705,000</strong></td>
<td><strong>$14,000,000</strong></td>
</tr>
</tbody>
</table>
A significant feature of this immediate program is the fact that an incremental cost which is a small fraction of our total operating budget could make a really significant change in our operation. The added annual cost of $705,000 is only about 11% of our total annual expenditure (including student aid). With this increment we could make a major impact on graduate instruction through the appointment of senior professors; we could put our salary scale on a competitive basis; we could give our whole curricular organization the kind of intensive study it needs, and we could offer fellowship support to graduate students on a more realistic basis.

3. Follow-on Programs Will Add a Large but Unknown Amount to the Annual Budget, Primarily in the Graduate Area. There are many developments following the immediate program which will add to the annual budgets. There will be demands for new or modified buildings, as in the case of the Water Resources Laboratory and the Radiophysics and Space Research Center already discussed. Operating budgets for research programs will be large. We will add young staff members in new areas as they develop. Our curriculum study will inevitably lead to expensive teaching innovations. We are likely to need additional high-speed computational facilities for our students.

It is impossible to estimate the magnitude of these additional costs. The more successful we are with the immediate program, the greater will be the follow-on expenses and the stronger will be our position in commanding support outside the University.

F. What Are Cornell’s Financial Resources?

The accompanying table shows the sources of income for the College of Engineering during the past eight years, together with the deficit which has been absorbed by other divisions of the University. Student Aid is not included in these data; the income through University sources for this purpose amounts to about $750,000 (which is offset by an equal expenditure, which is also unlisted in the summary table).

1. If Recent Trends Are Followed, Income from Tuition, Endowment, and Gifts Will Double in Ten Years. The data in the summary table shows the rate at which income from all sources (except from endowment for student aid) has increased during the past eight years. Tuition income and general university income (from endowments and gifts) has risen rapidly, indicating a doubling in the next ten years if present trends continue.

2. Funds from Existing Sources Can Accomplish Only a Small Part of the Immediate Program in Section D Above. Our operation already represents a deficit in the whole university picture, so that expansion of any part of the Engineering College program will necessarily be done with a further deficit. Appointment of senior professors can be made slowly within the presently available resources. Study of curriculum is possible only at a low rate. Only in the area of sponsored research will the income rise sharply. This rise is assured by work already under way in the Radiophysics and Space Center and by work which will be undertaken during the next year in the Materials Science Center.
<table>
<thead>
<tr>
<th>EXPENDITURES</th>
<th>’52–’53</th>
<th>’53–’54</th>
<th>’54–’55</th>
<th>’55–’56</th>
<th>’56–’57</th>
<th>’57–’58</th>
<th>’58–’59</th>
<th>Est. ’59–’60</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Salaries of Faculty and Technical Personnel</td>
<td>$974,173</td>
<td>$1,114,232</td>
<td>$1,135,023</td>
<td>$1,156,114</td>
<td>$1,146,254</td>
<td>$1,339,625</td>
<td>$1,438,922</td>
<td>$1,608,028</td>
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<tr>
<td>(a) Less Salary Recoveries from Research Contracts</td>
<td>-53,683</td>
<td>-73,686</td>
<td>-56,209</td>
<td>-51,658</td>
<td>-35,568</td>
<td>-52,001</td>
<td>-75,188</td>
<td>-80,000</td>
</tr>
<tr>
<td>4. Restricted Expendable Funds</td>
<td>44,992</td>
<td>59,809</td>
<td>88,279</td>
<td>66,078</td>
<td>104,915</td>
<td>237,478</td>
<td>239,453</td>
<td>240,000</td>
</tr>
<tr>
<td>5. Accessory Instruction by Other University Divisions</td>
<td>417,548</td>
<td>455,279</td>
<td>496,659</td>
<td>520,646</td>
<td>631,276</td>
<td>707,264</td>
<td>746,741</td>
<td>750,000</td>
</tr>
<tr>
<td>6. Sponsored Research</td>
<td>792,500</td>
<td>764,300</td>
<td>798,500</td>
<td>611,600</td>
<td>695,000</td>
<td>722,100</td>
<td>715,900</td>
<td>750,000</td>
</tr>
<tr>
<td>7. Indirect Expense -Share of University Plant Maintenance, Administration, etc.</td>
<td>850,919</td>
<td>995,570</td>
<td>1,060,687</td>
<td>1,224,139</td>
<td>1,449,027</td>
<td>1,708,918</td>
<td>1,900,452</td>
<td>2,100,000</td>
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<tr>
<td>(a) Less Overhead Recovery from Research</td>
<td>-166,037</td>
<td>-194,659</td>
<td>-178,854</td>
<td>-174,693</td>
<td>-161,803</td>
<td>-188,615</td>
<td>-216,981</td>
<td>-235,000</td>
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<tr>
<td>Total Expenditures (not including student aid)</td>
<td>$3,068,368</td>
<td>$3,359,699</td>
<td>$3,584,551</td>
<td>$3,603,538</td>
<td>$4,090,484</td>
<td>$4,740,299</td>
<td>$5,062,531</td>
<td>$5,455,782</td>
</tr>
</tbody>
</table>

NOTES:

Line (2) - Includes Dean’s Office personnel plus secretarial and clerical staff in school and department offices.
Line (3) - Includes general operating expenses and equipment appropriations.
Line (4) - Includes allocation of restricted equipment grants, allocations to equipment accounts from laboratory testing income, and the Engineering Coop Training program.
Line (5) - Charges to the College based on unit student-hour costs for instruction given to engineering students by the College of Arts and Sciences, and other units.
Line (6) - See “Income” tabulation for break-down by sponsoring agencies.
Line (7) - Based on enrollment proportions.
### COLLEGE OF ENGINEERING
#### SUMMARY OF INCOME

<table>
<thead>
<tr>
<th>INCOME</th>
<th>'52-'53</th>
<th>'53-'54</th>
<th>'54-'55</th>
<th>'55-'56</th>
<th>'56-'57</th>
<th>'57-'58</th>
<th>'58-'59</th>
<th>Est.'59-'60</th>
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</thead>
<tbody>
<tr>
<td>1. Tuition and Fees</td>
<td>1,226,028</td>
<td>1,307,349</td>
<td>1,452,627</td>
<td>1,745,614</td>
<td>1,925,958</td>
<td>2,233,694</td>
<td>2,479,296</td>
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<td>2. Accessory Instruction Sold</td>
<td>42,854</td>
<td>69,677</td>
<td>66,512</td>
<td>62,714</td>
<td>57,142</td>
<td>54,448</td>
<td>62,152</td>
<td>57,000</td>
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<tr>
<td>3. Professorships (Endowed and Supported by Grants)</td>
<td>35,234</td>
<td>34,000</td>
<td>23,500</td>
<td>53,428</td>
<td>72,787</td>
<td>83,407</td>
<td>88,049</td>
<td>84,500</td>
</tr>
<tr>
<td>5. Restricted Expendable Funds</td>
<td>45,080</td>
<td>46,950</td>
<td>70,585</td>
<td>66,078</td>
<td>104,915</td>
<td>237,478</td>
<td>239,453</td>
<td>240,000</td>
</tr>
<tr>
<td>6. Sponsored Research</td>
<td>792,500</td>
<td>764,300</td>
<td>798,500</td>
<td>611,600</td>
<td>695,000</td>
<td>722,100</td>
<td>715,900</td>
<td>750,000</td>
</tr>
<tr>
<td>(a) By Government</td>
<td>(696,500)</td>
<td>(661,100)</td>
<td>(731,400)</td>
<td>-568,200</td>
<td>-643,200</td>
<td>-661,000</td>
<td>-639,100</td>
<td></td>
</tr>
<tr>
<td>(b) By Industry</td>
<td>(88,000)</td>
<td>(98,200)</td>
<td>(54,100)</td>
<td>-36,700</td>
<td>-35,700</td>
<td>-53,800</td>
<td>-71,000</td>
<td></td>
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<tr>
<td>(c) By Foundations</td>
<td>(8,000)</td>
<td>(5,000)</td>
<td>(13,000)</td>
<td>-6,700</td>
<td>-16,100</td>
<td>-7,300</td>
<td>-5,800</td>
<td></td>
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<tr>
<td>7. Share of General University Income</td>
<td>445,139</td>
<td>709,191</td>
<td>763,187</td>
<td>781,858</td>
<td>949,408</td>
<td>1,108,057</td>
<td>1,116,942</td>
<td>1,157,000</td>
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<tr>
<td>8. Miscellaneous Income</td>
<td>3,556</td>
<td>1,082</td>
<td>1,511</td>
<td>16,305</td>
<td>62,011</td>
<td>40,338</td>
<td>40,000</td>
<td></td>
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<tr>
<td>Total Income</td>
<td>2,677,346</td>
<td>3,018,640</td>
<td>3,263,166</td>
<td>3,409,976</td>
<td>3,908,688</td>
<td>4,588,368</td>
<td>4,829,303</td>
<td>5,172,500</td>
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<tr>
<td>Deficit</td>
<td>391,022</td>
<td>341,059</td>
<td>321,385</td>
<td>193,562</td>
<td>181,796</td>
<td>151,931</td>
<td>233,228</td>
<td>283,282</td>
</tr>
</tbody>
</table>

**NOTES:**

Line (2) - Credit for instruction given by the College to students from other divisions of the University.

Line (3) - Includes income from endowed professorships and annual grants in support of professorships.

Line (5) - Includes income for the Engineering Coop Training program, restricted equipment grants, laboratory testing income, and income from special programs.

Line (7) - Includes endowment income, Alumni Fund, unrestricted gifts, etc.
# ENGINEERING STUDENT AID 1958-59

## Undergraduate

A. By College of Engineering $326,185
   
   I. McMullen Fund $187,443
   II. Other Endowments $28,330
   III. Revolving Funds $110,412

B. By Other University Agencies $170,670
   
   I. Endowed Funds $11,367
   II. Revolving Funds $132,807
   III. Free Tuition (Employees' Children) $26,496

C. By University (A plus B) $496,855

D. By Agencies Outside University $240,560
   
   I. New York State Scholarships $156,332
   II. Regular NROTC $84,228

E. Total By All Sources $737,415

## Graduate

Awards Administered through Graduate School $37,586

*Scholarships for Teaching Assistants $35,419

Restricted Fellowships and Scholarship Grants
   
   In Engineering (includes stipends, tuition and expense grants to University or College) $122,250

*Assistantship stipends not included; these are included in instruction costs on Expense analysis. $195,255

## Summary

Total Undergraduate Student Aid in Engineering
   
   From University Sources $496,855
   From Outside Sources $240,560 $737,415

Total Graduate Student Aid $195,255

Total Student Aid $932,670
Preface

Before President James A. Perkins assumed office on July 1, 1963 he visited the campus a number of times and asked advice about where he should invest his time before the “honeymoon” was over. Many people told him that Basic Biology needed attention and he decided to make this his number one effort at the beginning. When he invited me to become his Provost, about two weeks into his tenure as President, he had already appointed a distinguished outside Advisory Committee to analyze the problem for him and to recommend how to deal with it. He asked me to manage the Advisory Committee operation and after its Report was submitted he appointed a local committee, with me as Chairman, to advise him about the implementation of the Report. The following letters and papers represent the major steps in the Biology Division’s evolution, beginning with the Advisory Committee’s Report.

This is the report of the external special committee, also known as the Morison Committee Report. The president’s appointment of an internal committee follows this report.

Dale R. Corson
October 23, 1963
I. Introduction

This committee was appointed by President Perkins to review the existing situation of biology at Cornell University and to make recommendations for its improvement. In pursuing these objectives, the committee has studied a large number of formal documents submitted to it in advance of its first meeting and carefully considered over 45 letters and memoranda provided by individual members of the faculty. Finally, it has heard testimony from all the major administrative officers in the University and a substantial sample of faculty members of all ranks. The committee wishes to take this opportunity to express its gratitude for the time and effort that these individuals put into their statements.

No matter what may be the differences of opinion about the present state of biology at Cornell or the measures that might be taken to change it, there can be no doubt at all that concern for the problem is spread throughout the faculty. The committee is most appreciative of the serious and cooperative spirit in which almost everyone appeared before it.

The committee's deliberations were, of course, greatly facilitated by the fact that teaching and research in biology has been under continuous scrutiny by administrative officers and faculty members for several years past. Only two years ago a careful study appeared in the form of a committee report entitled “Biology at Cornell”.1 Many less formal statements are available, and indeed it appears that almost everything that can be said about biology at Cornell has already been said by someone. It is therefore not surprising that the committee ended up with an opinion and a proposal, the elements of which are contained in some of the written statements submitted to it by members of the Cornell faculty.

II. The Present Situation

A. Structure and Organization

The most striking feature of biology at Cornell is that bits and pieces are scattered throughout many of the separate departments of five of the schools or colleges which compose the University. In no one of these places does it present itself as a more or less coherent and integrated body of knowledge. In part, this random distribution seems to have been due to accident, in part — to evolution unchecked by appropriate selection pressures. Perhaps the single most important cause is to be found in the fact that much research in biology has been valued primarily for its immediate contribution to the solution of practical problems in Agriculture and Veterinary Medicine. Whatever the reason, the result is that important segments of biology are represented only as adjuncts to certain practical arts which enjoy departmental status; e.g., genetics appears in Plant Breeding and Poultry Husbandry, bacteriology as a part of Dairy and Food Science, ethology as a part of Conservation. Perhaps it is symbolic of the fragmented, if not actually inverted, character of biology at Cornell that the only course actually called “biology” is given by an assistant professor in the Department of Entomology. Surely, as one of our informants put it, “This situation must be unique to Cornell.”

1 Report of the Special Committee Appointed by the Deans of the Colleges of Agriculture, Arts and Sciences, and Veterinary Medicine.
In the College of Arts and Sciences where one might have supposed that biology would be valued, at least in part, for the contribution it might make to the understanding of life in general, the only department devoted exclusively to biological matters is Zoology, where the emphasis appears to be largely on the preparation of students for medicine and the provision of so-called “service” courses for other divisions of the University. Modern work on such characteristic life processes as immune reactions, growth, differentiation, and the storing and processing of information by biological organisms is notably absent. Attempts to compensate for some of these lacks are, however, found in the Department of Chemistry, in Engineering Physics, and in the newly formed and still unproven special section of Cognitive Studies. Some biologically oriented studies of behavior are also found in the Department of Psychology. Admireable though these attempted compensations may be in themselves, they are all likely to be seriously handicapped by lack of true biological perspective. The committee is particularly concerned that the field commonly referred to as molecular biology, which holds such promise for understanding many of the most characteristic properties of living organisms, is represented primarily, if not indeed wholly, as a branch of chemistry.

In the College of Agriculture, work of a biological character is found in virtually every department. Much of this is quite properly of a so-called applied nature, although Cornell has a long tradition of back-stopping such work with excellent representation from more basic areas. Indeed, the quality of basic research in the Agricultural College has been so high in the past that it has supplanted work of a similar nature in the other schools of the University. Two exceptions to the general rule of providing for basic science only as a handmaiden to some specialized applied area are found in the Departments of Botany and Biochemistry. Biochemistry, of course, is also found in various places in the other schools, notably in Home Economics and in the Graduate School of Nutrition. Incidentally, the latter organization is probably the only school of its kind in the world.

In a situation as diverse and as widely disseminated as this, it would be unwise to attempt any detailed or comprehensive appraisal of quality. In the time allowed the committee, such a general appraisal would in any case have been impossible. Nevertheless, on the basis of their general knowledge of several of the fields represented at Cornell and of the information and opinion provided by the presentations to the committee, the members believe they are safe in saying that research and teaching in many of the fields of biology are at a relatively lower level than they were two or three decades ago. Almost as serious as the decline in the quality of the work being done is the dearth of activity in certain areas of increasing importance. In other areas, such as the biology of behavior, bits and pieces may be found scattered in various corners of the University, but there is no place in which a substantial core of the science may be found around which to rally the dispersed forces. The committee is prepared to go into further detail in regard to its opinion on the existing situation of biology at Cornell upon request. It has not done so in the present report largely because so much of what it would say is already contained in readily available statements previously prepared by members of the faculty. The committee believes that the present fragmentation and inadequacies of biological work at Cornell can be traced rather clearly to certain peculiarities in organizational structure and administrative procedure. By American standards there is an unusual degree of decentralization of authority throughout the University. The result in many of the schools is that the actual course of events is left largely in the hands of department heads. At its best this system provides for excellent work in the individual specialties. On the other hand, it tends to obscure or even eliminate responsibility for the development of appropriate work in the more general aspects of biology.

In this connection we must draw attention to certain peculiarities of administrative structure which have made it relatively easy to emphasize the development of individual specialties at the expense of overall coherence. First and foremost, of course, is the fact that one important part of Cornell is a privately supported College of Arts and Sciences and that another equally important part is a group of colleges primarily supported by the State of New York. Of the latter, the most significant for the present argument is the College of Agriculture. From time to time in the past, substantial parts of what are usually regarded as basic biology have slipped away from the College of Arts and Sciences and turned up in the College of Agriculture. In part, this movement has been due to the greater vigor and better quality of particular subjects as represented in Agriculture. Furthermore, in times of financial stringencies it has apparently been easier to obtain financing from the state than from private sources. This difference in method of financing is often cited as one of the important reasons for the high degree of autonomy enjoyed de facto if not de jure by the several colleges of which Cornell University is composed.

Somewhat the same explanation may be offered for the almost equally substantial degree of autonomy enjoyed by the major departments within the Agricultural College. The point here is that money for the College of Agriculture seems to have been most easily obtained through appeals to the particular constituencies of particular departments. Thus the New York orchardists were expected to lobby with special intensity for the Department of Pomology, dairymen for the Department of Dairy and Food Science, poultry men for the Department of Poultry Husbandry, and so on. The committee is not questioning the political wisdom of this decision and it is of course well aware that for many years, and perhaps even today, the policy has contributed importantly to the acknowledged eminence of the school. The only comment it wishes to make is that the system has not proven well adapted to the development of a well balanced and appropriately integrated plan for research and teaching in the more basic aspects of biology. Later on it will also call attention to the probability that failure to develop more comprehensive work in biology somewhere in Cornell may make it increasingly difficult for the College of Agriculture to maintain its place of leadership. At this point we may note that several other leading schools have already provided for the growth of strong independent departments representing the basic aspects of biology and biochemistry.
It is harder for us to understand why “applied” and “vocational” attitudes toward biology should have apparently diffused into the College of Arts and Sciences. As we have remarked above, the Department of Zoology seems to be primarily concerned with the preparation of students for medicine and with the giving of certain service courses for other departments of the University. One obvious cause of the incomplete representation of biology in the arts college is the actual transfer or at least the tacit release of certain important subjects like botany, genetics, microbiology, and biochemistry to other colleges. A search for further explanations would lead the committee into subtle areas of morale and personal predilection with which it is unprepared to deal. We must call attention, however, to one of the problems confronting the undergraduate in arts and sciences who wishes to become familiar with certain important areas of biology. Some of the most significant and exciting areas of modern biology are found, if not in Cornell, in the other colleges, notably, of course, in Agriculture. Unless the arts student is unusually enterprising, he will not learn of their existence, since they are not listed in the catalogue of his college. Furthermore, lack of communication among the colleges has apparently made it difficult to develop well-ordered curricula involving courses taken in the two institutions. Many of the foregoing difficulties are perhaps inherent in the operation of a group of schools and colleges which look for their major support to very different sources, draw their students from quite different pools, and charge them quite different tuitions. If so, they can only be solved by some change in the overall structure of the University, which is, of course, quite different from that encountered in other U.S. universities.

B. Procedures

1. Promotions and Appointments

The inherent structural problems described in the preceding section are exaggerated rather than minimized by certain important administrative procedures which are apparently traditional at Cornell. We refer here especially to the methods of making faculty appointments, and of supervising and evaluating the work of graduate students. As must be expected, the practices employed in recruiting, appointing, and promoting faculty vary somewhat from school to school. In general, however, less care is taken to insure uniformly high quality and especially to consider the needs of the University as a whole than is common in other institutions in the same general category as Cornell. It is our understanding that at least in many instances the major responsibility is vested in the head of the department in which the vacancy occurs and that his recommendation is frequently forwarded to the President and the Board of Trustees with little more than pro forma scrutiny by his dean. The final action by the President and the Board is again, as a general rule, more or less automatic.

In favorable cases, and there are many of these, the head of the department will seek opinions from his senior colleagues within the department itself and in other relevant areas of his own college and even perhaps in other colleges of the University. It does not appear, however, that he is required to do any of these things, and in many instances such consultation is little more than perfunctory. The inherent weaknesses of this system (or lack of system) are made even more apparent when one learns that in some areas there has been a tendency to fill a considerable proportion of the vacancies with candidates who have received their graduate training at Cornell. Admittedly, the dangers of this policy are now increasingly recognized, but in many of its departments the University can demonstrate only too clearly the hazards of relying entirely on hereditary excellence. We have not made a thorough analysis of this problem, but we were told that something like fifty percent of the members of at least one of the college faculties are Cornell trained. Unlike the teaching of biology as a subsection of entomology, this situation may not be unique to Cornell; but it is certainly unusual among the better class of institutions in the United States.

2. Conduct of Graduate Training

The method of selecting, supervising, and examining graduate students exhibits many of the same virtues and defects of decentralization that characterize the method of making appointments to faculty posts. At its best, there is a great deal to be said for a system which allows the prospective student to select his major and minor supervisors and to work out with them a schedule of studies and researches which best fit his background, capacities, and talents. It is hoped that in any reform which is undertaken, these immense virtues will be preserved as fully as possible. On the other hand, the necessity of a reform is indicated by the very serious abuses which have been allowed by the above latitude of action. As currently practiced at Cornell, the system of graduate instruction frequently results in much too narrow specialization on the one hand, or a sort of diffuse dilettantism on the other. As far as we could determine, it is the first of these dangers which is more often experienced in practice. Although in many, if not most, instances the major and minor supervisors are drawn from different departments and even from different colleges or schools, all three may represent closely related specialties in a single administrative organization. In some such cases, a Ph. D. may represent a training experience limited to practical work in a single specialty in applied biology. Even more serious is the fact that the adequacy of this training is determined by the people responsible for planning and carrying it out. In other words, the examiner who determines what the student knows is the same person who prepared the student for the examination.

III. Recommendations

A. Procedural Matters
1. Appointments and Promotions

We believe that one of the most obvious ways of improving biological teaching and research at Cornell, of decreasing its present fragmentation and of gradually filling the gaps which have presently developed would be a thoroughgoing reform in recruitment and promotion policies. Such reforms should include the institution of selection committees broadly representative of the University as a whole. We particularly emphasize the importance of making sure that the needs of the graduate school be adequately represented. In some institutions it has been found useful to include one or more members from outside the University as well. We recommend that serious attention be given to this possibility at Cornell.

It is not our intention that final authority in the matter of appointments and promotions be vested in the ad hoc committees. Their deliberations should, however, be made directly available to the President, who should normally attend at least the final meeting of such committees in person or be represented by the Provost. We also feel very strongly that it is not enough to consider the credentials of a candidate in vacuo, so to speak. In every instance, a given individual should be directly compared to several others from both in and outside the University. This statement applies with equal force to promotions and to new appointments. A diligent effort should be made to identify the best possible candidates with the help of prominent biologists throughout the country.

Perhaps this matter of adopting more effective measures for recruitment in the making of senior appointments is almost too obvious to be mentioned in such detail. We do so, however, since we regard it as probably the single most important reform which we can suggest. The committee feels, in fact, that if a more rigorous system of appointments had been enforced during the last three or four decades, many of the problems which now plague biology at Cornell would never have developed.

2. Graduate Training

In order to correct some of the difficulties discussed above in connection with the administration of the graduate program, we make the following suggestions. Regulations should be adopted forthwith which would provide for review of all individual graduate programs by some central authority. Examining committees at every stage of training should contain a majority of persons who have not had prime responsibility for the candidate's training. As in the case of the committees for reviewing appointments and promotions, attention should be given to the inclusion of examiners from outside the University. It is unlikely that this procedure can be adopted as a routine, but the reasonably frequent inclusion of visiting examiners tends to elevate the tone of the whole examination procedure, introduce fresh ideas from outside, and ensure that standards are comparable to the best there are elsewhere.

B. Organizational Changes

The committee is convinced that in order to give basic biology the place it deserves in the University and to ensure its future health, it will be necessary to make certain changes in the organization of the University. In a word, biology must be represented as an entity in its own right whether it is called a department, a division, a school, a college, or an institute. Biology must be seen at Cornell as a body of knowledge worth pursuing for its own sake and not merely as a series of adjuncts to the raising of larger crops, the improvement of industrial processes, or the training of premedical students. This is to not deprecate the importance of biological science in all these respects. We do wish to emphasize, however, the transcendent importance of biological research and teaching in relation to the University's primary mission of understanding the nature, both of the universe in which man finds himself and of the quality of his own being. As more and more of this universe comes under human control, men (people) are increasingly called upon to make technical decisions and value judgments about the direction in which changes are proposed. To cite a simple example, many citizens of New York are now being asked to decide whether or not they should put fluorine into their water supplies. Somewhat more difficult is a whole series of decisions involved in the use of pesticides, detergents, and other compounds which on the one hand add to the abundance and convenience of living, and on the other, may actually make life impossible for numerous species which in the past may have been man's good friends.

Finally, one must note that human nature itself is gradually coming under human control as we learn more about the genes and chromosomes which determine the composition of man's body and the stuff of his personality. As we develop accurate understanding of how genes and environmental influences interact to produce their final product, we learn to control the nature of the final product itself. Even though not all of us may welcome with enthusiasm the prospect of deciding what sorts of people ought to be born and in just what direction they should be trained, none of us can long avoid the necessity of thinking soberly about such possibilities. Our point is that we can no longer rely wholly on the classical humanities, even with the help of the so-called social sciences, in making "value judgments". The Life Sciences must play their part not only as means to a better life, but as one of the methods of determining what the good life is.

We therefore make no apology for recommending independent status for biology at a high level in the University structure. Admittedly, such a general appeal to the importance of biology might not be fully persuasive in an institution in which the subject already existed in reasonable health. As pointed out above, however, the whole structure of research and teaching in biology at Cornell has become truncated and deformed to an extent incomprehensible to those who have not followed its history. Among the advantages to be expected from the development of a division or college of biology are the following.
a. It would immediately establish an important psychological bond among the various scattered elements of basic biology now leading a precarious existence on the periphery of the campus. Closer interaction among these groups would immediately improve morale, with a resulting improvement in the quality of research and teaching at both the graduate and undergraduate levels.

b. It would facilitate the identification of gaps between groups and the recruitment of individuals to represent these now neglected areas.

c. The planning of undergraduate curricula in biology for the various colleges should be greatly improved.

d. It would surely lead to the gathering together of the essential elements of basic biology in a single geographical area on the campus, whether in a single building or in a group of closely related ones. This, in turn, would facilitate the execution of cooperative research and the planning of graduate programs for individual students. The quality of the graduate student experience would be enriched by increasing the number of informal contacts between students and teachers, and of such formal activities as graduate seminars, visiting lectureships, etc.

e. Although the point is frequently overemphasized, the unification should effect some economies in the use of expensive equipment, library facilities, photographic laboratories, machine shops, etc.

f. Finally, the granting of independent status to biology would allow its voice to be heard at the highest levels of university planning and decision, a point we feel must be emphasized if the existing situation is to be corrected.

The committee spent a great deal of time in discussing the exact nature of the new administrative entity, its relationships to the existing colleges, and the details of what it should and should not contain. It must be confessed at once that we are not nearly so convinced about certain of these matters as we are about the recommendations made earlier in this report. We have been particularly concerned that any changes in administrative structure do the least possible damage to existing excellencies in biology, isolated though these may now be from one another. Our concern applies particularly to the College of Agriculture, where the high quality of much of the basic work done in the several departments of this great institution has played a most important role in its high reputation throughout the world. The same concern applies in theory to the College of Veterinary Medicine, but here the damage likely to be done by any reorganization in other parts of the University is not likely to be serious, since biology is already represented by strong departments at the basic level.

It is true that one of the principal reasons for recommending a new division is the opportunity it will give the basic biologists in all parts of the University to talk with one another, to exchange ideas and actually to engage from time to time in interdisciplinary research. It seems at first glance inevitable that increased contact with others will reduce the contact with current colleagues in the separate departments of Agriculture. It is not contemplated, of course, that all the basic scientists in the school would be physically transferred to the new laboratories and departments. On the other hand, some certainly would wish to give all or at least a substantial fraction of their time to work elsewhere on the campus. Insofar as such shifts occur, they will admittedly result in some immediate loss to Agriculture. We feel, however, that in the long run, the advantages of having strong representation in every important field of modern biology on the Cornell campus would greatly outweigh the temporary disadvantages. Indeed, some of our consultants expressed serious worry over the possibility that the present pattern of support for biology in the College of Agriculture is inadequate for modern conditions, and that it may lose some of its international standing if it does not encourage biological work on a far broader basis than in the past.

The members of our committee could not escape the impression that in some quarters of the College of Agriculture any recommendation to alter the existing pattern of biological research and teaching was regarded as a threat to the welfare of the school. On occasion it almost seemed that the very existence of our committee was interpreted as a hostile act. We cannot emphasize too strongly, therefore, that in recommending changes in the present administrative structure, we have given, if anything, more attention to the future welfare of Agriculture than to that of any other unit of the University. In a word, we feel that a better, more broadly based, more comprehensive, more independently administered division of biology will in the long run be as good for the College of Agriculture as it will for the rest of the University. In addition to the general reasons already cited, we would mention one specific point. We doubt very much that it will be as possible in the future, as in the past to attract the best biological brains to Cornell if they are asked to accept relatively isolated positions in the existing departments of the College of Agriculture. Recruitment in all the sciences is far more difficult than it was in the twenties and thirties. Competition is extreme, and it is not only the outstanding men [candidates] who are able to demand the working conditions they want. Nowadays, one of the most frequent reasons for choosing a particular post is the opportunity it gives for working closely with colleagues in related fields.

Although some of the personnel needed for the new entity can and should be drawn from existing departments of all the colleges, many new positions must be created especially in those fields not now sufficiently represented on the campus. We are not now in a position to estimate the exact number, but it would probably not fall far short of ten new professorships, plus an appropriate number of positions as associate and assistant professors. A building should be provided as soon as possible which would house the new unit in close proximity to the basic sciences of chemistry and physics on the one hand, and the Colleges of Agriculture and Home Economics on the other. We can hardly do more than sketch the final content of the recommended college since the availability of personnel and several other factors would play important roles in determining the final result. In general, however, we would expect
it to cover the subject areas of zoology, botany, microbiology, genetics, biochemistry, developmental biology, ecology, physiology, molecular biology, evolution and modern biosystematics, and certain aspects of higher behavior. In some instances, existing departments bearing some of the names enumerated above might join the new division more or less as such. In other instances, only a portion of the personnel might be transferred, and in still others, joint appointments between the new division and existing departments might suitably be arranged. Such details must, it seems to us, await the processes of evolution and daily executive decisions. In enumerating subject areas, we are not to be thought of as recommending individual departments to represent each area. In our discussions of this matter, we found ourselves thinking in terms of three or four major sections which could group the various subject areas together in different ways. One example of such a grouping might be suggested as follows: evolution - biosystematics and population studies, biological mechanisms, behavior of individuals and groups. Whatever the final names of the new organizational units may be, we wish to emphasize the need to give prominent places to the newer and most rapidly growing areas in biology. In recommending a new school or college we are not necessarily recommending that it include all the attributes of existing colleges. We do feel, however, that it should have a primary responsibility and authority for the overall organization of biological research and for teaching at both the graduate and undergraduate levels through out the University.

We would urge, in fact, that all regularly scheduled courses in the biological sciences (including biochemistry) be organized and presented under its auspices. Included here of course should be the organization and supervision of the undergraduate major in biology and the development of honors programs. It is our understanding that, at present, opportunity to follow an honors program in biology is offered in the College of Arts and Sciences to only five students per year. This is, of course, far below the proportion found in other colleges in Cornell's category.

Because of the obvious problems in establishing a separate college or school in a single subject area, the committee devoted much of its time to debating the possibility of placing a new department of biology in one of the existing colleges. It decided against such a recommendation at this time for the following reasons.

1. Biology has by now become so dispersed, if not indeed disintegrated, at Cornell that its rehabilitation demands the single-minded attention of an administration with the responsibility and authority to effect the necessary changes.

2. It was difficult to avoid the impression that certain attitudes and emotions developed over the years, especially between the College of Arts and Sciences and the College of Agriculture, would impede cooperation between them if one or the other were to be given sole responsibility for biology.

3. Each of the two colleges mentioned has in effect had a prolonged opportunity to develop a broadly based program in biology. The fact that neither has done so did not encourage the belief that either would do so now.

4. On the positive side, it is hoped that the establishment of a new college would provide an opportunity to experiment with a new form of relationship between the private and state interests in Cornell. In the time available to us it was of course impossible to go into a detailed investigation of the relationship between the endowed and the state-supported colleges. Nevertheless, we came to believe that many of the problems we encountered in the organization of biology could be traced to the basic dichotomy between the two kinds of colleges. On several occasions we felt we were dealing with the tacit assumption that privately supported education is inherently superior to that supported by the state. It is scarcely necessary to point out that several first-class state universities elsewhere in the U.S. demonstrate the falsity of this assumption. On the other hand, certain peculiarities about the situation at Cornell still make it possible for those who are so disposed to "look down their noses" at the contract colleges. By contracting with Cornell only for specified types of training for specified vocations, the state has given the impression that it is not interested in the broader, more liberal, (or, if you will, more gentlemanly) type of education or in the advancement of pure knowledge. These activities are left, in principle at least, to the endowed college. Whether or not this restricted attitude toward education on the part of the state was ever really justified we simply do not know. We do know, however, that it is now obsolete. All over the country municipal, state, and federal agencies are supporting the broadest, most liberal kinds of education and the purest, most fundamental (or as some would say, "most useless") types of research. As a matter of actual fact, such research and such liberal education are to be found even in the contract colleges at Cornell, but curiously enough, no one seems quite ready to admit it. Least of all, is anyone apparently ready to defend the budget in Albany on the grounds that the contract colleges could be a key element in the development of a broadly based system of public university education in the State of New York?

2 The present situation in regard to premedical education illustrates how silly things can get. Largely for historical reasons, premedical students are expected to enroll in the College of Arts and Sciences, whereas pre-veterinary students who will pursue much the same courses are found in the Agricultural College. It is obvious to anyone who takes the trouble to look that one can obtain a perfectly good premedical education while enrolled in either the College of Agriculture or of Home Economics and, of course, at a considerable saving in tuition. No mention of this possibility is made in any of the college catalogues, however, and no premedical adviser is available in the contract colleges. It seems clear that an increasing number of New York citizens are preparing themselves for medical school in this way, but no one we asked seemed to have more than a very vague impression as to how many actually do so. Indeed, the uncomfortable and apologetic answers we received suggested that there is a widespread feeling that there is something clandestine and "not quite cricket" about getting into medicine in this way.
We hope that the establishment of a new college would provide an opportunity for working out a relationship with the state [that is] more appropriate to the 20th century than the existing one. At the present we can foresee only rather dimly what the outlines of such a plan might be. We do believe, however, that if the college is to accomplish the purposes we have in mind, it should at the outset derive its support approximately equally from private and state sources.

IV. Summary

The committee found itself in general agreement with the widely held view that research and teaching in biology is unduly fragmented among the several colleges at Cornell. The resulting absence of clearly designated responsibility for the overall welfare of biology has resulted among other things in serious inadequacies and gaps, especially in the most rapidly developing and exciting areas of biology. Throughout the University, biology seems to be pursued largely for its immediate relevance to certain practical problems like the training of physicians or the raising of larger and better crops. While clearly recognizing the crucial importance of the biological sciences in such matters, the committee feels that vocational importance provides too restricted a base from which to conduct a program in biology appropriate to a great University. In order to establish a sounder basis for biology at Cornell, the committee recommends that:

1. Procedures for filling tenure positions either by promotion or new appointment be revised to take full account of the needs of the University as a whole and of the highest standards of excellence as reflected in the opinions of fully qualified individuals both within and without the University.

2. Procedures for the selection, supervision, and examination of graduate students be revised to provide for greater responsibility for the review of individual training programs by representatives of the University administration. Examining committees should include a majority of scholars who have not been primarily responsible for planning or supervising the program of the individual being examined.

3. An entirely new school or college of biology be established to assemble in one place representatives of the fragments of the subject now scattered over the campus together with new appointments in areas of biology now inadequately represented. This unit should have responsibility for planning and conducting all formal course work in all the basic aspects of biology and should be adequately represented in the planning and conduct of all graduate work in biology. It should also serve as a center for fostering cooperative and interdisciplinary research and should be specially charged with providing advice and help to those University departments with a primary responsibility for the application of biological science to the solution of practical problems.

Boris Ephrussi   Alden H. Miller
H. O. Halvorson   M. M. Rhoades
David R. Goddard   Robert S. Morison, Chairman

October 23, 1963
Appointment of an Internal Committee on Biology at Cornell

December 23, 1963

To: Members of the University Faculty

From: James A. Perkins, President

Re: Biology Committee

From the work of the Morison Committee, I am convinced that we require a strong new administrative arrangement to promote biological studies most effectively at Cornell. I have appointed the following committee from the Faculty and administration to advise me on the steps we should now take.

Richard H. Barnes, Dean, Graduate School of Nutrition
Stuart M. Brown, Jr., Dean-elect, Arts and Sciences
J. Herbert Bruckner, Professor of Poultry Husbandry
Thomas Eisner, Associate Professor of Entomology
W. Keith Kennedy, Director of Research, Agriculture
Philip Morrison, Professor of Physics
George C. Poppensiek, Dean, Veterinary College
Adrian M. Srb, Professor of Plant Breeding
Frederick C. Steward, Professor of Botany
John R. Vallentyne, Professor of Zoology
Dale R. Corson, Provost, Chairman

I have asked the committee to direct its attention to: 1) a definition of the academic objectives, not only for the new administrative unit, but for Cornell's whole biology effort, wherever located, and 2) recommendation of a specific organizational plan for implementation. It is hoped that the committee will make its report by March 1, 1964.
Preface

“The Report of the President’s Committee on Biological Sciences”

March 4, 1964

and

Transmittal of the “Report of the President’s Committee on Biological Sciences” to President Perkins by Provost Corson (who was also the committee chair).

March 5, 1964
Report of the President’s Committee on Biological Sciences

March 4, 1964

Contents:
Letter of Transmittal
Preamble
Part One: Recommendations
Part Two: Explanation and Amplification
Transmittal of the Report of the President’s Committee on Biological Sciences
from the internal committee

President James P. Perkins
300 Day Hall

Dear President Perkins:

The eight undersigned members of the President’s Committee on Biological Sciences, who constitute a majority, are honored to submit their report. It recommends the creation at Cornell of a Division of Biological Sciences with inter-college responsibility for and authority over basic biological science.

The Committee undertook to translate previous Cornell studies and the Morison report on basic biological science into a workable proposal. We started from the clear consensus that a major change was necessary, yet even the most novel ideas suggested have been tempered by the necessity to preserve what is good while providing for that which is better.

Three important attitudes have informed our work. First of all, we recognized that we were charged with a matter of University-wide concern. Biology is too broad a subject, and the structural issues its present organization raises too wide, to bring it under any heading less complete than that of the University as a whole, or at least that of the Ithaca campus.

Second, we felt that the context of the new structural proposals should be that of a working partnership and not a distinct competition with the many diverse and vigorous organizations now concerned with teaching and research in biology at Cornell. We sought to emphasize the more general and basic aspects of biology in association with the other natural sciences and with the specialized and technological activities which many Cornell biologists have as their central concern. The distinction between basic and applied cannot be sharp and static; it rests upon emphasis and direction.

Third, the new organization must have flexibility: universities and sciences, like organisms, must grow, develop, and change. This proposal seeks the goal of strong and growing biology at Cornell, not by pre-assigned plan, but by moving with strong and hopeful steps along a course which can be modified to suit a changing environment. In brief, the new organization should be viewed as a step in the evolution of the University as well as of the arrangements for basic biology.

The formation of this Division is a first and essential step towards the development of a strong and coherent program in the basic biological sciences. The proposal insures continuity with the present. It preserves existing strengths in both basic and applied biology and enables biology to develop in an intimate relationship with the physical sciences.

This plan recognizes that biologists at Cornell have not, hitherto, been in effective control of their discipline, and it will correct this. It recognizes the great dispersion of biology on the Cornell campus, and it will overcome this by closer administrative ties between the dispersed units. It recognizes that many gaps need to be filled in order that the subject of biology can be responsive to modern trends, and it provides machinery for identifying and filling these gaps. It recognizes that present physical resources need to be more wisely used, that plans for their extension need to be coordinated and that a centralized facility which will represent biology on the campus needs to be built. It recognizes also that the undergraduate curriculum and the arrangements for graduate training lack coherence and integration, and it proposes means by which this may be restored. All this is inherent in the proposal.

The adoption of an inter-college organization is much more than an expedient: it is the logical recognition of the scope and range of modern biology and of the extent to which it penetrates and permeates the activities of the University as a whole. But with this pervasiveness, there is an imperative need for strong central control and direction.

Also, it is inevitable that so diffuse and far-reaching activities as those which comprise basic biology will be financed from different sources. Few branches of science today meet their ever-increasing financial needs from a single source. Our philosophy here is that the important budgetary control is over the policy which governs the expenditure of funds and not merely their acquisition or the accounting procedure or the sanction for the day-to-day disbursements. The plan provides for this through control by the new Division over appointments and promotions.

At Cornell, New York State has traditionally furnished much of the resources without which biology could not have achieved either its past distinction or its current potential, and in any foreseeable future, this will need to continue. In fact, we now look, hopefully, in an atmosphere of change and experimentation, for an increasing awareness on the part of the State of the importance of basic
biology, even though this is not specifically oriented to application. Again, hopefully, we look to the increased involvement of State funds in the needed financing of the work of a Division of Biological Sciences at Cornell University. On the other hand, we do look to a much greater and more immediate recognition than in the past of the responsibility of the endowed university of Cornell to provide funds and resources for basic biology. Hence we foresee that, in a spirit of partnership and not rivalry, the subject of biology may be developed by drawing on the resources of both state and endowed units on a University-wide basis and for the good of the whole.

We recognize that adopting our proposal will require very substantial changes in the existing relationships between the University and the State of New York, including perhaps changes in existing legislation. We also recognize that the approach to the State must be planned and made with care. But we are confident that all of this can be achieved.

Finally, we urge that all new appointments in biology and plans for new buildings and facilities be made only after an examination of their relations to the proposed new division.

Our report is in two parts. Part One contains a concise statement of our ten recommendations. Part Two explains the recommendations in greater detail and amplifies them.

Respectfully submitted,

Stuart M. Brown, Jr. Philip Morrison
J. Herbert Bruckner George C. Poppensiek
Thomas Eisner Adrian M. Srb
W. Keith Kennedy F. C. Steward
(signatures by six)
It is implicit in the world of the President’s Committee on Biology that this subject stands in a special relation to the University at this time, and that a secure basis for the healthy development of modern biology has some special significance for the future of science and of the University. Therefore, before recommendations are made and administrative procedures are stipulated, it is appropriate to ask why the affairs of biology, which have not received this special attention in the past, should do so now. The short answer is that biology literally means “knowledge about life.” It deals, therefore, with a subject which we have all experienced, and it is the one discipline through which may come an understanding of man as an organism. But it is the sudden surge of progress in biology in the last decades, and the challenge to the imagination which is aroused by the compelling conclusion that the next great thrusts in human knowledge will come through biology, that impel a re-examination of the arrangements that fit Cornell, as a vigorous university, to be an active participant in these developments. However, while we face and hope to solve the local problem, we recognize it as one which has its roots deep in the history of science and in the changing objectives and goals of biology and its current relations to the other natural sciences.

The great impact of the science of biology upon thought and human welfare is not new. It has been felt in familiar but nonetheless dramatic ways in the past. The intellectual ferment caused in the 19th century by the study of evolution raised questions about the origin and nature of man and aroused discussions on heredity versus environment, nature versus nurture, adaptation and survival. All of this affected society in far-reaching ways that were not anticipated when the doctrine was being formulated and submitted to scientific analysis through the descriptive study of organisms and populations.

The industrial revolution of the 19th century, requiring an ever-increasing preoccupation of man with the complexities of technology, demanded a greater efficiency in the production of his food. Scientific agriculture began to flourish in the aftermath of the Napoleonic Wars, and this has continued to this day, although there may be an eventual limit to our ability to feed all the people on the earth. The knowledge of plant nutrition, a first fruit of the 19th century marriage between chemistry and biology, is now familiar in the widespread use of synthetic fertilizers, but its 20th century sequel in the need for the most minute traces of zinc or molybdenum may not be so well known. The study of animal and human nutrition gave us knowledge of proteins, carbohydrates, and fats in our diet, but a productive partnership of chemistry and biology have since made vitamins and hormones as familiar as household words.

Therefore, the knowledge about evolution and the details of plant and animal nutrition, as well as the many dramatic applications of science to agriculture, medicine, and public health, may readily be mobilized to show how important the study of biology has been to man. But even all this misses the drama of the change that has now overtaken biology — a change which modifies its relationships to other natural sciences — and alters the kind of training a biologist should receive and the type of scholar who will find satisfaction in working in this field.

In brief, 19th century biology was “knowledge about organisms,” i.e., about plants or animals or bacteria. In the mid-20th century, as biology has now come into its own, it has become increasingly concerned with “knowledge about life.” This does not render the work on the organisms obsolete. Quite the contrary! It means that their study can now be pushed ever more intensively to the point of asking what life really is. How does the animate world utilize matter and energy in the organized living cells of plants and animals in order that they may grow, develop, reproduce, and respond to stimuli in their environment?

The study of cells, which also began in the 19th century, led through the investigation of their multiplication and of their responses to the twin subjects of cytology and of general physiology — two branches of biology which focus attention more upon the cells than upon the organisms from which they originated. The long-delayed recognition of the importance of the principles of genetics, soon to be linked to the behavior of the cell nucleus and of its chromosomes, furnished another great area in which broad biological generalizations could be drawn. The dramatic rise of biochemistry, no longer dominated by the chemistry of natural products, but deeply concerned with the intermediate steps by which organisms function as chemical machines, again permitted broad relationships to be seen, and comparative biochemistry was born. In their biochemical arrangements to apply energy to useful purposes, all organisms show similarities; and in the arrangements by which they transmit likenesses from generation to generation, there are also great similarities, as the science of genetics has shown. But the understanding of the inner workings of cells required other tools to be developed. First came the physical and chemical attack upon the structure of complex biologically important compounds, like starch, cellulose, and proteins, and later upon the very nature of the hereditary material (DNA) itself. Meanwhile, the descriptive science was being pushed by the aid of the electron microscope to ever lower levels of organization at magnifications which almost allow macro-molecules to be seen, so that the fine structure of the ground substance of protoplasm, as the physical basis of life, came to light. What seemed to be optically clear and fluid became increasingly complex, with its content of self-duplicating organelles and an elaborate system of granules and structures composed of membranes and vesicles.

In the broad sweep of these events, the biologist can no longer be content with natural history — fascinating and important as this may be — for he must comprehend knowledge that ranges from the level of molecules to man. And while his task of interpreting living things may seem to have been simplified by the great areas that organisms have in common, and by the contributions that have come from the study of the substances they contain and the predictability of their properties, there are still baffling problems to be solved before the intrinsic differences among the organisms are understood, or before we can explain how cells which contain apparently the same blueprint of information nevertheless use it in so many different ways.
In other words, biology begins where chemistry and physics leave off; it is pre-eminently concerned with problems of organization: organization at the molecular level, at the level of the sub-cellular organelles, at the cellular level, at the level of organs with their special functions, at the level of organisms and of populations and of their interactions. Each of these different levels of organization poses special problems and requires different approaches, training, and techniques. In fact, the great modern advance in biology largely stems from the fact that biological organization can now be comprehended in the language and through the techniques of other sciences. Its great attraction is that it can now make use of the special skills and knowledge drawn from other sciences, but all this means that biologists who know their organisms must lead the way. Although this [development] has come about first in genetics, it must and will permeate other areas of biology. Not only have biologists now the tools for the job, but the developments in other sciences have also reached the point at which, in partnership with biologists, they can attack the problems of life itself, which should yield to scientific analysis and interpretation. While the ability of man to recreate life de novo may be beyond his control, the ability to synthesize and mold the characteristics of organisms is a not too distant goal.

Thus, all this foretells profound technological applications in agriculture and in medicine; it helps us understand ourselves as organisms in the world in which we live; it prepares us for the great challenge as man ventures out into space; it poses problems that impinge upon all branches of the University, from the humanities to technology; it demands a student body and a faculty with wider horizons and deeper insights than heretofore. And if Cornell is to play a distinguished role in the biology of the future, as in the past, it must be equipped and geared and eager for the job. Thus the problems of biology are peculiarly university-wide at Cornell, as at any great institution which intends to rise to the challenge that the life sciences now present.

**PART ONE: RECOMMENDATIONS**

1. A Division of Biological Sciences shall be established with inter-college responsibility for and authority over basic biological science.

2. The Division shall chart the course of basic biology at Cornell and keep it responsive to the changing needs of the times.

3. The Division shall prescribe the curriculum for an undergraduate major in biology with appropriate areas of specialization. This major shall be available to all qualified students in the University, irrespective of their college affiliations. But the Division will matriculate no students and award no degrees.

4. The Division shall establish and supervise standards for its graduate students.

5. The Division shall provide the atmosphere and resources for excellence and creativity for research and advanced studies.

6. The Division shall be comprised of basic biologists holding positions at Cornell who shall also be regular members of appropriate colleges and departments. In particular, the Division shall include those positions now allocated to the academic departments of Biochemistry, Botany, and Zoology, and those positions in such subject areas as bacteriology and genetics which are essential to the work of the Division. These positions now number between forty and forty-five. In addition, persons who, irrespective of the allocation of their positions, are working in basic biology may also be included in the Division.

7. The Division shall have control over all appointments to and promotions in positions allocated to the Division,

8. The Division shall be under the direction of a senior administrative officer who should be an outstanding biologist. In partnership with the deans of the appropriate colleges, he shall be responsible for the preparation of the budget and the allocation of funds. He shall be responsible to the office of the President for the formulation and execution of division policy.

9. The senior administrative officer shall have an executive board comprised of distinguished faculty members representing major areas of basic biology.

10. The Division shall have a continuing responsibility to assess resources and needs and to recommend all measures necessary to attract and retain a distinguished faculty. As the present physical facilities at Cornell are inadequate for the work of the Division, it is mandatory that a new centralized biological facility be provided without delay. To fill obvious gaps and to remedy existing weaknesses, at least ten new positions in biology, including newly-endowed chairs, are required.

**PART TWO: EXPLANATION AND AMPLIFICATION**

1. **Definition of the Division**: The Division of Biological Sciences, as we conceive it, will be a new and unique kind of administrative unit, at least at Cornell. In having a university-wide responsibility, the powers of the Division will exceed those of any existing department or college. Yet the Division will not be a college, because it will award no degrees and matriculate no students. It will not be an academic department because it will embrace several departments, will not be placed within any college, and its chief administrative officer will be directly and primarily responsible to the office of the President. Unlike a center, which is a special kind of administrative unit at Cornell, the Division will have authority over the appointment and promotion of its members, and be responsible for their undergraduate teaching in basic biology as well as their activities in research, graduate, and post-graduate studies.
The Division will be a genuinely inter-college unit. Its members will be drawn from the faculties of the different colleges, though each member will retain his affiliation with a college and with an academic department within a college. It is hoped that members of the division will be elected to membership in the faculties of all colleges offering an undergraduate major in biology. As both the College of Agriculture and the College of Arts and Sciences will presumably offer undergraduate majors in biology, it is hoped that all members of the Division will be members of at least these two college faculties. Courses taught by members of the Division will be part of the regular offerings of an existing school or college, especially the College of Agriculture and the College of Arts and Sciences. Students taking courses in the Division or satisfying the requirements of an undergraduate major in biology as prescribed by the Division will of course be drawn from the various schools and colleges of the University.

2. Needs no amplification other than that provided by the paragraphs below.

3. The Undergraduate Curriculum: Just as there is now an undergraduate major in botany available to students in the College of Agriculture and the College of Arts and Sciences, it is envisaged that in the future there will be an undergraduate major in biology available to students in these and other colleges of the University. The curriculum for this new undergraduate major will be set by the Division. This means that at the undergraduate level biology will have the same degree of integration and definition as any other basic science at Cornell, such as Chemistry or Physics. There is a central core of instruction which every undergraduate biologist should receive; the Division will specify this. But provision will also be made for various areas of specialization as defined by the Division. Each student must, of course, meet the ancillary requirements of the college in which he is enrolled, and will receive his degree in that college.

There is a legitimate need for courses in basic biology having some special reference to other fields. The Division shall recognize this and, where appropriate, provide the courses.

4. Responsibility of the Division for Graduate Work: Within the framework of the Graduate School, the Division will be responsible for the quality of the graduate students who enter and the kind of training they receive. Every candidate for a graduate degree in basic biology at Cornell either has or should quickly acquire the central core of knowledge. Beyond this, the Division must provide the opportunity for a distinguished research thesis in any major area of biology in which candidates are accepted. All graduate students, of course, must also satisfy the general requirements of the Graduate School.

5. The Responsibility of the Division for Research and Advanced Studies:

In a modern university, postdoctoral training and advanced studies and research are necessary to advance knowledge and to maintain quality at the graduate and undergraduate levels. Providing an atmosphere of excellence and creativity at the postdoctoral and research level inevitably permeates the undergraduate and the graduate schools. In other words, one should build from the top down as well as from the bottom up. The revitalized biological climate at Cornell should attract postdoctoral fellows and distinguished scientists on leaves or on fellowships.

The organization of the Division, the establishment of new and improved physical facilities, and the new professorships that are to be established (see Section 10) will attract the postdoctoral fellows and visiting scientists which a modern biological organization needs.

6. The faculty of the Division of Biological Sciences: The faculty of the Division of Biological Sciences will represent Cornell's integrated effort to achieve excellence in teaching and research in basic biology. Since the division will have inter-college responsibility, it will be assigned appropriate personnel and concomitant resources from more than one college. The faculty will be supported both by endowed and public funds.

a. Specific Relationships of the Division Faculty to Other Units of the University

i. Relationships to the colleges: Each member of the Division will be automatically a member of the college which provides his position. However, since the staff of the basic sciences of physics, chemistry, and mathematics are represented in the College of Arts and Sciences. It seems appropriate that the staff for basic biology also be fully represented in that college.

ii. Relationships to departments: Each member of the Division will be a member of a regular academic department. The Division will draw on personnel from existing departments. Existing biological departments, however, need to be redefined. New departments may need to be established, and membership in departments reassigned. The plan for these changes will be made by the Division and will be executed in cooperation with the appropriate deans. The new structure for biology at Cornell should be sensitive to clusters of related subject matter that have become increasingly meaningful as the science has developed. For example, personnel might be meaningfully grouped according to orientations of interest such as evolution, growth, and development, or behavior. The new structuring of biology at the departmental level should take into particular account fruitful borderline areas between older and more formal compartments of the subject matter of biology. The details of realignments of faculty and of placing faculty in new contexts are not appropriate matters of concern to this committee, but we do emphasize the need for such changes.
b. The Sources of Faculty for the Division:

To provide immediate reality for the Division, Cornell has a substantial number of faculty positions presently devoted to basic biology. The positions and the appointees to them will be used to form the initial faculty of the Division. It is essential that present sources of faculty be supplemented with new positions, in order the gaps be filled and that certain areas be further developed. The details of the need for new faculty are left until later. The following paragraphs deal with the critical problem of mustering Cornell’s present resources in faculty, which must form the core of the new effort in basic biology.

i. Present departments entirely devoted to basic biology: Except for a few service functions, the present Departments Biochemistry, Botany, and Zoology are devoted entirely to basic biology. The faculty positions in these departments, in total number about 27, are entirely appropriate to the Division and are to be allocated to it. Although the positions and their incumbents will be incorporated into the Division, the three departmental organizations need not be incorporated intact into the new framework, and will in any case be reorganized.

ii. Other units entirely devoted to basic biology: The functions of the Laboratory of Cell Physiology, Growth, and Development represent an important area of basic biology that should be a component of the Division. The positions and personnel of this laboratory should, therefore, be incorporated into the Division. There may be other similar units which should also be incorporated.

iii. Fragments of basic biology presently placed in departments with major responsibilities for technical or applied work:

As basic biology presently exists at Cornell, fragments of the subject are scattered into various administrative units other than departments and laboratories devoted entirely to fundamental work. If the Division is to be organically sound, and if the presently fragmented areas are to develop in an integrated and vigorous fashion, at least certain of the fragments must be brought into the Division.

Before designating those fragments that should be incorporated into the Division, one should recognize that the fragments are of different kinds and play different roles. In designating the Division faculty, it seems most useful to avoid fine discriminations among the actual and potential roles of these diverse fragments of biology, but instead to recognize that for practical purposes they may be placed into one of two categories as follows: (1) fragments of biology whose faculty representatives occupy positions unequivocally allocated to basic work, particularly where the work has a university-wide role in representing some substantive area of basic biology; (2) fragments of biology whose representatives do basic work which is primarily justified in relation to a particular applied area.

Category 1: Positions in this category are clearly exemplified by the bacteriology section of the Department of Dairy and Food Science and the genetics section of the Department of Plant Breeding. Although these substantial fragments of bacteriology and of genetics at Cornell exist in applied departments and have valuable interactions with their applied counterparts, the personnel representing bacteriology and genetics have for a long time assumed university-wide responsibility for teaching a large spectrum of subject matter in biology and have conducted research appropriate to a unit devoted to basic biology. The present personnel represent areas of biology that will be important to the Division, and the positions to which they are appointed are a permanent part of Cornell’s investment in basic biology. Analogous fragments of biology are found in the Departments of Conservation, Entomology (including some designated as ‘biology’, and Plant Pathology. The appropriate positions should be assigned to the Division, and the faculty holding these positions should be assigned to either an existing department or one to be created. This does not preclude the retention of membership in their present department through joint appointment. Prior to the implementation of this proposal, a list of positions in this category will be agreed upon.

Category 2: In our discussion of Category 2, we recognize at the outset that several of the larger units at Cornell, e.g., the College of Agriculture, the College of Veterinary Medicine, and the School of Nutrition, have strong obligations in various aspects of applied biology. We also recognize that in order to fulfill these obligations, the applied units need to have certain work in basic biology under their complete authority. In this situation, to assign to the Division all positions whose incumbents are doing basic biology would not be feasible and would lead to clear conflict of major interest. But certain faculty whose work is directly necessary to applied biology may be appropriate to appointment in the Division and may wish to be members of the Division faculty. In such instances, we visualize that upon invitation by the Division and with consent of the faculty member’s dean and department head, he might be appointed to the Division and would then serve as a regular member. He would be appointed into some particular department within the Division, but through joint appointment would retain membership in his department of origin. However, the position itself as distinct from the faculty member would remain under the control of its original administrative unit. If the work and interests of a given member in this category should change, the procedure of appointment could again be invoked to arrange his release from the Division.

Other categories: As the work of the Division develops, further categories of membership may prove useful, but the Committee believes that at the outset only the two described above should be established.

iv. New sources of positions for the Division: The preceding paragraphs have dealt with sources of positions for the Division that seem presently and appropriately available from within the University. Both our own thinking and that of the Visiting Committee for Biology stress the need for additional positions. Problems relating to entirely new positions are dealt with in Sections 7 and 10.
of this report; Section 7 deals with the reallocation of positions to the Division. Appointees to new positions within the Division will have the same sets of relations as described for original members in the Division, i.e., they will be appointed into the appropriate college of the University and to an appropriate department.

7. Control over Appointments and Promotions: It is axiomatic that excellence in basic biology can be secured and maintained only where there is control over appointments and promotions. The following typical situations to be met by the Division are considered:

a. Filling of a vacancy in a position allocated to the Division

As soon as it is known that a vacancy will occur in one of the positions allocated to the Division, the head of the department in which the position is placed will automatically inform both the dean of his college and the senior administrative officer of the Division.

The senior administrative officer, in consultation with his executive board, will then consider how the vacancy may be so filled as to strengthen basic biology in the University as a whole. The question will be whether the vacancy should be filled by someone working in the same area as the resigning incumbent or by someone working in a new or different area. The various alternatives will be explored, and after discussion with the appropriate dean and department head, a decision made.

The field of candidates in the area chosen will be canvassed and whatever procedures may be necessary to guarantee the identification and appointment of the best man [person] available will be adopted. This will as a matter of course require the use of ad hoc committees.

The actual mechanism of appointment, after a candidate has been selected and approved by the Division and the office of the President, will follow the course appropriate for the college in which the initial appointment is made.

b. Appointments to entirely new positions

The resources of both the Endowed and the State Colleges must be mobilized to create new positions. We visualize the procedure as follows:

The Division, through its senior administrative officer and with the advice of its executive board, will first stipulate the need; i.e., it will designate the area of biology which is to be strengthened or developed and the type of candidate best qualified for appointment.

The appropriate deans and the senior administrative officer of the Division, working closely together, will then determine the college in which the new position is to be created and which will provide the funds for its support. In most cases, the decision will be made in terms of considerations about housing, the location of the laboratories and instruments which the holder of the new position will be using. But this should not preclude the use of endowed funds to strengthen work that may be appropriately placed in one or another of the State colleges, or of State funds to support work carried out in the laboratories of an endowed college.

The new position will be filled in the normal way; that is, by undertaking a thorough canvas of suitable candidates, by appointing ad hoc selection committees, etc. After the appointee has been approved by the Division and the office of the President, the formal mechanism of appointment will be that of the college in which the new position has been created.

Thus, every appointee will be a member of a college as well as of the Division and of a department within the Division. But the device of joint appointments should be used to provide for membership in different faculties wherever this is desirable.

c. Appointments to the Division of persons whose position is not allocated to the Division

Cases will arise in which an investigator should, by virtue of his basic work, be a member of the Division, although the position to which he was appointed is allocated to an applied department. The arrangements to cover cases of this sort will invoke the partnership between the Division and the appropriate dean. There is no need for any special machinery for appointment or promotion. (See Category 2 above)

d. Promotions, salary increments, and terms of appointments

Once an appointment to the Division has been made, the future professional welfare of the appointee will be an active concern of the Division. This means that it is the responsibility of the senior administrative officer to examine salaries and levels of existing appointments, and to make recommendations for promotions or salary increments to the appropriate dean.

The above categories all relate to professorial appointments. There will inevitably be a number of postdoctoral fellows, visiting professors, and investigators. At this state, no special recommendations for the making of these appointments are necessary.

When the Division comes into being, careful consideration will need to be given in order that it may avoid unnecessary disparities between members of the Division who are initially members of different colleges. It is recognized that the retirement schemes of the State and endowed colleges are and will be different, but some other differences may be more easily resolved. In this category
is the present anomaly of the use of nine or eleven months' bases for the payment of stipend, the different policies that exist on the supplementation of salary from federal grants, the different rules which govern consulting, travel expenses, and attendance at scientific meetings. All this will need to be reviewed. The objective, however, will be to adopt the most liberal policies possible in order that terms of appointment and conditions of work in the Division shall be free from avoidable restrictions and discrepancies.

8. Financial Support

Strengthening biology at Cornell will require substantial amounts of money and this needed support must be attained by (1) re-aligning existing resources in the most effective manner, and (2) securing additional funds. Both steps require full use of State and non-state monies. Providing support from state and non-state sources increases the magnitude of the administrative details, but it does not preclude a high degree of budgetary control by the senior administrative officer. Indeed, such control and responsibility are essential to the development of basic biology.

The budgets for the departments in the Division will be prepared in partnership with the respective deans and the needed financial support will be sought through joint cooperation and effort. Obviously, the final allocation of funds for and within the Division will depend upon the source and amount received. Once the allocations have been determined in consultation with the deans, the funds will be expended in keeping with the fiscal policies of the respective colleges.

9. The Executive Board

The breadth of modern biology extends beyond the scope of the most distinguished scientist. Therefore, the Committee considers it mandatory that the senior administrative officer have the advice and counsel of an executive board comprised of faculty members representing major areas of basic biology and appointed for definite terms. The duties of the board shall be to assist the senior administrative officer in the development and execution of policies and programs essential for the vigorous growth of a dynamic discipline. The executive board shall be composed of not less than five and not more than seven faculty members, and appointment to the executive board shall be by the President upon the recommendation of the senior administrative officer. The executive board shall meet upon the call of the senior administrative officer, but not less than once monthly except with the consent of all the members. At least four times each year the Board shall meet with the Deans of the Colleges of Agriculture and Arts and Sciences, and with other administrative officers as appropriate.

10. The Responsibility of the Division to Assess Resources in Basic Biology

After the Division is established and working, it must discharge its continuing responsibility to ensure that Cornell's resources of personnel and physical facilities are adequate to maintain the subject at the forefront of the science. This implies continuing vigilance to develop new areas, particularly the borderline areas between branches of science, and to provide new facilities. While these are long-term objectives, certain immediate needs must be met in order that the Division can start effectively. These needs fall into two categories: (a) Physical facilities, (b) Professional personnel.

Physical facilities

The Division should survey all existing facilities that are available to basic biology, consider their fitness for modern needs, their present allocation and use, and in consultation with appropriate deans and department heads, formulate the plans for their improvement and re-allocation where necessary.

The Division should immediately become aware of all existing or tentative plans for the development of physical facilities which involve biology. Insofar as these relate to basic biology, the plans should come within the sphere of the Division, form part of a master plan for the best development of biology in the University as a whole.

It is quite apparent, however, the existing facilities, however realigned, will be inadequate for the development of basic biology at Cornell with the necessary standards of excellence.

It is generally recognized that the existing Department of Zoology will, in its realigned form, need to be re-housed. However, over and above this pressing need, a centralized facility is needed to accommodate all those activities of the Division which cannot function properly if they are dispersed among the departments. In particular, this building should house: (a) the hard core of instruction which all undergraduates and graduate students in biology require, irrespective of their area of subsequent specialization. This will need both qualified staff and expensive facilities to meet modern needs.

(b) Accommodation for seminars and visiting professors and lecturers which serve the biological community as a whole.

(c) Professorial staff and their physical facilities that are needed to develop areas of basic biology that are not now, and cannot be, interpolated in existing colleges and departments.

Professional personnel

It goes without saying that the Cornell biological faculty should be distinguished in each major subject area. The criteria of such excellence and distinction can only be stipulated by biologists; this is the function of the senior administrator and his executive
board, acting for the Division. High caliber appointments automatically attract others; moreover, it is virtually impossible to attract and retain high-caliber personnel in positions of isolation from people of similar stature in related fields. To attract and retain such a faculty, a mechanism for the close association of its active people is essential; the divisional organization should provide this. Where association can be based on close physical proximity, this is highly desirable; where it is not so feasible, a feeling of belonging to a closely-knit, integrated organization is essential.

Therefore, Cornell must have some new professorships adequate to attract and retain scholars of outstanding distinction in basic biology. The organization of the Division and the improved physical facilities that are advocated will all contribute to the atmosphere of creativity and excellence necessary to attract outstanding biologists to the new professorships and to retain a distinguished faculty. The reverse is also true; the influx of new distinguished faculty is essential for the accomplishment of the desired ends. It is not wise to stipulate here a definitive list of the new professorships required, whether this is to be ten or more. However, the exciting things in biology are happening, and will continue to happen, in the borderline areas between the more formal divisions of the subject and in those areas where contact is made with the other natural sciences. The following are obvious examples of dynamic and fruitful areas at the present time, irrespective of the particular organisms or group organism which may be under investigation:

- Growth, development, and morphogenesis
- Genetics in relation to metabolism and differentiation, i.e., information transfer at various levels
- The study of organization and function at all levels, i.e., bridging the gap between the molecule, the cell, and the organism
- Subcellular structure and organization of protoplasm as the physical basis of life, i.e., the fine structure of cells and their organelles
- The study of behavior, whether at the level of organisms or of populations

This list is meant to be illustrative — not complete; but in any, or all of these areas, Cornell needs additional strength
Transmittal of the Report of the President’s Committee on Biological Sciences from the Provost

March 5, 1964

Dr. James A. Perkins
President, Cornell University
300 Day Hall

Dear President Perkins:

Attached is the report of your Committee on Biological Sciences, appointed last December, whose mission was to define the academic objectives for Cornell’s whole biology effort and to recommend a specific organizational plan for implementation. The Committee took as its starting point last October’s report by the outside committee of distinguished biologists (the Morison Committee). The Morison Committee pointed out “the transcendent importance of biological research and teaching in relation to the University’s primary mission of understanding the nature, both of the universe in which man finds himself, and of the quality of his own being.” That Committee found that Cornell falls short of its potential in this regard because research and teaching in biology are unduly fragmented among the several colleges, and that as a result, inadequacies and gaps exist. To correct these deficiencies, the Morison Committee recommended establishment of an entirely new school or college of biology.

Your present committee recommends the establishment of an inter-college division to have responsibility for, and authority over, basic biological sciences. This division shall prescribe the curriculum for an undergraduate major in biology, available to all qualified students in the University, although the division itself will matriculate no students and award no degrees. The division shall also establish and supervise standards for its graduate students, within normal Graduate School procedures.

This division shall be comprised of those faculty members now in the departments of Biochemistry, Botany, and Zoology, as well as certain basic biologists in other departments. The members of the Division faculty shall also be regular members of appropriate colleges and departments, but with control of appointments and promotions residing in the Division. The Committee recommends that the Division shall be under the direction of a senior administrative officer who will work in partnership with the deans of the appropriate colleges for the preparation of the budget and the allocation of funds. This officer shall be responsible to the office of the President, however, for the formulation and execution of division policy.

The Committee also recommends early provision of a new centralized biological facility and the establishment of at least ten new faculty positions in biology.

The Committee is unanimous in its belief that establishment of an inter-college Division, as outlined above, is a sound and progressive step. The Committee is not unanimous, however, in its view of the future evolution of this administrative arrangement. The majority believes that the dual administrative responsibility proposed in the report has advantages in promoting the concept of “partnership” which outweigh the obvious administrative difficulties and which provide the basis for indefinite continuation of the arrangement. The minority believes that the Division will prosper in the long run only if it has completely independent status, and that the future evolution of the organization must be in this direction. Some members of the Committee believe that eventual integration of the Division with a larger administrative body of the University is desirable.

Another point on which a minority view exists concerns the formal relationship between the Division and basic biologists in applied departments. The Committee is unanimous in its belief that there are a limited number of faculty members in such departments whose work has no direct purpose other than to serve the ends of high-quality basic biology (referred to as “Category 1” faculty members in the report), and who should therefore be assigned, along with their positions, to the Division. However, the Committee is divided in its view regarding the larger number of basic biologists whose work is essential to applied ends (referred to as “Category 2” faculty members in the report). The majority believes that such faculty members should have a formal relationship with the Division only if the faculty member, his department head, his dean, and the Division agree that it is desirable for him to be assigned.
full-time to the Division (with his position remaining under the control of his original department, however). The minority believes that high-quality basic biology in applied departments will be possible only if faculty members in this category have the privilege of joint or courtesy appointments in the Division, while remaining as full-time members of their applied departments.

For various of these reasons, Dean Barnes and Professor Vallentyne have withheld their signatures from the Committee’s letter transmitting the report. Other Committee members have views which diverge at one point or another with the details of the report. The entire Committee agrees, however, that it is important to proceed with the development of basic biology at Cornell, and they agree that the inter-college Division is an essential first step.

Sincerely yours,

(signed)

Dale R. Corson
Chairman
Preface

Critiques of the Draft Report Proposing a Division of Biological Sciences:

by

C. E. Palm, Dean of the New York State College of Agriculture, February 27, 1964

and

J. R. Vallentyne, dissenting member of the Committee, March 3, 1964
Provost Dale R. Corson  
Day Hall

Dear Dale:

At your invitation I met with Professors Brown, Eisner, Kennedy, Srb and Steward last Thursday to review some of the matters that will arise in the implementation of any plan to strengthen basic biology at Cornell. Thinking that it would be more constructive to present my own analysis of the situation at the outset, for clarification of thinking if for nothing else, I wrote out the enclosed memorandum and gave each member of the committee a copy.

You will note that my No. 3 plan is essentially that which the committee discussed at the meeting on February 22. I voiced my impression then as to difficulties in its workability, and have not changed my mind.

I felt the discussion on the 27th, which lasted over a two-hour period, was friendly and helpful. Each of us has the same basic objective, viewed from a different vantage point. My feeling is that from the short-run and long-run viewpoints, we have to be as certain of success as possible. I still believe that the comments in this memorandum which I gave the committee offer possibilities which should be explored.

Sincerely yours,

(signed)

Charles E. Palm  
Dean

CEP:am

CC: A. H. Peterson

Enc.
Memorandum for Discussion of Biology at Cornell University

From C. E. Palm
February 27, 1964

Discussion at the request of the Provost with Professors Brown, Eisner, Kennedy, Srb, and Steward

Among the several ways to strengthen basic biology at Cornell University are the following:

1. Establish a new Division of Biological Sciences, or Life Sciences, in the endowed university that would have ample funds to provide an organizational structure with maximum freedom for the work of the professors, with a minimum of restrictions. Existing Cornell professors who would qualify could be appointed and others recruited. One difficulty with this proposal is the fact that it would be costly and funds for such an enterprise are not now available even if the administration were willing to approve it. Such a Division might be separate or within the College of Arts and Sciences.

2. Recognize through an appropriate request to State University of New York, the State Education Department and the Division of the Budget, that the role of the present New York State College of Agriculture at Cornell University, is in fact, and should be formally recognized as a College of Agriculture and Life Sciences. The Master Plan for State University is being revised now for the next 5 years, and will be submitted to the Legislature in September of 1964. Recognition of this expanded responsibility could provide an important source of support for strong undergraduate specialization in the life sciences, for strengthened graduate and post-doctoral training, on the part of State University in its working relationship with Cornell University. Official recognition would permit the reorganization of our resources under the direction of a new director of life sciences within the College of Agriculture and he, in turn, would be able to work with other units of Cornell University in providing a coordination of the total resources and arrange for the participating appointments of professors in a university-wide structure for basic biologists whose work and recommendations would be sought in guiding administrative action. The time is right and a decision will be made within months which can alter the future course of this type of support. The assurance of continuing financial support for facilities and personnel from this relationship with the state, should it be developed, would be a tremendous asset to the future of basic biology at Cornell University.

3. Provide an administrative Division of Biological Sciences in the university as an authoritative unit, to bring together units and segments of basic biology from the Colleges of Arts and Sciences and Agriculture, with possible appointments from other administrative units, and to coordinate them into a functional Division exercising the power to direct the development of basic biology through “partnership with the deans,” but with final power resting in the Director who would in fact have the power of the Office of the President to work with an executive committee of 5 - 7 professors, in approving all appointments, promotions, salary increments and the development of budgets within the Division. At the same time, the professors in the new Division would remain as members of their present or reorganized departments, within their own colleges, subject to the administrative procedures and regulations of that college. This plan would call for the commitment of a definite number of positions now, presumably binding for the future as well, from each college. The Director and his Executive Committee would work with the deans to decide on new positions, new facilities and which college would seek the support needed by the Division. Future rearrangement of basic biological resources in the component colleges supporting the Division could be attempted, if not in fact carried out, by the Division. At the earliest possible moment the new Division of Biological Sciences would plan for the construction of a modern, central facility, recognizing in so doing that all participants of the Division cannot be housed in a central location.

4. A modification of the program outlined in proposal #3 might shift the emphasis from authoritative control to coordinated control, on the part of the Director and his executive committee, with the deans participating in the decision making process. It would be university policy that the deans and department heads or chairmen concerned with basic biology would seek the suggestions of the Division through the Directors, the executive committee or ad hoc committees of the Division qualified to deal best with specific problems, including appointments, promotions, new programs and the like. It would not be mandatory, however, that the dean or department chairman follow this advice. The responsibility for the operation of the college and its departments would remain under the jurisdiction of the dean and his administrative associates, including department heads. The Division would have the opportu-
nity, in event of disagreement with the college over the use of its assigned resources in basic biological sciences, to sit down with higher university administration, and the college administration concerned, to review the total picture and reach a decision. While it seems unlikely that such a discussion would be called for very often, it would permit points of view and an outline of responsibilities in terms of unit responsibility and total university concern. Further those concerned between the Division and the participating colleges and departments would all be interested in developing strength in biology; they would soon develop a recognition of other uses to which these participating resources may be committed or shared; the source of funds which, at times, dictates appropriate use procedures and the like. The Division of Biological Sciences could develop a feeling of cooperative, friendly participation on the part of the segments of the whole, rather than a cooperation forced by administrative power which can never provide the feeling of comradeship in a joint undertaking. The Director would have the power derived from leadership, and even though he would lack some of the authority over the professors and the participating colleges as outlined in proposal #3, his influence in leading basic biology into new areas of strength at Cornell could be even greater. The Division leader must be an individual of quality, as measured by scientific competence, leadership ability and personal magnitude. The success of any venture, and particularly one that involves joint effort will, in large measure, rest upon the qualifications – broadly considered – that he brings to the job.

Any one of these proposals might be followed, but the chances for success differ. For the long pull I prefer an attempt to see what can be developed from an implementation of proposal #2 integrated with #1. As long as Cornell University is a hybrid of resources, perhaps new vigor can come from joint effort of this type. If approved, careful exploration of proposal #2 might be undertaken immediately. It would have the possible advantage of reorientation of an established contract unit — not the request for a new one — to better serve its original charter for the future, to accommodate new needs of both State University and Cornell University in providing jointly for expanding opportunities in biology at all levels, and to strengthen the life sciences upon which the future of agriculture depends.

Proposal #3 seems unlikely to succeed because too many inherent difficulties are involved, administratively.

Proposal #4, while less impressive, could be the first step in the development of an inter college program, with the definite understanding that it would provide a forum for the faculty in the overall surveillance of biology and its needs. It would require those responsible for administration at the college and departmental levels to consider the recommendations of the basic biologists in making appointments, promotions, and the like, or be responsible to review alternatives with the university administration and the Division leadership. Since we do not know as yet where we will be or, for that matter, we are not sure where we want to be until some explorations have been made in terms of long-range support, I prefer proposal #4 as the first step in strengthening basic biology at Cornell.
March 3, 1964

Dr. James A. Perkins
President, Cornell University
300 Day Hall

Dear Dr. Perkins:

Let me make it clear at the start that I regard the majority report of the Committee on the Biological Sciences as the only feasible solution that can be put into effective action without undue delay. My only major disagreement lies in the fact that the authors of the majority report clearly regard the proposed inter-college Division of Biological Sciences as something more than an interim solution to the problem, and perhaps even as something more than an isolated innovation in the structure of the University. In my opinion the proposed organizational framework for the Division is such that it cannot function effectively on anything more than an interim basis. It is on this point that I dissent strongly from the majority point of view. I am convinced that if the inter-college intent of the majority report is instituted on anything more than an interim basis, it will deal a fatal blow to the future of the basic biological sciences at Cornell, not in the sense of instituting a regression, but fatal in that it will prevent Cornell from gaining future access to a leading position in the biological sciences.

One must recognize that the current problem in biology originated in a past laxity of the College of Arts and Sciences in that it failed to retain staff and instruction in one of its essential subjects (biology as a whole), coupled with an uncontrolled vigor of the College of Agriculture in initiating instruction and even departments in basic, non-applied sciences. These trends brought about a break in a long-standing tradition of the University.

The solution to the problem now is surely to repair the broken structure rather than to encircle it. Because of the present educational and financial commitments of the University, this probably requires the formation of a new Division of Biological Sciences with an instructional staff essentially as outlined in the majority report. But this Division, if it is to be effective, must, within the usual limits given to budgetary units of the University, control its own staff and budget and be responsible through a senior officer to a single superior. Furthermore, I regard it as essential that steps be taken to bring this new Division into a larger administrative unit that encompasses basic science in general, whether this be through a Division of Science in the College of Arts and Sciences, a College of Science, or by some other means. In my opinion, the Morison Committee was absolutely correct in suggesting the formation of a new and separate unit for the biological sciences, rather than an inter-college structure of the sort outlined in the majority report. The only comments that I would add to the Morison report are: (a) their suggested unit is more like a department than a college; and (b) the new unit should be tied administratively to other units of basic science.

My specific objections to the majority report are as follows:

1. The proposed “solution” to the problem as outlined in the majority report is to my way of thinking no solution at all in a long-term sense; rather, it may even formalize some of the very factors that led to the development of the problem in the first place. To suppose that one needs to create inter-college divisions whenever a subject serves the interests of more than one college is a fiction. If it were true, then we should seriously consider comparable inter-college arrangements for psychology, physics, chemistry, English, and so on.

2. The proposed inter-college Division is basically founded on a weak administrative structure in which the real distribution of power and authority between the senior officer of the Division and the eternal triangle of deans that he must deal with is ill-defined. The majority report assumes an unusual degree of partnership and cooperation between high-level administrators and colleges that really in some cases have separate roles and functions, yet in others, common and conflicting interests. One surely understands that cooperation is implicit in all that is done in the University; but, in the final analysis some one has to say what it is that is to be done. That distribution of power and authority should be defined with unmistakable clarity.

3. The admittedly complex machinery inherent in the operation of the inter-college Division would surely not attract the best possible candidates for the office of senior administrator. If the probability of obtaining a leader with defined qualifications were 0.75 under the most favorable of circumstances, then I would estimate the comparable probability for the proposed scheme to be about 0.20 at best. This single consideration has profound implications for the future of the basic biological sciences at Cornell.
In my opinion, the new Division must operate as a unified body in all respects if it is to thrive. This would be quite impossible for the inter-college Division as conceived in the majority report, since it would be split from the very start in several respects: undergraduate instruction and curricula; tuition of students; duties of staff; consulting practices; salary scales and retirement benefits; etc. Over the years these trivial matters would act to re-enforce any frictions that might develop for other reasons. The Division would be deprived of the unity of spirit and purpose that in my opinion are sine qua non conditions for ... its excellence. If mixed State and endowed monies are to be used for the Division, it is essential that there not be two different kinds of dollars, but only one — joint in origin.

No subject can function at its best when it is subservient in all or in part to any end other than that of the subject itself. One does not expect medical schools to produce good biology any more than one expects biology departments to produce good medicine. The situation is no different regarding biology and agriculture: it is in the interest of both that they be separate in terms of university structure. This does not preclude the possibility of basic biologists working on applied problems in the College of Agriculture any more than is the case in other applied units of the University. Nor does it imply any profound difference between basic and applied workers, for in the long run every one seeks recognition of his work in application. But it does clearly imply that in a statistical sense the basic biological sciences will function best over the years if they are in control of themselves.

The majority report makes little more than passing note of the fact that the basic biological sciences are basic sciences, and that they will function best both in their own right and with regard to inter-science developments if they are linked administratively with other basic sciences. One should recognize that the basic sciences have common philosophies, needs, interests, approaches, and justifications for existence and funds. Their presence in the same administrative structure does not make it impossible for one or more of them to pass into intellectual insignificance, but it does, I think, make it much less probable. One wonders if some analogy can be made between science and language (viz., the Division of Modern Languages in the Arts College).

The majority report really only directs itself to well-delineated portions of two colleges: Agriculture, and Arts and Sciences. No mechanism is described for the formalization of common interests between the Division and units external to it by joint appointments of a courtesy nature. These could be instituted on a limited scale with profit to the University as a whole, the appointees having voting rights in the Division, but retaining membership in their parent departments; however, to maintain a strong and healthy Division, the number of such appointments would have to be limited.

Some degree of legislation may be necessary to formalize the participation of staff members from the College of Agriculture in the proposed Division, as outlined in the majority report. If this is the case, then the enactment of such legislation might fix the structure of the Division for a longer period than would be desirable under the circumstances. When legislation is enacted, it should be for a more workable long-term solution. As a set of alternate recommendations to those of the majority, I submit the following changes and two new recommendations for your consideration:

Changes:

Recommendations 1-10 as listed in the majority report of the President’s Committee on Biological Sciences shall be accepted with the following changes:

(a) In Recommendation 1, replace “inter-college” by “university”.
(b) Delete the first sentence of Recommendation 6.
(c) Delete the last two sentences of Recommendation 8.

New Recommendations:

11. The University shall institute on an interim basis the essentials of the proposed Division of Biological Sciences as outlined in the majority report, and as here amended; but if legislation prohibitive to the future evolution of the Division, as described in Recommendation 12 is required, then those parts requiring legislation should be left in abeyance until such time as Recommendation 12, can be implemented.

12. The administrative officers of this University shall enter into discussion with appropriate representatives of the State of New York concerning the creation of a non-interim Division of Biological Sciences with a new and independent financial arrangement that will permit a wiser utilization of existing funds for the purpose of furthering the basic biological sciences. It shall be understood that in improving the standards of these basic sciences at Cornell, long-term benefits will accrue to those units of the State University of New York that utilize the basic biological sciences as a groundwork for their specialized pursuits. It shall also be understood that the Division will utilize both state and endowed funds and staff; that it will operate as a single unit; and that it will be administratively located eventually, if not initially, in a larger unit of the University that will also encompass other basic sciences.

Sincerely,

(signed)
Preface
The purpose of this memorandum is to report to the Faculty on the establishment of the Division of Biological Sciences.

James A. Perkins
October 20, 1964
MEMORANDUM

To: The Cornell University Faculty
From: James A. Perkins
Subject: The Division of Biological Sciences

The purpose of this memorandum is to report to the Faculty on the present status of the Division of Biological Sciences.

1. Establishment of the Division. The Division of Biological Sciences was established by the Board of Trustees effective 1 July 1964.

2. Responsibilities of the Division. The faculty and administration of the Division of Biological Sciences, in cooperation with the faculties and administration of other units of the University, are charged with charting the future course of basic biology at Cornell. Specifically, the Division is responsible for organizing and conducting appropriate courses of study in the basic biological sciences, at both the undergraduate and graduate levels. The Division Faculty will establish the curriculum in basic biological sciences for inclusion in the undergraduate degree programs of the College of Agriculture and the College of Arts and Sciences; in consultation with the Faculties of these Colleges, the Division Faculty will administer this portion of the degree programs for such students. The Faculty of the Division will establish and supervise standards for graduate students in the biological sciences, within normal Graduate School procedures. In planning its curricular offerings, the Division Faculty will recognize its responsibility to the needs of students specializing in areas other than basic biology.

3. Director of the Division. Dr. Robert S. Morison has been appointed Director of the Division of Biological Sciences, and also Professor of Biology in the College of Agriculture and in the College of Arts and Sciences. The Director will have administrative responsibility for the Division, its personnel, and all its programs of instruction and research.

4. The Faculty of the Division. As of 1 October 1964, the membership in the Faculty of the Division is as listed below. Primary responsibility for the positions occupied by these faculty members has been assigned to the Division of Biological Sciences, but they will continue to be members of their respective colleges and to participate in the affairs of those colleges.

   John M. Anderson, Professor of Zoology
   Harlan P. Banks, Professor of Botany
   John P. Barlow, Associate Professor of Oceanography
   Richard A. Barr, Assistant Professor, Laboratory of Cell Physiology, Growth, and Development
   David W. Bierhorst, Associate Professor of Botany
   Antonie W. C. Blackler, Associate Professor of Zoology
   Joseph M. Calvo, Assistant Professor of Biochemistry
   LaMont C. Cole, Professor of Zoology
   Louise J. Daniel, Professor of Biochemistry
   Eugene A. Delwiche, Professor of Bacteriology
   William A. Dilger, Associate Professor of Conservation
   Thomas Eisner, Professor of Entomology
Perry W. Gilbert, Professor of Zoology
Donald J. Hall, Assistant Professor of Biology
George P. Hess, Associate Professor of Biochemistry
Robert W. Holley, Professor of Biochemistry
William T. Keeton, Associate Professor of Biology
John M. Kingsbury, Associate Professor of Botany
Georges A. Knaysi, Professor of Bacteriology
James N. Layne, Associate Professor of Zoology
Samuel L. Leonard, Professor of Zoology
Russell E. MacDonald, Associate Professor of Bacteriology
William N. McFarland, Assistant Professor of Zoology
Robert S. Morison, Professor of Biology
Harry B. Naylor, Professor of Bacteriology
A. Leslie Neal, Associate Professor of Biochemistry
Walter L. Nelson, Professor of Biochemistry
Edward C. Raney, Professor of Zoology
R. Blake Reeves, Assistant Professor of Zoology
Frank Rosenblatt, Lecturer in Psychology
Harry W. Seeley, Professor of Bacteriology
Edgar M. Shantz, Associate Professor, Laboratory of Cell Physiology, Growth, and Development
Charles G. Sibley, Professor of Zoology
Adrian M. Srb, Professor of Genetics
Frederick C. Steward, Professor of Botany and Director, Laboratory of Cell Physiology, Growth, and Development
Harry T. Stinson, Professor of Genetics
Charles H. Uhl, Associate Professor of Botany
Lowell D. Uhler, Professor of Biology
John R. Vallentyne, Professor of Zoology
P. J. Van Demark, Professor of Bacteriology
Bruce Wallace, Professor of Genetics
Harold H. Williams, Professor of Biochemistry
William A. Wimsatt, Professor of Zoology
Stanley A. Zahler, Assistant Professor of Bacteriology

In addition, Richard D. O'Brien, Professor of Entomology, and Professor Harold A. Scheraga, Professor of Chemistry, are members of the Division, although their positions remain in their respective departments. The Division of Biological Sciences will also recommend, for concurrence by the appropriate dean, appointments to positions now vacant which have been assigned to it from the Departments of Biochemistry, Botany, and Zoology.

In addition to the faculty listed above, joint appointments to membership in the Division for other biologists who can participate in the Division's work will permit close integration of the program of the Division with the programs of other biologically oriented departments. It is anticipated that a number of joint appointments will be made to the Division faculty during the coming months.

5. Organization of the Division. For the current academic year, the primary organization of the Division of Biological Sciences will consist of four Sections: Section A (Biochemistry and Related Subjects), Section B (Botany, Genetics, and Related Subjects), Section C (Zoology and Related Subjects), and Section D (Bacteriology and Related Subjects). The Faculty of each section will consist of the faculties of the corresponding Departments of Biochemistry, Botany, and Zoology, and of the Bacteriology section of the Department of Dairy and Food Science, and of members of other home departments whose work makes assignment to a given section appropriate.

The following officers have been appointed Chairmen of Sections for the term 1 October 1964 to 30 June 1965:

Section A (Biochemistry and Related Subjects): Richard D. O'Brien
Section B (Botany, Genetics, and Related Subjects): Harry T. Stinson
Section C (Zoology and Related Subjects): LaMont C. Cole
Section D (Bacteriology and Related Subjects): Harry W. Seeley

It is anticipated that by 1 July 1965 this temporary organization will be replaced by a more permanent departmental organization for the Division.
6. **Executive Committee.** An Executive Committee will be formed to advise the Director on the development and execution of Divisional policies and programs. For the period until 31 December 1965, the Executive Committee will consist of nine members appointed by the President: two members elected and recommended by the Division Faculty; two members recommended by the Director; the four Section Chairmen and the Director of the Division, who will serve as Chairman of the Committee, *ex officio*. A slate of nominees for the elective positions will be circulated soon by a Nominating Committee consisting of Professors Daniel, Reeves, and B. Wallace, Chairman. This scheme of Executive Committee organization will be reviewed during the course of the coming year.

7. **New Professorial Chairs in Biology.** The Board of Trustees has established, from endowed funds, the Charles A. Alexander Professorship of Biological Sciences. The University has been awarded by the New York State Board of Regents an Einstein Professorship, to become available on 1 July 1965; the appointment to this chair will be used to strengthen the Division. Other funds are in hand and additional funds are being sought to permit the establishment of other chairs.

8. **Facilities for the Division.** Plans are being formulated and support sought for new central facilities for the Division of Biological Sciences. The Division will continue to have at its disposal the space currently assigned to its members. Negotiations are under way to secure additional space for an expanded Division faculty.

9. **Biological Systematics.** The future organization and location of the University’s systematics collections, and in particular the relations between these collections and the Division of Biological Sciences and the several applied departments which use them, are currently under study. A committee of distinguished biologists from outside Cornell -- Dr. Lincoln Constance, University of California at Berkeley; Professor Robert R. Miller, University of Michigan; and Professor Wilson S. Stone, University of Texas, Chairman -- will visit the campus on 30 November and 1 December to advise us on the future of the systematics collections. No decisions concerning the organization of our work in systematics will be made until after review and discussion of the visiting committee’s recommendations.
Preface


This letter was in response to a letter to the editor of the Alumni News from an alumnus complaining about the University’s fund-raising activities. I had taught the student in a Physics/Engineering Physics course on Electromagnetic Field Theory some years earlier. There seemed to be a suggestion in his letter to the Alumni News that Cornell professors never learned to know their students, so I wrote the letter, with tongue in cheek, to suggest that I did know him.

Later, when I was president, I addressed the Los Angeles alumni group. Trustee Adele Rogers went with me and introduced me. As I remember it, there were 17 alumni there, all of whom I had taught as undergraduates. Fortunately, I remembered all of them and could address them by name.

Dale R. Corson
And Non-Support

EDITOR: During the eight years since I became an alumnus of Cornell, the university has been relatively unsuccessful at inspiring my financial support. This is a complaint, not a confession; I really would LIKE to be persuaded to give tangible support to the university, but Cornell, and more particularly the alumni organization, is attempting this persuasion in the worst possible way. Having fretted privately for several years over this seeming misdirection of effort on the (essential) operation of fund-raising, I would like to explain my problem; perhaps other alumni feel as I do.

Why don't I give to the university as much as my means allow? Don't I appreciate all it did for me? Yes, I am acutely aware of the excellence of the educational opportunity which Cornell presented me. This feeling has been reinforced by my experience as a graduate student at Stanford University and by the experience of teaching undergraduates at Stanford and Carnegie Institute of Technology. In the wake of the student rebellion at Berkeley, there has been a great deal of discussion of the faults of modern large universities: professors preoccupied with their research, poor teaching, little contact between student and professor, students caught in a large impersonal machine; each of these points contrasts sharply with my experiences at Cornell. Yet a general belief in the excellence of Cornell and in the importance of the university in my life are not enough; I must be reminded, to be directly motivated, before I will reach for my checkbook.

What appeals will motivate me? Neither a general sense of duty to higher education, nor social pressure from a local alumnus will have much effect. Arguments about my duty to repay the cost of my own education will cause me to nod my head in agreement, but will not cause much action in the vicinity of my wallet.

Finally, I am LEAST likely to respond to the one type of appeal with which I am constantly assaulted — and insulted — the appeals to give money to Cornell out of loyalty to a social (tribal?) group called “My-Class.” As a matter of fact, as a five-year engineer I was never clear as to which My-Class I belonged to; as I recall, the university didn’t seem very certain either. This merely points up the absurdity of expecting me to have a loyalty to a perfectly irrelevant group made up of an accidental association. I was born in the month of January but I have no particular loyalty to the group of all people born in January.

Give to Cornell out of loyalty to my class? Don’t be absurd. Give to Cornell out of loyalty to, and appreciation of, the university as an academic institution? Yes, but I need to be reminded of the past, present, and future greatness of that institution. Tell me about the remarkably able professors, as well as the administration which makes it possible for these gifted men to carry on both teaching and research. Why don’t I receive appeals directly from the university, signed by President Perkins or by one of these faculty members who are no doubt profoundly influencing students today as they influenced me ten years ago?

Several months ago I received in the mail an expensively printed picture-book, presumably sent to all alumni, which told about research in progress at Cornell. This booklet was beautiful and exciting. After reading it twice, I determined to express my appreciation for the excellence of Cornell via my checkbook when the inevitable follow-up letter from President Perkins arrived. But such a letter never came! Instead, after some months, I received a letter from a My-Class Idiot asking me to send money to support MyClass so that my name would be inscribed among those of my peers on their list of Good MyClassMen. That’s a pretty crude method of social persuasion, fellows; go take a course in Sociology.

The latest and most incredible chapter in this history of idiocy came recently, in the form of a letter from MyClass asking me to send money not even to the university but to the treasury of MyClass itself! To pay the costs of “our” Reunion next year. Not very likely! How can I take seriously the task of financial support of Cornell, when neither Cornell itself nor its alumni seem to take it seriously?

PALO ALTO, CAL. - ROBERT T. BRADEN ’57 Degree: B.E.P 1957 Class: ?
Dear Braden:

I read your letter to the editor in the December ALUMNI NEWS and I am moved to reply. The President has been rather busy lately and it may be a while yet before he writes you asking for your contribution, so I am offering myself as a correspondent and as a fund receiver.

Of course, I am not the President, I am only the Provost. Nobody quite knows what the Provost’s job is, although on the university’s organization chart, my name appears in the same box with the President’s and in type of the same size. I tell myself that it’s irrelevant that there was only one type size on the typewriter with which the chart was prepared. In any case, my office is adjacent to the President’s and it would only take a moment to step across the hall to hand him a check.

You will forgive the President for not writing sooner, I am sure. Several things have been occupying his attention. You know, of course, about the 73-million-dollar fund drive which kept him busy for awhile. He realizes now that he could have saved some of that time had he appealed directly to you. The next time there is a Centennial Campaign he will be able to operate more efficiently. He has also been busy with students. You may have heard that students sometimes sit down on the floor in front of him, especially at ROTC Reviews. You can spend a lot of time trying to step over students without hurting them, especially when their arms are interlocked. He also has ambitions about playing golf a couple of times a year. His wife keeps telling him that he needs exercise, but I don’t think he is likely to get it.

You say that soliciting funds by class is silly and, now that I think of it, I guess it is. Some of the classes have endowed professorships – 1912 and 1916 for example. 1916 even contributed a wooden chair to go along with the professorship. When they said they wanted to create a “chair” they really meant it. How about a “Class of 1956 and/or 1957 Professorship?” If you have a chair made, however, please use better wood than the class of 1916 did – their chair split.

In spite of what you say about the foolishness of class associations, I always think of you in association with your classmates, particularly in physics 225 which I taught to you along with some 60 other students in Rockefeller Hall, Room C, in the fall of 1954. I think of you sitting there in the front row with Ahearne on one side of you and Chace on the other (I assigned seats so that I could learn the names of the students easier). Coward sat next to Chace and I believe he also went to graduate school at Stanford. On the other side of the aisle in the front row was Craft and then it must have been D’heedene.

I don’t know whether you sat far enough from the window so that the snow which blew in around the window didn’t fall on you sometimes. One of the projects you might want to think about is the provision of funds for replacing Rockefeller. It’s getting a bit run down at the heels these days.

One interesting fact was the way the grades ran in the first row. Starting with Ahearne, near the window, they were very high. Ahearne was in the Air Force out at Kirtland Field at Albuquerque for a number of years and the last I heard from him he was in graduate school at Princeton. I have been watching the mail every day, expecting a Christmas note from him. But to continue with the grades, you came next and you always took advantage of my grading system in which I graded on both quality and quantity of work, with quality counting more than quantity. You always did a brilliant job on the easy questions on the exams and I don’t think I ever did discover whether you could answer the really hard questions. Nevertheless, I rated you as a first rate student. But as one continued across the front row, the marks were lower and lower until we came to D’heedene where they jumped up again. The last I heard of him, he had completed his PhD at Harvard, I believe it was, and I have lost track of him since.

Closing my eyes and looking around the room, some other people stand out in my memory. Right behind you was, as I remember it, Georgiev who did only a so-so job in his lecture classes, but who was an absolute genius in the laboratory. I remember his performance in the physics 210 lab very well. He worked for a while at Lincoln Laboratory and went to graduate school at MIT. There was also Kehoe. I ran into him down in Washington a year ago. He is now President of the Telluride Association. Then there was Laura Lawrence. I think she was a physics major, but in any case she was a good student. She went to work for the General Electric Company and married a GE engineer who was even taller than she. Farther back, sitting on the aisle, was Moon. He sometimes came to class battered, bruised, and scarred. I think he played 150 pound football. By the way, if you know any prospective football players with 800 SAT scores, send their names along with your check.

There were many other students but it would take too long to comment on them.

In your letter you refer to teaching not only at Stanford but also at Carnegie Tech. I am curious to know what you were doing there. I recommended you to Professor Schiffl at Stanford for graduate study in physics. I told him that you were a good bet and I commented on your extensive background as a research assistant. I remember that you had experience in programming for digital
computers, but I cannot remember exactly where you got it. Perhaps you got it the summer you worked at the Sandia Laboratory in Albuquerque. You may even have worked at Los Alamos. My memory does not seem to be particularly good. The charge that faculty members never get to know their students well must be true. I cannot even remember if I met your parents. I know that your home was in Princeton, New Jersey and that your father worked for RCA, but my memory is hazy. Had I been your advisor I might have done better.

The physics course in which you sat in the front row was an unusually successful one for me. I learned so much that I felt compelled to write a book. If you ever have a chance to recommend a text sometime you might recommend mine. The illustrations are first-rate. You might even use it yourself if you ever teach a course about Maxwell’s equations.

I am still curious about that Carnegie Tech reference in your letter to the editor. Perhaps when you send in your check you can clarify that reference for me and let me know what you are doing now. Also send us some more students like yourself.

Sincerely yours, (sig) Dale R. Corson Provost

cc: Pres. Perkins ALUMNI NEWS
Preface
Sol Goldberg, then University Photographer, presented these images of Dale’s early days as President to Dale and Nellie upon his retirement as President.

1977
Legends for Volume One

p.75 Dale, Nellie, and Corson daughter Janet, then a high school senior. (Later, as an MD, Janet now heads Cornell’s Gannett Clinic.)

p.77 Top left: Julius A. Stratton, Chairman of the Board of the Ford Foundation (1964–1971) and former President of MIT (1959–1966), who spoke at the Investiture/Commencement Ceremonies in Barton Hall. Top right: Rev. Dr. Ralph N. Helverson (Unitarian Universalist minister of the First Parish in Cambridge, MA, 1959-1977, and also the Ithaca Unitarian Church, and former Unitarian chaplain at Cornell; a Corson son, Richard, at right, was a student at Georgetown University. Mid-page: The Hangovers. Bottom left: Austin H. Kiplinger (later a Chairman of the Board of Trustees). Center: Jansen Noyes, Jr. (the next Chairman of the Board of Trustees, 1978–1984. Right: Patricia Carry (later a Vice-Chair of the Board of Trustees).

p.78 Dale and Nellie

p.79 Top left: Provost Robert Plane and President emeritus Deane W. Malott. Top right: Trustee Adele Rogers. Bottom: University of Toronto President Claude Bissel, Corson and President emeritus Deane Malott.

p.80 Top right: Nellie. Middle left: At right of photo is Jacob Gould Schurman III (grandson of former President Schurman).

p.81 Dinner in Memorial Room of Willard Straight Hall.

p.82 Dale R. Corson in full academic regalia.

p.85 Top left: Julius A. Stratton speaking in Barton Hall ceremony. Bottom left: Trustee Chair Robert Purcell presiding. Has just introduced Corson as the eighth President of the United States. This breaks the tension for Macebearer Morris Bishop and fellow trustees on the platform.

p.86 Macebearer Bishop stands at the side of the new president, who is congratulating a doctoral candidate.

p.87 Top left: An uninvited speaker is being “escorted” off the stage. Top right: The mood lightens¹ for the platform party. Bottom left: Trustee Purcell passes to the new president the University mace that symbolizes the authority and responsibility of the president. Bottom right: The Board Chair shakes the new president’s hand.

p.88 Julius Stratton and the newly invested president in the recessional.

p.89 Top: Corson addresses a gathering that includes Trustee Harold Uris (leftmost) and Vice President John Burton (rightmost). Left middle: John M. Olin (trustee emeritus) and Corson converse.

p.90 Nellie and Dale in the Statler.

p.91 Nellie and Trustee John M. Olin.

p.92 A Library dinner. Top right: Corson, Lilly and Felix Reichmann (associate librarian) receive a rare book from Arthur Dean (former Chair of the Board of Trustees).

p.93 Class of ’50 presented the Corsons with hats.

p.94 A student reception in the Memorial Room of Willard Straigh Hall.

p.95 Nellie and Dale at Reunion with Frank Clifford (at extreme right).

¹ At the 1970 Commencement, where I was “invested”, there were two attempts to take over the microphone and the Macebearer, Professor Morris Bishop, used the mace in its historic role to repel the uninvited guests. In the process, the topmost piece of the mace, a bear holding an upright oar, was bent rather badly. Later I realized too late that the officials managing the commencement ceremony had sent the mace for repair. I thought it should have been left permanently in its damaged state, documenting one of the university’s more dramatic commencements.
Cornell University
Board of Trustees

Dinner
in honor of

Dale R. Corson

on the occasion of his investiture
as eighth President of Cornell University

Sunday, June 7, 1970, 7:15 p.m.

Memorial Room
Willard Straight Hall
The Cornell Board of Trustees
cordially invites

to a ceremonial dinner
in the Memorial Room of Willard Straight Hall
at 7:15 PM Sunday, June 7, 1970
preceding President Corson’s Investiture.

RSVP
236-3201

Cocktails
6:30 PM
Presiding
Robert W. Purcell, Chairman of the Board of Trustees
of Cornell University

Honored Guests
Claude Bissell, President of the University of Toronto,
and Mrs. Bissell
Robert Brode, Professor Emeritus of physics at the
University of California at Berkeley, and Mrs. Brode
Harris Dates, Chairman of the Tompkins County Board
of Supervisors
Mrs. Edmund Ezra Day
John Sloan Dickey, President Emeritus of Dartmouth
College, and Mrs. Dickey
Howard Dillingham, President of Ithaca College, and
Mrs. Dillingham
Larkin H. Farinholt, Vice President and Trustee of the
Alfred P. Sloan Foundation
Samuel B. Gould, Chancellor of the State University of
New York, and Mrs. Gould
The Reverend Ralph Helverson and Mrs. Helverson
James M. Hester, President of New York University,
and Mrs. Hester
Deane W. Malott, President Emeritus of Cornell Uni-
versity, and Mrs. Malott
Floyd R. Newman, Presidential Councillor of Cornell
University, and Mrs. Newman
John M. Olin, Trustee Emeritus of Cornell University
Jacob Gould Schurman III and Mrs. Schurman
Julius A. Stratton, Chairman of the Board of the Ford
Foundation, President Emeritus of the Massachusetts
Institute of Technology, and Mrs. Stratton
Cornell University

Commencement Exercises
and
Investiture of the President

11 a.m., Monday, June 8, 1970
Barton Hall, Ithaca, New York
Investiture of the President

Presidents of the University traditionally have been inducted into office and presented to the academic community with appropriate exercises. Such observances tended to be highly elaborate in the spacious early days of Cornell, but they have steadily moved toward greater simplicity in modern times. Today’s investiture of the eighth President is the first to be performed as part of a University commencement. It marks the formal and ceremonial recognition of the presidency of Dale R. Corson.

All the Presidents since the foundation of Cornell have been men of high qualifications and public eminence. None though, whatever their other distinctions, have brought to the position so long an association and so varied an experience with the University as does Dale Corson. Professor, departmental chairman, dean, and provost—teacher, research scholar, and administrator—the new President in today’s brief ceremony receives from the trustees the University mace, symbolizing the authority and responsibility of his high office.

DISTINGUISHED GUESTS

CLAUDE BISSELL
President, University of Toronto

ROBERT BRODE
Professor Emeritus of physics, University of California

HARRIS DATES
Chairman, Tompkins County Board of Supervisors
Representing Tompkins County

MRS. EDMUND EZRA DAY
Wife of Edmund Ezra Day, former President of Cornell University

JOHN SLOAN Dickey
President Emeritus, Dartmouth College
Representing the Ivy League colleges and universities

HOWARD DILLINGHAM
President, Ithaca College

LARKIN H. FARINHOLT
Vice President and Trustee, the Alfred P. Sloan Foundation

SAMUEL B. GOULD
Chancellor, State University of New York

THE REVEREND RALPH HELVERSON
Former Unitarian Chaplain, Cornell University

JAMES M. HESTER
President, New York University
Representing the Association of Colleges and Universities of the State of New York

DEANE W. MALOTT
President Emeritus, Cornell University

DONALD McMASTER
Presidential Councillor, Cornell University

FLOYD R. NEWMAN
Presidential Councillor, Cornell University

EWALD B. NYQUIST
Commissioner of Education, State Education Department
Representing the Regents of the State of New York and the State Education Department

JOHN M. OLIN
Trustee Emeritus, Cornell University

JACOB GOULD SCHURMAN III
Grandson of Jacob Gould Schurman, former President of Cornell University

JULIUS A. STRATTON
Chairman of the Board, the Ford Foundation
President Emeritus, Massachusetts Institute of Technology
Preface

Sol Goldberg prepared this photo album for the Executive Staff when Dale was leaving the presidency of Cornell.

Sol Goldberg
June 1, 1977
To Believe Dale-y
or
To Believe Day-by-Day in Day
The Corson Years: A Cornell Chronicle
Presented to Dale R. Corson with respect, affection and
a touch of levity
June 1, 1977
The Executive Staff

Mark Barlow, Jr.    David Knapp
Constance Cook    Samuel Lawrence
Donald Cooke    Robert Matyas
June Fessenden-Raden    Paul McKeegan
William Gurwitz    Richard Ramin
William Herbster    Byron Saunders
Robert Horn    Neal Stamp
The Beginning...

Jan Noyes' Thirtieth Reunion

Bob Purcell took a back seat...
but then he thrust it to me.
The First Couple

Life was a rosy Big Red apple
Expansive President and Expanded Staff

"Surowitz, there is vice president in charge of haircuts"
Early explanation of "Stretch-out"

An egg-shaped horn and a disinclined plane
They heard my views ...

I heard their views ...
"Broken Frontiers ... and Quagmires"

"We've got to turn the lobby into an information center."

Carpenter, two a.m. the second night.

For a while, an omnipresence.
Woodstein and Rothsills

This stand-up idea is not an idea whose time has come

"We are all delighted to be here today to meet the press."
On Schoellkopf and in Barton

"Honorable Trustees, Distinguished Deans, Esteemed Executive Officers, and Sol... in the rear."

"Cornell's eighth president, Martin Van Buren"
By pen and by phone
Pen by Bill Rogers, phone by L.B.J.

Person-to-person
"If you can get the cameras to me, I can wholesale them stateside"
Of Backs and Wax and Ships of State

"It's Marinaro, like the sauce."

Setting to know Hugh.

A Johnson Pledge
Lines and Words

For parents, a beginning

For presidents, an ending
Outreach, Reaching Out

"I hear you're going to someday be replaced by that quiet, reserved Dyson boy."

"The coach sez... Cornell stuffs Blue Jays and displays 'em in the Ornithology lab."

"I realize you crave anonymity because of your annual giving record, but welcome back anyway."
Corson Candids

"No need to enlarge on your explanation"

"This is one lecture you're gonna Leica"

"Take your time. You'll have two or three hours to admire them while waiting for the elevator."
Alumni Advice and Consent Corner

An Insightful Touch

"In response to your two questions, our policies on legacy admissions and on winning football teams are quite clear."
A Time to Listen

I heard their words, their songs, their laughter and their crying.
"Both of us had to deal with large numbers of unhappy individuals continually racing around in circles."

"There were days when people came to my lectures directly from Teagle."
Signs of the Times

“The years go by in single file; But none has merited my fear, And none has quite escaped my smile.” (Wylie)

“Didn’t I name him vice president in charge of haircuts a few pages back? I’ll have to check my black book...”
Such Dedication ... Such Uncommon Ability

"You’d think, at a pancake house, they’d have a crêpe paper ribbon."

“This budget memo? No big deal, Jack. Just a drop in the bucket."
Nellie Eriswold Corson--Woman of Status

"Her life has been committed to, has been consumed by, the University fully as much as mine has been... I want to acknowledge the debt I owe my wife for all that she has done to support me and for all that she has suffered through the past eight years."
"Goodbye and good luck"
"The opportunity to be at Cornell has been a great privilege for us. The opportunity to associate with, and be a part of, a faculty of the quality we have at Cornell; the opportunity to teach students of the ability we have at Cornell, the opportunity to count as friends the hundreds, the thousands of supportive alumni we've come to know; the opportunity to work with a Board of Trustees with the ability, and the dedication the Board Cornell has; the opportunity to work with an administrative staff and a university work force of such dedication, and in many cases, of such uncommon ability, as Cornell has; the opportunity to live in a physical setting of such natural beauty—these have all been privileges of the highest order, and we're grateful."

Dale R. Corson
May 25, 1977

Dale and Nellie, the opportunity to be at Cornell during the years of the Corson presidency have been a great privilege for us. The opportunity to associate with and count as friends two people of such quality, dedication, uncommon ability, and, of course, such natural beauty, have been for us privileges of the highest order for which we're grateful.

The Executive Staff
Remarks at Dinner Honoring President and Mrs. Corson

Preface

On the occasion of my retirement from the presidency, a light-hearted affair with numerous high jinks along the way was held. These are my remarks at the dinner given by Trustees and Presidential Councillors, Union Club, New York, New York, May 25, 1977, honoring Nellie and me.

Dale R. Corson
Response from President Corson

Mr. Noyes, Mr. Kiplinger, President-elect and Mrs. Rhodes, friends:

I stand here before you tonight somewhat unwillingly, and embarrassed. I'm embarrassed because, while I welcome a degree of appreciation as much as anyone, you've gone too far. However, since I'm here, and since you have been so kind, and since I know my future is behind me, I might as well relax and enjoy it. To paraphrase Adlai Stevenson, flattery is like smoking. It doesn't hurt you as long as you don't inhale. I've been treated so well during the past year that I now realize I should have resigned every year.

I want first to say something about the University presidency as an institution, then give some advice to Dr. (Frank H. T.) Rhodes and finally make some purely personal comments.

In my early days as president I was often asked how I liked my job. It always made me think of the story Abraham Lincoln told in reply to the same question. The story concerned the man who had been tarred and feathered and was being ridden out of town on a rail. Someone in the crowd yelled: “How do you like it?” The man on the rail replied: “If it wasn't for the honor of the thing I'd prefer to walk.”

Carl Becker reported that one of his Cornell colleagues viewed the president’s chief function as being “to obviate the difficulties created by his office”.

One of the more perceptive commentators on the University presidency is Clark Kerr, himself at one time president of the University of California, a position he left rather precipitately a decade ago. He left the position, he said, the same way he assumed it: fired with enthusiasm.

Kerr’s most famous statement about his task as president was his description of the job: to provide sex for the undergraduates, parking for the faculty, and football for the alumni.

I’ve succeeded more with some of these duties than I have with others. When Herman Hickman was appointed football coach at Yale many years ago, he said he would try to keep the alumni “surly but not mutinous”. The president of the University of New Mexico is William Davis, who at one time, was head football coach at Colorado. He was coach in a year when Oklahoma beat Colorado, 62-0. On the following Monday morning, Colorado’s president called Davis to his office to tell him that the alumni were getting restless about the football situation and to ask what he had to say for himself about the Oklahoma game. Davis’s reply was, “Thank God we were up for the game.”

Clark Kerr spoke in a more serious manner about the University presidency in a lecture series at Harvard, the Godkin Lectures, in 1963. He said: “The university president in the United States is expected to be a friend of the students; a colleague of the faculty; a good fellow with the alumni; a sound administrator with the foundations and the federal agencies; a politician with the state legislature; a friend of industry, labor and agriculture; a persuasive diplomat with donors; a champion of education generally; a supporter of the professions (particularly law and medicine); a spokesman to the press; a scholar in his own right; a public servant at the state and national levels; a devotee of opera and football equally; a decent human being; a good husband and father; an active member of the church. Above all, he must enjoy travelling in airplanes, eating his meals in public, and attending public ceremonies. No one can be all these things. Some succeed at being none.

“He should be firm, yet gentle; sensitive to others, insensitive to himself; look to the past and to the future, yet be firmly planted in
the present; both visionary and sound; affable yet reflective; know the value of a dollar and realize that ideas cannot be bought; inspiring in his visions yet cautious in what he does; a man of principle yet able to make a deal; a man with broad perspective who will follow the details conscientiously; a good American, but ready to criticize the status quo fearlessly; a seeker of truth where the truth may not hurt too much; a source of public policy pronouncements when they do not reflect on his own institution. He should sound like a mouse at home and look like a lion abroad. He is one of the marginal men in a democratic society — of whom there are many others — on the margin of many groups, many ideas, many endeavors, many characteristics. He is a marginal man, but at the very center of the total process.” Those are Clark Kerr’s words.

In the light of those words I feel like Clement Attlee, whom Winston Churchill described as a modest man, because he had much to be modest about. A couple of years ago the Provost of Earlham College, Paul Lacey, suggested that the job description for a college or university presidency might read as follows: “Wanted, character actor, with wide experience playing professorial roles. Should be six feet or taller, have slim athletic build, look good in tweeds and casual sport clothes. Some skill in tennis, squash, skiing helpful. Must be able to read aloud with deep conviction, memorize parts quickly, have good memory for names, faces, quotations from Shakespeare; enjoy touring. Some possibility of improvisational roles and ad lib performances after first year.”

Speaking of Shakespeare, there’s a quotation I have sought to use for 18 years. Having failed to find an opportunity I’ll give it to you now, with no context at all. It’s from Coriolanus and it refers to Ulysses’s travels. “You would be another Penelope; yet they say, all the yarn she spun in Ulysses’s absence did but fill Ithaca full of moths.”

I once spoke at a dinner honoring a newly elected university president and I gave him some advice about how to be a successful university president. In good conscience I can do no less for my successor, Frank Rhodes. So here are some principles that I’ve developed from years of experience in trying to persuade others to do as I think they should do instead of as they think they should do. I’m quick to admit that, in formulating these principles, I’ve borrowed frequently and shamelessly from others.

1. Corson’s Lemma. This is a derivative of Parkinson’s first law. It states that the work will expand until it is 50 per cent greater than that which can be completed in the time available for its accomplishment. You might as well get used to this idea and decide what you will leave undone.

2. The Principle of Bases and Fences. This says that it takes less time to touch bases than it does to mend fences.

3. The Principle of the Impossibility of Solution. Many problems, if not most, are impossible to solve. All one can do is to resolve the issues. The best advice is: when in doubt, do the right thing.

4. The Golden Rule. Never forget the Golden Rule. This is a simple statement that says: whoever has the gold makes the rules. I call your attention to Corson’s Corollary to this rule, however: make sure you have the gold.

5. The Principle of Necessary Evil. In order to maintain a degree of humility and to see yourself as others see you, look in the mirror every morning and say, “I’m an evil, but am I a necessary one?”

6. The Principle of Equal and Opposite Unpopularity. If you’re equally unpopular, but for different reasons, with all parties to a dispute, you’ve probably found an appropriate resolution of the problem. If everyone is unhappy with you for the same reason, or if everyone is happy with you for the same reason, you’ve probably done the wrong thing.

7. The Principle of Appreciated Cost. It always costs more than they say it will.

8. The Principle of Controlled Boldness. Gamble. Be bold. Nothing ventured, nothing gained. Take a look around you occasionally, however. It’s like the three rules for courting a woman. The first rule is: be bold. The second rule is: be bold. The third rule is: don’t be too bold.

9. The Principle of Success in Intercollegiate Athletics. I’ve tried for years to discover this principle but I’ve not been entirely successful. I think the principle is probably: find a good coach and pray.

With these principles in mind, there’s no reason why you shouldn’t sleep like a baby; that is, sleep for an hour and then wake and cry for an hour.

I also want to remind Dr. Rhodes about an ancient maxim concerning trustees (that I read somewhere) and then advise him about his inauguration. The maxim says that “the trustee is like a small boy’s definition of a lie — an abomination unto the Lord but a very present help in time of trouble.”

In 1969 there were two fashions for university presidential inaugurations. In one fashion the new president was inaugurated the same day he was elected. That way he was sure to be around for the inauguration. In the other fashion the inauguration was postponed for a year so that if the new president didn’t last out the year, no time was wasted on formalities. In my case, we chose the second fashion. Actually, I was never inaugurated. Instead there was an investiture at Commencement following my first year in office. It was a great day. There were demonstrations and disruptions and two attempts to take over the microphone. Morris Bishop
made international news when he bent the mace jabbing the protestors in the appropriate places. Those were the good old days!

The high point of the occasion, however, was my introduction as the eighth president of the United States, which put me in a terrible spot. Not only did I not have the inaugural address of the eighth president of the United States with me, I didn’t even know who the eighth president was. I thought it was Andrew Jackson but he proved to be the seventh.

It’s on this matter of the president of the United States that I want to advise Dr. Rhodes. If he’s introduced as the ninth president of the United States I want him to be prepared. The ninth president was William Henry Harrison, and I had intended to have a copy of his inaugural address to give Dr. Rhodes, but there’s a problem. Harrison spoke for an hour and 40 minutes. Now, we have a “war on waste” and my conscience won’t let me use the volume of paper required to reproduce a 100-minute speech. I see no solution except for Dr. Rhodes to go to the library and memorize the speech.

There are some other aspects of the Harrison inauguration which Dr. Rhodes should note carefully. Harrison wore no coat or hat when he gave his marathon speech and as a result he developed pneumonia and died precisely one month after the inauguration. There are some lessons here. I advise Dr. Rhodes to postpone the inauguration as long as possible and I advise him to wear a hat and coat when he gives his address.

Now we come to the personal comments.

When we came to Cornell in 1946, we had no ambition to be president of the University or of anything else. Fate, of course, plays a large part in the way anyone is propelled into a role such as the one I’ve played the last eight years. In the first place, we more or less tossed coins in deciding whether to come to Cornell or go to the University of Michigan or go to the Bell Telephone Laboratories. When I became chairman of the Physics Department in 1956, I was probably the logical choice for the job, although accepting it involved an anguishing decision. There was no logic at all in my choice as dean of the Engineering College. I was a last minute substitute after the prime candidate, whom I had helped recruit, withdrew. If President Perkins had been a physical scientist instead of a social scientist, I would never have been provost. If there had been no trouble in 1969, I would never have been president. But here I am.

I could produce evidence to suggest that I haven’t performed the job as well as some might have expected. For instance, in 1938 A. Lawrence Lowell, who was president of Harvard for a long time in the early years of this century, published a book in which he wrote: “A university president should never feel hurried, or have the sense of working under pressure, for such things interfere gravely with the serenity of judgment he should always retain…. If he feels overworked it is because he does not know how to delegate work to others … he has not learned that his business is thinking, not routine.” I may have retained many things, but serenity is not one of them. Perhaps if President Lowell had lived half a century later he might have written a different book.

I want to say a word about my wife’s role the last eight years. Her life has been committed to, has been consumed by, the University fully as much as mine has, and I’m pleased that you have recognized her tonight also. She’s lived through all the same troubles that I’ve lived through and she’s supported and encouraged me in all my ups and downs during these difficult years. In addition, she has had the disadvantage of being separated from the immediate scene and so has not known what was going on from minute to minute and hour to hour.

One of the amusing events, one of the few amusing events, which occurred during the most difficult days happened when she was driving through the campus one day and saw a huge crowd outside Day Hall. Disturbed at what new trouble had erupted, she sought out the nearest phone and called my office. When there was no answer, she knew the worst had happened again and called the Safety Division to find out what it was. She learned that a routine fire drill was in progress.

A few years ago we were guests of the British Commonwealth Association of Universities at their quinquennial Congress in Edinburgh. Following Edinburgh, there was a special session for several days just for the vice chancellors and their presidential guests at Exeter. There one session was devoted to the problems of the wives of vice chancellors. A wife of one of the Australians spoke and she explained that the reason there was no woman vice chancellor in the Commonwealth was because in that case there would be no wife to accomplish the other half of the job. She also explained that she spent half her time pretending not to know about things that she did know about and the other half pretending to know about things she did not know about.

I want to acknowledge the debt I owe my wife for all that she has done to support me and for all that she has suffered through the past eight years.

The opportunity to be at Cornell has been a great privilege for us. The opportunity to associate with, and be part of, a faculty of the quality we have at Cornell; the opportunity to teach students of the ability we have at Cornell; the opportunity to count as friends the hundreds, the thousands of supportive alumni we’ve come to know; the opportunity to work with a Board of Trustees with the ability and the dedication of the Cornell Board; the opportunity to work with an administrative staff and a University work force of such dedication, and in many cases, of such uncommon ability, as Cornell has; the opportunity to live in a physical setting of such natural beauty — these have all been privileges of the highest order, and we’re grateful. I’m grateful particularly for the support of the Board of Trustees during my years as President, and I ask that you support Frank Rhodes as you have supported me.
Although we’ve been at Cornell for 31 years, we don’t propose to end our association now. Our position is similar to that of a State of Maine native who was asked by a summer visitor, “You lived here all your life?” The Mainer replied, “Not yet.”

In our years at Cornell we have experienced the exhilaration of extraordinary achievement by faculty colleagues, by students, by athletic teams. We have experienced the exhilaration of Nobel Prizes and National Book Awards. We have experienced the exhilaration of Commencement in Schoellkopf on a glorious spring day.

We have also known the sorrow, the terrible empty sorrow, of brilliant lives ended too soon, of young lives lost before their promise ever bloomed, of tragedy thrust on us from every direction. Perhaps we, more than most, have felt these sorrows because our lives, more than most, have been interwoven with the life of the whole University.

Between Uris Library and Morrill Hall, on that beautiful place Goldwin Smith called “the platform overhanging the lake”, there’s a stone bench placed there by Andrew D. White and his second wife, in 1892. While the circumstances were quite different, the words carved on that bench reflect the joys and sorrows we’ve known at Cornell:

“To those who shall sit here rejoicing,
To those who shall sit here mourning,
Sympathy and greeting
So have we done in our time.”

Concerning success in life, I think it was Ralph Waldo Emerson who once wrote:

“To laugh often and love much; to win the respect of intelligent people and the affection of children; to earn the approbation of honest critics and endure the betrayal of false friends; to appreciate beauty; to find the best in others; to give of one’s self; to leave the world a bit better, whether by a healthy child, a garden patch, or a redeemed social condition; to have played and laughed with enthusiasm and sung with exultation; to know even one life has breathed easier because you have lived — this is to have succeeded.”

We’ve not done a great deal of singing with exultation, but we hope there are lives who have breathed easier because we’ve lived. For having enriched our lives beyond our ability ever to repay, thank you.
In This Issue

Changes

Hail and Farewell

Corson Looks Back

July 1977
Preface

The July 1977 issue of the Cornell Alumni News featured Dale Corson when he stepped down as president. This retrospective was put together by John Marcham, the editor of Cornell Alumni News.

Marcham produced an amalgam of two talks I had given to alumni.

Dale R. Corson
Changes

Cornellians began to see a personal side of Dale Corson in the last weeks of his administration that they had largely been denied for the decade and a half he was provost and President of the university. For fourteen years he has been a public spokesman of almost Lincolnesque distance, the utterer of official words. Nor did it help that he had to suffer the written and spoken abuse which for a generation has passed for student political comment and activity. He remained throughout a dignified figure, but of choice and necessity a remote one. Only on occasion, as at Commencement (opposite page) when he congratulates a PhD recipient, have unexpected flashes of warmth and humor come through to the public.

Then this May came a couple of interviews with the press, and two dinners in his honor in New York City, on which occasions colleagues spoke publicly about some commonly overlooked aspects of his career, and he himself spoke a bit about his own interests and feelings, and how he viewed his recent past at Cornell.

The two main articles in this issue are drawn from these occasions, one adapted from a speech by his friend, fellow physicist, and former colleague, President Robert Sproull ’40 of the U of Rochester, and another adapted from two speeches the President himself gave.

In addition I’d like to summarize here what Jim Myers ’62 of the Ithaca Journal and I learned in separate interviews with the departing President, and some remarks I gave at the same Alumni Association of New York dinner in New York at which Sproull and Corson spoke:

Myers wrote: “Corson is a serious, hard-working, sometimes taciturn figure whose spirit has borne its share of wear. He seems to see himself as a man who was prepared to endure with that kind of problem:

“’I was born in a moral crisis, World War I. That was followed by the financial problems of the ’20s. [Corson spent his early years on a Kansas farm. His father was a truck driver and later went into the lumber business.] My father lost everything he had. I went to college and graduate school in the Depression. That was followed by the traumas of World War II, the Korean War, and on top of everything, the Vietnam War…. My spirit has been afflicted since the day I was born.’”

“In his remarks, Sproull reminds us of the importance of Dale Corson as a scientist and professor. We’ve always known that US and foreign governments turn to him for advice in a variety of scientific and educational matters, and now it’s easier to understand why.”

In my interview, I was interested to learn what diverted Corson from science into administration. In one of his talks he had said that accepting the chairmanship of the Cornell physics department in 1956 “involved an anguishing decision.”

He started his explanation to me by referring back to World War II. As a young faculty member at the U of Missouri, he was summoned to wartime duty in Washington. “From the time I started going to Washington in 1942 I was an administrator and helping administer very large projects. I sat at the right hand of a major general in the War Department. I dealt with everybody at the highest levels, except FDR.”

Of his acceptance of the physics chairmanship, “I realized it was going to change my career. I rationalized that I would only be giving up a bit of teaching, but the die was cast by going to Carpenter Hall” three years later, when he became dean of Engineering.

When I spoke at the alumni dinner in New York, I concentrated on his style as an administrator, telling several Corson stories by way of illustration:
A number of years ago, an alumnus wrote a letter to the university complaining about the impersonality of education on the Hill, and about some other things as well. Administrator Dale Corson answered that letter in a way few of us forget. He started by recalling that the letter writer had taken a course in physics with Professor Corson while an undergraduate, then reminded the writer of the hour, seat location, and a few details of his performance in the course. I don't remember what else Administrator Corson wrote about the alumnus's criticism, but his main point regarding the alleged impersonality of Cornell teaching had already been made.

A year ago, walking to a Saturday afternoon faculty party, my wife and I fell in alongside the Corsons. I spoke of wishing I had gotten to watch the crew races that afternoon. President Corson said that he had, as a passenger in a launch driven by the coach of women's rowing at Cornell. He was fascinated, he said, by the coach's explanation that women, because they are not built the same as men, row differently. Although today I still remember how women are built differently from men, I do not now remember exactly how they row differently. But I do recall that Dale Corson, the old physics professor, had made it a point to learn, understand, and then try to explain the theory to those of us listening. Nor was he satisfied with a superficial explanation; we got the 400-course-level explanation.

Which is, I believe, typical of the way he has played the game as university President. He is constitutionally unable to slough off a problem, or accept simplistic analysis. I recall a few years ago when the campus community was arguing—rather loosely—about the optimum rate at which Cornell should be expending the principal from its investments. The President himself took time out to plot the choices in a set of rather sophisticated mathematical equations.

Another item: Back when he was provost and I was a sub-administrator of the university—rather than editor for the Alumni Association as I am now—he summoned me one evening to work out the announcement of the resignation of an employee who was on a hot seat at that time. Many of us in Day Hall thought the employee's forced resignation was unfair, and I protested the case to the provost. It pained me to argue with him about anything. As a consequence, my protest was more reasonable than what I felt or what I would have said on the subject to any other official in Day Hall. It was so in part because I sensed Provost Corson had already been through all the logic I was offering, and was even more pained than I at the need to let an employee go.

He heard me out patiently but let me know the matter was settled. Only later did I hear the decision was not of his making, and only later still that he had in fact already spent time that afternoon walking alone in the woods near his home, worrying through his part in the case. A lot of difficult decisions got carried out for Cornell during this period out of simple respect for Dale Corson.

When he finally was given the title of President in 1969, which recognized the responsibility he had been carrying already in the years before, some of the black student leaders on campus told me they were not unhappy. They had been in meetings with top administrators for a number of years by then, and they said one official or another might agree to their proposals quite freely, but almost invariably Provost Corson would nudge his fellow administrator and remind him of just what the consequences of one action or another would be that they were agreeing to so readily. He was known—then as now—as someone who could figure out the real end result and price of carrying out a flowery educational principle.

Not only had he thought it out in his head, but he had probably also made note of it in the little notebook he always seemed to have with him. As a consequence, when he said something was possible, members of the university community knew it was in fact possible.

He has tended the equations and the educational account books of the university for a good many years now. It's the way he plays the game and it's a very important reason Cornell survived one of the most dramatic events experienced by higher education in the chaotic 1960s and early 1970s. Someone understood the university well enough, and was in turn respected sufficiently by his fellow members of that community, that factions which distrusted one another would allow his administration the time to knit back together the fabric of a torn institution.

His characteristics of low-key statement, careful analysis, patience, and openness set the pattern by which Cornell put itself back together in the 1970s.

To return to the interview of Jim Myers with Corson:
“As Corson described it, the university in his years moved away from trying to deal with campus disruptions by talking. It just didn’t seem to do any good. By the time of the Carpenter Hall takeover [in 1972], the university’s approach had become more stern and cold, something that at least to the young seemed also to be represented in Corson’s bearing.

“We followed legal pursuits and went straight to the restraining order,” Corson said.

“Corson’s intentions were basic: First, to keep people from getting hurt and, second, to use all legal means of resolving the dispute without bringing police on campus. And Corson believes he spent plenty of time in discussions with campus demonstrators.

“I did lots of talking in 1969,” Corson said. ‘And in Carpenter Hall, I went there at 2 a.m. We had a whole symposium discussing the issues.’

“But Corson also found himself a target of abuse from student protesters. The occasions were numerous and the issues involved varied. And eventually, it began to try his patience. His patience ran out, he says, before the 1976 occupation of Day Hall by students protesting the proposed decentralization of the minority program. By that point, he had decided it was no longer of much use to discuss university policies with protesters.

‘Civility was a word the people involved in these protests have never heard of,’ Corson said. ‘It doesn’t matter what group it is; I’ve got better things to do than take that kind of abuse.’

‘Still, Corson seemed particularly disheartened by those demonstrations last year. ‘I was discouraged to be diverted from the efforts of dealing with which way the university was going,’ he said. ‘I thought we were past that kind of thing.’

‘Just before Commencement, Corson announced he was stepping down….

“Corson maintains the demonstrations had nothing to do with his decision to step down—that back in 1970 he wrote to the trustees saying that he foresaw a seven- or eight-year term for himself as President.

“I wasn’t eager to step down in the middle of the fray,” Corson said of the 1976 demonstrations. ‘If anyone thought they were going to force me out of office, they were wrong.”

“It’s easy now to forget that 1969 was not the end of the President’s problems at Cornell. The black student rampage in 1970 was one further crisis; the Carpenter Hall occupation by white activists in 1972 was followed by two nights of rioting in the streets of Collegetown the same spring, and the smashing of windows on several campus buildings, which brought Corson to the brink of calling in police to restore order.

He was calm and deliberate and patient, but he would not be pushed around. He once stillled a roomful of angry black student protesters when he told them he thought they were detaining him against his will and that he intended to leave. He left.

What had brought this midwesterner to Ithaca in the first place? In 1940, his research fellowship at an end at Berkeley, he visited all the major universities in the East, including Syracuse and Rochester but not Cornell (“Too hard to get to”). He ended up accepting a faculty post at Missouri, then did wartime service. After the war, he had offers from an industrial lab, the U of Michigan, and Cornell.

He went to Ann Arbor in December 1945, and during his visit the temperature never got above 5-below. Buffalo had five feet of snow and he did not go to Ithaca. He knew a biophysicist named Robley Williams ’31, PhD ’35, who was at Michigan then. Recently Corson reminded Williams that he asked him at the time what he would do if he had a choice between Michigan and Cornell. Williams took ten seconds to answer, “Cornell.” When Corson recalled this recommendation the other day, Williams said the story sounded unlikely: “I’m surprised it took ten seconds to answer.

“It was almost a flip of a coin between Cornell and the University of Michigan,” Corson says. “It’s hard to say why I chose to come here. The physical setting, I guess; and Hans Bethe was a deciding factor. I considered him the greatest physicist in the country.

During this spring, Cornellians in Ithaca grew unhappy with the thought they might lose Dale and Nellie Corson because of his departure from the presidency, but it turns out they are not leaving town. The President has been named to the post of chancellor, and will by his own estimate spend about three days a week in New York City for the university for the next two or so years, helping mostly with the affairs of the Medical Center, and working with President-elect Frank H.T. Rhodes on fundraising.

Did that arrangement have Rhodes’s approval? Oh yes, Corson said. “Our recent visit to a foundation was typical of the way I think it will go. He, and I, and Dick Ramin ’51, vice president for public affairs] made the call. It went well. I left early. I’d have been taking money out of my own pocket if I’d listened to Frank Rhodes any longer.

“Something of his regard for his successor and of his humor and his relief at no longer being chief executive came through all at once. I expect Cornellians everywhere will be glad to learn that the Dale Corson they had grown to respect and rely on from afar, and to know better in the last few weeks, will be able to relax a bit and enjoy the community and institution he has served so thoroughly for three long decades. —JM  
[John Marcham ’50, CAN Editor]
Preface

Robert Sproull ‘40, a former colleague and fellow university president, traces some roots of the departing Dale Corson.

Sproull was a member of the Cornell physics department with Dale Corson, an administrator in physics, and vice president for academic affairs before leaving to become president of the University of Rochester (1975–1984).

This article is an adaptation of an address before the Alumni Association of New York City in mid-May.
Robert L. Sproull: My goal should be to tell you how to be content without Dale and Nellie Corson. But I don’t know how to do that. So, like speakers everywhere, I’ll subvert my invitation and do what I think I know how to do.

Dale Corson arrived at the top just at the time of Cornell’s need. He had the right attitudes, the right experience, the right attributes, and character—an old-fashioned word you don’t hear much any more. I’d like to explain how it came about that this particular character—I use the word both in the literal and the punning sense—was there at that particular time with those particular attributes.

He was born in Pittsburg, Kansas. Many of you may go through a whole lifetime without thinking much about Pittsburg, Kansas. It’s almost Oklahoma; it’s even more almost Missouri. And it’s too far from Emporia, Kansas to amount to much. But he went on to Emporia, where he graduated from high school in 1930.

You know about Dale’s love for mountains, and photographing same, and hiking, and Nellie and Dale’s camping in the mountains, and interesting their children in the mountains. The thing you need to know about Emporia is that any little mound big enough to serve as what they call a cyclone cellar and what we’d call a tornado shelter is called a mountain in Emporia. So from this flatland in Southcentral Kansas, Dale’s route was ever outward and upward and his passion for mountains must surely have grown out of the absence thereof in Emporia.

He got his BA at Emporia College in 1934, went to the University of Kansas at Lawrence for a master’s degree, and went to Ohio State for a short while. He then went to a place where, if you’ve heard about that place in that period you’ve really heard about what was happening in the 1930s in physics. He went to Berkeley, and got his PhD there in 1938.

Berkeley, California in 1938, plus or minus a couple of years, was the Athens of the golden age of nuclear physics. I use my words with a certain care. That was the place where nuclear physics was born. To be there at that time was to be in the right place at the right time. And Dale was right in the middle of it. He took part in the design of the sixty-inch cyclotron. You’ll have to realize that that was the machine in the world. It wasn’t only the best machine or the biggest machine or the machine that was most recently built. Berkeley was the place where nuclear physics was being done, and it was a time when nuclear physics was still done on a human scale. Nuclear physics has recently gotten completely out of scale. For instance, the physics Nobel Prize winners last year probably spent tens of millions of dollars and had scores of people involved in each of their experiments, one on the East Coast and one on the West Coast. They even have had two different names for the same particle. And it probably isn’t much of a particle anyway. But in Berkeley around 1938 nuclear physics was still at the human scale where one or two or three people could make a discovery that was truly of earth-shaking importance.

If you look in the current edition of the *Encyclopedia Britannica* under the A’s and come to Astatine, you’ll find the following statement: “Astatine was first synthetically produced [I like that word synthetically; there’s no other way to produce it.] (1940) at the University of California by Dale R. Corson, K. R. Mackenzie, and Emelio Segre, who bombarded....” Dale was the discoverer of astatine, one of the first of the new elements that are not found in nature at all. It filled in the periodic table, completed the halogen series, and its discovery was one of the great events of the development of physics and of chemistry.

He then went off to the University of Missouri. He wasn’t there very long but he had a distinction which I have always coveted. While he was away from Missouri in wartime service he was promoted from assistant professor to associate professor. It was hard enough
for me to get promoted while I was present at my university. To be promoted while you weren’t even at a university seemed to me to be something of a prize.

The war came along, and Dale went to MIT to participate in the early days of microwave radar, at the Radiation Laboratory, and then went to the Army Air Corps in Washington and London on some of the big new radar programs. Toward the end of the war he went to Los Alamos where he organized the Sandia laboratory—one of the two great applied laboratories which have kept the American edge in the strategic deterrent.

Young people today don’t think much about strategic deterrence, but they aren’t faced with what faced us at the end of the war. In fact in 1945 or 1946 probably none of us would have given a hoot for the chance that for the next thirty years there would not be a nuclear exchange, a thermonucleation of one country by another. In fact, though, for thirty years deterrence has worked. It’s fair to say that founding the Sandia laboratory, even though it had a military context, was a very peaceful and consequential thing to do and one that in fact helped to keep this country and the whole world in a situation where there’s been some stability. In 1946 all the predictions were that within a period of at most five years—some apocalyptic folk said at most three years—the various elements of the world would be nuclearly bombarding each other. Creating this laboratory, and other service during the war, got Dale Corson a Presidential Certificate of Merit in 1948.

In the general diaspora after World War II, people from Los Alamos, Sandia, and such places were distributed all over the country. Dale and Nellie came to Cornell along with Hans Bethe, Robert Wilson, and others, about July of 1946.

Coming when he did, accomplishing what he then did, makes it possible to say of him (to use Acheson’s phrase): “He was present at the Creation” of a lot of things.

• He was a key participant in the creation of the first Cornell synchrotron, which was among the first synchrotrons anywhere, and he later participated in one way or another in the building of all other Cornell synchrotrons.

• He was one of the creators of the engineering physics department, which was an innovative element in the Cornell scene right after the war and which took quite a lot of creating.

• Third, and a little more difficult to explain, he was a key participant in the creation of the transition of physics from the pre-war love-and-string-and-sealing-wax variety to the postwar age of electronics, computing, and money. It was a transition that affected everything—research laboratories, teaching laboratories, right down to freshman teaching. And Dale was an essential part of that revolution.

During all this he and his PhD students were discovering lots of things. I don’t want to try to describe any of these in detail. He wrote a number of review articles. A long and thorough one with Wilson on nuclear particle detectors, counters, and other energy measuring devices in Review of Scientific Instruments in 1947 is one of the most cited articles of all time. He wrote a similar review article with A. O. Hanson on electron-gamma ray interactions. He wrote many individual articles, often with his research students, on topics like the mu meson experiments being done at Cornell, and radiation from electrons going around in synchrotron orbits.

Through all this, and much more that I have not described, Dale established superb academic credentials, which are a sine qua non in dealings with faculties. Faculties do a certain amount of huffing and puffing, and administrators sometimes have their houses blown down. There was no way that any faculty person could ever blow Dale Corson down because Dale had been there first and with more and better work than any faculty member who might have been tempted to blow.


As chairman of the physics department, he enjoyed the respect of everyone in the department. The department at that time had a very large nuclear and theoretical physics component. It had a somewhat smaller component involved with solid-state and low-temperature physics. He had the respect of every one of them and at the same time a tremendous concern for teaching. There was no skepticism on the part of anybody in the department about his commitment to teaching. There was no way that junior faculty
members or anyone else could slide off their teaching responsibilities by casting aspersions on the chairman’s commitment to teaching. It was just there and universally acknowledged.

When he went on to become the dean of the College of Engineering, however, there was considerable skepticism. Even though he had been a member of the engineering physics faculty for many years by that time, lots of people in the College of Engineering asked questions like, “Is he a real engineer? Does he understand the need for real engineering?” Nobody asked me those questions at that time but I could have answered them.

One thing I knew about was the wiring of the Corsons’ house. If you have ever seen the wiring you would know that its creator had to have at least a PhD in “real” electrical engineering. It’s so complicated that at one time I feared when I monkeyed with the hot water heater controls that steam was going to come out of the television set. But it worked, and that shows that Dale was a real electrical engineer from the word “go.”

Actually, though, his credentials as an engineer were conveyed in an even firmer way in another respect, and that is with concrete. I don’t know if any of you have observed Corson’s concrete; you will never have seen as good concrete in your life. We were with the Corsons in the Soviet Union a couple of years ago and Dale went around shaking his head all the time that he was looking at Soviet concrete; it was all falling apart.

Years earlier, he was in the midst of a huge concrete operation at his home on South Hill. I tried to get some samples from time to time but he always came out too even at the end of his mixes. I wanted to take some samples over to Thurston Hall to see how they performed as specification concrete. I had learned some concrete from Solomon Hollister, too, and Holly would have been very proud of Dale’s concrete. I never did get a sample, however, but it’s just as well. It’s said that time heals all wounds; well, time messes up a lot of things, too. The one thing that time shows is that Corson concrete survives into the ages. There are blocks of concrete on South Hill that will be there into the twenty-second century. Nobody should have worried about his commitment to engineering or whether he was a real engineer.

As has already been said, as provost Dale Corson ran the day-by-day operation of the university. During that period he almost
single-handedly created the biology division, he renewed attention to Upper Campus problems which had been largely neglected, he straightened out the Arecibo mess, he finished the Olin Library, he got the Uris Library going. I could go on with a much longer catalog of accomplishments.

I suppose I’m treading on rather marshy ground when I say the next thing, but in my view Jim Perkins was and is superb as an educational theorist and as a writer on educational topics, but Jim was not an educational operator, not a manager. He didn’t, as I see it, have the patience to manage, to talk with all the people that had to be talked with—the kind of sensitive interaction already referred to. In short he could not serve as the only executive, and the load came onto Dale already in 1963.

So when Dale took over the leadership role in 1969 it was as if all this earlier experience had somehow been programmed as preparation for that role. All of his credentials with the faculty, all his experience with the department and the college, all of the experience really running the university but not having the position of the top man as chief executive—all of this was by way of preparation.

Cornell would have stumbled badly, according to me, without his calm and capable direction. There were really mobs of special pleaders in those days, and not all of them with Cornell’s interests uppermost. Those were the days when people had funny ways of getting immortality. In the thirteenth century, the way you got immortality was by giving more Hail Mary’s than the guy next door. In the 1960s you got immortality by shouting obscenities. It was a terrible period to try to live through. With all of the special pleading groups, each one nominally putting Cornell’s interest first but in fact frequently putting their own interests first, it was a difficult time.

What was needed and what Cornell found at that time was someone who was intensely loyal to the idea of a university as an institution, and intensely loyal to Cornell. It took unbelievable patience to find a safe path through the mine fields laid by groups such as I have described. It’s not likely, according to me, that anybody else could have done it. I certainly don’t know of anyone during that period who could have done it.

An essential part of all this has been Nellie Corson. She established herself very early as a friend of all junior faculty and helped a host of young people adjust to an alien and a sometimes rather forbidding Ithaca and Cornell climate. Her Campus Club contributions and leadership were continuous and outstanding. A derivative of this was her service to the Sage Infirmary. She was a trustee.
of the Public Library in Ithaca for many, many years. But mainly she served in an ever more vital role as Dale's responsibilities and troubles grew. She was continuously the friendly, soothing, unaggressive, and unthreatening point of contact of thousands of people with the administration. And she established that contact in a way that made Dale's job possible.

These fourteen years as provost and president have left Dale so tired that he has now stepped down, or as I prefer to say, stepped up. But he can look back on many successes. I have named a few already, and I will name a few others that are a little more offbeat and not so likely to be known to you.

He has a very highly respected book with Paul Lorrain on electromagnetism that's gone to two editions and has been widely used.

He served as the Ford Foundation's man on Latin American engineering education. He was the foundation's senior consultant and authority on this for many, many years.

He served on just about every committee you can name: ACE, PSAC, NYSSAC, NASULGC, CICU, AAU, and I could go on and on and on. And on most of these after serving a year or two they would make him chairman—a problem that he has because people will identify leadership capabilities.

Lately he has been chosen by the Macy Foundation to be chairman of its Commission on Physicians for the Future.

We all know him as a superb photographer, with a one-man show at the Johnson Museum a little while ago; we saw his trillium photograph on the cover of the *Alumni News* last December, and his earlier pictures on the solar eclipse [November 1973 issue].

I could go on with a lot more significant accomplishments but I don't want to. What I want to do now is talk about some of his significant failures. Maybe this will help in what should have been my purpose, to make you content.

The first one is that Dale could never catch a fish. He couldn't even hire a fisherman who could catch a fish.

Second, many, many years ago he gave up punning but not until he was awarded a certificate by the Ohio State University, awarded to Stale Coarsepun. I think we are all glad he gave it up at an early enough age, or we would have been punished to distraction.

He dutifully invested in a small foreign car each year or two. It had to be foreign because he had to leave it in front of Day Hall in full view of all the faculty. That was a success in a way, but the failure is that with the salt on the Ithaca streets he could never make those cars last as long as a totally improper American car.

He couldn't get even a trace of loyalty, unselfishness, or even perspective into one of his favorite professors.

He couldn't get a seat on Mohawk Airlines by arriving even five minutes before departure. He had to arrive at least ten minutes ahead or they wouldn't let him on board.

He could never get Jim Perkins's Spanish up to his standard.

He could never understand why Cornell football teams had kickers who weren't always superior to kickers on the other team. Sometimes he had to be physically restrained from running down to the field to show the Cornell punter how to kick.

And finally, he could never teach the Cornell faculty how to spell. *Commitment, consensus, liquefy* were misspelled on the Cornell campus more often than they were spelled correctly. And as far as sabbatic is concerned, he once made a ukase that said no faculty member would ever be allowed to go on sabbatic unless he could spell it. But with typical Corson patience he abolished that ukase almost as soon as he issued it.

I hope the Cornell Board of Trustees will name something substantial for Dale. (Nellie already has her name going on growing things.) The Cornell board has good taste and a sure touch in naming things; they may even have a sense of humor when naming chilled water plants.

But, believe me, there will not be a Corson chilled water plant. When they name things for Dale and Nellie, they will be warm and friendly things. These two have succeeded where most have failed, by really caring for people and programs, when all around are complaining and stridently calling for attention. They have served Cornell well and without them Cornell would not have been preserved as the great institution it still is.
Preface

Dale Corson looks back at the recent past, and offers some advice to his successor.

This article is an amalgam of remarks given at the same dinner of the Alumni Association of New York City in mid-May (as addressed by Sproull in the preceding talk) and at a subsequent one for trustees, presidential councilors, and Tower Club members.

July 1977 Cornell Alumni News. pp 18-21

Ed: This article is included for completeness of the CAN issue, although it essentially repeats the text of a preceding article, “Remarks at Dinner Honoring President and Mrs. Corson.”
Dale Corson looks back at the recent past and offers some advice to his successor.

I welcome a degree of appreciation, as does everyone, but you have gone too far. However, since I am here, since I know my future is behind me, and since you have been so kind I might as well relax and enjoy it. To paraphrase Adlai Stevenson, flattery is like smoking. It doesn’t hurt you as long as you don’t inhale.

In my early days as President I was frequently asked how I liked my job. It always made me think of the story Abraham Lincoln told in reply to the same question. The story concerned the man who had been tarred and feathered and was being ridden out of town on a rail. Someone in the jeering crowd yelled: “How do you like it?” The man on the rail replied: “If it wasn’t for the honor of the thing I’d prefer to walk.”

Carl Becker reported that one of his Cornell colleagues viewed the President’s chief function as being “to obviate the difficulties created by his office.”
I once spoke at a dinner honoring a newly elected university president and I gave him some advice about how to be a successful university president. In good conscience I can do no less for my successor, Frank Rhodes. Here are some principles that I have developed from years of experience in trying to persuade others to do as I think they should do instead of as they think they should do. I am quick to admit that, in formulating these principles, I have borrowed frequently and shamelessly from others.

• The Principle of Bases and Fences. This says that it takes less time to touch bases than it does to mend fences.

• The Principle of Necessary Evil. In order to maintain a degree of humility and to see yourself as others see you, look in the mirror every morning and say, “I am an evil, but am I a necessary one?”

• The Golden Rule. Never forget the Golden Rule. This is a simple statement that says: whoever has the gold makes the rules. I call your attention to Corson’s Corollary to this rule, however: make sure you have the gold.

In order to demonstrate the wide applicability of these rules, I’d like to cite an instance of this one, as I once applied it in a situation involving President Sproull.

Many years ago, in fact a quarter of a century ago, he and I and two other people went on a canoe trip in Northern Ontario. To understand the importance of my principle, you have to understand Sproull. He’s a man of enormous energy and enormous curiosity and enormous capacity for work. These are among the qualities which make him such a good university president, but they represent certain shortcomings as far as canoeing is concerned.

Sproull wanted to explore every island, to look into every bay, to arrive at every portage first. I shared none of these interests. In fact, they placed a substantial burden on me. I learned on the second day, however, how to deal with the problem in a completely satisfactory way. First of all, I made sure that I was never in Sproull’s canoe, and second that I always had the food supply in my canoe. As a result, I went where I wanted to go, at my pace, and stopped whenever and wherever I felt like it, and I never had to worry about Sproull. In the end, he always came to me. I had the gold and I made the rules.

• The Principle of Appreciated Cost. It always costs more than they say it will.

• The Principle of Controlled Boldness. Gamble. Be bold. Nothing ventured, nothing gained. Take a look around you occasionally, however. It’s like the three rules for courting a woman. The first rule is: be bold. The second rule is: be bold. The third rule is: don’t be too bold.

• The Principle of Success in Intercollegiate Athletics. I’ve been trying for years to discover this principle but I have not been entirely successful. I think the principle is probably: find a good coach and pray.

With these principles in mind there is no reason why you should not sleep like a baby, i.e. sleep for an hour and then wake and cry for an hour.

In 1969 there were two fashions for university presidential inaugurations. In one fashion the new president was inaugurated the same day he was elected. That way he was sure to be around for the inauguration. In the other fashion the inauguration was postponed for a year that if the new president didn’t last out the year, no time was wasted on formalities. In my case we chose the second fashion. Actually I was never inaugurated. Instead there was an investiture at Commencement following my first year in office. It was a great day. There were demonstrations and disruptions and two attempts to takeover the microphone. Morris Bishop made international news when he bent the mace jabbing the protestors in the ribs. Those were the days! The high point of the occasion, however, was my introduction as the eighth president of the United States, which put me in a terrible spot. I didn’t even know who the eighth president of the United States was. I thought it was Andrew Jackson but he proved to be the seventh.
I've often wondered about the attitude of the Cornell Club of New York. There on the second floor in the hallway beside the lounge, there are photographs of all the Cornell presidents. Under each president's name are the dates of service. For example, there's Jacob Gould Schurman, 1892-1920. When my photograph was put up in 1969, the date placed under the photograph was 1969, period. It seemed to me at the time it would not have involved a great deal of risk to have placed a dash after 1969 and then left four blank spaces. However, confidence was in short supply everywhere in those days.

Now to come to the personal comments.

When we came to Cornell in 1946 we had no ambition to be President of the University or of anything else. Fate, of course, plays a large part in the way anyone is propelled into a role such as the one I have played the last eight years. In the first place, we more or less tossed coins in trying to decide whether to come to Cornell or go to the University of Michigan or go to the Bell Telephone Laboratories. When I became chairman of the physics department in 1956, I was probably the logical choice for the job, although accepting the position involved an anguishing decision. There was no logic at all in my choice as the dean of the Engineering college. I was a last-minute substitute after the prime candidate, whom I had helped recruit, withdrew. If President Perkins had been a physical scientist instead of a social scientist I would never have been provost. If there had been no trouble in 1969 I would never have been President. But here I am.

I could produce evidence to suggest that I have performed the job less well than some might have expected. For instance, in 1938 A. Lawrence Lowell, who was president of Harvard for a long time in the early years of this century, wrote: "A university president should never feel hurried, or have the sense of working under pressure, for such things interfere gravely with the serenity of judgment he should always retain. ... If he feels overworked it is because he does not know how to delegate work to others ... he has not learned that his business is thinking, not routine." I may have retained many things but serenity is not one of them. Perhaps if President Lowell had lived half a century later he might have written a different book.

I want to say a word about my wife's role the last eight years. Her life has been committed to, has been consumed by, the university fully as much as mine has been and I am pleased that you have recognized her tonight also. She has lived through all the same troubles that I have lived through and she has supported and encouraged me in all my ups and downs during these years. In addition she has had the disadvantage of being separated from the scene and so has not known what was going on from minute to minute and hour to hour.

One of the amusing events, one of the few amusing events, which occurred during those difficult days happened when she was driving through the campus one day and observed a huge crowd outside Day Hall. Disturbed at what new trouble had erupted, she sought out the nearest phone and called my office. When there was no answer, she knew the worst had happened again and called the Safety Division to find out what it was. She learned that a routine fire drill was in progress.

I want to acknowledge the debt I owe my wife for all that she has done to support me and for all that she has suffered through the past eight years.

I want to express my appreciation and thanks to the alumni of Cornell University. There are few universities in the country that enjoy the loyalty and the dedication and the affection of alumni to the degree that Cornell does. I've long been aware of this extraordinary relationship, but I never fully appreciated it until I became President in 1969. I expected alumni support to be withdrawn to a substantial degree, and I expected to be faced with a long, up-hill battle as far as alumni were concerned. Quite the opposite happened.

The first major evidence came early in the fall in 1969, a month or six weeks after my formal election as President, when our great alumnus, Nicholas Noyes of the Class of 1906, came into my office to tell me that he was going to give me a boost to demonstrate his confidence. He didn't disclose his intent, saying that he wanted a day or two to think about it and would be back to me before the weekend was over.
Knowing his generosity, I suspected that he intended to make a substantial gift to the university, and I thought it might be as much as $25,000, and I even dared hope that it might be $50,000. A day or two later Nick returned to my office to say that he was going to give the university a million dollars on the basis of a challenge to other alumni. He would match dollar-for-dollar any gift from an alumnus which exceeded the highest previous gift from that alumnus, and if we succeeded in getting the total from other alumni up to three million, he would give us his entire million. We did qualify and as a result alumni annual giving moved from $2.5 million a year to $4 million in the wake of Nick’s gift, and we never fell back.

During the height of our troubles in 1969, two of our largest donors called me to tell me to do my best and not worry about them; they would continue to support me and support Cornell. It’s impossible for me to tell you what that kind of support and the support of all the other tens of thousands of alumni meant to me and to Cornell at that time, and what that kind of support has meant in the years since. Without it I could never have succeeded.

There is one footnote to the Nicholas Noyes story. When he made the commitment for the million dollars, he said all he wanted in return was one seat on the fifty-yard line for the Yale football game. That received a certain amount of coverage in the press as the most expensive football ticket ever sold.

The opportunity to be at Cornell has been a great privilege for my wife and me. The opportunity to associate with, and be part of, a faculty of the quality we have at Cornell; the opportunity to teach students of the ability we have at Cornell; the opportunity to count as friends the hundreds, the thousands of supportive alumni we have come to know; the opportunity to work with a Board of Trustees with the ability and the dedication of the Cornell board; the opportunity to work with an administrative staff and a university work force of such dedication, and in many cases, of such uncommon ability, as Cornell has; the opportunity to live in a physical setting of such natural beauty—these have all been privileges of the highest order.

We are grateful. I am grateful particularly for the support of the Board of Trustees during my years as President and I ask that you support Frank Rhodes as you have supported me.

Although we have been at Cornell for thirty-one years we do not propose to end our association now. Our position is similar to that of a State of Maine native who was asked by a summer visitor, “You lived here all your life?” The Mainer replied, “Not yet.”

A serious Corson addresses an anti-war rally on the Arts Quad in the full of ’69.
In our years at Cornell we have experienced the exhilaration of extraordinary achievement by faculty colleagues, by students, by athletic teams. We have experienced the exhilaration of Nobel Prizes and National Book Awards. We have experienced the exhilaration of Commencement in Schoellkopf on a glorious spring day.

We have known the sorrow, the terrible empty sorrow, of brilliant lives ended too soon, of young lives lost before their promise ever bloomed, of tragedy thrust upon us from every direction. Perhaps we, more than most, have felt these sorrows because our lives, more than most, have been interwoven with the life of the whole university.

Between Uris Library and Morrill Hall, on that beautiful place that Goldwin Smith called “the platform over-hanging the lake,” there is a stone bench placed there by Andrew D. White and his second wife in 1892. While the circumstances are quite different, the words carved on that bench reflect the joys and sorrows that my wife and I have known at Cornell:

To those who shall sit here rejoicing.
To those who shall sit here mourning.
Sympathy and greeting.
So have we done in our time.

Concerning success in life I think it was Ralph Waldo Emerson who once wrote: “To laugh often and love much; to win the respect of intelligent people and the affection of children; to earn the approbation of honest critics and endure the betrayal of false friends; to appreciate beauty; to find the best in others; to give of one’s self; to leave the world a bit better, whether by a healthy child, a garden patch, or a redeemed social condition; to have played and laughed with enthusiasm and sung with exultation; to know even one life has breathed easier because you have lived—this is to have succeeded.”

We have not done a great deal of singing with exultation but we hope there are lives who have breathed easier because we have lived.

For having enriched our lives beyond our ability ever to repay, thank you.
Preface

An “engineering statement” designed by Dale R. Corson, president emeritus of the University, has become the focal point in the Joseph N. Pew, Jr. Engineering Quadrangle. Design features of the accurate timepiece are described in an interview article by the associate editor of the Quarterly.

Cornell Engineering Quarterly 15(4) Spring 1981
To create an “engineering statement” was the goal of its designer, Dale R. Corson, president emeritus of the University and former dean of the College of Engineering. And the gleaming stainless steel sundial in the Joseph N. Pew, Jr. Engineering Quadrangle is exactly that, if judged by its success as a highly accurate scientific instrument for reading time, as a functional and beautiful work of art, and as a fitting monument to Joseph N. Pew, Jr., and the college to which he had been so generous.

The finished work, a six-foot-diameter “bowstring” type of equatorial sundial, is deceptively simple in appearance. All the complicated adjustments for day-to-day astronomical variations are made by the internal mechanism, a marvel of engineering design that makes the Cornell sundial one of the most accurate in existence. (Its error is no more than 30 seconds.) It is also simple to use. All the observer has to do, besides waiting for the sun to shine, is to set a dial for the correct date and read the time directly on simple scale.

Planning, construction, installation, and final alignment of the sundial took place over the eighteen-month period from June 1979, through November 1980. The program marking the dedication of the quadrangle on September 20, 1979, included the unveiling of a model of the sundial. But getting from that model to the final instrument was a long, complicated procedure, accompanied by many revisions of design because of esthetic, practical, and technical considerations.

FROM IDEA TO REALITY: A COOPERATIVE VENTURE

The idea for a sundial came from Pew’s widow, Alberta, who was consulted about the landscaping plans for the quadrangle that would be dedicated to her husband. “He loved the garden, and a garden suggests a sundial. Also, a sundial is a perfect timepiece for an engineer,” Mrs. Pew said.
Corson’s involvement in the project came about as a result of his criticism of the sundial design originally proposed by Cornell’s Department of Design and Project Management. “I felt that it shouldn’t be just a garden ornament,” he said. “Precision was one quality it had to have.” Corson’s knowledge of sundials preceded this project by many years. “I’ve been interested in astronomy for a long time; at one stage I thought I might like to be an astronomer,” he explained. “Then during World War II, I had occasion to learn celestial navigation, which is closely related. It was during that period that I became interested in sundials.” In later years, Corson translated his ideas for sundial designs into scale models made of wood and cardboard. So when the opportunity arose to improve upon or, as it turned out, completely redesign the proposed Engineering Quadrangle sundial, he knew exactly what he wanted to accomplish. He also knew how to go about it, obtaining the assistance of friends and associates from his long and varied career at Cornell.

“President Corson never takes no for an answer,” explained Richard M. Phelan, professor of mechanical and aerospace engineering, who played an important role in the design and fabrication of the internal mechanism of the sundial. He feels that Corson is the only person who could have accomplished this particular task, involving so much cooperation among individuals at the University, several departments, and alumni. “The sundial is a monument to the reservoir of goodwill and love for Corson felt by members of the Cornell community who gave of their time, expertise, and labor to carry out the project,” Phelan said. Those involved in the project included alumni who helped arrange for materials and manufacture, machinists who made the parts, a Cornell landscape architect who designed the setting, and buildings and grounds personnel who installed the completed sundial.

GETTING THE SUNDIAL TO READ ITHACA TIME

The basic problem Corson confronted was to make the sundial readings correspond to local clock time. Most simple sundials record apparent solar time, which differs in two respects from standard mean time, the time to which we set our clocks and watches and to which we schedule our daily lives.

First, there is a difference between standard time and local time. Eastern Standard Time, for example, refers to time on the 75th meridian, whereas Ithaca is at longitude 76 degrees, 29 minutes west. After it passes the 75th meridian, the sun must always move through one degree, 29 minutes before it passes Ithaca’s meridian. (The sun will appear to be due south when it passes the local meridian.) Since the sun moves at 15 degrees per hour, one degree and 29 seconds corresponds to 5 minutes and 56 seconds of time. To take account of this longitudinal correction, the hour scale on the sundial is simply displaced toward the east so that it will record noon, say, 5 minutes and 56 seconds before the sun is actually due south in Ithaca.

The second correction is more complicated. It is required because the sun does not keep uniform time—sometimes the sun is fast (that is, it reaches the standard meridian before a clock indicates noon) and sometimes it is slow. The correction is more than 16 minutes at its maximum; four times a year (April 15, June 14, September 1, and December 25) the sun and the clock agree. The departure of sun time from clock time derives from the ellipticity of the earth’s orbit and from the tilt of the earth’s axis with respect to the plane of the earth’s orbit.

The differences are ordinarily provided in tabular form, one correction for each day of the year, and are referred to as the equation of time. Using such an equation-of-time table, Corson derived, through Fourier analysis, an actual equation that gives the correc-
tion for any time of year. His equation was programmed into a numerically controlled milling machine used to cut a cam which, together with a system of gears, pulleys, and cables, and in response to a simple manual setting, provides the necessary daily adjustment. The beauty of Corson's design lies in the simplicity of the manual operation needed to effect the complex mechanical adjustments.

How does it work? The visible part of the sundial comprises two semicircular arcs. A “bowstring” arc holds the shadow-casting rod, which is parallel to the earth’s axis. A second arc, parallel to the earth’s equatorial plane, provides a base for a time scale engraved with lines, each corresponding to one minute, running from 6 a.m. to 6 p.m. Both arcs sit on a granite base with four sides sloping inward at an angle of approximately ten degrees. (Corson, an accomplished amateur photographer, had found the ten-degree slope to be a pleasing one when making frames to exhibit his photographs.) The working parts, including the heart of the mechanism, the cam, are contained within the granite base. When the month and day are set by turning an exterior knob, the cam is made to rotate. This in turn moves a cam follower, which, through a system of pulleys and cables, shifts the sundial’s time-scale arc so that the correct Eastern Standard (or Daylight) Time is indicated by the shadow of the rod.

No specialized knowledge of astronomy or sundials is necessary in order to set the sundial. In fact, it was intended to be what Phelan calls an “audience-participation sculpture”—the first person who happens along in the morning sets the date. Any “extra” adjusting done by curious passersby does not hurt and might have the beneficial effect of helping to lubricate the cam mechanism.

WORKING OUT DESIGN AND CONSTRUCTION DETAILS

The location, dimensions, and construction materials of the sundial were arrived at after some experimentation with scale models and after discussion of practical considerations.

The location in the quadrangle was determined not for esthetic reasons, but by the shadows cast throughout the year by the surrounding buildings and trees. Careful calculations were made to find the sunniest spot. To ensure that the sundial would never have to be moved, the site was checked for any buried pipes or cables. Stability of the soil was another consideration; any shifting because of freezing and thawing would reduce the accuracy of the timepiece.

The original plan called for an overall diameter of three feet, but this proved to be too small for the large expanse of open space in which it would be placed. Practical considerations limited the size, however. For example, the time scale could not be so high off the ground that it could not be viewed straight on. An increase in size would also increase the weight of the steel arc to be moved by the pulley system, requiring a larger mechanism in the base. A diameter of six feet proved to be large enough to provide a focus for the quadrangle, to increase the reading accuracy because of a greater distance between minute lines, and yet to keep the sundial compact and light enough for ease of viewing and strength of internal workings. The “bowstring” rod was designed with a diameter...
CORSON’S EQUATION OF TIME

An actual equation of time was derived by Dale R. Corson from tabulated empirical data that have been known as the equation of time. Corson’s expression, derived via Fourier analysis, is:

\[
ET (\text{in minutes}) = \frac{-7.3412 \sin \frac{360}{365} n + 0.4944 \cos \frac{360}{365} n}{360} + 360
\]

\[
ET = \frac{-9.3795 \sin \frac{360}{365} n - 3.2568 \cos \frac{360}{365} n}{360} + \frac{0.0774 \cos \frac{360}{365} n}{360} - 0.1739 \sin \frac{360}{365} n - \frac{0.1283 \cos \frac{360}{365} n}{360}
\]

\[ET = \frac{n}{365} \text{ is the number of the day of the year (January 1 = 1; December 31 = 365).}\]

ET is for noon Greenwich Mean Time; to calculate the correction for noon Eastern Standard Time, \(n\) is replaced by \((n+0.2)\).

Since \(ET\) is the average for the leap-year cycle, it can be wrongly by possibly 20 seconds during the few months prior to February 29 in a leap year.

Stainless steel was chosen as the construction material because it seemed suitable for an engineering sculpture and because it is durable and available in plate form. It was used not only for the exposed parts, but for many interior pieces as well: any piece that would come in contact with an exposed part, and many on a level inside that, were fabricated of stainless steel in order to protect against rusting and electrochemical corrosion.

A longtime friend and associate of Corson’s, William E. Mullestein, made arrangements for fabricating the large arcs. Mullestein, a 1932 Cornell graduate in civil engineering, is former chief executive officer of Lukens Steel Company in Coatesville, Pennsylvania (a company that does not make stainless steel). He enlisted the help of Robert Buckley, chief executive officer of Allegheny Ludlum Industries and a Cornell Law School graduate, who arranged for a gift of the two-inch-thick steel plate from his company. Mullestein also offered to provide machining of the arcs at Lukens. Leonard Pompa, an engineer who has retired as the international manager for the company, was put in charge of this assignment—one that Corson described as a difficult job well handled. All the measurements had to be extremely precise, and even a difficult two-foot-long hole, 7/8 inch in diameter, through which the cables were to run, was perfectly drilled.

The next step was to have the standard and daylight time scales engraved on a stainless-steel plate 8 inches wide, 3/8 inch thick, and more than 7 feet long. In a memo written before the engraving was done, Corson wrote: “This is a bit tricky, inasmuch as the engraving will be done on a flat plate which will then be rolled to the final curvature, compressing all the distances on the surface in the process. Consequently, the scale as specified must be expanded. I hope the amount of compression on rolling is as advertised.” The engraving was done by Thomas Claro, whose shop in Philadelphia is so small that a rearrangement of equipment was necessary before the work could proceed.

PHELAN’S WORK ON THE ADJUSTMENT MECHANISM

Meanwhile, at Cornell, Phelan was working on the design and manufacture of the internal adjustment mechanism. Corson had enlisted his help in translating the movement of the cam into the appropriate movement of the equatorial arc. Phelan made an initial design (see the figure), but because many of the parts were machined to fit as construction proceeded, no final drawing of the actual mechanism exists. The complicated nature of the mechanism, coupled with the constraints of size and shape of the base, dictated a final configuration with many odd angles and tightly fitted parts.

The engineering challenge is what Phelan enjoyed most about the project. The problem, as he saw it, was the need for laboratory accuracy in an outdoor setting in Ithaca. I knew it could be done, but it would have to proceed step by step, with each piece helping to design the next.”

The basic design of the adjustment mechanism consists of a series of gears which transfer the movement of the setting knob into a rotation of the cam, and a system of pulleys and cables which transmit the action of the cam up through a hole in the bowstring arc to the time-scale arc. This is made to move back and forth on a track with rollers.

A worm-gear reduction unit, located just inside the base from the setting knob, has a reduction ratio of 200 to 1. Two spur gears further reduce the movement by a 2-to-1 ratio. To protect the workings against the application of excessive force (for example, if the setting knob is turned while the exterior is covered with ice), a slip clutch is provided in the drive between the gears and the cam shaft. Because the cam shaft is directly connected to the month-day dial, the position of the cam will always correspond to the date shown on the dial.

The positive-drive cam has a diameter of approximately 9½ inches. It has a curved groove, one inch wide, in which the radial-roller cam follower moves up and down as the cam rotates, activating the cable and pulley system. A compound pulley provides the correct multiplication for the appropriate movement of the time scale on the equatorial arc.

All bearings are sealed and lubricated for life, making the sundial relatively maintenance-free. To gain access to the internal workings of the sundial, the granite base would have to be dismantled—an operation that should not be necessary for many years. Non-contacting seals are used between the major moving parts to minimize friction. Water flows along grooves and out drainage holes located so that the drips will not fall on any part of the mechanism.
The cable used to transmit the movement of the cam to the equatorial arc has a breaking strength of 400 pounds, far in excess of the 40 pounds that might be exerted in normal circumstances. The cable is of the type used in aircraft and is made of stainless steel.

LOCAL FABRICATION, ASSEMBLY AND INSTALLATION

Most of the parts of the internal mechanism were fabricated in the machine shop in Upson Hall, the mechanical and aerospace engineering building. “Everything the shop did was superb,” Phelan commented.

As each piece was completed, the next was made to fit with it. Dimensions had to be changed according to the availability of materials, as well as the fit of parts. Phelan, whose office is in the same building, was readily available to make the necessary changes from the original design.

It was known almost from the outset, for example, that holes would have to be drilled in the equatorial arc in order to reduce the weight to be moved by the internal mechanism. The size and location of these holes could not be determined, however, until after the hour scale had been screwed down to the equatorial arc: the kind, number, and placement of screws would dictate where the underlying lightening holes could be drilled.

Standard and daylight time scales were engraved on a flat stainless-steel plate, which was later rolled to the correct curvature. A rod on the sundial’s “bowstring” arc casts a shadow across the time-scale arc, permitting a reading that is accurate to at least 30 seconds.

In the final version, the movement of the setting knob, far right, is reduced by a 400-to-1 ratio by the worm gears and the spur gears. A slip clutch, located between the gears and the cam shaft, protects the workings from application of excessive force. At the opposite end of the cam shaft from the month-day dial is a positive-drive cam with a curved groove for a radial-roller cam follower. As the cam rotates, the cam follower moves up or down, initiating a movement in the pulley system. Cables from the compound pulley transmit this movement to the equatorial arc for the appropriate adjustment for each day.

The surrounding photographs (by Corson) show parts of the completed mechanism: the cam, part of the pulley mechanism, and the month-day dial with setting knob.

Figure 2. Adjustment mechanism of the sundial (from an early working diagram). The basic mechanical parts are shown in a configuration similar to that of the completed sundial.

The cable used to transmit the movement of the cam to the equatorial arc has a breaking strength of 400 pounds, far in excess of the 40 pounds that might be exerted in normal circumstances. The cable is of the type used in aircraft and is made of stainless steel.
A numerically controlled milling machine in the Floyd R. Newman Laboratory of Nuclear Studies was used to machine the cam. The computer-driven machine, fed Corson’s equation, was able to cut the steel to the necessary shape with an accuracy of one or two thousandths of an inch. According to Corson, this task could have been accomplished with traditional machining methods, but to have done it with the equipment available in, say, the 1950s, when I last worked in a machine shop, would have been terribly complicated. “The precision of this cam was the crucial element in the ultimate accuracy of the sundial.”

Assembly of the parts proceeded slowly, as each piece was fit to the next, with modifications made as necessary. “Every part was made so it could be shimmed,” Corson said. “We put in small shims to adjust the spacing of the parts so that they worked freely. That all had to be hand-adjusted. We would try it and measure it and take it off and adjust it a little bit and try it again.” The last adjustment to be made was machining the grooves on the compound pulley in order to provide the correct multiplication for the movement of the arc.

After assembly in Upson Hall, the sundial was lifted by a crane and set in its permanent site, which had been prepared by the laying of a concrete base with a ramp and steps rising to its slightly elevated height. The landscape design was done by Peter Trowbridge, assistant professor of landscape architecture at Cornell. Proper alignment of the instrument was the next step. Measurements accurate enough for exact placement would have been difficult, so the final alignment was accomplished by setting the sundial to the correct time and then fixing it in the required position, using leveling and rotation-alignment screws in the base.

The ultimate test, for accuracy, took place during the first week of November. The sundial lived up to expectations, with a built-in error of no more than thirty seconds. Corson makes periodic checks to ensure against any changes in accuracy. You can set your watch by it, Phelan points out; it keeps better time than Cornell’s landmark, the McGraw Tower clock.

AN ENGINEERING STATEMENT: IS IT THE LAST WORD?

Far from exhausting Carson’s interest in and enthusiasm for sundials, this project has increased his desire to create the “perfect” solar timepiece. How would he improve on the present design? The next model would be equipped with four cams, rather than one, to accommodate the leap-year cycle. The present cam treats all Februarys as if they had twenty-eight days, which introduces an error, in some months and some years, of as much as 20 seconds (a good portion of the current sundial’s 30-second margin of error). If I were to work on sharpening up the shadow, and changed the cam for each year, I don’t see why I couldn’t make a sundial accurate to five seconds,” he said.

Phelan looks in a different direction for his next engineering challenge, but says he is pleased to have his name associated with this project. Furthermore, the design problems he encountered while working on the sundial were put to academic use. Students in M&AE 325, Mechanical Design and Analysis, taught by Phelan, were assigned problems relating to the design of the gears, slip clutch, cam, and cable attachments; after the students had completed their designs, they were shown the actual parts for compari-
son. Such an exercise helps relate coursework to real engineering problems, Phelan believes.

“The sundial project was a happy operation, involving many people and creating lots of enthusiasm,” Corson said. “Everywhere I turned, there were people eager to participate.” It is through this cooperative work of Cornell professors, staff members, alumni, and friends that the College of Engineering has a new landmark, a unique engineering statement. — ANN POLLOCK

Left: Engineering students seemed to be proud of the newly installed sundial; many have a proprietary feeling about it as a fitting focal piece for their campus.
Corson at the relocated Sundial on the engineering quad

The Relocated Sundial with the new Duffield Hall in the background
Preface

Since 1963 we have owned a summer vacation cottage on the ocean in far down-east Maine. There was always much discussion about our county being the “Sunrise County” where the sun always comes up first. I doubted that this was so, even though we were the farthest east county in the country. After I acquired a personal computer I set about making the calculations in this piece. I have long known the astronomy involved and the calculations are easy.

Dale R. Corson
May 5, 1988
I once received a notice of the forthcoming 4th of July celebration at Eastport, Maine and it caught my attention. The notice began “Dear Friends: did you know that our nation’s Independence Day, the 4th of July, first began Eastport, ME? Why? ‘Cause we’re the first city in the nation to see the sun—that’s why! The day always begins at Eastport.” The notice goes on to invite us to the celebration this year and to contribute to its support.

I have visited Eastport several times and I am sure the celebration will be a good one and that the Flag Raising and the Calathumpian Parade and the Cod Fish Races will be worth supporting, but I am equally sure that Eastport will not be the first place to see the sun on July 4 or on any other day. I have been thinking about this problem for a long time and I want to pass on my thoughts to Eastport.

It all began in the summer of 1963, when there was a total eclipse of the sun in eastern Maine and I traveled there with my family to observe it. In spite of bad weather we succeeded in seeing the eclipse and it was a memorable experience. The experience extended beyond the eclipse, however, because we happened to see a vacation cottage for sale and we bought it. In the years since 1963 we have spent part of nearly every summer there, learning about Maine life and immersing ourselves in its customs and folklore.

One interesting piece of local folklore is the claim that Washington County, which is ours and which also includes Eastport, is the “Sunrise County,” where the rays of the rising sun first strike the United States. Large billboards, each portraying a red sun rising from the horizon, proclaim this alleged fact at the county borders.

I have felt a degree of pride in our county’s primacy as far as sunrises are concerned, but I have also felt a degree of uneasiness about the claim. It is reasonable that the sun comes up here before it does anywhere else in the country because Washington is the easternmost county in the United States. Still, there are mountains in other counties in the state where the first rays might strike. There is Cadillac Mountain, for example, on Mt. Desert Island which is in Hancock County to the west of US. (Actually it is to the southwest but on the coast of Maine there are only two directions: east and west.) Cadillac is 1,530 feet high, which is elevation enough to make several minutes difference in the time of sunrise. There is also Mt. Katahdin which is 5,268 feet high and it is in Piscataquis County. Although it is well inland, the mile high elevation has a big effect.

Furthermore, there is always the possibility that one place or another might have greater or lesser advantage as the seasons change and the sun moves north and south in its annual cycle. I finally decided to resolve these uncertainties by calculating the times of sunrise at a number of places, which I am qualified to do, and comparing them. The calculations required are not particularly complex but to do them by hand for different latitudes and longitudes and for different times of the year is much too time-consuming. The type of investigation I have now made became feasible for me with the availability of personal computers.

To begin the discussion, let us look at the time of sunrise at West Quoddy Head lighthouse, which is a few miles east of Eastport and which stands at the easternmost point of Washington County – and of Maine and of the United States – at Latitude 44º 49’ North and Longitude 66º 57’ West, and let us consider December 21, the day when the sun is at the southern-most point in its annual north–south cycle. On that day the sun rises at 7:01:46 am Eastern Standard Time – or it would if the view of the rising sun were not
obsured by the hills on Grand Manan Island, which is Canadian. Taking account of the horizon-obscuring hills on Grand Manan the sun actually appears at 7:04:50 am. The view of the rising sun at Eastport is also blocked by Grand Manan on this date.

At this point I must add a word about the actual time of sunrise. The basic calculation of the sun’s position, the calculation which a navigator makes, refers to the center of the sun’s disc. For sunrise, however, we are interested in the top edge of the disc, which “comes up” before the center of the disc does. This correction can be as much as two minutes in these considerations, depending on the latitude of the observer and the time of year. Furthermore, when the sun is near the horizon the apparent position is always higher than the true position because of refraction in the earth’s atmosphere. The sun appears to be about one disc diameter higher than it actually is, i.e. the disc appears to sit on the horizon when actually the upper edge of the true disc is just emerging. The refraction correction can be as much as four minutes, again depending on location and time of year.

Elevation above sea level can also affect sunrise time but the correction is readily calculated, especially if the ocean provides the horizon. One way to calculate this correction is first to find the direction of the rising sun in order to find the latitude and longitude of the point on the horizon where the rays of the rising sun just graze the surface of the ocean and go on to strike the elevated point. Sunrise at the two places is at the same instant, and the time at the surface point is readily calculated. The distance to the horizon point depends on the elevation and is about 12 statute miles for an elevation of 100 feet, 39 miles for 1,000 feet and 87 miles for 5,000 feet. (The apparent distance is somewhat different because of refraction but the effect is calculable). Obscuring hills on the horizon also have an effect and correction again requires knowing the direction of the rising sun so that I can determine the elevation and distance of the hills on the horizon by studying a topographic map.

Of these four corrections (half diameter of the solar disc, refraction, elevation above sea level and obscuring hills) only the refraction calculation is uncertain. The magnitude of the correction depends on the temperature and pressure of the atmosphere, and it can vary under extreme conditions by tens of seconds. Under ordinary conditions the uncertainty can be reduced to a few seconds using well-established refraction data.

Coming back to West Quoddy Head, we need to know how to compare the time of sunrise there with the corresponding times at other places. A convenient way is to find other places having the same sunrise time and draw a line, on a map or chart, which passes through West Quoddy Head and through all the other points. The latitude and longitude of such points are readily calculated. The navigator knows such a line as a “line of position.” I shall call it the “sunrise line.” Any point lying to the east of the sunrise line through West Quoddy Head has an earlier sunrise.

The sunrise line is perpendicular to the line pointing toward the sun at the moment of sunrise. In fact it is a small piece of a very large circle on the earth’s surface, a circle whose center is the point where the sun is directly overhead. On December 21 the sun comes up in the southeast and the sunrise line runs at right angles, from the northeast to the southwest. It is part of a circle whose center is in the South Atlantic Ocean about 500 miles south of the island of St. Helena.

On June 21 the sun comes up in the northeast and the line runs from the northwest toward the southeast. The center of the circle in this case is about at Riyadh, Saudi Arabia. At sunrise the center of the circle is always a quarter of the way around the earth.

Looking at the line for December 21 we see that all of Maine lies to the west of the line and consequently has later sunrise. Washington County seems to be home free. It appears to be the true sunrise county. But what about Cadillac Mountain? Since it is 1,530 feet high the sun touches it before it touches any nearby sea level points.

The horizon distance is easily calculated, and for Cadillac Mountain it is 47.9 miles (in practice we must use the apparent horizon distance, corrected for refraction, which is somewhat less than 47.9 miles). We draw a circle with this radius around Cadillac Mountain as center. The sun’s rays graze the horizon point and touch the top of Cadillac at the same instant, so that both have the same sunrise time. If the point on the circle in the direction of the rising sun lies to the east of the sunrise line through West Quoddy Head, sunrise on Cadillac will be earlier than at the Head.

What do we find? Alas, the sun does rise earlier on Cadillac than it does at Quoddy. In fact it rises at 7:01:09 EST, about 3 1/2 minutes earlier.

We have another card to play, however. Is there any hill in Washington County whose horizon circle extends beyond Cadillac’s? A good candidate would be Yellowbirch Mountain near Whiting, but its 325-foot height is not enough greater than that of the Grand Manan hills to be of help. There is a 247-foot hill near the ocean between West Quoddy Head and Cutler but it too is cut off by Grand Manan Island. The best hill is west of Cutler and is 192-feet high. Sunrise there on December 21 is at 7:01:14 EST, five seconds later than on Cadillac Mountain! It is a dead heat. The small uncertainties in the calculations make such a small difference insignificant. Eastport loses by a few minutes.

The December 21 sunrise line for Cadillac Mountain and Cutler slants rather sharply to the west as we proceed south and it might lead to trouble so we should pursue it. No part of Maine lies to the east of this line so there are no other contenders in Maine but what about Massachusetts? The only serious competitor is Cape Cod but it loses by about two minutes. Nantucket Island comes closer. Senkey Head Lighthouse, at the eastern tip of the island, registers 7:02:19 on December 21, only one minute behind Cadillac and Cutler.
As we proceed farther southwest Cape Hatteras extends somewhat to the east but not nearly enough. Miami Beach, Florida, however, is a front-runner. Carysfort Reef Lighthouse south of Miami Beach records 7:02:03 on December 21, only 45 seconds off the pace. Key Largo and all the other keys are too far west to compete successfully.

If we were to allow competition from tall buildings it would be a somewhat different story. A 400-foot high hotel would put Miami Beach on an even footing with Cadillac Mountain, but if we allowed that competition we would enter the tops of our Maine light-houses and of our tall trees. Competition in this race is restricted to ground level.

As the sun moves north after December 21 the sunrise lines slant less sharply to the west and Florida, and even Cadillac Mountain, quickly lose their positions in the race. By January 1 Cutler is beginning to edge past Cadillac, and Miami Beach has already dropped two minutes behind. By January 10 Washington County's supremacy is clearly established (although Eastport is never quite the front runner) and it stays that way until about May 1 when other contenders appear.

The first is 1,600-foot Mars Hill, in Aroostook County, adjacent to the New Brunswick border between Houlton and Presque Isle. Its elevation serves only to get it on equal footing with the hills on the horizon in New Brunswick, but by May 1 it has already crept ahead of West Quoddy Head (which has now outrun Cutler) by a few seconds, and from May 1 until about August 10 Washington County is out of the race. For a time the winner is Mars Hill, and for a time in the middle of May and again in late July Mt. Katahdin, in Piscataquis County, is the leader. From June 1 until mid-July Cold Mountain near Van Buren, with an elevation of 1,000 feet, is probably the grand champion. Sunrise there on June 21, when the sun is at its northernmost point, is at 4:36:20 Eastern Daylight Time. On the same day Katahdin is 4:36:38 – another close race. Precise calculation of these times requires careful study of topographic maps to determine the elevation of the hills on the horizon and these particular times are probably no better than half a minute or even a minute.

To sum it all up: for a couple of weeks in December, around the winter solstice, Washington County and Cadillac Mountain, in Hancock County, are in a dead heat, with Nantucket Island and Miami Beach, Florida hard on our heels. From early January to about May 1 and from August 10 to mid-December Washington County is supreme. From May 1 to August 10 Aroostook County and Piscataquis County are the winners.

Now that I know the facts about the sunrise race, how do I feel about it? I am pleased to know that our county is supreme most of the year, and I am amazed that on December 21 sunrises in Washington County and Cadillac Mountain in Maine, at Nantucket Island and at Miami Beach, Florida are all within a one minute interval – a remarkable coincidence.

I feel sorry for Eastport. It will disappoint them to know that for a few months Van Buren, Caribou and many other “cities” are ahead of them. Part of the year Eastport even loses to Miami Beach. That will be hard to accept.

Checking the calculations by actual observation has been fun. I must confess that much of my checking has been done at sunset instead of sunrise. The calculations are nearly identical and 8:17 p.m. is a much happier time to make precise observations than is 4:47 am. Besides, from my cottage in Washington County, I have a clear view of sunset whereas I would have to go somewhere else to get a clear view of sunrise. When the obscuring hills are at some distance, say 15 miles, my calculated times agree within a fraction of a minute, say 15 or 20 seconds on the average, with the observed times. The biggest uncertainty is the height of the trees on the hills. When the hills are only two or three miles away the agreement is not as good – a 25-foot uncertainty in tree height produces significant uncertainty in sunset or sunrise times. I have checked many sunrises at home in Ithaca, New York with comparable results. I have made one observation of sunrise time on Cadillac Mountain. My calculated time was within 30 seconds of the observed time.

I do not mind losing the sunrise race to Mt. Katahdin. I once climbed Katahdin and it is a real mountain. I can derive pleasure from lying in bed before the sun comes up, knowing it is shining on Katahdin. Aroostook is a beautiful county, off in a remote corner of the United States, and it deserves its few weeks of glory. Mars Hill and the other high wooded hills rising from the green potato fields are a pleasing spectacle.

I also have a certain amount of kindness in my heart for Cadillac Mountain and Hancock County. The people of Hancock County are worthy for the most part, although anyone who has driven through the Ellsworth traffic on an August weekend may have some doubt. I have a slight reservation about Cadillac. It does have a highway to the top which, to a mountain climber, carries an element of shame. Still, the view from the top is magnificent. On balance, I don't mind letting Cadillac Mountain have a small piece of the glory.

I am happy that we do not lose the race to Miami Beach. Anyone attracted to the coast of Maine has a certain amount of reservation about Florida, and I am pleased that I can hold my head high when I go there.

The sign boards that proclaim our sunrise supremacy in Washington County will probably be removed eventually because Maine now has an anti-billboard law. In the meantime, perhaps we should change the signs to read: “A Sunrise County or “The Most-of-the-Time Sunrise County.” As for Eastport, I will attend their 4th of July celebration sometime. It might be as interesting as the one at Jonesport with its lobster boat races. And besides, I can learn what a Calathumpian parade is.
Preface

Stuart Brown was Chairman of the Philosophy Department, Dean of the Arts College (two terms), and Vice President for Academic Affairs emeritus. Sometime during my period as President, he stepped down from his Vice President role.

I recommended him to Harlan Cleveland, the new President of the University of Hawaii, in 1970, for the Academic Vice President position Harlan was seeking to fill. Stuart served there for a few years. When he left, the Hawaii House and Senate adopted a joint resolution of praise for Stuart and his role in University of Hawaii affairs and sent me a copy.

Stuart Brown, Jr. delivered this brief speech after the dinner on the occasion of the dedication of Corson-Mudd Hall on September 9, 1982.

Dale R. Corson

Remarks by Stuart M. Brown, Jr. at the Dedication of Corson–Mudd Hall
Mr. Kennedy, Dale and Nellie Corson, their friends

When Keith Kennedy invited me to speak here tonight, he asked specifically for anecdotes about Dale Corson as a university administrator, successively Chairman of Physics, Dean of Engineering, Provost and President.

Now, an anecdote is a true tale, interesting and amusing and not widely known, so that the telling of it is something like revealing a secret. For example, on the morning when I first met Dale, he and I were both department chairmen and I went to visit him in his office on a matter of urgent university business. But by pure coincidence, that was the morning after Sputnik had made its first passes over Ithaca on a cloudless night. We had both been out observing it, but as you can imagine, Dale had done much more than that. He had photographed it in a precisely timed sequence of shots as it passed west to east across the sky through the constellations. From these photos, he had then plotted its precise track from the Midwest where he first picked it up, to out over the Atlantic where he lost it. He had enjoyed himself immensely and still glowed with the pleasure and excitement of it. In more recent times, he has got something of the same pleasure and excitement from the design and construction of sundials.

I regret to have to say, however, that I know of no anecdotes like this about Corson as a university administrator. For this dearth, there are probably two reasons. One is that though as a university administrator he knew many secrets, he also knew the importance of keeping them secrets. The other reason is that he is a deeply serious man who as an administrator has been serious about his work and quietly dedicated to it. This combination is not productive of anecdotes.

So what I want to relate here very briefly is personal rather than anecdotal. I begin with a profession: I learned more about university administration from Dale Corson than from any other person. This profession, taken by itself, does not mean very much. But it means a lot when I add to it that before I ever knew Dale, I had two superb teachers of administration, men who taught me carefully by both precept and example. One was a young West Point graduate under whom I served in World War II. The other was George Sabine, who was dean of the graduate school and vice president for academic affairs here at Cornell during the 1940’s. From these two and Corson, I learned that the most essential ingredient of successful administration is knowledge of the institution – comprehensive, detailed, and deep knowledge of the institution’s aims and goals, its fine structure and resources, and its wider social setting. Armies, of course, are authoritarian; universities are participatory and consensual; and I have never met anyone who understands this difference better than Corson or has put it to better use. Even Sabine did not understand it more deeply. Moreover, Sabine’s Cornell was really a university of the period between the two wars — a smaller, simpler, more autonomous and more leisurely institution. It was no trick at all for a man of Sabine’s energies and encyclopedic knowledge to know the whole university comprehensively and in detail, the strength and weaknesses of every academic department and every principal faculty member. What is incredible is that Corson knew his Cornell of the 60’s and 70’s just as thoroughly and deeply as Sabine knew his of the 40’s.

The device which Corson perfected in order to accomplish this was program review. As Corson perfected it, program review had two distinct but inseparable aspects. In one aspect, it was informal — a constant, continuing, day-to-day, part of his interaction with us, his deans and department chairmen. He never let us forget that as administrators, our principal day-to-day business was with objectives, means, and timetables. In its other aspect, program reviews were formal, carefully planned, finely structured events. The appropriate deans, department chairmen, and other officers would meet formally in Corson’s office and review systematically a department, division, or entire college. I can remember very vividly, for example, what must have been the first review of the Division of Biology. Corson would inquire about everything: budget, housing, staff, retirement schedules and tenure tables, research and teaching, the commitment to graduate and undergraduate instruction. Everything!

These reviews, more than anything else, I think, gave Corson his immense knowledge of the university, and his knowledge gave him his immense authority. They also had another outcome. They changed the university without Corson himself ever having to do anything more about it. They made us think about what we were doing; they changed the focus and intent of our own thoughts, and so made an immense difference in what we did. In consequence, Cornell became a different and I think, a better place.

SMB, Jr.
The Corson family gathered for the dedication of a building in honor of Dale
Preface

Seven thoughtful and provocative papers – written by Dale Corson between 1984 and 1998 – follow. These reflect his broad interest in topics that range from research and research policy for the public good, to insights into the effective organization of research universities to facilitate multidisciplinary research, to his abiding interest in keeping undergraduate education affordable and strong. He elucidates the dilemma of exponential growth behavior.
Preface

The Board action on May 29, 1977, in electing me Chancellor of the University, included the following assignment: “To prepare for the Board a comprehensive report on the status of Cornell University and on the status of higher education generally as viewed from the perspective of 14 years’ service as Provost and President.”

The report discusses what I saw as the status of higher education at the time, and it discusses problems peculiar to Cornell. There are also thoughts about general problems, such as University investment philosophy and desirable tenure ratios.

Dale R. Corson
March 1, 1978
March 1, 1978

Mr. Robert W. Purcell
Chairman, Board of Trustees
Cornell University
30 Rockefeller Plaza
Room 5400
New York, NY 10020

Dear Mr. Purcell:

The Board action on May 29, 1977, in electing me Chancellor of the University, included the following assignment: “To prepare for the Board a comprehensive report on the status of Cornell University and on the status of higher education generally as viewed from the perspective of 14 years service as Provost and President.”

I am transmitting herewith the report which the Board requested. The report is intended to serve two functions: 1) to provide perspective for the Board on what I perceive as the present trends in higher education and on the possible impact those trends will have on Cornell University, and 2) to give the Board a number of more or less unrelated comments on matters that are specific to Cornell. I hope the Board will find both aspects of the report useful.

Sincerely,

Dale R. Corson
Chancellor
INTRODUCTION
CORNELL IS IN GOOD CONDITION
HIGHER EDUCATION IS IN A PERIOD OF CHANGE
  The Public Has Lost Some of Its Confidence in Higher Education
  The Days of Growth Are Gone
  There Are Important Steps We Can Take
  Accountability Will Grow
  There Must Be New Emphasis on Undergraduate Education
  We Must Maintain Our Independence
  The Growing Gap between Public and Private Tuition Charges Is a Matter of Concern
  Can Our Inflation Rate Be Reduced to That of the General Economy?
  Here Is a Salary Policy That Could Restrain Salary Inflation Rates
THE IMPACT OF GOVERNMENT ON HIGHER EDUCATION IS ENORMOUS
  There Has Been a Long and Beneficial Government Involvement
  Federal Support Increased Sharply after World War II
  Higher Education and Research Received a Big Boost after Sputnik
  Problems with the Federal Support System Began to Appear in the Late 1960s
  There Are Now Many Government Student Support Programs
  There Are Many Other Ways in Which State and Federal Governments Support Universities
  There Are Several Areas Where National Interest Dictates Increased Federal Support
  A New Dimension Has Entered the University-Government Relationship: Regulation
  We Are Threatened by New Tax Legislation
CORNELL’S RELATIONSHIP TO NEW YORK STATE MUST BE CLARIFIED
  Cornell University is a Unique Resource for the People of New York State
  Cornell Research is Vital to the State’s Economy
  Cornell’s Special Mission Is to Extend the Benefits of Its Research and Knowledge to
    All the People of New York
  Cornell Is a Single University Whose Strength Depends on Its Unity
  The Cornell-SUNY Relationship is Beset by Ambiguity and Confusion
Cornell Does Not Present Its State-Unit Budgets Directly to the Governor and the Legislature
The Cornell Statutory Units Are Fundamentally Different from the SUNY Institutions
SUNY Necessarily Imposes Inappropriate Administrative Requirements
The Cornell Relationship to New York State Must Be Changed
There is a Good Start toward Clarifying the Ambiguities

I HAVE VIEWS ON A NUMBER OF MATTERS THAT ARE SPECIFIC TO CORNELL
  We Are Spending Too Much Capital
  The Total Return Concept Has Not Worked
  The Future Must Be Protected
Note Added February 11, 1978
  I have Questions about Trustee Organization for Determining Fiscal Policy
  High Tenure Ratios Are Not Necessarily Bad
  Campus Appearance Could Be Much Improved
  Whatever Happened to Confidence? to Trust? to Faith?
  The Future of Student Trustees is Clouded
  Some University Business Must Be Conducted in Confidence
  I Am Concerned about Intercollegiate Athletics
  Cornell Must Conquer Its Tenth-Place Syndrome
  Senior Administrators Need Sabbatic Leaves
  I Violated the Terms of My Employment Agreement

APPENDIX A: The Government, the Universities, and Research: Preface
APPENDIX B: The Government, the Universities, and Research: An Overview
APPENDIX C: Further Thoughts on Prudent Unrestricted Investment Income Distribution
INTRODUCTION

It is not often that a university president gets a chance to tell a board of trustees where to go, or, more exactly, where they should be going and what they should look for en route. But when one becomes a university chancellor, telling the trustees where to go is written into the job description. I hope also to give you my views about some of the places we have been, where we are now, and about the road signs I think you are likely to see on the route ahead.

I believe that higher education in this country is in a period of rapid and, possibly, profound change. My intent is to put this change and potential change into some degree of perspective for you. At the same time, I also have some comments particular to Cornell University, which I shall give you for whatever they are worth. They are simply the distillation of thirty-one years of Cornell watching and Cornell living.

Before proceeding to the perspective and the distillation, I want to thank you for my more than thirty-one years at Cornell. It has been a privilege to be here. I thank you for your encouragement, your support, your patience, and your wisdom during my years as president, and I commend you for your devotion to the University. My years as president were turbulent ones, and they were challenging ones. There were periods of despair and periods of hope, periods of frustration and periods of accomplishment, and there was one period of pure joy. It lasted from December 31, 1969 to January 1, 1970. The year 1969 had finally come to an end. Through all my years, you were steadfast in your devotion and in your support. I am grateful.

In discussing the current state of higher education, some of the things I have to say are based on solid fact: the size of the traditional college-going student pool will decrease sharply in the next decade, for example. Some of the things I have to discuss are based on likely developments: the amount of money from public sources going into private higher education seems likely to increase, for instance. Some of my comments are pure conjecture: the possible revolt by the public over the ever-widening gap between the cost of attending a public institution and that of attending a private one, for example.

What I give you in this discussion is my own opinion, and I am no seer. There is no guarantee that what I say is absolute truth or that what I think may be the evolutionary path over the next decade or two will, in fact, prove to be the actual path. I am extrapolating from the facts and from what I believe are the unmistakable trends at the present time.

My opinion is informed, however, even though I stopped talking about what I was reasonably sure I understood in 1959 when I stopped being an active professor and started as a full-time administrator. I have been an intense observer and participant in the total higher educational scene for the past eighteen years, and especially for the past fourteen years. I served a three-year term on the Board of Directors of the American Council on Education and a three-year term on the Executive Committee of the Association of State Universities and Land-Grant Colleges. I have participated actively in the affairs of the Association of American Universities. Recently I served two years as president of the Association of Colleges and Universities of the State of New York. Where my view is clouded, it may be from overexposure, from total immersion in the problems that concern us so much. I hope that you, with your greater degree of detachment, can take my views, derived from my total immersion, and put them in a perspective that will help you guide one of the country's preeminent institutions through the inevitable turbulence of the coming years. If I can help you clarify your own thoughts even a little, I will be satisfied.

President A. Lawrence Lowell of Harvard stated his views on the functioning of Harvard's governing board in a 1920 report. In it he said that even private education has a public character, that it must keep in touch with public needs, and must maintain access via men of affairs to means for attaining aims approved by the public; that teaching, like all public services, must have an administration including both expert and lay elements. (Laymen are necessary to inform experts about results expected, not the means to attain them.) The governing board, Lowell continued, must have final authority because it is the trustee for the public which, even for a
private university, determines its objectives. Trusteeship is the holding of a charter of public trust for an institution. That is your task, and it is that task which I am seeking to illuminate in this discussion.

Trustees of universities such as Cornell are, in normal times, not merely custodians. They are builders charged with the responsibility to add on, to change constructively, to start. Today more than ever, they must be alert, they must preserve, they must protect, they must build. You as trustees, with your devotion to the cause of higher education as practiced at Cornell, and with your understanding of Cornell’s unique nature, must be alert to the University’s problems and the pressures against which it must be buttressed.

An important aspect of being alert is being prepared for unforeseen change, for such change has been a mark of higher education in the last decade. The student disorders which swept our campuses in the 1960s came upon us suddenly. I visited Latin American universities frequently in the 1960s. In the early to mid-60s, I watched the student upheaval there with increasing interest but with considerable detachment because I knew such upheaval could never come to higher education in the United States. And then, suddenly, there were Berkeley, Columbia, and Cornell. The rapidity with which financial problems descended on us is another example of sudden change. Within a three-month period in 1974, the tenor of the times and the financial posture of many institutions went from positive to negative. You must, therefore, be prepared for the unforeseen, the unanticipated. You must keep an ear to the educational rail, watch for warning signals, and feel the changes in the wind.

When I consult my clouded crystal ball, the signs I see that concern me most and which should most concern the Board of Trustees of this University, are those related to the preservation of the trinity of pluralism, excellence with diversity, and independence. My mission is to help you preserve this trinity.

CORNELL IS IN GOOD CONDITION

Cornell, in my opinion, is in remarkably good shape. We have come through a period of campus disorders and financial crisis without serious damage to the University. The quality of our student body continues high — one of the joys of being a Cornell professor is the opportunity to teach such students. Our faculty continues to achieve major distinctions in a gratifying manner. Through our troubled period, we have built some remarkably strong academic programs. Biology and geology are prime examples. There is even a good prospect that we can undertake the construction of the first building of a new biology complex on lower alumni field before long. It is gratifying to me to see renewed interest in a field such as Classics.

Basic research support by the federal government fell by approximately 18 percent in constant dollars during the past decade. At Cornell, federal support increased by about 14 percent in constant dollars. The Arecibo observatory has become a national facility: The National Astronomy and Ionosphere Center. It is the only national laboratory administered by a single university. In a period when many university high-energy particle accelerators have been closed down, the Wilson Synchrotron has flourished and has also taken on some aspects of a national facility. We are now moving rapidly ahead with a $20 million upgrading program which will maintain the Wilson laboratory as one of the two preeminent university high-energy physics facilities in the country.

The addition of the Herbert F. Johnson Museum of Art to the campus has been one of our greatest accomplishments. It was begun shortly before our major troubles started and was carried through the construction phase during the troubles. It has been operating for several years as a highly successful addition to the Cornell program and is a major resource for this entire part of New York State.

We have finally faced up to the major maintenance problems that have been accumulating for many years. Shortly after Acting President de Kiewiet became president of the University of Rochester in 1950, he remarked to me that Cornell had the worst policy of deferred maintenance of any university he knew. That policy prevailed until recently. When the critical program undertaken two years ago is completed and the ongoing program has been brought to the requisite level of annual support, we can take satisfaction in having a physical plant which will continue into the indefinite future in a state of good repair.
The support of our alumni has been outstanding. I had expected an alumni revolt in 1969 and 1970 but it did not come. Instead, the alumni body has backed us in a remarkable fashion. Our unrestricted annual giving has moved from about $2.5 million a year in 1969 to nearly $5 million a year now, an average annual rate of increase of almost 9 percent. We have endowed many new chairs in the past decade, a number of them with alumni gifts.

Finally, the campuswide cooperation in facing up to the financial crisis which befell us in 1973 and 1974 and which, in my opinion, will continue indefinitely, at least in some degree, has been a gratifying experience for me.

I believe that President Rhodes has taken over at precisely the right time, that he is exactly the right person to lead Cornell ahead vigorously, and that he has a sound base on which to build.

HIGHER EDUCATION IS IN A PERIOD OF CHANGE

_The Public Has Lost Some of Its Confidence in Higher Education._ At the end of World War II the public believed that academic scientists could solve any problem, and the academic scientific world was riding high. Microwave radar was a highly successful war-time development, accomplished largely by academic physicists. The success of the proximity fuse and a number of other scientific and technological developments contributed materially to the Allied success in the war and enhanced the academic reputation. The most spectacular development of all was the atomic bomb. People who could move from the scale of ordinary objects and events to the incredibly minute scale of single atoms and back again to the man-sized scale with such devastating effect could surely solve any problem. "Research" was a magic word.

Fortunately for the universities in this country, a conscious decision was made to place the nation's research program largely in the hands of universities, and as a result the universities flourished. Not every country has done it this way. The West Germans, for example, have evolved a series of highly competent research institutions largely independent of universities, and the Soviet Union has followed a similar pattern.

The bloom of the research rose was beginning to fade, however, when Sputnik I was launched in 1957. But that basketball-sized object, revolving around the earth once every ninety minutes and shining brightly in the predawn sky, generated in this country a shock of inferiority which revolutionized support for research and for education. We had to be absolutely certain that our science and our education were the best in the world. This interest in, and support for, education and research became the hallmark of the 1960s.

The support extended beyond science. Substantial benefits were felt by all disciplines as national policymakers set out to prove that the American educational system was unsurpassed. Academicians were viewed with respect and confidence.

Now we have gone to the moon and we have photographs from the surface of Mars, but the problems of the cities, the lagging economy, and a severely limited energy supply are all there before us bigger than life. No one believes that academicians know how to solve these problems, and consequently, we are no longer held with the regard we once enjoyed.

Right now there is a particular lack of appreciation for the role of the research university. The national emphasis in recent years on short-range, fast pay-off research is evidence of a lack of understanding of the nature and goals of research. The public wants the academy to work toward a solution of the most pressing problems. The public wants the university to solve the school busing problem and clean up the smoke and help diminish crime in the streets and supply acceptable new sources of energy. The public becomes restless with academic people who have been sitting in their laboratories and libraries for the past twenty-five years working at problems which the public all too often believes are irrelevant. The tragic irony is the failure of many academic people to perceive that they are placed in jeopardy by the public demand for control and for institutional accountability that derives from this public attitude.

How we in this country maintain the capacity to produce high quality research and scholarly effort is central to the problems that face us all. The tenor of the times is against research and against scholarship and against expensive education. As costs increase, the public demands a greater role in educational decision-making. National policy seems directed at pulling all research universities down to a lower level. Policy implementation at both national and state levels means less support for the research universities.
In New York State there has been a deemphasis on support for research and extension educational services. The impact at Cornell of state budget cuts has fallen most heavily on research and extension functions. The political thrust is toward teaching, not the dalliance of research or public service. Teach our young people, they say. But they ignore the interrelationship between solid research and good teaching.

I believe it worth asking whether the university is the major place where research will be conducted in the future. Heart disease and cancer research are being carried on extensively in national laboratories and specialized research institutes. There seems to be a trend toward national centers for energy research. I believe it important that research continue to be centered in the universities. The university offers a research scientist insights gained through interaction with students. With the students come new perspectives, new interpretations, new information, analysis, feedback, challenge, the need to defend positions, enthusiasm, and emotion. The effectiveness of the research scientist in the university is amplified many times through the work of students. This beneficial interaction and its products are found in greater degree at the university than in the research institute, in my opinion. National interest will be served by maintaining the research focus in universities.

The Days of Growth Are Gone. The post-World War II and the post-Sputnik confidence in universities, and the national will to make our higher education the best in the world, led to a great growth in the 1950s and 1960s. That growth has ended. Those days are gone and they will not return. Furthermore, the declining birth rate will produce a decline in high-school graduates, which in New York State will amount to about 30 percent between now and 1990. The fraction of those graduates who elect to attend college seems likely to decline also, and so the number of young people seeking higher education will decline sharply.

We must learn to live in a different way, and the transition is painful and slow. Most university faculty members have had no experience with anything but growth and expansion, and it is particularly hard for them to understand that the new austerity which has befallen American higher education is not synonymous with sterility. American universities were alive and well before the period of great growth and they can be alive and well after such a period. The excellent libraries, laboratories, facilities, and programs which were the products of the period of growth are still here, and we are much better off than we were before. We must adapt to the new circumstances, however.

Growth in the United States is a national characteristic and a national resource. The nation has had a continual history of change through growth. Now, for the nation as well as for higher education, the growth is over and many of the problems that American society faces today are directly related to the limitation on growth. The decline in the birth rate and the realization that energy sources are limited would dictate a brake on growth even if there were no other factors. For higher education there are other factors, and altogether there is a new national posture with which we must cope.

Until recently, societal institutions have been geared to rapid growth. New colleges and universities opened, while those already established expanded and offered new programs. When we had an idea for a way to improve the university, we were usually able to finance it. If we needed new faculty the increasing student body guaranteed an opportunity to appoint new members. If we needed new facilities, there were usually public or private means for securing those facilities. If we needed graduate students to work in a newly established field, the growing number of students and the increased emphasis on graduate study guaranteed the supply. Now the forces are against us and we are left with a problem of making the most of what we have gained over the last two-and-a-half decades without the expanding means we came to rely on.

For society, reality has come in the form of over-extension of public operations. Our Social Security system faces a major funding crisis. Social benefit programs, extended beyond the capacity of the city to pay, have made the words “bankruptcy” and “New York City” almost synonymous. For higher education, near-future reality is in the form of declining applicant pools and declining enrollments.

The United States has had little experience with anything but growth. Until now, no American institution has had to face the possibility of atrophy, except perhaps the pony express and the village blacksmith. There is little experience from which to learn and from which to mold the future.

The brake on growth has produced a morale problem in universities, particularly among younger members of the faculty. It has been heightened during the period of high inflation, when faculty members have seen their salaries increase less rapidly than the cost of living, when they have seen the library acquisition budget increase much less rapidly than the shocking inflation in the cost of books, when they have seen general-expense budgets fall below adequate levels. They ask themselves if they made a mistake in choosing an academic career.

I do not know how to counter this problem — how to help people in the University get the view into proper perspective, to help them see that it is not just Cornell University that is having trouble, but all of American society. Nor does it do any good to point out that things are much better now than they have been in the past, even in the relatively recent past. When I listen to the morale problem which a 7-percent salary increase precipitates in the face of a 10-percent increase in the cost of living, it is hard for me to refrain from reciting Cornell history from the late 1940s and the early 1950s. For five years, from 1948 to 1953, I received no salary increase and was promoted to full professor in 1952 with no salary increase. Many of my colleagues had similar experiences.
There Are Important Steps We Can Take. To counter the declining public support and to cope with the limited growth, there are several things we can do. In the first place, whatever we do must be assessed in view of the public interest and the national welfare. We have no chance to change anything if we argue that the present situation is hard on academic administrators or budgets or professors or even students. We have to make the argument that our most creative minds are a resource that we can hardly afford to waste. The educational process must be able to accommodate and develop them. Intellect — educated, creative intellect — should be at the highest premium in our history, and it is up to us to sell this point of view to our many constituencies if we are to promote our own cause effectively.

We must prove that we are interested in society’s problems and that we have solutions to help deal with these problems. Our land-grant status at Cornell and our experience in taking new knowledge to the people who need it stand us in good stead. We must pay careful attention to our land-grant mission.

There will undoubtedly be continuing federal emphasis on that research which is perceived as making an immediate contribution to the solution of problems that are of societal concern and which are the foci of political attention. It seems inevitable to me that in responding to public pressures, faculties as a whole will shift a portion of their effort to research that is closer to the applied than to the basic end of the research spectrum, and there will be more large-scale interdisciplinary research in universities. If we in the universities are to do more problem-oriented research, we must bring to bear all the disciplines that can cope with the problem. Interdisciplinary research inevitably leads to ad hoc administrative structures to contain that research, and the administrative organization of the university is apt to be increasingly complex.

As the perception of national problems shifts, so will the fields of inquiry emphasized by the federal agencies. This change will generate problems for universities since it is difficult to shift personnel and resources to accommodate rapidly changing external pressures.

Declining federal support in terms of constant dollars has been with us for a decade and we have had an opportunity to learn the effect of such downward support and what to expect in the future. Federal agencies will attempt to stretch their funds to cover as much research as possible. They will do this in many ways, including downward pressure on indirect cost recovery, reviewing the relative cost of proposals from different universities and approving those with the lowest costs, pressuring universities to share the cost of research, and maintaining pressure to minimize the amount of faculty salaries charged to research grants.

Accountability Will Grow. A society which finds itself overcommitted and overextended in the development of highways, social welfare programs, and many other areas is not likely to stand idly by while higher education, which is spending some 2.6 percent of the gross national product, does whatever it wants. The public is going to demand the accountability which goes with the expenditure of such large amounts of money in such difficult times. For a private university, the need for, and right to public funds in no way mitigates the difficulty. The question is not whether the strings are going to be attached, but rather how many strings, what kinds of strings, and where they will be attached. There will be increasing reluctance to channel funds into higher education, because higher education is acceptable and good and therefore worthy of support.

To counter what we believe is excessive accountability pressure and to change the public attitude which emphasizes short-term goals, there are several things we must do. First of all, we must demonstrate that a private university can keep its own house in order. We must maintain the quality of our faculty at the highest level. We must be certain that our graduates demonstrate the quality of their education through their performance in their postcollege careers. We must educate our own community about the accountability milieu in which we find ourselves.

We must become advocates and we must use every channel of communication open to us. The University administration necessarily bears the greatest burden of presenting our priorities to federal and state agencies, but trustees and individual faculty members must increasingly play the advocate role. Education of legislators and legislative staffs about our problems is all-important. They must come to understand the role that a university such as Cornell plays on the national stage, and they must come to understand the problems which beset us and to help us find ways to cope with these problems.

We must take our message to our public, and the first public available to us is our own alumni. We must help them understand the nature of our plight and what they can do to help us in a world where the emphasis is more and more on results, on applications, on solutions to society’s immediate problems. We must engage the support of industrial leaders who understand the complex relationships between research and application, between education and productivity, and who also have ready access to the power structure of the federal government. Some of these leaders are among our alumni and trustees. Wherever they are, we must seek them out and solicit their support.

There Must Be New Emphasis on Undergraduate Education. Undergraduate education has always had substantial emphasis at Cornell, but I think that the pressure of the times will demand more emphasis in the future. Of all the major research universities, I think none has a higher ratio of undergraduates to graduate students. We have an excellent student/faculty ratio. We have many
superb undergraduate programs, but we also have some of the ills which the public associates with undergraduate programs in research universities. We have large classes. We have inadequate advising systems. We have a significant fraction of elementary instruction provided by teaching assistants.

None of these ills prevents an undergraduate student from obtaining an excellent education, but when the public, which in this case means the parents of undergraduate students, pays high tuition to send children to private universities and when the number of college-age young people is declining, the public is going to demand correction of what it perceives as weaknesses in the system. Consumerism in higher education is on the increase.

Some of the perceived ills can be corrected only through a change in attitude of the faculty. Advising is such a case. There are two types of supportive service that undergraduates need: personal counseling and academic advising. Counseling can best be organized centrally and conducted through the Dean of Students office. In general, Cornell does this well. Individual students will always find faults with the system, but on the whole I believe that Cornell does about as well as any place and better than most.

Academic advising is another matter. We do not do it well at Cornell, and indeed, most universities do not do it well. I do not think we will provide adequate advising until the individual faculty member believes that advising is an important part of the job and that salary and promotion depend, among other things, on the quality of the academic advising he or she provides.

Advising is not easy. It takes time and patience, and many faculty members have neither. I carried one class of advisees through five years of undergraduate work, starting with about fifty advisees and finishing with about thirty. (I contend that it was the difficulty of the curriculum which persuaded the other twenty to seek some other field, not the quality of the advising.) It required a great deal of my time. I had to know each student's strengths and weaknesses. I had to know the entire University curricular possibilities in all fields my advisees were interested in. I had to plead the case of advisees who were in danger of being dropped by an associate dean or a faculty committee from a program or from the University. I had to help them find employment or seek admission to graduate school when they graduated. More often than I wanted, I was the one who held their hands when girl friend troubles interfered with their academic progress.

I was the one who suffered most from all this effort. There can be no question that my own career was hampered by my attention to my advisees. The hours I lost from my laboratory were hours that I never regained. I was willing to pay the price, but many faculty members are not. My period of intense student advising was at a time and under circumstances in which I had no worry about promotion. I never felt that I could not afford the time I devoted to my advisees. The situation is different now, and many advisers do feel they cannot afford the time. Only when advising brings obvious rewards will the situation change, but change it must if we are to compete successfully for the able student in the face of rapidly rising tuition charges, a declining student pool, and a demanding public.

I see no way to deal with the problem, which is perceived as caused by the use of teaching assistants, without more elementary teaching effort by the full-time faculty. One of the ironies is the disrepute of this teaching system when some of the best instruction in the University is provided by teaching assistants. When I was dean of the College of Engineering, we gave prizes ($1,000 and $500) for three successive years for the best teaching of engineering freshmen. The winners were selected by a faculty-student committee from nominations made by the freshmen themselves. The first surprise was the number of nominees. There were perhaps as many as ninety instructors nominated each year, which told me that nearly everyone teaching engineering freshmen was providing the something extra which at least one freshman felt was needed. The second surprise was the number of teaching assistants and instructors who were prize winners; 50 percent of the awards went to them.

Admittedly, there is also bad instruction by teaching assistants, and it is the bad instruction which must be eliminated. I see no way to do it unless the faculty accepts more of the teaching burden. One way would be to eliminate teaching assistants completely, with graduate students supported financially some other way and with the full-time faculty doing the teaching. Another way would be to provide much more instruction and supervision for teaching assistants in their teaching roles. Either way costs faculty time, but again, in the market we are moving into, it must come.

I don't know what to do about the large class. Part of the advantage of the large research university is the availability of outstanding scholars and great teachers who attract large numbers of students. We need to pay more attention to ways that permit students to have the experience of sitting at the feet of the great teachers, while at the same time providing them more opportunities for small-class experiences in which they can interact with instructors and other students.

Curricular structure is always subject to constant change, and I think there will be no particular problem in responding to the needs of the times by shaping attractive curricula. I believe that there has been far too much specialization in undergraduate curricula in the post-World War II era, but I don't see this as a problem in facing the competitive market ahead. The problem is being addressed and as other curricular problems are identified they will also be addressed.

The problems which the public perceives with undergraduate education in a university such as Cornell can be solved only when the faculty members perceive that their own welfare is in jeopardy. This is not going to happen quickly or easily. Faculty members, by
and large, already work hard — far harder than the public thinks. The problem of attention to the undergraduates cannot be dealt with simply by requiring the faculty to work harder. They are already overextended. The solution can come only through substitution of work related to undergraduate education for work related to research and other scholarly activity. Only the realization of the absolute necessity for such a shift will change the present situation. Such a shift of emphasis will change the individual faculty member’s sense of priorities and accomplishment and it will change the institution’s sense of priorities and accomplishment. A pattern of three decades will not be changed easily, but change it must and the change must begin now.

**We Must Maintain Our Independence.** One of my biggest worries about the growing pressure of public accountability is the ever greater intrusion of government into our business. I will discuss this intrusion in some detail in a discussion of governmental relations. We saw the House of Representatives pass a bill which would have given the House itself veto power over individual National Science Foundation grants. We saw the enactment of health manpower legislation which gave the secretary of health, education, and welfare the authority to assign medical students to our medical college. We saw legislation passed by both houses of Congress, but fortunately rejected in conference, which would have prescribed some of the curriculum in our medical schools. Even now the state of California is attempting to prescribe curricular details in California medical schools.

If we are to maintain our independence in the face of these growing pressures we must resist at every turn. We must show that we recognize the public welfare issues and we must demonstrate that we can deal with them better with our independent way of proceeding than with government-prescribed ways.

The one sure way to resist such pressures is through rejection of funds offered with such strings attached. With the financial pressure that is certain to be with us for many years this will not be easy. There are programs at Cornell and at all universities which are properly supported by federal funds and state funds and we must have those funds. However, the great strength of the private university, and in my opinion the overwhelming reason for the continued importance of the private university, is its relatively greater degree of independence. To maintain that independence we must have private funds available to us, funds which will permit us to conduct our programs the way that we think they should be conducted and which, if we feel it necessary, will permit us to say “no” to government funds with inappropriate strings.

The day is likely to come when we must decide whether to accept strings we consider unfortunate or to reject the funds that come with those strings. Only an adequate private funding base can give us the strength to make the decision on the basis of principle.

**The Growing Gap between Public and Private Tuition Charges Is a Matter of Concern.** The cost of providing education in a college or a university is steadily increasing, both at private and public institutions. The rate of increase is nearly everywhere greater than the general economy inflationary rate and is probably higher in private than in public institutions. The charges made by private institutions reflect the rising cost precisely, while charges made by public institutions are rising more slowly where the burden is being borne by public tax support. The gap between private and public charges is growing and it is already large, now several thousand dollars a year.

I am concerned about the possible reaction to this widening gap. Parents may be increasingly reluctant to pay twice for the higher education of their children — once through tuition charges made by private institutions, if they send their child to a private institution, and a second time through taxes required to support the public institutions. There has already been a large shift in enrollments away from private institutions to public ones. Over the past twenty or twenty-five years, the weight has shifted from about two-thirds on the private side to two-thirds on the public side in New York State. While this shift has been taking place the private institutions have also gained in enrollment, but the overwhelming burden of accommodating the larger number of young people attending college has been borne by public institutions.

What will happen now that total enrollments are leveling out? Will the shift to public institutions continue? If so, the enrollments in private institutions must necessarily decline and some private institutions will be in trouble. Our immediate concern, of course, is what will happen at Cornell.

The problem is to a considerable degree psychological. The Cornell tuition charges of endowed colleges have increased less rapidly than has disposable personal income per capita over the last decade, and for the last five years the increase in tuition has just matched the increase in disposable income. The attached chart shows the relevant data.

Even though tuition has not exceeded family income, on the average, families are being hit hard by these rising tuition charges and I cannot predict how the majority of families will react in the future as the gap widens. What really is at issue is our priority scale. Since World War II, the American standard of living has increased dramatically and now that we have become accustomed to a degree of affluence unknown before, it is hard to return to more austere ways. We do not wish to give up the summer cottage, the boat on the lake, or the winter ski vacation. If it comes to a choice of giving up these luxuries or sending our children to a public university, we may well choose the public university.

There are several indicators that we in private institutions must be alert to. We must watch the number of our applications and the quality of our applicants. At Cornell we have about six times as many freshman applicants as places available and three times as many applicants as the number of acceptances we issue. But the total number of applicants has declined slightly during the last
four years, and as the total applicant pool in the country declines markedly in the next decade so will the Cornell applicant pool. At the moment our situation seems secure, but we must be alert. For one thing, we must look at applications college by college. Some colleges are on much safer ground than are others. Some are already digging uncomfortably far into the applicant barrel to select a class. When the size of the barrel declines substantially, some colleges may find themselves forced to admit students with qualifications below the traditional standard.

Another indicator to watch is the trend in tuition charges at public institutions. In some states the issue of free public higher education has become a highly charged emotional one. If it remains public policy in the major educational states to provide free, or at most low-cost, higher education in state institutions, the private colleges and universities will, in my opinion, be in serious trouble. If the public institutions change their policies and charge a larger fraction of the true cost to the student, the psychological pressure on the private institutions will be somewhat relieved.

A major point of concern likely to remain is the high rate of cost increase in the private institutions. Private costs have increased somewhat faster than public costs since World War II and probably longer. As long as there is a differential increase rate, the day of reckoning is inevitable. Such costs increase exponentially — i.e., at a fixed percentage per year rather than by a fixed amount per year. The nature of such exponential quantities requires that the difference between the two expense curves gets bigger and bigger and finally arrives at a point which is sure to have repercussions.

<table>
<thead>
<tr>
<th>Fall</th>
<th>Endowed Tuition</th>
<th>Statutory Tuition¹</th>
<th>Disposable Personal Income per Capita</th>
<th>Consumer Price Index²</th>
</tr>
</thead>
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<tr>
<td>1967</td>
<td>2,050</td>
<td>675</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>1968</td>
<td>2,200</td>
<td>675</td>
<td>107.3</td>
<td>106.9</td>
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<td>1969</td>
<td>2,350</td>
<td>700</td>
<td>114.6</td>
<td>113.5</td>
</tr>
<tr>
<td>1970</td>
<td>2,600</td>
<td>825</td>
<td>126.8</td>
<td>122.2</td>
</tr>
<tr>
<td>1971</td>
<td>2,800</td>
<td>900</td>
<td>136.6</td>
<td>131.0</td>
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<tr>
<td>1972</td>
<td>3,000</td>
<td>1,200</td>
<td>146.3</td>
<td>140.0</td>
</tr>
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</table>
When I was a dean, I attempted to implement in my college a salary policy designed to increase the salary pool no faster than the general inflation rate. I did not achieve notable success, but my plan does serve to highlight the features essential for a controlled salary policy. Last year when the College of Arts and Sciences department chairmen called my attention with some vigor to salaries in the Arts College, and when they decried the lack of a salary policy, I proposed the one I had attempted myself. I am including this proposal here, more to make clear what would be required to contain the rate of increase in salary budgets than with any hope that my ideas will be adopted.

**Here is a Salary Policy That Could Restrain Salary Inflation Rates.** Let us assume, to begin with, that there is no inflation, and let us assume that a faculty member enters the system as a beginning assistant professor and that he leaves the system as a full professor after thirty-five years of service. Let us also assume that there are ranges on salaries for each professorial grade and that the typical faculty member enters the grade at the bottom edge of the band and leaves it on promotion at the top of the band. We must then decide what ratio of final salary, after thirty-five years, to entering salary we wish to adopt as a policy. For the typical faculty member, a ratio of 3:1 is the one I adopted.

In my illustration, progress is by fixed increments (not by fixed percentages) through a given grade, with a jump in salary on promotion, and another series of fixed annual increments until the next promotion. If we were to deal always with percentages, it takes about 3.2 percent per year over thirty-five years to reach a final salary that is three times the entering salary. Four percent per year would produce a 4:1 ratio over thirty-five years. If increases were to be by percentages, the salary increments would be smaller in the beginning and larger toward the end.

When the faculty member leaves the system at the end of thirty-five years of service, the position is recycled, and the replacement enters at the beginning of the assistant professor grade and repeats the process. With a large faculty such as in the Arts College, there will be a wide distribution of faculty positions in this diagram, and for purposes of discussion, let us assume that there is a uniform distribution as far as years of service are concerned.

With this simple model, the amount of money required each year for salaries is exactly the same, although individuals are progressing through the system at a rate which will guarantee them a final salary which is three times their entering salary.

### Can Our Inflation Rate Be Reduced to That of the General Economy?

Except during the period of double-digit inflationary increases, our tuition charges have increased somewhat faster than have the consumer price index and other general inflation indices. Whether our private university educational inflation rate can be reduced to that of the general economy is a matter of major importance to us. I doubt that it can, and there are some relevant factors that are worth mentioning. The increasing requirements imposed by federal regulation almost guarantee that the administrative cost of the University will increase disproportionately to the cost of education and consequently, even if the cost of education increased at the general inflationary rate, the overall cost would increase faster. The very nature of the University also dictates costs that increase at a disproportionate rate simply because we continually undertake new endeavors. To be the kind of fine university we wish to be requires a high-quality art museum, but the operation of that art museum adds to the operating costs of the University, and we are unlikely to abandon an established program like intercollegiate athletics to accommodate the new expenses. (Fortunately, part of the museum operating cost is endowed.)

Student interests change. We have now an all-time high interest in biology with a parallel loss of interest in physics, for example. To respond to that interest we build first-class new biology programs, but we cannot easily decrease the size of the physics operation, nor would we necessarily want to if we could. Physics is one of our most distinguished fields and to remain distinguished requires a faculty of substantial size, although perhaps not as large as we had a few years ago when the total number of those in professorial ranks reached fifty (which, incidentally, is small compared to some of the state universities). But it would be difficult to cut the size of the faculty by half and maintain our present distinction.

The library is the heart of any university and the cost of maintaining our collections, a cost completely beyond our control, has increased at a rate that far exceeds any ordinary measure of inflation.

One reason all universities have educational inflationary rates that exceed the general inflation rate is salary policy. We replace full professors with other full professors rather than recycling the position back to the starting rank. We follow a variety of other practices that inevitably lead to salary budgets that grow faster than general inflationary rates.

When I was a dean, I attempted to implement in my college a salary policy designed to increase the salary pool no faster than the general inflationary rate. I did not achieve notable success, but my plan does serve to highlight the features essential for a controlled salary policy. Last year when the College of Arts and Sciences department chairmen called my attention with some vigor to salaries in the Arts College, and when they decried the lack of a salary policy, I proposed the one I had attempted myself. I am including this proposal here, more to make clear what would be required to contain the rate of increase in salary budgets than with any hope that my ideas will be adopted.

**Here is a Salary Policy That Could Restrains Salary Inflation Rates.** Let us assume, to begin with, that there is no inflation, and let us assume that a faculty member enters the system as a beginning assistant professor and that he leaves the system as a full professor after thirty-five years of service. Let us also assume that there are ranges on salaries for each professorial grade and that the typical faculty member enters the grade at the bottom edge of the band and leaves it on promotion at the top of the band. We must then decide what ratio of final salary, after thirty-five years, to entering salary we wish to adopt as a policy. For the typical faculty member, a ratio of 3:1 is the one I adopted.

In my illustration, progress is by fixed increments (not by fixed percentages) through a given grade, with a jump in salary on promotion, and another series of fixed annual increments until the next promotion. If we were to deal always with percentages, it takes about 3.2 percent per year over thirty-five years to reach a final salary that is three times the entering salary. Four percent per year would produce a 4:1 ratio over thirty-five years. If increases were to be by percentages, the salary increments would be smaller in the beginning and larger toward the end.

When the faculty member leaves the system at the end of thirty-five years of service, the position is recycled, and the replacement enters at the beginning of the assistant professor grade and repeats the process. With a large faculty such as in the Arts College, there will be a wide distribution of faculty positions in this diagram, and for purposes of discussion, let us assume that there is a uniform distribution as far as years of service are concerned.

With this simple model, the amount of money required each year for salaries is exactly the same, although individuals are progressing through the system at a rate which will guarantee them a final salary which is three times their entering salary.

### Note

1. Tuition charged New York State residents registered in the Colleges of Agriculture, Human Ecology and I&LR.
2. Annual figure for the calendar year 1977 index number is an estimate.

**Source:** Cornell University Office of Admissions; U.S. Dept. of Commerce, Survey of Current Business.

**Table:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Beginning Assistant Professor</th>
<th>Intermediate Professor</th>
<th>Full Professor</th>
</tr>
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<tbody>
<tr>
<td>1973</td>
<td>3,180</td>
<td>156.1</td>
<td>200.0</td>
</tr>
<tr>
<td>1974</td>
<td>3,430</td>
<td>168.3</td>
<td>222.2</td>
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<tr>
<td>1975</td>
<td>3,775</td>
<td>184.1</td>
<td>244.4</td>
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<tr>
<td>1976</td>
<td>4,100</td>
<td>200.5</td>
<td>266.7</td>
</tr>
<tr>
<td>1977</td>
<td>4,400</td>
<td>214.6</td>
<td>288.9</td>
</tr>
</tbody>
</table>

**Source:** Cornell University Office of Admissions; U.S. Dept. of Commerce, Survey of Current Business.
In the face of inflation, the whole diagram must be tilted upward so that the inflationary rate must be added to the average 3.2 percent rate built into the system. At the end of thirty-five years, the real standard of living will have increased by the same factor of three from beginning of service to the end of service. If there is a 5 percent inflationary figure, the individual faculty member on the average, will see an 8.2 percent per year increase, yet the pool from which salaries are paid increases only at the inflationary rate of 5 percent. Remember that this assumes that every position is recycled.

What does one do with outstanding faculty members? Obviously, they must progress through the system faster than does the typical faculty member and will reach the top level earlier. The salary pool, however, need increase only at the inflationary rate as long as the average is maintained; that is, for every one who progresses at a higher than typical rate, there must be another who progresses at lower than the typical rate. There will, of course, be individuals who enter the system above the line for the typical rate. Again, the system will remain in balance as long as there are others who leave the system before completing thirty-five years of service. The only requirement is that the number in any given calendar year remain the same and that the average for the group falls on the average progression line. Flexibility in the system is unrestricted, subject only to the condition that the total salary pool progresses only at the inflationary rate.

Salary after n years of service as a multiple of salary for entry-level assistant professors.

If the faculty expands and the total salary pool expands accordingly, nothing has changed in the system other than that there are more lines progressing through the system at any given time.

A large problem is what to do with the outstanding faculty member whose final salary should be more than three times the entering salary and who reaches the top of the standard professorial band well before retirement. I can think of only one way to deal with the problem and that is to provide, in the overall salary pool, a certain amount of money for “super grades.” This is the policy of the U.S. Government Civil Service. It is also the policy of the University of California and I assume for other state systems. In both the federal government and the California system, there are specified salaries above the standard salary bands with a specified number of salaries to be supported at the “super grade” level. Any satisfactory system must have provision for this type of appointment.

In the absence of a clearly stated policy (I believe most faculty members and probably most deans would be better off without a stated policy), we do not follow the rigid practices necessary to make such a system operate. As provost I once allowed myself to be talked into replacing a full professor, who was a member of the National Academy of Sciences, with an incoming faculty member at a salary which was upgraded by several thousand dollars per year. It is not common practice to recycle positions to the starting point, nor is it the practice to deal with fixed annual increments instead of percentage annual increments. Many of the practices we do follow lead us into the combination of exponential growth and salary pools that increase faster than the inflationary rate, so that we are led directly into the common University problem of an inflation rate exceeding the cost of living index by 2 or 3 percent in normal economic times. Such practices, as is true in all exponential growth situations, eventually lead to a crisis.
THE IMPACT OF GOVERNMENT ON HIGHER EDUCATION IS ENORMOUS

All of higher education, both public and private, is inextricably tied to government at both the state and federal levels. We could not live without these ties, yet in recent years the ties have appeared to me to be shifting from a healthy, benign nature to an unhealthy, malignant nature which is becoming more pervasive and which I see as a serious threat to the future or to what I consider the appropriate future. In trying to assess this problem and whether the danger is real or imagined it may be useful to trace the historical development of the higher education-government relationship in order to put into perspective the way we arrived at our present position.

There Has Been a Long and Beneficial Government Involvement. In New York State involvement of higher education with government goes back to the founding of Kings College, now Columbia University, in 1754 under a royal charter with government-designated trustees. Kings College developed slowly in the prerevolutionary period and nearly expired during the Revolutionary War.

The Regents of the University of the State of New York is a body established by the legislature in 1784 and, I believe, is the oldest, continuous state agency in America. It certainly is the oldest, continuous state educational agency. The regents constitute the State's educational policymaking body, responsible for the general supervision of all educational activities from the lowest to the highest level and embracing all professional licensing and regulating functions. The regents have the authority to register or to deregister higher educational programs, as they have been doing in their review of doctoral programs in all institutions in the state in recent years. The authority they exercise, including the deregistration authority, has been challenged in the courts by the State University of New York, but to date the regents' authority has been upheld. The regents also exercise some control over facilities and programs through their master-planning efforts which require every higher educational institution to file a master plan every five years. This authority has been exercised, at least as far as facilities are concerned, in an advisory way and used as a basis for recommending new legislation to the legislature. Whatever else the master plan is, it has become a vast bureaucratic exercise requiring each institution to file volumes of documentary material which appear beyond the capacity of any reasonable organization to read or to understand.

In the early and mid years of the nineteenth century, public higher education in the form of state universities began to take shape, and by the time of the Civil War some of the great state universities, particularly in the Midwest, were already on the way to becoming distinguished institutions. That development, directly under state governmental control, has continued to the present time with some of the greatest universities in this country falling in this category. These universities have politically-appointed trustees or regents and, in some cases, they have trustees or regents who are elected on party platforms in political elections.

The first Morrill Act in 1862, which laid the base for the so-called land-grant universities, was a turning point in American educational history. The use of public lands to subsidize higher education was an imaginative and new approach to the subsidization problem. The coupling of "agriculture and the mechanic arts" with the traditional liberal studies which had characterized most higher educational institutions, particularly the private ones, up to that time was a radical departure. The concept of public service and the concept of research in fields directly related to the welfare of the people was a radical departure from the practice of earlier times. The concept of "extension" to take the products of academic research for application to the problems of everyday living was also a radical departure.

The Morrill legislation led to the establishment of some of the nation's greatest universities, primarily in the public sector. Only two private universities, Cornell and the Massachusetts Institute of Technology, fall within the land-grant group of institutions that benefited and which continue to benefit from the public subsidy embodied in the land-grant concept. MIT's status as a land-grant university in Massachusetts is now shared with the University of Massachusetts. Cornell is the only private university with the entire land-grant mantle for its home state. It is the entire University, incidentally, not just the statutory colleges at Cornell, which bears the land-grant responsibility.

From the Civil War era to the World War II era, public educational systems continued to grow and embraced the concept of municipal colleges and universities and the concept of the two-year institution oriented partly toward continuing higher education at a four-year college and partly toward vocational training ending at the two-year level. Some of the great colleges and universities in this country developed during this period. To name only one, City College in New York City, primarily an undergraduate institution, developed over a long period into one of the nation's most distinguished colleges.
Federal Support Increased Sharply after World War II. Following World War II, the ties between the federal government and the major universities became much stronger than they had ever been before. This country made a conscious decision at the end of World War II to place its fundamental research primarily in universities and to support that research with federal funds. In my opinion this was a momentous and wise decision. In other countries and other societies decisions were made in different directions. In West Germany, for example, there is a large system of research institutes, most of high quality and most unrelated to any particular university. The Soviet Union has evolved a system of research institutes which are, at most, loosely tied to universities.

Several benefits derive from the American system. The effort of a single faculty member-research scholar is amplified many times over through the work of students. If students are to learn to solve the difficult, novel problems which become the subject of quality scholarship in a university, they must apprentice themselves to faculty members who are themselves involved in solving difficult and novel problems. The team of professor plus students, a team which frequently involves postdoctoral fellows at the beginning of their research careers, has been particularly effective in producing new scholars and in producing new insights into the problems at hand.

This type of research, which has been so successful and which has led to fundamental developments of great consequence to society at large in the post-World War II period, has been financed primarily by federal agencies. In the immediate postwar era, funding came primarily from military agencies, such as the Office of Naval Research and the Office of Scientific Research in the Air Force. There was a great deal of skepticism and fear on the part of academic scholars in the immediate post-war era about the kind of control these federal agencies would exercise. The immediate control in the day-to-day work of reviewing proposals, awarding grants, and administering grants has, in almost every case, been exemplary, especially when the granting agencies have been Washington-based. Individual research proposals have been evaluated primarily by a “peer-review” mechanism in which panels, consultants, and experts in the field have evaluated proposals for the granting agencies.

With the creation of the National Science Foundation, support by other federal agencies has dwindled. The National Science Foundation and the National Institutes of Health are now the dominant federal research-supporting agencies. The NSF annual budget is now in the three-quarters of a billion dollar range. More and more of the fundamental research has been shifted to this agency with the gradual phasing out of the other agencies, particularly the military agencies. In my opinion this trend has both good and bad aspects. By concentrating resources in the hands of an agency dedicated to research, more coherent programs have been possible, but by limiting diversity of support, considerable strength has been lost.

While federal research funds have, for the most part, been administered in exemplary fashion, the federal agencies have exercised enormous control over university activities through the areas of scholarship they have chosen to support. Nuclear physics, for example, has prospered, but the cupboard has been bare for many areas outside the natural sciences.

Higher Education and Research Received a Big Boost after Sputnik. In the period following the launch of Sputnik I in 1957, support of academic scholarship generally received a large infusion of new funds. New agencies such as the National Endowment for the Humanities and the National Endowment for the Arts were created and federal support of scholarly work extended into fields other than the natural sciences. Support for graduate student fellowships also developed rapidly during this period. The result has been an enormously creative endeavor, but one which has had many problems and one which hit its peak about a decade ago.

Problems with the Federal Support System Began to Appear in the Late 1960s. Beginning in the late 1960s, the endeavor supported by federal funds began slowly to change its character and the support began to fall, at least when measured in constant dollars.

The problems have included fluctuations in funding from year to year and from Congress to Congress, so that the maintenance of an ongoing cohesive program in a given field or at a given institution has often been difficult to achieve. In recent years there has been substantial governmental withdrawal from the support of graduate students, which has serious implications for the future of scholarly work in this country. The support has been withdrawn for many reasons. The cost of financing the Vietnam War undoubtedly had a great deal to do with the initial withdrawal of support, although the growth during the immediate post-Sputnik years was at a rate that could not possibly have been sustained indefinitely. As the economy slackened and as population growth slowed, manpower studies indicated an overproduction of people educated and trained at the highest level. Manpower studies have been notably unreliable, but nonetheless they have had an important impact on support at the graduate level in many fields.

As our society has been beset with more and more urgent problems, including the energy problem, civil rights issues as they evolved during the late 1960s, and the blight of our cities, an urgency for immediate results has forced an emphasis on applied research with short-term objectives. Those who believe, as I do, that long-term goals are achieved only by slow painful building of a large pool of specialized understanding, think that the emphasis on applied research in universities has been excessive.

There has also been a shift in attitude on the part of federal agencies toward “buying,” or to use the more acceptable word “procurement,” of research results as opposed to the concept of partnership between the federal government and the institution. This shift in concept has eroded the system, in my opinion.
Finally, the attitude that prevails in most federal agencies toward “cost sharing” is, I think, unrealistic. The federal government has sought help from the universities in dealing with a specified set of problems. The universities have responded, often with government help, by expanding their faculties, by making tenured appointments, and by undertaking other long-range, ongoing commitments. There have been no adequate means other than federal of paying for those commitments, but the federal agencies have asked the universities to “cost-share.” In private universities the only way this cost-sharing can be supported is to pass the burden on to its primary constituency — namely, its students — and this means primarily to its undergraduate students. This seems to me a short-sighted policy on the part of the federal government and one destined to lead, in the end, to weakening of the entire system. An additional problem to the cost-sharing requirement is the inadequate means of indirect cost recovery. The present means involves a series of negotiations based on complex formulae and end up as allocation of a fraction of the direct salary cost to an overhead pool. Indirect cost reimbursement is universally viewed as diversion of funds from support of the research at issue, a diversion that places university administrators and university research staff in an unhappy adversary relationship.

There Are Many Government Student Support Programs. The federal government started providing support for students with the G.I. Bill following World War II. There was also a post-Sputnik leap with the National Defense Education Act of 1958 which provided several means for strengthening instruction in science, mathematics, and modern foreign languages, as well as grants and loans for college students. The Higher Education Act of 1965 substantially extended the support of students. It is an egalitarian piece of legislation, intended to provide access to higher education for all students regardless of economic and other social circumstances by complementary programs of grants, loans, and work-study arrangements. This legislation was amended and strengthened in succeeding years until it now provides about $3.75 billion per year in student support in various forms. Cornell students receive about $3.9 million per year in federal grants, about $1.4 million in federal work-study support, and $800,000 in federal loans.

New York State has long had a program of regents’ scholarships awarded on the basis of merit and to be used at accredited institutions within the state. The concept of student aid was extended in 1974 with the adoption of the Tuition Assistance Program (TAP) which provides up to $1,500 per year to lower-division students and $1,300 to upper-division students. The amount awarded to any particular student is calculated on the basis of that student’s need. In addition, there are special programs for minority students, such as the Higher Educational Opportunity Program (HEOP) which makes awards to students at private institutions and the Educational Opportunity Program (EOP) which makes awards to those in public institutions. At present the annual state appropriation for HEOP is $8 million and for EOP is $7.9 million.

There Are Many Other Ways in Which State and Federal Governments Support Universities. There are many other government support programs that have evolved over the years. I will not attempt to list them in detail, but I will mention some of the major ones. In New York State the most important program is the so-called Bundy Program. This is a series of grants to the private institutions in the state based entirely on the number of graduates, with different grant levels depending on the degree awarded. The legislation was adopted in 1968 with $400 per baccalaureate degree, $400 per master’s degree, and $2,400 per doctorate degree. At the present time the formula provides $940 for baccalaureate degrees, $650 for masters degrees, and $3,100 for doctorates. The annual state appropriation to support the Bundy Program is now $66.6 million. Cornell’s annual Bundy income is now about $3.5 million.

Another important state effort is the so-called capitation grants to private schools in the health sciences. At the present time the formula provides $1,500 for each lower-division (first two years) medical student and $2,500 for each upper-division student. There is no state capitation support for nursing education. Federal capitation appropriations provide about $1,300 per medical student per year (although authorization is for $2,000) and $400 per nursing student. Cornell’s capitation income is about $800,000 per year from the state and $430,000 from the federal government.

There is pressure to restrict New York State student support to New York State residents (even though New York State is a net exporter of students). For example, if our out-of-state Medical College enrollment exceeds 30 percent, we lose some of the state capitation income.

There are other state and federal governmental aid programs that support a variety of programs of importance to the state and to the nation and make it possible for Cornell and other similar universities to do a more effective job, both in teaching and in research, than would otherwise be possible. At the federal level, there are specific legislative programs in support of the land-grant mission. These include so-called Bankhead-Jones and Morrill-Nelson funds which support teaching, Hatch funds which support research, and Smith-Lever funds which support cooperative extension programs. At Cornell these amount to about $11.7 million per year, with $7.8 million coming through the Smith-Lever route and flowing into the extension program at the county level.

In recent years the Sea-Grant Program, designed along the lines of the land-grant program, has been established to promote research of various kinds pertaining to the sea. Cornell shares the New York State designation with the State University of New York, and important work is being done under the aegis of this program.

In the mid-1960s the New York State legislature created five distinguished professorships in the sciences called Einstein Professorships and five in the humanities called Schweitzer Professorships, each to be funded at an annual level of $100,000 and to be open on a competitive basis to all universities in the state. The $100,000 annual appropriation was intended to cover salary for the distinguished professor and for supporting staff. Cornell has had an Einstein Professorship from the beginning (Professor Ephraim Racker in biochemistry). The appropriation was cut in half a number of years ago and we moved to restore half the cut with Cornell funds;
for the last several years we have operated with a total budget of $75,000 per year. The professorships have been removed from the governor’s budget several times but they are still maintained by the legislature at the half-funding level. In my opinion, they have accomplished the mission intended. They have brought distinguished scholars to the state, scholars who have enhanced the quality of instruction and who have conducted high-level programs and scholarly research through which substantial amounts of money have flowed to the state.

Following the Sputnik thrust, another response by New York State was creation of the State Science and Technology Foundation. Since its founding in 1965, the foundation has granted $5.8 million to twenty-eight different institutions. The largest grant to Cornell was $100,000 for the Plasma Physics Laboratory. The foundation has now faded from the scene.

The creation of the National Endowment for the Arts and the Humanities in the early sixties added an entirely new thrust to federal initiative in scholarly areas. The appropriations were small for many years but have now reached the level of $124 million per year for the arts and $121 million for the humanities. The New York State Council on the Arts, funded at a level of $27 million in 1977 (down from $34 million in 1975), also contributes significantly to the cultural life of the state. There are a number of state and federal programs that support libraries, and Cornell has benefited from these to some slight degree.

All the government programs, both state and federal, discussed to this point have influenced the quality of college and university operations in the United States, and in New York State particularly, in major ways for a long time. The quality of the overall higher educational effort has been much higher with the government support than it would have been without such support. Government initiatives have been significant factors in producing what I regard as the best university system in the world.

There Are Several Areas Where National Interest Dictates Increased Federal Support. During the past two and a half years, I have worked with a group of fourteen other university presidents, representing the major research universities in the country, in examining the future of the research university and its relationship to the federal government. Several private foundations assisted in this examination.

In our study we focused on four areas where we believe that increased federal initiative is required if the national interest is to be served adequately. In these four areas the problems are of such a scale that no institution or group of institutions working alone has any chance to deal adequately with the problems.

The first area considered is that of basic scientific research. We argue for a broader approach by the federal government to all aspects of the academic sciences. We believe that federal funding patterns must reflect the nature of the long-term commitment that institutions make when they engage in basic research. We discuss all the other problems that I have sketched in discussing the institution-government relationship and suggest ways that the problems might be dealt with.

The second area we discuss is the support of graduate students. We call for more graduate fellowships and we also argue that eligibility for merit awards should be broadened to include graduate students pursuing advanced degrees in the social sciences and the humanities.

Our third area of concern is the research library. We provide a broad analysis of the problems these important institutions now face and we recommend that the federal government pay urgent attention to these problems. We also call on the Library of Congress to take a leadership role in formulating and implementing policies that would lead to more efficient management and preservation of the significant collections housed in research libraries.

Our fourth area of focus is international studies. We stress the need for federal support of scholarly activities concerned with foreign areas. We point out the rationale for federal involvement in maintaining and further developing support for enhancing our competence in international affairs.

I am including both the Preface and the Overview to our study as appendices to this report so that you will understand the general thrust of our study. The partnership between universities such as Cornell and the federal government is so important that I believe it is worth your while to read these pages to see for yourself what fifteen presidents of the country’s foremost universities think about the problem.

A New Dimension Has Entered the University-Government Relationship: Regulation. In the last fifteen years government involvement has taken on a new dimension. That new dimension is regulation and, in my opinion, regulation threatens to strangle the very institution that government support has nurtured so successfully.

In the past fifteen years we have seen a vast network of regulatory legislation and executive orders emerge, all in the name of socially desirable objectives. I can find no fault with the objectives, which include social justice, health and safety, fair employment practices, and accountability for the proper use of state and federal funds. I suppose that it is inevitable for such regulation to appear, given the magnitude of the public funds now provided. When one spends public funds, one must be accountable to the public for the way those funds are used. There can be no argument with that principle. The argument is with the mode of accountability.
Living with the regulations now in place involves high cost, the rules are inflexible, there are regulations which overreach the intent of the underlying legislation, there is over-zealous administration of the regulations, and there is interference with the very objectives of the educational programs the regulations seek to promote.

Among the specific areas where these regulations have heavy impact are the following:

1. Equal employment opportunity and affirmative action, which affects recruitment procedures, job advertising, record keeping, and report-making.

2. Nondiscrimination on the basis of sex (Title IX of the Education Amendments of 1972). Although Cornell is in a much better position than many universities, we are still faced with major costs in providing equal opportunity for athletic competition.

3. Occupational Safety and Health Act (OSHA). If the provisions of this act were enforced rigidly, we would probably be required to make massive and unnecessary modifications to our buildings. Some of the onerous restrictions are now being modified or relaxed. I hope the trend continues.

4. Equal access for the handicapped. This, again, is social legislation I cannot quarrel with, and there are many useful steps we can take. On the other hand, expecting Cornell to provide opportunities for those in wheelchairs to the same degree that the University of Illinois has long provided them does not seem sensible to me. If the guidelines for implementing the basic legislation are enforced in detail, we will be required to make massive modifications to buildings and other facilities on our campus.

5. Protection of human and animal subjects is now specified in detail by guidelines designed to implement underlying legislation. Again, the objectives are commendable and for the most part we have been able to comply.

6. The privacy of records as provided by the so-called Buckley Amendment (the Family Educational Rights and Privacy Act of 1974). This legislation has worked to the detriment of the students it was designed to help.

7. Employer taxes and employment practices designed to promote the welfare of the employees. These again represent desirable social objectives, but they impose heavy financial burdens on universities and contribute in a major way to the rapidly rising cost of education. This trend may in the end destroy the quality we have struggled so long to establish. These programs include Social Security, where the cost to the employer and, therefore, ultimately to the student is rising at a dramatic rate; unemployment compensation; workmen's compensation; pension reform (ERISA); and the Fair Labor Standards Act, which severely restricts the flexibility with which our labor force is used. (An employee, for example, cannot work extra hours one week and be compensated by time off another week.)

8. Grant and contract requirements which impose regulations on patent policy, copyright policy, indirect cost recovery, right to publish research results, subcontracting standards, financial audits, equipment-purchasing practices, and research-reporting standards.

9. Environmental protection and antipollution regulations. These have extracted a heavy toll from Cornell. It is costing us millions of dollars to comply with the New York State air-pollution standards because the energy crisis has forced us back to the use of coal in our heating plant.

I can make no reliable estimate of the cost to Cornell of complying with the regulations that have emerged from both the state and federal levels in the past fifteen years. It amounts to millions of dollars per year, however, and these regulations have required an administrative machinery which is out of proportion to the traditional concept of the size of the bureaucracy required to administer an educational institution. Behind every report required by regulatory legislation lie thousands of hours of clerical time compiling data, thousands of hours of computer-programming time, thousands of dollars to assemble the data, and thousands of hours of supervisory effort to make sure that the reports are properly constructed and submitted. A change in the federal requirement for reporting ethnic composition of staff and student body from five ethnic types to six required an entirely new computer program, an entirely new computer analysis of employment data, and an entirely new set of reporting forms.

Added to all these costs is the new preoccupation with grievance procedures and litigation over real or imagined violations by the University of the details of the regulations. Occasionally there are violations of the regulations and injustices done which must be righted. Most often the alleged violations are not substantial and, in the end, adjudication results only in the expenditure of time, effort, and money.

Government intrusion has reached the point of specifying students to be admitted and curricula to be taught. The most severe case so far is the legislation concerning the health professions that was enacted in August 1976. This legislation specifies that the secretary of the Department of Health, Education, and Welfare has the authority to assign up to 10 percent of the third-year class to each medical college receiving federal capitation funds. Eligible students are those who are American citizens attending foreign medical schools who have passed the Part I examination of the National Board of Medical Examiners. This examination covers the basic sciences and is taken by medical students after completion of the basic sciences portion of their curriculum. Many medical
Bork went on to say that government regulation is a peril of our times:

“...I have a long history of continuous creation, is that they may at last fail from not comprehending the great institutions which government into what they had thought were their private concerns. Growing numbers of scholars and academic administrators sense that the state has seriously overstepped the area of its legitimate concern in higher education, and that much worse is in prospect. I think both the diagnosis and the prognosis are quite correct.

What is not correct, and what I have heard in the pronouncements of university presidents, is the thought that the federal government makes a unique kind of error when it undertakes to regulate universities, or that universities are so different and more subtly complex than other institutions that regulation is bound to be uniquely destructive when applied to them. None of these things are true. What we are witnessing is a more general political phenomenon in which government regulation expands to control the decisional processes of all institutions in the private sector and the effects of overregulation are quite as pernicious for other private institutions and, indeed, for state and local government.

Bork went on to say that government regulation is a peril of our times:

My dominant impression of the peril of our time, and of the time that stretches ten or twenty or thirty years ahead of us, is that expressed by Walter Bagehot: “The characteristic danger of great nations, like the Romans and the English, which have a long history of continuous creation, is that they may at last fail from not comprehending the great institutions which they have created.”
… Have the universities gained or lost in authority and autonomy in the last decade? Have the major corporations gained or lost? Have political parties gained or lost? The answer is clear in every case: they have lost authority, autonomy, prestige and power, they have done so precipitously, and the trend promises to continue.

What may not be evident is why universities in particular have proved so vulnerable and why they have not resisted and do not resist more vigorously and effectively. Should they continue to fail to do so, not only universities but all of society will be the losers.

Bork emphasized that universities could do a much better job of resisting government control:

... it would be possible for universities to rally more effective political opposition to control, at least to minimize and contain it, had they not damaged their own images so badly in the recent past. While university spokesmen talk of the indispensable role of the university as the base for disinterested scholarship and impartial attempts to understand our world, the universities sometimes behave in ways that belie the image. I would not be misunderstood. Much disinterested and brilliant scholarship takes place in universities. But much takes place that is by no definition disinterested, brilliant or scholarly, and those activities frequently occur in public and make the newspapers. So it is that when our spokesmen talk of the scholarly ideal, the public thinks it knows better.

...There is...a pleasure which is nonetheless real, even if perverse, in seeing elitist institutions scream when the remedies they have prescribed for others are applied to them.

...we have lost, in large measure through our own efforts, the indispensable presumption that the decision maker should be the institution concerned rather than the government.

…General movements are influenced by innumerable small victories and losses over details. There is, therefore, every reason for educators to make their case publicly, to use such political influence as they can muster over the details of political regulation, and to try to educate the President, the Congress, the courts, and, perhaps most importantly, the federal bureaucracy about the ways in which universities work and the harm that is done to them as organisms by well-intentioned efforts to make them perform in ways that are perceived as fairer.

Since it is true that government does not understand universities or the mode of abstract intellectual endeavor, it is important that universities make an effort to understand bureaucratic government. Bureaucrats are as well-intentioned a group as I have ever seen, but they move according to bureaucratic imperatives of which they are not even aware. We tend to create a new bureaucracy for every principle we wish to enforce. That means every such organization has one principle: health; safety; clean environment; racial equality; sexual equality; whatever. No single principle is fit to live with. At some point every principle becomes too expensive in terms of other values to be pushed further. But most of us would recognize the stopping point much sooner than would an equally intelligent person whose career is defined entirely by the single principle, and so bureaucracies thrust on past the balance point to produce results that are disastrous to institutions and processes that depend upon a balance of principles.

Bureaucracies produce more laws than Congress does. . . The matters are now so complex that congressional oversight is defeated, and indeed the effort to follow the bureaucracy is now so far beyond the politician's capacities that Congress has created enormous staff bureaucracies of its own to watch the other bureaucracies.

...universities cannot simply rely upon educating the bureaucracies; they must, if they wish not merely to survive but to survive as vital and autonomous intellectual centers, make the case against any additional regulation and seek to roll back much that now exists.

...It would help if the universities were publicly more assertive. There is in much of the rhetoric coming from university leaders today a defensive note with an unattractive whining undertone, partly, one supposes, because they are aware that they seek an autonomy not granted to others and which many of them have vigorously opposed granting to others....Universities and higher education...are not more complex than corporations and the economic marketplace, and the case against the politicization of the former is really no stronger than the case against the politicization of the latter.

There is the whole frightening problem and, rightly or wrongly, there is the way that at least one informed observer views us.

**We Are Threatened by New Tax Legislation.** A final problem of federal impact that has to do with our very survival is tax policy. Private institutions in the country rely heavily on gifts to build buildings, to create facilities, and to support ongoing operations. Were there no gifts, the quality of any private university would be far lower than it is today. Fortunately our tax laws provide incentives for charitable giving. Many institutions other than universities are the beneficiaries of this national policy: museums, symphony orchestras, libraries, churches, for example, are all made possible by such charitable giving.
We are now living under the Damoclean sword of tax "reform" which threatens to take away the incentives for charitable giving. If, for example, the tax advantages attendant to the gift of appreciated securities disappear, a large fraction of our gift support will also disappear. The tax reforms of the last decade have threatened to remove this incentive, but so far such a move has failed. It is possible that new tax legislation to remove the incentives for charitable giving will meet a more favorable climate in the future. As trustees, you must realize that the very existence of the University, and certainly the University of the quality which you cherish, is threatened by such legislation. You must be ever alert to this particular danger and if the danger appears imminent you must be prepared to use every means available to explain the impact of such reforms to the legislators involved. You must be alert, and you must be ready to act.

**CORNELL’S RELATIONSHIP TO NEW YORK STATE MUST BE CLARIFIED**

_Cornell University Is a Unique Resource for the People of New York State._ Cornell is the state’s only land-grant university – the legacy of Senator Justin Morrill’s dream of a great institution in every state to serve the education needs of all the people.

The uniqueness of Cornell lies in the combination of its excellence in teaching and in research with its special mandate from the state to take the fruits of scholarship and research to the people who can put them to use. It also lies in the special combination of public and private resources which makes these activities possible.

Cornell has four specialized or professional schools on its campus which have no counterparts elsewhere in the state. These units, spawned by Cornell’s land-grant role and originating as normal components of the University, have evolved over the years to where they are now funded substantially by the state. The statutory colleges (so-called because their funding and administrative arrangements are now embodied in state law) and their dates of origin are:

- New York State College of Veterinary Medicine (1894)
- New York State College of Agriculture and Life Sciences (1904)
- New York State College of Human Ecology (part of the College of Agriculture until its separation in 1925)
- New York State School of Industrial and Labor Relations (1944)

Two other unique assets of the University are the New York State Agricultural Experiment Station at Geneva, founded in 1880 to pursue research of importance to the state’s farmers, and the Cooperative Extension Service, the statewide network that links scholarship and research to people’s practical problems.

The total budgets (1976-77) for these units and the state’s share in their funding are approximately as follows:

<table>
<thead>
<tr>
<th></th>
<th>State Funds</th>
<th>Total</th>
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<tbody>
<tr>
<td>Agriculture and Life Sciences</td>
<td>$19 million</td>
<td>$36 million</td>
</tr>
<tr>
<td>Human Ecology</td>
<td>4 million</td>
<td>7 million</td>
</tr>
<tr>
<td>Industrial and Labor Relations</td>
<td>4 million</td>
<td>5 million</td>
</tr>
<tr>
<td>Veterinary Medicine</td>
<td>4 million</td>
<td>10 million</td>
</tr>
<tr>
<td>Geneva Experiment Station</td>
<td>4 million</td>
<td>5 million</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$35 million</strong></td>
<td><strong>$63 million</strong></td>
</tr>
</tbody>
</table>

In addition to these items, the state provides about $6 million for general services such as utilities, plus more than $1 million for the support of Cooperative Extension beyond those funds provided through the statutory colleges. For all of these activities combined, the state provides about $43 million of a $75 million total.

Nonstate support for these activities comes from student tuition and fees, from the counties in the case of Cooperative Extension, and from the following federal sources: the Hatch Act, which has supported agricultural research at land-grant institutions since 1887; the Smith-Lever Act, which has funded extension programs since 1914; the Second Morrill Act of 1890; and the Bankhead-Jones Act of 1935, which provides funds for teaching at land-grant institutions and research grants and contracts.
The state-supported activities take place in the context of a highly diverse university of more than 16,000 students, two-thirds of them undergraduates, with a total annual budget of more than $250 million and an endowment (derived from private philanthropy) valued at approximately $300 million.

**Cornell Research Is Vital to the State's Economy.** The average consumer is largely unaware of the direct benefits of this research. In 1975, fifty cows on New York dairy farms produced as much milk as eighty cows did in 1950, only twenty-five years before. The resulting cost saving amounts to nine cents per quart of milk at the farm. This represents a saving of some $450 million dollars every year to the 18 million consumers in the state. Similar cost reduction is also true for egg production. Savings, compared to 1950 standards, to New York consumers for milk and eggs together amount to some $700 million annually. This saving for only two food items, is equivalent to more than thirty years of state support at the 1976-77 level, for all the teaching, research, and extension programs of the entire State College of Agriculture and Life Sciences — in Ithaca, in Geneva, and throughout the state.

The list of what else Cornell does for the state is long. It includes the reduction of oat rust, crop damage from nematodes, and mastitis in dairy cattle. It includes the introduction of new and improved agricultural products, from apples to zucchini. It includes improvement of quality in the state’s water resources; development of the state’s fisheries; upgrading of nutrition; the study of health care delivery and municipal finance; and advancement in the health sciences in cancer, hypertension, kidney disease, and a host of other areas.

When I was a graduate student at Berkeley in the late 1930s, Petaluma, California was the poultry capital of the world. Today one would have difficulty finding even one chicken in Petaluma. The California poultry industry was wiped out by Newcastle disease. Before the disease could gain a foothold in New York State, the Cornell Veterinary College avian disease experts had controlled it. The poultry industry in New York State was untouched.

**Cornell’s Special Mission Is to Extend the Benefits of Its Research and Knowledge to All the People of New York State.** By far the largest public service outreach program in the state is Cooperative Extension, which conducts an informal educational program from the New York State Colleges of Agriculture and Life Sciences, Human Ecology, and Veterinary Medicine at Cornell University. The purpose of this more than sixty-year-old educational program is to help people in both rural and urban areas to:

- improve the quality of their lives;
- develop their problem-solving skills;
- become competent consumers;
- conserve and wisely develop natural resources;
- build better communities.

A field force of 450 extension agents and specialists is employed throughout the state. Nearly 300 faculty members at Cornell have extension responsibilities and provide on-the-job training and advice on program content for agents and specialists. Program areas include commercial agriculture, community resources development, consumer education, home economics, marine resources development, and 4-H youth development. Cooperative Extension has reported 7.5 million direct contacts in a single year with residents of the state.

Within the New York State School of Industrial and Labor Relations at Cornell, there is also an Extension and Public Service Division which provides educational services with and without college credit for labor, management, government, civic, educational, and community groups throughout New York State. General subject areas include manpower development and training, problems of unemployment, automation and depressed areas, human and employee relations, collective bargaining, supervision, executive development, labor legislation, and the history, structure, and functioning of labor unions. The School has district extension offices in Buffalo, Rochester, New York City, Albany, Long Island, and Ithaca.

Specific examples of what Cooperative Extension and Cornell’s other extension programs mean in the lives of New York State citizens include the application, on the farm of the agricultural research mentioned earlier. The examples include the fostering of cooperative marketing aimed at providing adequate supplies of high-quality food at reasonable prices. They range from Cornell-supervised nutrition counseling for low-income families to an inter-library loan system that makes expensive, hard-to-find books available to thousands of interested readers anywhere in the state. They include advice to the homeowner on reducing costs of construction or heating, and the use of the recently completed Johnson Art Museum as the base for traveling art exhibits in the Southern Tier Region.

The Cornell Medical College in New York City, together with The New York Hospital, has many programs that combine research, training, and patient care to serve the public, including a comprehensive care center for premature infants, a burn and trauma center, and the Rogosin Kidney Center, which performs more than 100 kidney transplants and 20,000 dialyses each year.

Under the supervision of professors in the College of Architecture, Art, and Planning, students have prepared financial analyses, housing and community development plans, landscape designs, historical preservation recommendations, traffic and parking studies, and commercial district plans for communities in New York State.
The College of Engineering has developed a videotape instruction program to help meet the educational needs of New York's professional engineers at their places of employment. The College also offers summer programs for engineers in such subjects as structural design for earthquakes, technical management, and control of industrial wastewater. The other professional schools at Cornell also offer summer programs for working practitioners.

The growing requirement for education to serve people of all ages makes continued support of the long-established extension programs especially important. The quality of teaching at Cornell also gains vitality from both research and outreach.

**Cornell Is a Single University Whose Strength Depends on Its Unity.** The statutory units are interwoven in the fabric of the entire University. The faculty in the statutory units are Cornell faculty, and the students are Cornell students who receive Cornell degrees.

There is an important perceptual aspect of Cornell's unity apart from the legal and administrative aspects. Outsiders, especially those in other countries, perceive of Cornell as a single entity. Developing nations hold Cornell in high regard for its agricultural research and do not think in terms of a statutory unit of the state or of the State University.

All of Cornell, including both the endowed and statutory units, is charged with the land-grant role.

The statutory units are built on the foundation of a strong and vital university largely created with private funds, and drew their original leadership from the faculty and administration of the endowed university. At no other institution is there such an interactive and mutually beneficial blending of public and private resources.

In the present institution, for example, the biological sciences programs would suffer immeasurably without the presence of the College of Agriculture and Life Sciences and the College of Veterinary Medicine. On the other hand, students in the statutory colleges are able to enjoy such privileges as the museums, the special library collections, performing arts, and distinguished lectureships without any charge made to them or to the state.

Cornell's own funds are invested in support facilities for housing, dining, and health services, and the state bears no responsibility for any potential financial problems arising from these obligations. The burden of noninstructional costs falls on students in the statutory colleges at Cornell, whereas much of it is borne by public funds at the institutions of the state university.

Cornell's worldwide reputation for excellence benefits the statutory and endowed portions alike. An important indicator of this reputation is the fact that Cornell in 1975-76 conducted $71 million worth of research, of which $14 million, or about 20 percent, came from public funds in New York State, and the remaining $57 million was attracted from other sources — mainly the federal government. About $27.5 million of these funds were provided to the statutory units, with the remaining $43.5 million going to the endowed units.

Maintaining this advantageous interplay requires that Cornell remain one university, without separation of the public and private sectors academically and organizationally. It also requires a distinctive relationship to the state, one in which the uniqueness of Cornell is recognized.

**The Cornell-SUNY Relationship is Beset by Ambiguity and Confusion.** The complexities and ambiguities currently surrounding the funding and direction of the state-funded units at Cornell make their administration difficult and potentially intolerable.

The legal basis of the Cornell-SUNY relationship is defined in Cornell’s Statutory Charter, Article 115 of the Consolidated New York Education Law, in the sections dealing with the four statutory colleges plus the New York State Agricultural Experiment Station at Geneva. The precise wording of the governance aspects of the law varies slightly among the sections applying to these different units, but several key points are consistent in principle:

1. These units shall be “controlled and managed” by Cornell University, acting as the representative of the state university, and subject to the supervision of the state university trustees.

2. Cornell is to have “custody and control” of all state-owned property provided for the use of these units.

3. The state university trustees “shall maintain general supervision over the requests for appropriations, budgets, estimates, and expenditures” for these units.

4. Cornell is to administer the statutory colleges in regard to the establishment of courses of study, the creation of departments and positions, the determination of the number and salaries of members of the faculty and other employees thereof, the appointment and employment thereof, the maintenance of discipline and as to all other matters pertaining to its educational policies, activities and operations, including research work.

5. Cornell is to regulate tuition charged to students, after consultation with the state university trustees, and is to regulate all other fees and charges in the statutory units. Money so received is to be spent for current expenses of the several colleges.
Further complicating the legal basis of the relationship are Section 352 of the State Education Law, which appears to define the statutory colleges as part of the state university, and Section 357, which states that statutory or contract colleges “shall be subject to the general supervision and control” of the state university trustees (emphasis added).

The state university statute (Education Law, Article 8), while including the statutory colleges within SUNY, makes a clear distinction between statutory colleges operated by private institutions on behalf of the state and state-operated institutions administered directly by SUNY. Under Section 355, SUNY is responsible for the review and coordination of the budget and appropriation requests for both state-operated institutions and statutory colleges. This section purports to set out in detail the administrative powers and duties of the SUNY Board of Trustees.

It is fair comment to say that the statutory language of the section contains so many contradictions and ambiguities that it is impossible to develop a clear perception of the legislative intent for the interrelationship of Cornell and SUNY in the fiscal administration of the statutory colleges.

Cornell is placed by this legislation in a strained and awkward position. Does it have full responsibility for administering the statutory units? What specific prerogatives are the SUNY Trustees entitled to exercise under their right and obligation of general supervision?

Cornell Does Not Present Its State-unit Budgets Directly to the Governor and the Legislature. The most important of the SUNY prerogatives is clearly the power of the purse. The SUNY Trustees’ “general supervision” authority has come to mean in practice that Cornell’s budget requests for the statutory units do not go directly to the Governor’s Office for inclusion in the Annual Executive Budget. They go instead to SUNY, where they are reviewed, usually reduced, and integrated into the SUNY budget presentation for the entire state university system.

The Cornell Statutory Units Are Fundamentally Different from the SUNY Institutions. The requirement for Cornell to seek its state funding through the SUNY system places the statutory units in direct competition with the large instruction-oriented programs of the state-operated institutions within SUNY. Yet the SUNY system — which includes four university centers together with four-year and two-year colleges — does not reflect the complex of extension, research, and service activities that supplement instruction in the statutory colleges at Cornell.

A facility such as the Geneva Experiment Station is a particularly obvious deviation from the SUNY instructional mold, since Geneva is dedicated to research rather than teaching and has no students.

SUNY, on the other hand, would be in a difficult position if it tried to treat its various units differently. It is fair to say that officials at the higher levels of management in SUNY have understood the special character of the state-supported units at Cornell and have sought to sustain a relationship of mutual trust and respect. The pressures to treat all alike, however, are inevitable.

In the better times of the recent past, when SUNY was expanding rapidly and funds were only moderately tight, the Cornell-SUNY relationship appeared workable. The new financial stringencies of the state, however, have caused serious cut-backs in nearly all SUNY units and expenditure categories, with the Cornell statutory units appearing at times to take a disproportionate share of the cutbacks. Since 1975, the Cornell statutory units have lost 200 positions — a total cut-back of nearly 10 percent.

Understandably, SUNY feels a special need to protect its new and growing institutions from cuts that would stunt them. It also must inevitably feel more protective toward institutions which are clearly “theirs,” as opposed to institutions identified with another entity such as Cornell. SUNY also is feeling pressure from budget officers in both the Governor’s Office and the Legislature to emphasize the number of students “processed” through the educational system, at the lowest possible cost per student, and to deemphasize operations such as those at Cornell, which are far more expensive than the typical SUNY institution because of the research and public-service components.

SUNY Necessarily Imposes Inappropriate Administrative Requirements. In reviewing the budgets for the state-supported units at Cornell, SUNY uses guidelines which presumably are well adapted to its instruction-oriented programs but are not well adapted to the units at Cornell.

For example, the guidelines establish overall enrollment quotas and specify the number of graduate students, transfer students, and upper- and lower-class students in each of the colleges. They also are based upon space utilization analyses which place major emphasis on the instructional function. Annually, the statutory colleges are evaluated in terms of a number of formulae for the allocation of funds, including that of the faculty/student ratio. The guidelines set the level of the full-time employee complement and stipulate the mix of professorial, professional, and nonprofessional personnel.

Salaries and adjustments thereto in the statutory colleges are subject to approval both by SUNY and the State Budget Office. Under present guidelines, appointments to vacant positions must be documented and approved by both SUNY and the budget office before the position can be filled by Cornell. If SUNY used guidelines and procedures for Cornell which differed from those applied to their own institution, they would have an impossible internal problem and an impossible problem with the State Budget Office.
However, the requirement to comply with the SUNY guidelines appears to contravene the responsibility placed on Cornell by its charter regarding administration of the statutory units, including such matters as educational policies, enrollment, employment, and salaries.

**The Cornell Relationship to New York State Must Be Changed.** Cornell believes that to continue on the present course means that the quality of the institution will inevitably erode. The welfare of New York State and its citizens requires a different direction.

The challenge to Cornell is to make the most of its combined public and private funding in the years ahead so as to stay at the forefront of higher education in the state, the nation, and the world. The administrative and perceptual unity of the institution must be preserved and enhanced. Cornell must continue to be one of the world’s major research universities. It must find new and better ways to use the results of its research in solving the problems of society. And these activities must continue to be linked directly to excellence in the classroom.

There appear to be three alternatives to relieve the difficulties in the current situation.

One possible approach is to separate out the research and public-service components of the activities at Cornell so that these are separately budgeted and are not inappropriately placed under SUNY guidelines designed for instruction. Research and public service are inseparably integrated with teaching, however, and there would be significant difficulties in trying to make a functional rather than organizational distinction.

A second alternative is to clarify the ambiguous relationship with SUNY, to reaffirm Cornell’s administrative control over the state-supported units, and to seek agreement on a separate and direct budget presentation by Cornell to the governor and the Legislature, so that the statutory units would not be in competition with the dissimilar units operated by SUNY.

The third approach is to seek a complete dissociation of the Cornell-administered, state-supported units from the state university. This would not be a radical step, in view of the fifty-year history of these units before the state university was created. It would have the singular and important advantage of removing all possibility of ambiguity and jurisdictional dispute. The state university might conceivably oppose such a move on the grounds that it would diminish the extent of SUNY’s responsibility for state-funded higher education in New York. The attitudes of the governor and the legislature have not been determined.

There may well be other possible alternatives to explore. The important point is to secure constructive change. The excellence of the entire resource at Cornell University, whether state-funded or endowed, is at stake.

**There Is a Good Start toward Clarifying the Ambiguities.** Both the Cornell Board of Trustees and the SUNY Board of Trustees have appointed members to a Joint Liaison Committee to study the difficulties inherent in the present relationship and to seek means to remove the obstacles to a more satisfactory relationship. With the good will that exists on both sides, and with the ready cooperation of the respective administrations, I am optimistic about resolution of at least some of the issues. Full resolution will require legislative action and the support of the governor, however.

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**I HAVE VIEWS ON A NUMBER OF MATTERS THAT ARE SPECIFIC TO CORNELL**

**We Are Spending Too Much Capital.** In 1973 I wrote a paper entitled “Prudent Unrestricted Investment Income Distribution” and in 1975 I simplified and extended the arguments. I wrote the paper to clarify my own thinking. The basic question I wanted to clarify for myself was: “With the ‘total return’ concept, under which the Capital Fund is managed, what fraction of the fund can we afford to distribute each year and still keep up with inflation?” By keeping up with inflation I mean: “I must be able to buy as many goods and services in a future year as I can buy this year, whatever the inflation rate.”

To clarify my own thinking, I analyzed the problem the only way I know how. I assumed a simple model, made a mathematical analysis of that model, and then tabulated the results in readily understandable form. To satisfy my own curiosity, I attempted in the 1975 paper to devise indices of performance that would tell me how to manage my resources in such a way that I could buy the maximum “program” over, say, a ten-year period or a twenty-five-year period.

It is not necessary to understand the mathematics I used or my rather complicated performance indices to get the message. The message is simple — we have been spending far too much capital. My paper is included here as Appendix C, and it is important that you understand the line of reasoning and the principal conclusions.
The model is necessarily arbitrary. In the first place, the capital gain in any given year is never the same as in any other year; the inflation rate varies from year to year, and the total return varies from year to year. Nonetheless, my Tables II, III, and IV and my monograph in Figure I must be taken seriously. The numbers in these tables will change slightly depending on the particular model. For example, one campus critic of Investment Committee distribution policy (he argued that we are distributing too little capital) held that my tables had to be wrong because they did not correspond to his calculation of the same quantities. His model, however, involved distribution at the end of the fiscal year on the basis of the capital worth of the fund at the beginning of the same fiscal year. I replied that my year-end distribution depends on the capital I have now, not on what I used to have. However, a fellow university president who is a mathematician pointed out to me that the equations for the second model are simpler—i.e., the basic equation is linear rather than quadratic, which makes it easier for a nonmathematician to understand. So I concede that there are different models that will give different detailed results, but the message is still the same—we are distributing too much capital.

To make my message clear, let me explain Tables II, III, and IV in Appendix C. In these tables the quantity (g) is the “total return rate.” It is the fractional increase in the total market value of the capital fund in a year. The market value of the fund increases because (1) there are dividends and interest incomes (these are treated as growth in the fund and will, of course, constitute part of the distribution at year-end), (2) there is capital appreciation in the fund, and (3) there are new gifts which are added to the fund. Please note that I include new gifts as part of the “total return”—the most favorable definition of total return one can imagine. Transfers into or out of the fund are not included in the calculation of (g), however. The quantity (r) is the fraction of the year-end fund total, after all the various gains which have been added—that is distributed—and (ip) is the fractional amount by which the year-end distribution exceeds the prior year’s distribution, given the growth factor (g) and the payout rate (r).

Following are some examples from Tables II, III, and IV of Appendix C. Please understand these examples.

From Table II, if the total return factor (g) is .10 (i.e., 10 percent) and one requires that this year’s distribution exceed last year’s distribution by 4 percent, then one can pay out 5.5 percent. The value of (ip), therefore, is the inflation rate that can be supported; i.e., with a 4-percent inflation rate, it will require 4 percent more dollars this year to buy a given amount of goods and services than it required last year. If (ip) is negative, as it has been for five of the nine years since the Capital Fund was established, we can support no inflation at all. In fact, it would require an economy deflating at the (ip) rate for us to “hold our own.”

Table III shows (ip), i.e., the inflation rate that can be supported for a given fund growth rate (g) and for a given pay-out rate (r). For example, if the growth rate is 10 percent and the distribution rate is 7 percent, only a 2.3 percent inflation rate can be supported.

Table IV shows what the total return rate (g) must be in order to support a given inflation rate (ip) for a given distribution rate (r). For example, if one is to support an inflation rate of 6 percent and pay-out at the rate of 7 percent, the total return rate must be 14 percent. In simple terms, this says that if one is to live with an inflationary economy, with a year-after-year inflation rate of 6 percent, and if every year one is to distribute 7 percent of the year-end market value of the Capital Fund, then year after year the Capital Fund must grow from the beginning of the year to the end of the year by 14 percent. This 14 percent can be made up from capital gains, from additions of new capital to the fund, and by dividends and interest. The sum of these three, however, must add up to 14 percent.

In the total-return concept it is incorrect to say that we must limit our distribution to our interest and dividend income. The fund is not invested to produce only dividends and interest. If this were the requirement, the investment policy would be different and the dividends and interest could be higher. What counts with the total-return concept is the total growth by whatever means.

It is instructive to examine the history of the Capital Fund transactions since the fund was established in 1968. In Table A, I have listed such a history. This table has been compiled with the assistance of Mr. W. D. Jones (who managed the Capital Fund in its beginning) and with the help of individuals in the Accounting Department, using data from the year-end financial reports. I am quick to say that no two people are likely to arrive at precisely the same numbers. To some degree the breakdowns are arbitrary but the overall impact of the analysis is firm. Please note that there have been transfers into the fund from other endowment sources and there have been appropriations from the fund (to meet deficits which the “distribution” did not cover and to meet critical maintenance needs, for example). None of these transfers or appropriations is involved in the growth (g) calculation nor are they part of the “distribution.”

The table (A) shows the initial $46 million transferred to the Capital Fund when it was set up in 1968. This sum represented the total endowment which was unrestricted both as to use of principal and as to purpose at the time the fund was created. The table also shows (under net addition) the $48 million transferred in 1970, when funds restricted as to purpose but unrestricted as to the use of principal were added to the Capital Fund. The net addition column lists other transfers into and out of the fund for whatever reason during the period. The column headed “Adjusted Po” is the market value of the fund at the beginning of the year after the transfers, and all percentages, whether of gain or of distribution, are percentages of the adjusted beginning-of-the-year figure or of the corresponding year-end figure.

Table B shows four quantities for the nine-year period:
(1) the annual gain (g) as a percentage of the adjusted initial capital at the beginning of the specified fiscal year (gain includes new gifts added to the capital during the year, the capital appreciation for the year, and the dividends and interest earned during the year);

(2) the distribution rate (r) at year-end, based on the market value of the fund at year-end, after all the gains, including income during the year, have been added;

(3) the inflationary rate (ip) which this particular gain and this particular distribution rate could support on a continuing basis year after year;

(4) the actual inflation rate (i) as measured by the consumer price index for the year in question.

Looking at the year 1968-69 in Table A, we see that although we added $1.3 million during the year from new gifts, and dividends and interest amounted to $1.2 million, we suffered a $4.6 million loss through capital depreciation so that we had fewer dollars at the end of the year than we had at the beginning. In fact, our gain for the year, was -4.4 percent, as shown in Table B. We distributed 6.2 percent, however, of the year-end value. If this total gain and this distribution rate were to be maintained year after year, we could sustain a deflation rate of 10.8 percent indefinitely. Actually, the inflation was +4 percent. In the nine years since the fund started there have only been two years, 1970-71 and 1971-72, when the fund performance was capable of supporting an inflation rate greater than the actual inflation rate. In 1970-71 we gained 19.6 percent in our fund value and we paid out only 6.5 percent, which together, if maintained indefinitely, could support an ongoing annual inflation rate of 11.8 percent. The actual inflation rate for the year was only 6 percent. In 1971-72 we gained 16.6 percent and paid out only 6.3 percent at year-end, which together, if maintained indefinitely, could support a 9.3 percent inflation rate, whereas we had only a 4.3 percent inflation rate for that particular year.

If one looks at the entire nine years, we have averaged only a 2 percent gain per year while our average distribution rate has been 7.7 percent. If this gain and this distribution rate were to be maintained indefinitely, we could support no inflationary pressures at all; in fact, we would have to live with a -3.9 percent inflation rate or a 3.9 percent deflation rate to hold our own. Actually, the average inflation rate over the nine years was 6.2 percent.

**The Total Return Concept Has Not Worked.** Looking at these numbers, there is only one conclusion I can draw. The total return concept has not worked and is not working now and we are depleting our capital resources at a dangerous rate. I am not an investment expert, nor am I a financial expert, and there may be aspects of the problem that I have overlooked. The basic conclusion seems inescapable to me, however, and I raise it for your consideration: Since total return has not worked, should we not abandon the concept and reexamine Capital Fund investment policy?

### A History of Capital Fund Transactions

**TABLE A**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1968-69</td>
<td>$46.3</td>
<td>$1.2</td>
<td>$47.5</td>
<td>$1.3</td>
<td>$1.2</td>
<td>$(4.6)</td>
<td>$45.4</td>
<td>$2.8</td>
<td>$42.6</td>
</tr>
<tr>
<td>1969-70</td>
<td>42.6</td>
<td>1.6</td>
<td>44.2</td>
<td>3.9</td>
<td>1.2</td>
<td>(10.2)</td>
<td>39.1</td>
<td>3.7</td>
<td>35.4</td>
</tr>
<tr>
<td>1970-71</td>
<td>35.4</td>
<td>47.7</td>
<td>83.1</td>
<td>1.8</td>
<td>3.1</td>
<td>11.1</td>
<td>99.1</td>
<td>6.5</td>
<td>92.6</td>
</tr>
<tr>
<td>1971-72</td>
<td>92.6</td>
<td>6.1</td>
<td>98.7</td>
<td>3.6</td>
<td>2.4</td>
<td>10.4</td>
<td>115.1</td>
<td>7.1</td>
<td>108.0</td>
</tr>
<tr>
<td>1972-73</td>
<td>108.0</td>
<td>14.2</td>
<td>122.1</td>
<td>3.3</td>
<td>2.5</td>
<td>(10.2)</td>
<td>117.8</td>
<td>8.1</td>
<td>109.7</td>
</tr>
<tr>
<td>1973-74</td>
<td>109.7</td>
<td>10.0</td>
<td>119.7</td>
<td>1.9</td>
<td>3.3</td>
<td>(31.2)</td>
<td>93.7</td>
<td>9.0</td>
<td>84.7</td>
</tr>
<tr>
<td>1974-75</td>
<td>84.7</td>
<td>(.3)</td>
<td>84.4</td>
<td>2.4</td>
<td>3.5</td>
<td>9.2</td>
<td>99.5</td>
<td>8.4</td>
<td>91.1</td>
</tr>
<tr>
<td>1975-76</td>
<td>91.1</td>
<td>(5.9)</td>
<td>85.2</td>
<td>1.0</td>
<td>2.9</td>
<td>(.2)</td>
<td>88.9</td>
<td>7.1</td>
<td>81.8</td>
</tr>
<tr>
<td>1976-77</td>
<td>81.8</td>
<td>(4.1)</td>
<td>77.7</td>
<td>.4</td>
<td>2.5</td>
<td>(1.8)</td>
<td>78.6</td>
<td>6.1</td>
<td>72.7</td>
</tr>
</tbody>
</table>

**NOTE:** Do not attempt to compare this table, other than year-end balance after distribution, with Table IPA 10/17 19-3, “University Investments, Capital Fund Pool” in the report “Financial Profile” October 1977. The “Rate of Return” included in that table cannot be calculated in a straightforward way from overall capital gains, income, distribution, and year-end balances. The numbers come from the A.G. Becker analysis of Cornell investment performance and bear no simple relationship to my definitions and data. See note added February 11, 1978, page 62.
TABLE B

<table>
<thead>
<tr>
<th>Fiscal year</th>
<th>g</th>
<th>r</th>
<th>ip</th>
<th>i</th>
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</thead>
<tbody>
<tr>
<td>1968-69</td>
<td>-4.4%</td>
<td>6.2%</td>
<td>-10.3%</td>
<td>4.0%</td>
</tr>
<tr>
<td>1969-70</td>
<td>-11.5%</td>
<td>9.5%</td>
<td>-19.5%</td>
<td>5.3%</td>
</tr>
<tr>
<td>1970-71</td>
<td>+19.3%</td>
<td>6.6%</td>
<td>11.4%</td>
<td>6.0%</td>
</tr>
<tr>
<td>1971-72</td>
<td>+16.6%</td>
<td>6.3%</td>
<td>9.3%</td>
<td>4.3%</td>
</tr>
<tr>
<td>1972-73</td>
<td>-3.6%</td>
<td>6.9%</td>
<td>-10.3%</td>
<td>4.3%</td>
</tr>
<tr>
<td>1973-74</td>
<td>-21.7%</td>
<td>9.6%</td>
<td>-29.2%</td>
<td>8.7%</td>
</tr>
<tr>
<td>1974-75</td>
<td>+17.9%</td>
<td>8.4%</td>
<td>8.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>1975-76</td>
<td>+4.3%</td>
<td>8.0%</td>
<td>4.0%</td>
<td>7.4%</td>
</tr>
<tr>
<td>1976-77</td>
<td>+1.4%</td>
<td>7.7%</td>
<td>-6.4%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Average</td>
<td>2.0%</td>
<td>7.7%</td>
<td>-4.8%</td>
<td>6.2%</td>
</tr>
</tbody>
</table>

$g$ is gain in fund during the fiscal year and includes new additions of capital, capital gains (whether realized or unrealized), and dividends and interest.

$r$ is the distribution at year-end calculated as a percentage of year-end value after the year’s gains have been added to the value of the fund at the beginning of the fiscal year.

$ip$ is the inflationary rate which could be supported indefinitely if the annual gain, $g$, and the distribution rate, $r$, were maintained indefinitely.

$i$ is the actual inflation rate (as measured by the consumer price index) for the fiscal year.

See note added February 11, 1978, in the following section.

(Cartoon removed) “All those in favor of hollering uncle, say ‘Aye.’”

**The Future Must be Protected.** I am concerned about the future. Our generation inherited a Cornell University which had a magnificent history and a magnificent record of achievement. We inherited great resources in the form of endowment, physical facilities, and tradition, all of which made it possible for us to do our job. I am now concerned as to whether we are leaving a Cornell University capable of serving the next generation as well as we have been served.

The excessive use of capital resources which I have just discussed is at the heart of my concern. I believe that there can be no doubt that Cornell has survived the extraordinary troubles of the past fifteen years and survived well. It is a strong university. There can also be no doubt that the excessive use of capital resources in the last decade has contributed significantly to the maintenance of that strength. I advocated the use of capital resources in order to maintain our position, and while I did not invent the total-return concept, I did support the large pay-out rate. Now, however, we must reduce that rate and begin to build for the future.

I believe it worthwhile for the trustees to reconsider the total-return concept. The optimism which we all felt about the economy a decade ago has proved unfounded. The 10 to 15 percent annual growth we discussed in 1968 has proved to be a 2 percent annual growth. With ten years of experience behind us, reconsideration seems appropriate.

Since I am not an expert on economics or financial management, my thoughts may be discounted justifiably. However, I am an expert on arithmetic and I have drawn my conclusions from relatively simple arithmetic.

I have concerns about the entire question of endowment management. I simply do not know how to manage the capital resources of an institution such as Cornell University in a way that will guarantee the best future for the institution. We have invested in the growth of the American economy, primarily through the common stock route in the equity market. I cannot predict what the future of the American economy will be, but there are two inescapable factors that bear heavily on it: 1) the decline in the rate of population growth and 2) the inevitable loss of fossil energy resources.

This country has known nothing but growth in its two-hundred-year history and the growth of our economy has been tied to pushing back the frontier that has always been there. Until well into this century, the frontier included a physical frontier to be developed. More recently, it has included a frontier of a higher living standard for a rapidly increasing population. (A population that doubles in thirty-five or forty years is a rapidly increasing one in my definition.) Neither the physical frontier nor the human frontier will be there in the future, at least in the way they have been in the past.

Rapid and inevitable exhaustion of the world’s oil resources has implanted itself on our consciousness only since the oil embargo of 1973. Although we refuse to take the facts seriously, we have a tremendous task of readjustment ahead of us.

With the population growth coming to an end and with the exhaustion of the world’s oil supply in sight, it seems to me that at best the economy is going to be shaky, with many ups and downs during the coming years. I suggest that this is inevitable because I see
stable markets or declining markets, not growing markets, for many of the goods and services that have sustained the American economy so well for so long. I see a heavy impact on just about everything we do as our sources of energy are depleted and as the costs of those sources rise. In my opinion, the economy must necessarily be turbulent during the coming decades.

These considerations raise questions in my mind about how one invests capital resources held in trust for an institution such as a university. I believe that the question is one worthy of consideration and study by a board of trustees.

Why not abandon the total-return concept but maintain the Capital Fund for investment in a flexible manner? In periods when capital funds are needed, say for critical maintenance purposes, the fund could be invested for high return. In recent years investment in high-yield, short-term bonds could have returned an additional million dollars per year, perhaps more. In other periods some other investment might be the best choice. Admittedly, the fund would not grow during such an investment period. However, during the past ten years, it has shrunk as we met our capital needs through the use of capital.

Perhaps our biggest trouble is making the unrestricted fund, which is available to meet capital emergencies, and the growth fund, which is invested for “total return,” one and the same. Every time we have a “down” market we have both negative “total return” and capital emergencies which require us to sell growth stocks at the worst possible time. There must be a better way.

Note Added February 11, 1978: I have attempted unsuccessfully to reconcile the differences between my analysis of the Capital Fund history (Tables A and B) and the A.G. Becker analysis published in “Financial Profile,” compiled by the Office of Institutional Planning and Analysis in October 1977. The general features of both analyses are the same, except that the Becker analysis is made in terms of share values and mine is made in terms of fund transfers, gifts, dividends and interest, capital appreciation, and distribution, all in dollar amounts. The share value approach is much the simpler if one wishes to know “how are we doing overall?” My approach gives more detailed information about how we arrived at our present position.

While my year-end figures for balances after distribution, the amount of the distribution, and the rate of income all agree closely with the Becker numbers, our rates of total return differ substantially. The Becker nine-year average is +4.67 percent; mine is +2.0 percent. I have erred somewhere in going back and forth from share values, number of shares, distribution in excess of income, and so forth. Since this report must “go to press” at this point, there is not time to redo the history of the Capital Fund transactions.

The principal conclusions would remain unchanged even if I redo the history correctly. The rate of return is far too small to sustain the payout rate we have demanded of the fund, given the inflationary pressure we have lived with.

There are two interesting numbers one can calculate from the year-end share values alone. The first is: given our investment performance (i.e., the total return we have achieved) and our distribution policy (i.e., the interest and dividends we have distributed plus the distribution in excess of income), what has been the average annual change in the share value? The answer is -4.0 percent.

We have gone downhill at a rate that will lose us 50 percent of our fund value in eighteen years, that is, in 1986. Meanwhile, inflation continues. With a 6 percent inflation rate, that which cost $1.00 in 1968 will cost $2.85 in 1986. If we had $1.00 to buy a dollar’s worth of goods and services in 1968, we will have 50 cents to buy $2.85 worth in 1986.

The second number is: had we distributed no income and if we had distributed nothing in excess of income — i.e., if we had distributed nothing at all, what would have been the average annual change in share value? The answer is +4.2 percent. This number is the “total return” rate and should correspond to the Becker number. The difference may arise from the use of quarterly share values by Becker and only year-end values by me.

Referring to my paper in Appendix C and asking what inflation rates we could support with a 4.2 percent total return rate and various distribution rates, we arrive at the following answers:

<table>
<thead>
<tr>
<th>Distribution rate r</th>
<th>Inflation rate i</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 % 0 %</td>
<td></td>
</tr>
<tr>
<td>5 % -1 %</td>
<td></td>
</tr>
<tr>
<td>6 % -2 %</td>
<td></td>
</tr>
<tr>
<td>7 % -3 %</td>
<td></td>
</tr>
</tbody>
</table>

Even if our distribution rate were as low as 4 percent, we could support no inflation at all. In fact, our present policies would require an economy deflating at a substantial rate for us to “hold our own.”

My overall conclusion remains unchanged: there must be a better way.

I Have Questions about Trustee Organization for Determining Fiscal Policy. I have questions about the current Cornell Trustee organization for determining fiscal policy, questions which I believe worthy of your consideration.
In the first place, I am not particularly happy about the bylaw provision that divides responsibility for the investment operation between the University administration (for investment office administration) and the Investment Committee of the Board (for investment operations per se). The Investment Office looks to the president for administrative authority on some matters and to the Investment Committee on others.

My basic concerns, however, are more substantial. There is no established trustee committee to consider investment-income policy in any way related to the requirements for income to meet operating expenses. The Investment Committee is concerned solely with investment policy and there is no committee other than the Executive Committee to deal with overall budgetary matters or with other matters of financial policy.

During my years as president and as provost, we used the chairman of the board, the vice chairman of the board, the chairman of the Executive Committee, and the vice chairman of the Executive Committee as an informal finance committee. The help, advice, guidance, and general wisdom of this group have been invaluable. On the other hand, the committee is not a formal one, there are no scheduled meetings, and every consideration is an ad hoc one. Would it not be wise to have a finance committee as a standing committee of the board, with regularly scheduled meetings, to weigh income and expense policies equally, to relate investment policy to the requirements for income as they may vary from time to time, and generally to consider fiscal policy as a whole?

I call this particular problem to your attention, hoping that University policies can be more coherent and that the University administration can be more effective.

High Tenure Ratios Are Not Necessarily Bad. I do not want to get into a discussion of the institution of tenure in this report, but there are some comments that I will make. In the long run, I think that the concept of tenure will have to be modified—the public will force it when higher education becomes a buyer’s market. Volumes have been written on the subject, and the trustee who wants to know more can turn to the published literature. As a single reference, I would cite the volume containing the work of the commission headed by our former Academic Vice President W. R. Keast: Faculty Tenure, A Report and Recommendations by the Commission on Academic Tenure in Higher Education, William R. Keast, chairman (Jossey-Bass Publishers, 1973).

Several years ago I asked myself the question: “Given the present tenure system, what do different ratios of tenured to total faculty numbers do to me? Are there tenure ratios above which I cannot go without damaging my University? If so, what are they? Are there circumstances in which a high tenure ratio might be desirable?”

To answer these questions, I made a model of a faculty and proceeded to analyze what happened as the tenure ratio went up. My model was a simple one; it assumed that the age distribution within the faculty was uniform — i.e., the same fraction of the faculty reached retirement age each year. With the model so defined, I compiled the arguments and the results in the attached paper. I still subscribe, in general, to the conclusions drawn there. Incidentally, the Cornell faculty “attrition rate,” r, is about 3.8 percent, where r varies from time to time because of the uneven age distribution among the faculty. For example, the substantial influx of faculty just after World War II—my generation of faculty—is now at retirement age and the turnover rate will be abnormally high for a time.

While only the broadest conclusions of my paper can be taken seriously, these should be taken seriously. A high tenure ratio is not necessarily bad provided it is not excessive, and I show what “excessive” means. A moderately high ratio can be beneficial, as the paper points out. Another important consideration is the possibility of reducing the size of a faculty in a way that continues a substantial inflow of young people, a sine qua non.

I suspect that large corporations have de facto tenure policies with all the undesirable features frequently attributed to higher educational tenure systems. I have known only one large corporation with any degree of intimacy and it had a “tenure” system that I considered highly undesirable. As far as I could tell, the corporation never dismissed any senior person, and I use the word “senior” to include people in the management hierarchy far down in the corporation. They solved their problems by moving people sidewise — solving a problem in one part of the corporation and creating a problem in another.

Basically, I think that “tenure” is a feature of American life more generally and not merely a feature of academic life. I do not propose to discuss the general institution any further. However, given the tenure system that prevails in American academic life, I am interested in its implications at this stage of our development. I recommend the discussion that follows. Don’t bother with the mathematics — unless you want to check the soundness of my reasoning — but study the conclusions.
THE ARITHMETIC OF TENURE

INTRODUCTION. The purpose of this paper is to explore the relationships among the factors bearing on the fraction of a given faculty which is tenured and to suggest some of the considerations to be taken into account in determining institutional policy with regard to the tenure ratio.

A SIMPLE MODEL. The mathematical relationships developed below relate to an idealized model in which the number of tenured members leaving the faculty each year is assumed to be always the same, all untenured members are assumed to serve a specified number of years before they are eligible for promotion to a tenured position, and a steady state is assumed, i.e. the total number of members in the faculty in question is always the same. The problems arising in reducing the overall size of a faculty over a period of years are also explored.

GLOSSARY OF TERMS AND SYMBOLS. The following terms and symbols always have the same meaning throughout the discussion.

N is the total number of members in the faculty under consideration.
F is the fraction of the total number which is tenured, and is called the “tenure ratio.”
N_t = FN is the number of tenured members in the faculty.
N_u = (1-F) N is the number of untenured members.
r is the attrition rate among the tenured members of the faculty; i.e., it is the fraction of the tenured membership which leaves the institution each year by retirement, resignation, or death. It is assumed to be the same year after year.
rFN is the number of tenured members leaving the faculty each year.
f = \frac{\text{no. of openings at the tenured level}}{\text{no. of untenured faculty members}} = \frac{rFN}{N(1-F)} = \frac{rF}{(1-F)},
is the fraction of the untenured number which can be promoted each year.

N_c is the number in the untenured “class” and is the number of untenured members eligible for promotion each year. If each untenured member must serve six years before promotion to tenure, N_c = N_u/6.
f_c is the fraction of the untenured “class” actually promoted each year. If the required untenured term is six years, f_c = 6f.
N_p is the number promoted to tenure each year.
N_{p6} is the total number promoted to tenure in a six-year period.
N_o is the number of untenured members who are never promoted.
F_{max} is the tenure ratio which will permit all the untenured members to be promoted after the specified years of service. It depends on the tenured attrition rate r.
x is the number by which both the tenured number and the untenured number are reduced each year in the particular reduction program discussed.
THE ANNUAL NUMBER OF PROMOTIONS DEPENDS ON THE TENURE RATIO \( F \) AND THE ATTRITION RATE \( r \).

We have for the fraction \( f \) of the untenured number which can be promoted each year:

\[
f = \frac{\text{no. of openings at the tenured level}}{\text{no. of untenured faculty members}} = \frac{rFN}{N(1-F)} = \frac{rF}{1-F}
\]

This equation simply says that for each opening at the tenured level, one untenured member can be promoted.

The relationship between \( f \), \( r \), and \( F \) is tabulated in Table I, where the numbers in the column at the left are the annual loss rates \( r \) from the tenured ranks and those across the top are tenure ratios \( F \). The numbers in the body of the table are fractions \( f \) of the untenured numbers promoted each year for the specified \( r \) and \( F \).

### Table I

<table>
<thead>
<tr>
<th>( r )</th>
<th>( F )</th>
<th>.5</th>
<th>.6</th>
<th>.7</th>
<th>.8</th>
<th>.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.05</td>
<td>0.08</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>0.04</td>
<td>0.04</td>
<td>0.06</td>
<td>0.09</td>
<td>0.16</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>0.06</td>
<td>0.06</td>
<td>0.09</td>
<td>0.14</td>
<td>0.24</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>0.08</td>
<td>0.08</td>
<td>0.12</td>
<td>0.19</td>
<td>0.32</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td>0.10</td>
<td>0.15</td>
<td>0.23</td>
<td>0.40</td>
<td>0.90</td>
<td></td>
</tr>
</tbody>
</table>

The relationship of \( f \), \( r \), and \( F \) can also be shown in a nomograph as in Figure I (next page), where any straight line across the chart connects consistent values of the quantities represented. In the example shown by the dotted line, 0.12 of the untenured number can be promoted to tenure each year if the tenure ratio is 0.75 and the attrition rate for tenured faculty is 0.04.

\( F \) = fraction of faculty which is tenured
\( r \) = annual loss rate of tenured faculty
\( f \) = fraction of untenured faculty which can be promoted to tenure annually

For example, if 75% of the faculty is tenured and there is an annual loss from the tenured ranks of 4%, then 12% of the untenured faculty can be promoted to tenure annually.

**Example 1.** Suppose that \( F = 0.50 \) so that in a faculty of 100 there are 50 untenured members and 50 tenured. If the attrition rate \( r \) is 4% (0.04), then the fraction of the untenured members who can be promoted each year is 4% of 50, or two members.

**Example 2.** Suppose that \( F = 0.75 \) so that in a faculty of 100 members 75 are tenured and 25 are untenured, and suppose also that the loss rate \( r = 0.04 \). There are 0.04 x 75 = 3 positions available each year at the tenured level, and the fraction of the untenured members who can be promoted annually is 3/25 = 0.12.

**Example 3.** Suppose that 81% of the faculty is tenured — i.e., \( F = 0.81 \), and suppose again that the loss rate \( r = 0.04 \). We then have \( f = 0.167 \) or, since there are 19 untenured members in a faculty of 100, there can be \( N_p = 3.2 \) promotions per year (whenever the number of promotions is fractional, it is to be understood as representing the average number of promotions over a period of years).

**THE UNTENURED “CLASS.”** The untenured “class” in any year includes the untenured faculty members eligible for promotion in that year. All members of the class leave the untenured ranks at the end of the academic year, either by promotion to a tenured position or by leaving the institution. \( N_c \) is the number in the class.

Suppose now that each untenured faculty member serves six years before he is eligible for promotion. If \( N_u = 50 \), then \( N_c = 50/6 = 8.33 \). In example no. 1 above \( N_c = 2 \), so that only two out of 8.33 can be promoted each year and \( f_c = 2/8.33 = 0.24 \). So two are promoted and 6.33 (always on the average) leave the institution each year without being promoted.

In example no. 2 above, \( N_u = 25 \) and \( N_c = 4.167 \) (assuming again a six-year service requirement to be eligible for promotion). Since there are three promotions each year, the fraction of the class which is promoted is \( f_c = 3/4.167 = 0.72 \).

In the third example, there are 19 untenured members spread over six years, so \( N_c = 3.167 \). This is also the number of annual promotions, so that \( f_c = 1.0 \) — i.e., everyone is promoted.

The three examples can be summed up as in Table II, where \( N_p \) is the number promoted each year, \( N_{p6} \) is the number promoted over a six year period, and \( N_0 \) is the number never promoted.
\[ F = \text{fraction of faculty which is tenured} \]
\[ r = \text{annual loss rate of tenured faculty} \]
\[ f = \text{fraction of untenured faculty which can be promoted to tenure annually} \]

Example: if 75\% of the faculty is tenured and there is an annual loss from the tenured ranks of 4\%, then 12\% of the untenured faculty can be promoted to tenure annually.
Table II
Number of annual promotions for different tenure ratios

<table>
<thead>
<tr>
<th>Example</th>
<th>N</th>
<th>F</th>
<th>N_u</th>
<th>N_c</th>
<th>r</th>
<th>f</th>
<th>f_c</th>
<th>N_p</th>
<th>N_{p6}</th>
<th>N_o</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>100</td>
<td>.50</td>
<td>50</td>
<td>8.3</td>
<td>.04</td>
<td>.04</td>
<td>.24</td>
<td>2</td>
<td>12</td>
<td>38</td>
</tr>
<tr>
<td>Example 2</td>
<td>100</td>
<td>.75</td>
<td>25</td>
<td>4.2</td>
<td>.04</td>
<td>.12</td>
<td>.72</td>
<td>3</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>Example 3</td>
<td>100</td>
<td>.81</td>
<td>19</td>
<td>3.2</td>
<td>.04</td>
<td>.17</td>
<td>1.00</td>
<td>3.2</td>
<td>19</td>
<td>0</td>
</tr>
</tbody>
</table>

What happens if the attrition rate is higher? If the attrition rate for the tenured ranks is higher, say 6% per year, the “turn-over” is greater and there is more opportunity for those in the untenured ranks.

Table III refers to the same examples except that \( r = 0.06 \).

Table III
Number of annual promotions when \( r = 0.06 \)

<table>
<thead>
<tr>
<th>Example</th>
<th>N</th>
<th>F</th>
<th>N_u</th>
<th>N_c</th>
<th>r</th>
<th>f</th>
<th>f_c</th>
<th>N_p</th>
<th>N_{p6}</th>
<th>N_o</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>100</td>
<td>.50</td>
<td>50</td>
<td>8.3</td>
<td>.06</td>
<td>.06</td>
<td>.36</td>
<td>3</td>
<td>18</td>
<td>32</td>
</tr>
<tr>
<td>Example 2</td>
<td>100</td>
<td>.75</td>
<td>25</td>
<td>4.2</td>
<td>.06</td>
<td>.18</td>
<td>(1.08)</td>
<td>(4.5)</td>
<td>(27)</td>
<td>0</td>
</tr>
<tr>
<td>Example 3</td>
<td>100</td>
<td>.81</td>
<td>19</td>
<td>3.2</td>
<td>.06</td>
<td>.26</td>
<td>(1.54)</td>
<td>(4.9)</td>
<td>(30)</td>
<td>0</td>
</tr>
</tbody>
</table>

The numbers in brackets () indicate that all the untenured members can be promoted in less than six years.

The “maximum” tenure ratio. Referring to the nomograph in Figure I, one sees that for \( f = 0.167 \) (i.e., 1/6 of all untenured faculty members can be promoted each year, which is to say that all untenured members can be promoted to tenure after six years of service) there is a tenure ratio \( F = F_{\text{max}} \) corresponding to each attrition rate \( r \). \( F_{\text{max}} \) is the tenure ratio which will permit all untenured faculty to be promoted to tenure after six years. \( F_{\text{max}} \) can be found from the nomograph for various attrition rates by pivoting a straightedge about the fixed point \( f = 0.167 \). The corresponding values of \( r \) and \( F_{\text{max}} \) are listed in Table IV.

Table IV
Dependence of \( F_{\text{max}} \) on \( r \) for \( f = 0.167 \)

<table>
<thead>
<tr>
<th>( r )</th>
<th>.02</th>
<th>.03</th>
<th>.04</th>
<th>.05</th>
<th>.06</th>
<th>.07</th>
<th>.08</th>
<th>.09</th>
<th>.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{\text{max}} )</td>
<td>.89</td>
<td>.85</td>
<td>.81</td>
<td>.77</td>
<td>.74</td>
<td>.71</td>
<td>.68</td>
<td>.65</td>
<td>.63</td>
</tr>
</tbody>
</table>

For a given attrition rate \( r \) there is a tenure ratio \( F_{\text{max}} \) at which all untenured members can be promoted after six years of untenured service. If the tenure ratio is lower than \( F_{\text{max}} \) not all the untenured members can be promoted. If the tenure ratio is greater than \( F_{\text{max}} \), there will be an insufficient number of untenured members to fill all the tenure vacancies with a six-year untenured service requirement.

If seven years of preliminary service is required, the straightedge is pivoted about \( f = 0.143 \) and for a given attrition rate \( r \) the corresponding \( F_{\text{max}} \) is slightly less than in the six-year case.

If shorter probationary periods are required before promotion, the tenure ratio can go higher before all the untenured members are promoted. If the decision point comes after four years of untenured service, then \( f = 0.25 \) for 100% promotion and all the \( F_{\text{max}} \) numbers are higher. Table V shows corresponding values of \( r \) and \( F_{\text{max}} \) for \( f = 0.25 \).

Table V
Dependence of \( F_{\text{max}} \) on \( r \) for \( f = 0.25 \)

<table>
<thead>
<tr>
<th>( r )</th>
<th>.02</th>
<th>.03</th>
<th>.04</th>
<th>.05</th>
<th>.06</th>
<th>.07</th>
<th>.08</th>
<th>.09</th>
<th>.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{\text{max}} )</td>
<td>.93</td>
<td>.89</td>
<td>.86</td>
<td>.83</td>
<td>.81</td>
<td>.78</td>
<td>.76</td>
<td>.74</td>
<td>.72</td>
</tr>
</tbody>
</table>
WHICH TENURE RATIO IS BEST FOR THE INSTITUTION? The tenure ratio which is best for the institution depends on several considerations. The institution’s ability to recruit effectively at the initial appointment level is one important consideration. If the particular faculty can have its choice of the young potential faculty members “coming on the market,” it is likely to want to promote most of its untenured members and the only way to do this is with a high tenure ratio. Take Table II, for example, where \( r = 0.04 \). With an 81% tenure ratio, there are 19 untenured members in a faculty of 100 and they are all promoted. If the tenure ratio is 75%, there are 25 untenured members and only 18 of them will be promoted. If the tenure ratio is 50%, there are 50 untenured members and only 12 of them will ever be promoted.

If the attrition rate is 6%, the tenure ratio for 100% promotion falls to 74%, as is shown in Table IV.

If the faculty’s ability to recruit effectively at the initial appointment level is poor, so that a significant “flow-through” of young faculty is required in order to select the most promising ones for promotion to tenure, a lower tenure ratio is better: with \( r = 0.04 \) a 75% tenure ratio gives an opportunity to select 18 out of 25 in a six-year period. With a 50% ratio there is an opportunity to “look at” 50 young people in order to select 12 in a six-year period. With such a relatively poor chance for promotion, the morale of the untenured group might be low, however.

A second consideration is the degree to which a faculty is willing to have its teaching and its research conducted by a continuously changing group of young people. If the faculty wants to build continuity and long-term stability into its program, it will want a higher tenure ratio with the consequent lower turnover.

WHICH TENURE RATIO IS BEST FOR THE UNTENURED FACULTY? From the standpoint of the prospective “promote,” the optimum situation depends on whether the number of tenured positions available each year is the important consideration or whether the number of appointments at the entry level is more important. If the number of tenured positions is the criterion, a high tenure ratio is best. In the examples in Table II, a tenure ratio of 75% produces three new tenured positions a year, while 50% produces only two permanent promotions a year. With a high tenure ratio, the problem from the standpoint of the young faculty member is that of getting appointed in the first instance. With an 81% tenure ratio only 3.2 (on the average) new entry-level appointments are made each year, but there is opportunity for every one of the appointees to achieve tenure. With a 50% tenure ratio there are 8.3 initial appointments a year, but only two appointees can eventually be promoted.

HOW CAN THE OVERALL SIZE OF A FACULTY BE REDUCED? If there is a shifting requirement for faculty in a particular field, it may be necessary to reduce the size of the faculty, and it is important to know how the tenure ratio influences the institution’s ability to make the required reduction. One way to effect the reduction is to decrease the number of tenured members by a certain number each year (by promoting a number of untenured members which is fewer than the number lost by attrition in the tenured ranks) and by decreasing the number of untenured members by the same number (by appointing a number at the entry level which is fewer than the number of promotions). In the example below we start with a faculty of 100 and reduce it over a five-year period to a total of 90 or 80 members.

Before the reduction begins, suppose we have a faculty of 100, 76 of whom are tenured and 24 untenured, so \( F = 0.76 \). If every untenured member must serve six years before becoming eligible for promotion, then four are eligible for promotion each year. Suppose, further, that the attrition among the tenured ranks is such that four are lost each year — i.e., \( r = .053 \). Suppose now that only three (instead of the possible four) are promoted at the end of year zero and only three (instead of four) junior members are brought in at the entry level. So four tenured members leave and only three are promoted, and the tenured ranks are reduced from 76 to 75. Four leave the untenured ranks but only three new ones are brought in. Thus the number of untenured members is reduced from 24 in year zero to 23 in year one. Suppose this process is continued for five years — i.e., each year four tenured members leave, one untenured member is not reappointed, three are promoted, and three new appointments are made at the entry level. Thus for the total faculty in question, five leave each year (four from the tenured ranks and one from the untenured) and only three new appointments are made. Thus the total number of faculty is reduced by two each year. For the different years we have the numbers in Table VI.

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>F</th>
<th>( N_t )</th>
<th>( N_u )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>.76</td>
<td>76</td>
<td>24</td>
</tr>
<tr>
<td>1</td>
<td>98</td>
<td>.77</td>
<td>75</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>96</td>
<td>.77</td>
<td>74</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>94</td>
<td>.78</td>
<td>73</td>
<td>21</td>
</tr>
<tr>
<td>4</td>
<td>92</td>
<td>.78</td>
<td>72</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>90</td>
<td>.79</td>
<td>71</td>
<td>19</td>
</tr>
</tbody>
</table>

So over a period of five years, we have reduced the total number of faculty from 100 to 90, and 15 untenured members have been promoted to tenure in comparison to the 20 who would have been promoted had the faculty size remained stabilized at 100. Like-
wise, only 15 new appointments at the entry level have been made, in comparison to the 20 who would have been appointed in the steady state N = 100 situation.

In the process of reducing the faculty from 100 total members to 90 by the particular route chosen, we have increased the tenure ratio from 76% to 79% and reduced the class size from four to 3.2. If all the untenured members are to be promoted at the end of six years (i.e., \( f = 0.167 \)), with 19 total untenured members we can promote 3.2 each year. Thus we start with a situation in which all untenured members are eventually promoted and we end with the same situation (provided the tenured attrition rate is no lower than 4.5%), except that now the total number of untenured members is 19 instead of the 24 at the beginning of the reduction process.

We can find the tenure ratio at the end of any reduction period of \( n \) years for the special case where the number of promotions per year is \( x \) fewer than the number lost by attrition and the number of new appointments is \( x \) fewer than the number of promotions each year. When there is an initial total number \( N_i \) we have:

\[
\begin{align*}
\text{year 0} & \quad F_i = F_i \frac{N_i}{N_i} \\
\text{year 1} & \quad F_1 = F_i \frac{N_i - x}{N_i - 2x} \\
\text{year 2} & \quad F_2 = F_i \frac{2x}{N_i - 2nx} \\
& \quad \vdots \\
\text{year n} & \quad F_n = F_i \frac{N_i - nx}{N_i - 2nx}
\end{align*}
\]

An interesting aspect of this method of reducing the size of the faculty (i.e., by reducing the number of tenured faculty and the number of untenured faculty by the same amount each year) is the fact that the tenure ratio never changes if the initial ratio is 0.5:

\[
F_n = 0.5 \left[ \frac{N_i - 2nx}{N_i - 2nx} \right] = 0.5
\]

If \( F_i \) is larger than 0.5, the tenure ratio creeps up slowly with time. If \( F_i \) is smaller than 0.5, the tenure ratio creeps down slowly. The numbers for a five-year reduction going from 100 to 90 (i.e., with \( x = 1 \)) and from 100 to 80 (i.e., with \( x = 2 \)) are shown in Table VII for initial tenure ratios \( F_i = .75, F_i = .60 \) and \( F_i = .40 \).

### Table VII

Reduction of a faculty of 100 to 90 or to 80 over a five-year period

<table>
<thead>
<tr>
<th>( F_i = 0.75 )</th>
<th>( N = 100 )</th>
<th>( F_i = 0.60 )</th>
<th>( N = 100 )</th>
<th>( F_i = 0.40 )</th>
<th>( N = 100 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x = 1 )</td>
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<td>( x = 1 )</td>
<td>( x = 2 )</td>
<td>( x = 1 )</td>
<td>( x = 2 )</td>
</tr>
<tr>
<td>n</td>
<td>N</td>
<td>F</td>
<td>N</td>
<td>F</td>
<td>N</td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
<td>.750</td>
<td>100</td>
<td>.750</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>98</td>
<td>.755</td>
<td>96</td>
<td>.760</td>
<td>98</td>
</tr>
<tr>
<td>2</td>
<td>96</td>
<td>.760</td>
<td>92</td>
<td>.771</td>
<td>96</td>
</tr>
<tr>
<td>3</td>
<td>94</td>
<td>.766</td>
<td>88</td>
<td>.784</td>
<td>94</td>
</tr>
<tr>
<td>4</td>
<td>92</td>
<td>.771</td>
<td>84</td>
<td>.798</td>
<td>92</td>
</tr>
<tr>
<td>5</td>
<td>90</td>
<td>.778</td>
<td>80</td>
<td>.813</td>
<td>90</td>
</tr>
</tbody>
</table>
CONCLUSIONS. Only general considerations can be concluded from this simplified model, of course, but the same considerations can be applied in analyzing a particular real-life situation. The following features emerge from the above models.

1. The attrition rate from the tenured ranks determines the absolute tenure ratios which are desirable and tolerable. The lower the attrition rate, the higher the permissible tenure level.

2. If a faculty can recruit effectively at entry-level appointments, a high tenure ratio is desirable in order to be able to promote as many as possible of the untenured faculty.

3. If a “flow-through” of young faculty is necessary to select good ones for promotion to tenure, a lower tenure ratio is required.

4. A low tenure ratio, say 50%, with a 4% attrition rate, offers so little chance for promotion that the morale of untenured faculty is apt to be low.

5. There is a critical high tenure ratio maximum beyond which there is not a sufficient number of untenured members to fill vacant tenure positions if there is a specified probationary period before eligibility for promotion is achieved (Table V).

6. A faculty is likely to want to build stability and continuity into its teaching and research programs, thereby requiring a relatively high tenure ratio. This is possible while at the same time bringing the maximum amount of “new blood” into the tenured faculty.

7. From the standpoint of the untenured faculty, a high tenure ratio offers the most number of available promotions to tenure.

8. A low tenure ratio offers a larger number of appointments at the entry level, but fewer appointments to tenured positions.

9. A faculty can be reduced in size over a period of years without major disruption of the appointment and promotion procedure no matter what the tenure ratio is.

Campus Appearance Could Be Much Improved. When I have visited British universities, I have always been impressed by the quality of the grounds care, by the luxurious lawns with neat edges, by the well-tended flower gardens, and by the richness of the plantings. We, on the other hand, with one of the most magnificent campus sites in the world, live with ragged lawns, with mud paths nearly everywhere we look, with trees and lamp posts plastered with posters and notices and, worst of all, with buildings and walls spray-painted with the slogan of the moment. Fortunately, painted slogans have nearly disappeared from the campus. The other features are still with us in abundance, however. We had the misfortune to lose the spectacular elm trees which characterized the campus, but we can recover from that misfortune and we have a good tree program under way.

Our task is to find a means for supporting more extensive grounds care and for promoting pride in campus appearance. Both problems appear large to me. There seems to be no way to undertake more extensive grounds care either by our own work force or by an outside contractor at a cost of less than $10 per worker per hour. This is a combination of direct labor cost and associated overhead costs, and these costs appear to be about the same for all the contractors in town. Some alumni have contributed funds for campus grounds maintenance and there is, I think, potential interest in substantial grounds endowment. This interest should be encouraged.

I do not know how to encourage pride in campus appearance. Sometimes I think that I am the only one who cares. I have watched people take short cuts along a muddy path in places where no more than ten steps could be saved by the short cut. The attachment for mud is with us and must be dealt on realistic terms.

When I became dean of the College of Engineering, the new quadrangle was taking shape and the mud paths were establishing themselves across the newly seeded lawns. I was determined to stop these practices, and with the superintendent of grounds, devised planting arrangements and simple fences of painted link chain on painted iron posts that proved successful in channeling the traffic. I wanted to use bushes with thorns, but the channeling was achieved with yews. We had already laid out a system of criss-crossing paved sidewalks that seemed to me adequate to handle the traffic. We succeeded in restoring the appearance of this particular end of the campus to a considerable degree. Unfortunately, the cost had to be borne by funds available to me as dean of the College, funds which otherwise could have gone into the academic program.

Measures similar to these have been undertaken in other parts of the campus, sometimes successfully, sometimes not. Narrow curbside walkways in places of heavy pedestrian traffic because of parked automobiles have been successful. There are, of course, many other ways to enforce a degree of discipline on campus pedestrian traffic if funds are available.

I do not know what to do about the posters and notices on trees and lamp posts, other than to conduct a vigorous public relations campaign to stop the practice. We formerly had a policy prohibiting all such posters, and for many years succeeded in curbing the practice simply by having the grounds force remove every notice that appeared. The practice has now outrun all capacity to cope with it by the removal process. I can suggest a publicity campaign, with photographs of workmen removing the notices and scrubbing the posts to remove the glue, and with a prominent display of the cost translated into student financial aid equivalency.
suggest doing the same thing with every spray-painted slogan that must be sandblasted off buildings and walls. I also recommend to the University Hearing Board that spray-painting buildings is a serious offense and anyone apprehended in such an endeavor should be treated accordingly. Let us make the most of our splendid physical setting.

**Whatever Happened to Confidence? to Trust? to Faith?** An attitude I have observed for a long time in some people associated with Cornell is a paranoia, a belief that things are not so good here, a feeling that Cornell used to be better than it is now and that others know how to do it better. There is an apparent feeling of inferiority, a reluctance to take pride in Cornell. I have seen this attitude in some of the faculty for a long time—University A has a better salary scale in Department B than does Cornell. University C is getting better graduate students than is Cornell. Cornell has an unenlightened Board of Trustees. University D has an administration which does not milk as much unjustified overhead reimbursement from sponsored research contracts as does Cornell's administration. Why is there not more confidence in one's university and in one's associates?

There is also an excessive chauvinism in some colleges at Cornell, an attitude that the work being done in other colleges within the University is not the kind of work that Cornell should be doing. There is the feeling that the only really worthwhile research in the University is that which is being done in my college, and within my college the only really good work is that which is being done in my department.

During the period of the student unrest in the 60s and the early 70s, some of the students appeared to develop a lack of confidence and a lack of trust to a degree far exceeding any the faculty had shown. There seemed to be a sense of guilt, a belief that somehow Cornell was immoral in its approach to life generally and to the political and corporate world in particular. *The Cornell Daily Sun* displayed this attitude in epic proportion. If it was possible to conceive an interpretation of a fact that put Cornell in a bad light, *The Sun* exploited the possibility. If there was an opportunity to misinterpret a confidential document leaked to *The Sun*, the paper made the most of the opportunity. If it was possible to attribute base motives to almost anyone, *The Sun* was there with the attribution.

I want to tell you that it is not so. I want to tell you that things are good at Cornell. I want to tell you that compared to about 95 percent of the universities in this country, Cornell is a marvelous place. I want to tell you that those other universities are not, by and large, doing things better than Cornell does them. I want to tell you that the colleges at Cornell are concerned with legitimate and important parts of the human existence. I want to tell you that our students are as able as those in any university in this country—and that means in the world as well. Our Board of Trustees is deeply committed to the welfare of the University. I want to tell you that the University officials who negotiate the overhead rates are deeply committed to the interests of the research staff. I want to tell you that you should be proud of your university and that you should believe that it is doing many things better than most other institutions are doing them and that it is doing just about everything it does as well as others.

I make my judgment on an informed basis. I have been associated with a number of universities around the country, in one way or another, and during the past fourteen years I have been heavily involved in a variety of associations that include all American universities that are at all like us. These associations include the American Council on Education, the National Association of State Universities and Land Grant Colleges, The Association of American Universities, and the Association of Colleges and Universities of the State of New York. I have listened to those from other universities discuss the problems on their campuses, I have spent time on some of those campuses, and I have studied papers and documents dealing with the whole panoply of problems that has beset American universities during the past ten or fifteen years. I am convinced that Cornell has done as well as any and better than most.

I urge you all — trustees, faculty, students, alumni — to believe in yourselves and to act accordingly. Education is not going downhill at Cornell. It has as much vitality as I have seen at any time during my thirty-one years here. Cornell is going to have a rough time during the next fifteen years, but it has an excellent position to start from. Be confident. Have trust. Have faith.

**The Future of Student Trustees Is Clouded.** The Cornell Board of Trustees has included faculty members for as long as I have been at Cornell and I have applauded the practice. I believe that the arrangement was improved when provision was made for the University Faculty to elect its representatives directly instead of having the board elect from a slate nominated by the faculty. Student trustees were provided for only after the 1969 troubles, and I have mixed views on the student trustee policy.

Many of the student trustees have worked hard and have been dedicated completely to the welfare of the University. It has been difficult for some of the student board members to understand that they are trustees for the entire University and that they are not there to represent just the student constituency. My own effort to explain this to newly elected students has met with indifferent success. It will be important to continue the practice of providing an orientation session to explain the role and responsibilities that go with trusteeship.

Some of the students have brought points of view to the board which the board would not have heard without their presence. Student trustees have sometimes been able to articulate a carefully thought-out point of view in a manner that all the trustees could emulate with profit. Student trustees have sometimes dominated discussion at board meetings.

My major concern is the board's inability to keep anything confidential when student trustees are present. There are problems which must be discussed in complete confidence. With the diversity represented on Cornell's Board of Trustees, there are bound to be conflicting views. It is vital for the continued loyalty of the individual board members and it is vital for the intelligent evolution of
policy that these points of view have free expression. If board members know that what they have said in confidence is going to be made public, they will no longer express their views openly and freely. We will all be the poorer as a result. There are also business matters where failure to maintain confidentiality can cost the University large amounts of money. There are matters where the administration must go to the board for help in assessing the possible implications of particular courses of action, implications which only the board can help clarify. When these discussions are made public, the weighing-of-alternatives nature of the discussion is lost and views and motives never intended to represent final views by any of the participants in the discussion are made to appear as flawed judgments. At the end, I was much more cautious in discussing controversial and undecided matters with the board than I was in the beginning.

I believe that the board must take the breaches of confidentiality seriously. The first step I would suggest is a more complete briefing session for new student trustees at the beginning of their terms. Some of the leadership (chairman, vice chairman, chairman of the Executive Committee, and vice chairman of the Executive Committee) and some of the faculty trustees should participate in these orientation sessions. If the breaches of confidentiality continue after a concerted effort to curb the practice, my reluctant recommendation is to revise the charter and by-laws of the University to remove the provision for student trustees. It is a drastic remedy and the board would lose a group of trustees that has contributed substantially over the past seven years. The board cannot properly do its business, however, unless everyone can speak freely with final positions arrived at after complete exchange of views. Confidentiality is essential to this end.

Some University Business Must Be Conducted in Confidence. The populism that has evolved in the country during the past decade has brought with it a demand for openness, the abandonment of confidentiality, and a requirement that any business that concerns the welfare of others be conducted in an open forum. There is good reason for such a thrust. After the disclosures of Watergate and the exposure of the excesses of the federal intelligence community, how can anyone trust anyone else in a position of authority? Unfortunately, this distrust extends to universities.

In many states there are “sunshine laws” which require that all business of boards of trustees or boards of regents be conducted in open session. At Cornell, meetings of the University Faculty are more or less routinely open to the public. There will be demands for still more openness and there will probably be even more widely applicable laws requiring open decision-making.

It is hard to find legitimate fault with this trend in American life, given our experience of the past decade or two. There are troubles, however, that limit the effectiveness of the practice. There are legitimate pieces of business that must be conducted in confidence until the decision is arrived at and the appropriate time for public announcement has arrived.

In the university world, one place where there has been insistent demand for public disclosure before any final decision is in the selection of senior university officials. In my view complete confidence is essential, although adequate provision should be made for mechanisms to bring to bear the views of those important to final decision. It is essential for one good reason: to get the best possible nominee for the job. In most cases the best possible nominee is someone who is already in a good position and who is not seeking a new job. He must be sought out and persuaded that the opportunities with us are better than the opportunities that he has where he is. He may be willing to look at our situation to see if, in fact, the opportunities are better. The last thing in the world, however, that he wants to do is to give his present employer the idea that he is dissatisfied. In such a situation the only way a potential nominee will even look at our opportunity is if we provide complete confidentiality in the proceedings. I have seen examples of university presidential searches in which I was convinced that the searching university came out on the short end of the deal through the withdrawal of the best candidates after the list of potential nominees had been made public.

There are other situations in which a person in a position of authority and responsibility needs to discuss the ins and outs of possible decisions with those most heavily involved with their implementation. There is the need to walk all around the problem to understand the problem fully and to try to assess the implications of possible courses of action. These possible implications need to be discussed with those who have a background of use in arriving at a final position. In arriving at a decision, there is need to winnow what is conjecture from that which is likely fact, and from that which is known fact. When any piece of this process is leaked to the public, often with distorted interpretation, the final decision is more likely to be flawed. Perhaps, more importantly, the next problem will not be attacked in as healthy a manner. The cards will be played closer to the vest. The public, which seeks to benefit from increased openness, may well be the loser.

I believe that openness about final decisions, with public disclosure as prompt as circumstances permit, is entirely appropriate and proper. But confidentiality in elements of the process is vital. Those who make decisions must be accountable for the final decisions. If the decisions are, on the whole, good ones, the decision-makers will be supported. If they are bad decisions, those responsible are likely to be seeking new employment.

I Am Concerned about Intercollegiate Athletics. Intercollegiate athletics in the United States are out of hand. They are ruled by two considerations: television and money. In football and basketball, the colleges and universities often appear little more than recruiting grounds for the pros, and education seems incidental. Television receipts are the means to building the new basketball arena or the new addition to the already over-sized football stadium. During the past two years, there has been concerted action by some fifty or sixty of the major football schools in the country to create a new subdivision of Division I (the major university division) of the National Collegiate Athletic Association, with membership rules that would squeeze out all but the big-time athletic schools.
The sole purpose, as I read the proposals, is to guarantee that all the T.V. receipts flow to the big-time schools. The Ivy Group schools average, through group incoming sharing, about $100,000 each in annual football T.V. revenues.

The new legislation was approved at the January 1978 NCAA annual meeting in Atlanta, but with an amendment, sponsored by the Ivy Group and Colgate and adopted by a narrow margin, which salvaged Ivy Group participation.

The adopted legislation provides for a new Division I-A with the following eligibility requirements: (1) sponsors at least eight men's varsity sports, including football, at the highest competitive level; (2) schedules at least 60 percent of its football games against other Division I-A teams; (3) averages more than 17,000 in paid attendance at all home football games in the preceding four years; (4) has a home stadium with at least 30,000 permanent seats and average at least 17,000 spectators at home games during one of the preceding four years; or (5) sponsors twelve men's varsity sports and schedules at least 60 percent of its football games against other Division I-A teams.

The alternative stated in condition (5) is the Ivy amendment to the original proposal. Without the amendment, only three of the eight Ivy schools would have qualified. With the amendment, all but Columbia qualify. We are "in" for the time being, but the trend is all downhill as far as I am concerned.

In my opinion, only the Ivy Group and Division II and Division III leagues have athletic programs appropriate to an educational institution. The Southeast Conference, the Southwest Conference, the Big Ten, the Big Eight, The Western Athletic Conference, and the Pacific Eight (about to be Ten) all appear to exist only for football and basketball.

I attended Ohio State one year as a graduate student and a couple of years ago I returned to that campus for a seminar on higher education administration. I still have one or two friends in the Physics Department and I called on them. The president of the university is a friend and I spent an evening with him and his wife. I had not talked to the faculty in the Department of Education, to my physics friends, or to the president more than ten minutes in each case before the subject of Ohio State football and Woody Hayes, the football coach, entered the conversation, such is the impact of football at Ohio State. The climax came when I entered a campus book store, a book store run under university auspices. The first thing I saw, and the first thing anyone else would see, was a three-foot-high photograph of Archie Griffin on the football field, this in a university-owned bookstore, mind you. I have experienced similar phenomena on other campuses.

I heartily subscribe to the Ivy Group principles and to the Cornell program and I would be content to go our own way and forget the Ohio States if it were possible to do so without interference, but it isn’t.

The recent NCAA action is evidence that we cannot "go it alone" in the Ivy Group. We have had difficulty maintaining our own standards for many years. During my period of involvement, one of the issues was the so-called 1.6 rule. This NCAA rule required that a freshman have a "predicted average" of 1.6 (about a C-) before he could be admitted to a college with the expectation of participation on an intercollegiate athletic team. The standard was entirely inappropriate for the Ivy Group. Our general attitude was that "our 1.6 students are as good as many of your 4.0 students." This type of argument, made as rationally as we could, has given the Ivy Group the reputation for arrogance and has seemed to motivate the NCAA to vindictiveness. An example was the Cornell probation in hockey after the father of an alumnus took two secondary school hockey players at his expense to the NCAA tournament in Boston without the prior knowledge of anyone at Cornell. The two students were not otherwise recruited by us and they never applied to Cornell for admission.

The Ivy Group has run afoul of NCAA regulations in several areas, including financial aid to athletes. Since we award on the basis of need, we have cases in which in particular sports the number of athletes receiving some degree of financial aid may exceed the number allowed by NCAA rules. This seems impossible in circumstances where NCAA rules have permitted 105 football scholarships (tuition, fees, board, room, and personal allowance) at any given school at any one time. Our troubles have come in other sports where NCAA standards are more restrictive.

So far, the Ivy Group has maintained an uneasy truce with the NCAA. I do not know if it can be continued indefinitely. I hope it can. The penalty for failure is ouster from the NCAA with consequent loss of any opportunity for participation in the national championship competitions. We have done well in the past decade in the "minor" sports, and to lose the opportunity for such competition would be unfortunate.

We pay another price for resisting "big time" athletics. The financial attractiveness of athletic scholarships in the "big time" schools makes it difficult for the Ivy Group to recruit outstanding scholar-athletes. After all, the education is not bad at Michigan or California or Stanford and the pay is much better. In such circumstances it is hard for us to maintain a high level of competition compared to the "big time" schools.

At Cornell my only requirement is that athletics be administered in the same way the other parts of the University are administered. This means that athletics must operate with the same financial standards that are applied to academic programs. Athletics must also be administered by the administration, not by the trustees and alumni.
On the national level there is a faint glimmer of reform, but it is no more than a glimmer. At educational association meetings the last few years there have been more and more voices raised opposing current practices. The American Council on Education has a major study of intercollegiate athletics under way. It will undoubtedly illuminate the scene, but I am pessimistic about significant reform. The television dollar is a powerful force to overcome.

I urge you to support reform, to support Ivy Group standards in the face of NCAA pressure, and to resist any temptation to go “big time.”

**Cornell Must Conquer Its Tenth-Place Syndrome.** Cornell has some truly preeminent programs, but it should and can have more. We suffer from what Professor Jack Oliver in geology has described as the “tenth-place syndrome.” We have been too willing to accept and applaud tenth-place ratings. Professor Oliver asserts, and I agree with him, that we could achieve more if we aspired to more and if we tried harder.

Achieving preeminent status in any field is not easy at any time and it is particularly difficult now that the period of growth is over. We cannot achieve preeminence without giving up something. There is no longer the money available simply to add more to what we are doing now. If we are to add something, we must take away something to make it possible.

The best example I know of a department that deliberately set about improving its own stature is Chemistry. Over a period of many years, the department elected to use the money available to it to improve faculty salaries rather than to add to the size of the faculty. As a consequence, the size of the department faculty remained relatively small while other departments grew, but the salary scale has remained high and the department has been able to compete for the best young chemists in the country. Because the department deliberately limited its size, the teaching loads have become relatively heavy as the number of students has increased. This is the price the department has paid for its policy.

Another feature of the Chemistry policy has been high promotion standards. Only those with outstanding qualifications have been promoted and awarded tenure. The department now has more members in the National Academy of Sciences than any other department in the University.

Teaching quality has not suffered in this operation. The department members have paid a great deal of attention to teaching, and they are among the best teachers in the University. They have produced some of the most widely used textbooks in the country and have designed undergraduate laboratory arrangements that have been widely copied in other colleges and universities.

Chemistry is an example of what has to be done if a department is to move from eminence to preeminence. The faculty of the department must have a will to make the move. They must be willing to limit the size of their department so that whatever money is available can be used to upgrade the department, not to increase its size. This inevitably means heavier teaching loads, but it is the only way.

The Chemistry example demonstrates another factor necessary to any such development. The department must have the capacity to help raise funds for its own upgrading. Without the Spencer T. Olin research wing to the chemistry building and without the improvement of the teaching space in the Baker Laboratory, the upgrading effort would have fallen short. Not only must the department participate in the fund-raising essential to the upgrading, but the administration and the board must support the effort. Since the administration and the board cannot attempt many such upgrading efforts at one time, they must be selective in what they choose to support. Once the potential of a department has been demonstrated and the commitment has been made, the department deserves all the help it can be given.

Biology and geology are other areas with histories that, to a considerable degree, parallel that of chemistry. Given an already good operation and given a determination to move to a position of preeminence, the administration and the board can help achieve more success stories.

One final comment on eminence vs. preeminence: the difference between the two is vast. To quote Philip Handler, president of the National Academy of Sciences, “In science, the best is vastly more important than the next best.” It is true in other fields as well.

Let’s think hard about how we use our resources to move into positions of preeminence wherever there is a real possibility.

To paraphrase an example I have used before, a fifteen-foot pole vaulter will win many competitions. Two fifteen-foot pole vaulters will win still more competitions, but no matter how many fifteen-foot pole vaulters there are on the team, they will never achieve greatness — they will never clear the bar at eighteen feet. Only an eighteen-foot pole vaulter can clear the bar at eighteen feet.

**Senior Administrators Need Sabbatic Leaves.** Senior administrative officers of the University need sabbatic leaves fully as much as members of the faculty do. The fundamental purpose of a sabbatical leave is “to increase the value of the individual’s future service to the university.” There are many ways this can be done. One way is to associate with another institution where different points of view and different techniques prevail so that one’s outlook on subjects of interest can be broadened. Another way is to go somewhere in a sequestered situation where one can organize one’s thoughts, and codify what has been developing in one’s mind, and where one can put on paper thoughts on a particular subject. It is always the author who learns the most in such an exercise, incidentally.
A third way in which one's future value can be enhanced is simply to get away from the routine for a time to take stock and to watch someone else's routine. All these virtues of a sabbatic leave are as applicable to an administrator as they are to a faculty member.

I speak with authority on this subject. In my more than thirty-one years at Cornell I have had a single, one-semester sabbatic leave— in 1954. I have watched faculty members return with greatly increased productivity after they have been away for a period. I have also watched administrators, myself included, continue year after year with no renewal and with no real opportunity to develop new ideas or to have imaginations stimulated. Stagnation is difficult to avoid when one never has an opportunity to remove oneself from continuous crisis, to get away from the sixty-hour (or the seventy-hour or the eighty-hour) weeks long enough to get some perspective.

I am convinced that it is impossible for a senior administrative officer to organize effective and efficient administrative systems and procedures when there is no time to ask: “What are we not doing that we should be doing?” Or: “How do other institutions attack particular problems?” Or: “What should I be doing to be sure that there is always a well-trained replacement ready to step into the shoes of every one of my key subordinates should the need arise?” Just to think of questions such as these, to say nothing of answering them, requires an opportunity for reflection and analysis. That opportunity is seldom available to anyone in any senior administrative post in the course of routine daily work.

Universities do not usually grant such leaves, although a few do. Rochester has done it; so has Yale. Both institutions have granted leaves in recent years to their presidents. SUNY granted such a leave to its chancellor. The president at one of the SUNY campuses spent a year on our campus.

The “tired administrator’s grant” I had from the Danforth Foundation in the summer of 1971 had a significant impact on my effectiveness in the succeeding years. That leave was for only ten weeks. I combined three activities during that period: 1) participation in a conference with a group of United States presidents and British vice chancellors discussing common problems, 2) travel in a part of the world where I had never been before and which did a great deal to get my own problems in perspective, and 3) relaxed reflection on my own problems at home.

Granting such leaves will be expensive, just as granting faculty leaves is expensive. As with faculty leaves, the increased productivity will far outweigh the cost. A system of administrator leaves must be planned and implemented formally. It cannot be left to happen without formal action to create the system. Adequate backup for those on leave must be provided, just as backup is provided for the faculty members on leave. Funds must be provided, just as they are for faculty leaves. You may ask: “Can we afford it?” I say: “You cannot afford not to do it.” Neither the frequency nor the length of the leaves need be rigidly specified. The fact of the leaves does need to be specified.

The testimony of one who has been in full-time senior administrative positions for eighteen and a half years with only one ten-week leave must be taken seriously. Cornell is as complex an institution to administer as any I know. The constituencies the Cornell administration must serve are more difficult than those in any other institution I know. We are moving into an era which, in its way, will be as difficult as any we have known. The spirit of the administrators must be kept high. We must not allow this spirit to be beaten into the ground. Please listen to me.

I Violated the Terms of My Employment Agreement. When I was elected president, the board suggested, and I agreed, that I should not undertake any outside consulting or other non-Cornell or non-higher-education-related assignments. The board agreed that I might continue as a director of the Tompkins County Trust Company, a position I had already held for a few years. I discontinued all other outside consulting and I declined all invitations to join corporate boards.

I followed the board’s wishes completely with one exception. I once undertook a consulting assignment which grew out of my banking knowledge (should I say: modest banking knowledge?). I accomplished this assignment one evening between 9:00 p.m. and midnight and the product of that assignment is included here.

Such an agreement limiting outside activities is not necessarily wise, either for the president of the University or for the University. I recommend that you not attempt to limit any future president in his activities unrelated to the University. Twenty-four hours a day, seven days a week of concentration on the problems of Cornell and the problems of higher education can be a debilitating experience. It is my opinion that a degree of participation in activities unrelated to the University or to higher education can be good both for the president of the University and for the University itself.
MEMORANDUM

TO: Dale R. Corson

FROM: Dale R. Corson

SUBJECT: Friendly, Generous Bankers and Interest Rates

Your friendly, neighborhood banker is a man who is willing to take your money, protect it for you, and even pay you interest for the privilege of having your money and using it for his own purposes while he is protecting it. These days a banker could not be called friendly unless he paid compound interest — i.e., he pays you interest on the principal this year and next year he pays you interest not only on the principal, but he also pays you in the second year interest on the first year's interest, if you leave it all on deposit with him, etc.

For example, suppose he agrees to pay you 4% compounded interest on $1.00 left on deposit with him. At the end of the first year, you have a sum of money $S_1$:

$$ S_1 = 1.04 $$

At the end of the second year, you have a sum $S_2$:

$$ S_2 = 1.04 + 0.04(1.04) = 1.0816 $$

At the end of the third year, you have a sum $S_3$:

$$ S_3 = 1.04 + 0.04(1.04) + 0.04[1.04 + 0.04(1.04)] = 1.1249 $$

The process can be continued for any number of years, but the calculation becomes tedious. However, the series can be “summed,” as the mathematicians say, so that at the end of “n” years, the sum $S_n$ is:

$$ S_n = (1.04)^n $$

That is, $S_n$ is simply 1.04 multiplied by itself the number of times represented by the number of years involved.

Compounding leads to some interesting numbers. Suppose, for example, my father had deposited $1 for me at a 4% compound interest rate at my birth. When I retire at age 65, I would have $12.80. Not bad! If he had been lucky enough to find someone who would have paid 10%, I would have $490.37. Not bad at all! If he had deposited $1,000 at this rate, I would be quite happy now. I might even be willing to forego some of the supposed pleasures I derive from my daily work and go fishing instead.

Let us now suppose that the friendly neighborhood banker is also generous and is willing to compound interest on a semi-annual basis. This means that he pays interest during the second half of the year, not only on the principal, but also on the interest earned during the first half. At a 4% semi-annually compounded rate, at the end of the first six months, you have with your $1 deposit:

$$ S_1 = 1.02 $$

and at the end of the year:

$$ S_2 = 1.02 + 0.02(1.02) = 1.0404 $$

or slightly more than you would have at the end of the first year with annual compounding. Again the “summing” can be done simply, at the end of “n” years, the sum is:

$$ S_n = \left(1 + \frac{0.04}{2}\right)^n $$

That is, it is one plus half the “annual” interest rate, all multiplied by itself 2n times.

If your friendly and even more generous banker will compound quarterly, you will have at the end of n years:

$$ S_n = \left(1 + \frac{0.04}{4}\right)^n $$

Let us now go back to my $1 deposited at birth and compounded semi-annually: at age 65 I would have $13.12, or with quarterly compounding $13.29. With my father’s lucky opportunity with a 10% rate compounded quarterly, I would have $614.05 — quite a difference. And what if $1,000 had been deposited originally?

So, by compounding more frequently, your friendly banker is really quite generous. Suppose he is willing to compound daily — i.e., pay interest tomorrow on the interest earned today. With the 4% rate at the end of “n” years, you have:

$$ S_n = \left(1 + \frac{0.04}{365}\right)^n $$

or, in my 65-year example, $13.46 at a 4% rate. At a 10% rate, compounded daily for 65 years, I would have $664.56.

To sum up, with $1 on deposit for 65 years, I have:
So, your banker is both friendly and generous if he compounds interest frequently. Suppose he were to compound every hour, or every second. Looking at the numbers above, it is reasonable to believe that if he were to compound every second, you might get rich in a hurry – after all, there are 31,536,000 seconds in a year – or would you?

To see what is involved, let us suppose that your banker is really generous and pays 100% interest. For annual compounding, you have at the end of the first year:

\[ S_1 = 1 + 1 = 2 \]

If he compounds semi-annually, you have at the end of one year:

\[ S_1 = \left(1 + \frac{1}{2}\right)^2 = 2.25 \]

For quarterly compounding:

\[ S_1 = \left(1 + \frac{1}{4}\right)^4 = 2.44 \]

For daily compounding:

\[ S_1 = \left(1 + \frac{1}{365}\right)^{365} = 2.71 \]

It appears that you are making money rapidly by more frequent compounding, so let’s try every second:

\[ S_1 = \left(1 + \frac{1}{31,536,000}\right)^{31,536,000} = 2.718 \]

Surprise! Going from daily compounding to compounding every second gains you only a fraction of a cent, even at 100% interest rate.

If you are a mathematician, you immediately recognize the quantity \( S_1 \), in the limit when the number of compounding periods increases without limit (i.e., “continuous compounding”) as the number “\( e \)”, the base of natural logarithms with value 2.71828. Thus “continuous” compounding at 100% interest rate yields this annual total – barely different from daily compounding.

To come back to the real banking world, say with a 5% interest rate, the “effective” rate is:

<table>
<thead>
<tr>
<th>Compounding</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>annual</td>
<td>5.000%</td>
</tr>
<tr>
<td>semi-annual</td>
<td>5.0625</td>
</tr>
<tr>
<td>quarterly</td>
<td>5.0945</td>
</tr>
<tr>
<td>daily</td>
<td>5.1267</td>
</tr>
<tr>
<td>continuous</td>
<td>5.1271</td>
</tr>
</tbody>
</table>

The mathematician recognizes the “continuous” compounding equation (say in the example for each second compounding) for 5%:

\[ S = \left(1 + \frac{0.05}{31,536,000}\right)^{31,536,000} \]

as simply:

\[ S = e^{0.05} = 1.051271 \]

For a concrete example, take a $10,000 deposit with a 5% rate:

- daily compounding annual interest = $512.67
- continuous compounding annual interest = 512.71

Continuous compounding yields a 4¢ advantage — only half enough to pay the postage to mail in the letter asking to have the account transferred to the continuous compounding bank!

Moral: Your banker may still be friendly and compound your interest continuously, but he is certainly not generous. If he wants to be generous, let him pay 10% interest and compound it any old way he wants.
APPENDIX A

The Government, the Universities, and Research
A Report on a Conversation Among University Presidents

December 1977

Preface

The relations between the needs of the nation and the responsibilities of organized education are massive and complex. The report we present here is the result of an effort by one group of educators to address a relatively small but crucial part of those relations: the places where the national interest and the consequent responsibilities of the federal government intersect with the special capabilities of the nation’s major research universities.

This report results from a series of meetings of the presidents of fifteen major universities. Sharing our belief that the general question of relations between the federal government and the major research universities is important, several private foundations helpfully sponsored four working sessions at which we could address these problems. Our small group of individuals cannot claim to speak for a constituency as large as the research universities of America, but together we do have knowledge of large and small institutions, public and private ones, and a broad range of specific relations with the government.

The greatest single danger before the world of education, in its relations with government, is that it may divide against itself—public against private institutions, universities against colleges, higher education against the schools. So we should begin by declaring our determined opposition to such conflict. In the long run the world of education is deeply interdependent; its parts cannot prosper at one another’s expense. As presidents of research universities, we are responsible for undergraduate colleges, and we have our full share of concern also for the health and strength of the country’s schools. In other forums and in other ways, we all try to help the cause of education as a whole.

We do not think it inconsistent with this general interest that we should here address a set of issues that is more specialized. We would hope to have this report and its arguments measured in terms of the welfare of the educational enterprise as a whole. There can be no blinking the fact that we are believers in a renewed and stronger partnership between the government and the major research universities and that, because of the inescapable financial realities of the situation, we believe a modest increase in federal funds must be part of that renewal. Our arguments do serve some of the needs of our own kinds of institutions and of the people who work in them. But if they do not also serve the general needs of education, they should not prevail.

Indeed, we ask that these analyses be judged by a still harder and broader test: the interest of the nation as a whole. The case for federal action does not, in our judgment, rest on the fact that our institutions have certain needs—there are many such needs which no one of us would think appropriate for federal concern. The basic responsibility of our institutions for their own survival in freedom is one that we do not wish to transfer to the federal government.

* The foundations providing assistance were the Carnegie Corporation, the Ford Foundation, the Lilly Endowment, the Andrew W. Mellon Foundation, and the Alfred P. Sloan Foundation.
What we here address instead is a limited set of issues in which our free society, as a whole, has an interest that can be protected only by the partnership whose renewal we urge. It is the national interest, not ours, that should determine the matter.

We believe that the general arguments here developed are largely in step with the thinking of our colleagues and friends in other research universities. Much of what we understand of these matters has been learned from such colleagues, as well as from scholars and administrators in our own institutions. We also are certain, however, that the analyses here offered can be refined, extended, and generally improved by the comments and criticism of others, which we invite, as indeed we invite help from everyone who shares our belief that these matters are important.

But we do not wish to end with disclaimers, however justified. We believe deeply that the issues here addressed really are of major importance to the future quality of American life. We do not apologize for raising them; we would be false to our own deepest obligations if we did not seek to have these issues and our response to them presented as clearly and persuasively as we can.

Derek C. Bok - Harvard University
William G. Bowen - Princeton University
Kingman Brewster - Yale University*
Robert Christy - (Acting President) California Institute of Technology
John E. Corbally - University of Illinois
Dale R. Corson - Cornell University*
Robben W. Fleming - University of Michigan
William C. Friday - University of North Carolina
Richard W. Lyman - Stanford University
C. Peter Magrath - University of Minnesota
William J. McGill - Columbia University
David Saxon - University of California
John C. Weaver - University of Wisconsin*
Jerome B. Wiesner - Massachusetts Institute of Technology
John T. Wilson - University of Chicago

*left the presidency in 1977
APPENDIX B
The Government, the Universities, and Research
A Report on a Conversation Among University Presidents

An Overview

The Federal Government and the Major Research University: Indispensable Partnership for Excellence

This report is an argument for a reassessment of one of the most complex and important of all the relations that mark our pluralistic open society: the connection between the major research universities and the federal government in furthering advanced learning of high quality. That relationship has been extraordinarily productive. It has no close parallel elsewhere in the world. It has been less effective in the last eight or ten years than in the twenty-five before. And it faces new tests that are the consequence of the continuing explosion both in knowledge itself and in what is now required for new progress in science and other kinds of scholarship.

Our report is not an essay on the financial plight of the academy, although the general financial stress in colleges and universities is relevant to our theme. Nor is it a study of higher education in its undergraduate phase. That subject also has close connections with federal policy, and nothing argued here should be interpreted as hostile to the national effort to open the whole of our diverse world of undergraduate colleges to all who can and will learn there. The undergraduate college, whether or not it is part of a university, is the necessary source of talent for the higher learning, as for other professions. Finally, this is not an essay on the administrative relations between government and the universities, although that too is an important and complex topic. Our concern here is with a subject both broader and sharper than any of these—a national need for excellence in higher learning which simply cannot be met without a renewed and stronger partnership between our major research universities and the federal government.

* * *

Our basic premise is that one of the decisive elements in the quality of any society is the level it is able to reach and sustain in the quality of its research and scholarship. First-rate scholarship alone does not assure the future of human dignity; the example of pre-Hitler Germany is proof. But what is insufficient is still indispensable, and certainly the American university tradition of excellence combined with freedom is one important strand in the more general freedom of our society as a whole. If the amount of first-rate research and scholarship achieved in American society should decline — as it is in danger of doing today — the next generation of Americans will be poorer in spirit, and also in pocketbook.

While this prediction seems to us inescapable, we do not think it easy to prove, nor do we suppose that all research is quickly profitable. It is not clearly and empirically demonstrable that every research laboratory enhances the quality of life or that every great library ensures the survival of freedom. Yet specific examples exist in abundance. We know that without modern biochemistry the practicing physician would be less able to help the sick, and we know that modern biochemistry rests on the imaginative basic research of a few of the best minds of the last two generations. We can demonstrate that the new patents of each decade of our increasingly technological society have their roots in basic research done years before. We can also point to a complex and constructive set of connections between, on the one hand, university work on China and Russia and, on the other, our ability to cope with these societies in our foreign relations.

First-rate work in any field of human action is rare and difficult, but nowhere is the quality of work more plainly decisive than in higher learning and research. It is hard to tell in advance who will do first-class scholarly and scientific work. Sometimes such work is recognized only slowly. Moreover, when a problem is extraordinarily resistant, even first-class work can fail. But none of these
qualifications detracts from the force of the proposition that it is quality that counts. In the simple words of Philip Handler, president of the National Academy of Sciences, “In science, the best is vastly more important than the next best.”

To accept that test is in no sense to abandon a democratic concern with the rights of all — and especially concern for equality of opportunity in the pursuit of first-class learning. It is nonsense to suppose a conflict between democratic values and extraordinary achievement. It is in the very nature of scholarly excellence that it accepts the test of free competition in ideas. As long as opportunity is open, achievement in higher learning is as consistent with democratic principles as any other form of excellence. From the days of Ben Franklin to the latest announcement of Nobel Prizes, democratic Americans have honored such excellence.

At the same time that it is rare and difficult, which has always been true, first-class research in all fields in the last two generations has become steadily and rapidly larger in scope, deeper in necessary specialization, and enormously more expensive. As little as fifty years ago it was still possible for a great physicist to know nearly all of physics and for his work, even if it was experimental and wide-ranging, to be supported by the very limited research funds available in the universities and research institutes of the day. The foundation of modern physics was laid in that generation, here and abroad, by scientists whose most expensive equipment had a cost less than one-tenth of one percent of what is required today to build a single particle accelerator. What is true of physics is true also, in different ways, of nearly every field of higher learning. The expanding universe of knowledge and investigation has brought with it an inescapable connection between first-rate equipment and first-rate results. There are still great investigators whose only immediate material requirements are pencil and paper, but even these scholars usually require access to complex special libraries, facilities that again are vastly more expensive than their counterparts of fifty years ago.

Over most of the years after World War II, the United States benefited from an extraordinary expansion in the quantity and quality of its scholarship and research. As we show later in this report, this expansion brought new levels of expense for all concerned, but the most dramatic expansion of all was a twenty-five-fold increase, in constant dollars, in the level of federal support for basic scientific research. The same period saw at least a tenfold increase, mostly without federal support, in the annual budgets of the fifty-eight largest libraries in the country.

Since 1968, in constant dollars, there has been a slowdown in the support of all research and scholarship—and in basic scientific research even a reduction of spending—with grave consequences to which we shall return. Meanwhile, the irreversible explosion in the cost of excellence continues. While no one can claim that every research dollar is well spent, the general austerity of today’s academy exerts a constant downward pressure on all costs, which gives at least modest assurance that, in the main, expansions in the cost of higher learning reflect only what is necessary for excellence. Even in the easiest days of academic expansion, even the richest of our universities faced hard choices imposed by the enormous distance between what the best scholars could profitably use and what society had given them. Comparatively speaking, in the years from 1955 to 1965, the great universities had financial support for the research carried out by their faculties at a level never reached before or since, but in absolute terms, even then, their budgets fell far short of what was needed to make the most of their abilities.

What makes it right to argue these matters mainly from the example of the major research universities is that these institutions have been and still are the determining sources of excellence in American science and scholarship. Quantitatively, their share in the nation’s research is large but not overwhelming. The forty universities with the largest expenditure for basic scientific research in 1974 accounted for just under a third of the total national effort, and all colleges and universities taken together spent only 54 percent of the total. But more important than this measure of the amount of research conducted is another: the major research universities are the dominant source of the investigators of each generation. More than 99 percent of these scholars and scientists get their advanced training, after college, in the doctoral programs of the nation, and most of the best doctoral programs (although not all) are to be found in the forty or fifty leading research universities.

Still more important in determining the sources of excellence is the qualitative test. There can be little doubt, from the very nature of the behavior of outstanding students and investigators, that excellence attracts excellence. Great libraries and laboratories are magnets with high drawing power of their own, but more important still are the great men and women. Fortunately for the nation, and for themselves too, the truly great scientists and scholars are not all in one place, or in ten. No one institution is as nearly preeminent as Harvard or Chicago or California may have been at different times in the last fifty years. The set of universities that lead our higher learning is now truly national in number and location.

This set of institutions is the fountainhead of our first-class science and scholarship; in the United States more than in any other modern society, the quality and quantity of excellent advanced study are dependent on the quality and quantity of what is done in the major research universities. These institutions are at once the necessary center of nearly all doctoral training and the natural home of a great majority of the most distinguished research scholars of each generation.

The research university has three great advantages over the research institute that is the dominating force in the research and scholarship of some other countries, notably the Soviet Union. First, it creates an inescapable connection between research and advanced study, treating them both as parts of a united endeavor. There are always stresses between the claims of one undertaking and the other, but in its resolute and insistent concern for both, the best American university tradition has a value that is almost unique in the world.
A second great advantage of our university pattern is that it permits escape from the cabin of narrow dedication to a single established discipline. We cannot claim that most university people do in fact make the most of their opportunities to work with colleagues who use other skills and ways of thought. But in most of our major universities, at least the opportunities exist for the natural scientists, the social scientists, and the humanists to talk to one another, and although many departments and individuals sternly resist “contamination” from exposure to the ideas of those outside their traditional intellectual borders, there are others whose horizons are continuously widened by living in the presence of many kinds of learning. As the government has a growing interest in all forms of higher learning (even though it is, correctly, relatively cautious in its relations to social and humane studies), it shares with the universities the good and important belief that no branch of learning should habitually claim to do better alone.

The third great asset of the American research university is its variety. No two universities are the same. Among them they have made room for both pure and applied science, for both the traditional and the novel, for both cooperation with and criticism of the government, for both the long view and the immediate issue, for research and for teaching, for technology and for art.

In the last ten years an unusual confluence of events has tested the resilience of our major universities with a severity not matched since the Great Depression. A time of social and political trouble, magnified though not created by the Vietnam War, has been followed by a time of economic trouble, intensified though not created by a federal government that has sometimes failed to understand the national value of basic scientific research and advanced academic training. Persistent inflation intensified by the oil crisis has hit hard at budgets already under stress. And perhaps more durable and deep-seated than any of these events has been the impact of a belated recognition that demographic change, bringing an end to annual increases in the number of our college-age youth, has drastically restricted the number of openings in prospect for those aiming for academic careers. After fifteen or twenty years in which there seemed to be a wide horizon of academic opportunity for almost every Ph.D., we are entering a decade as restricted, in quantitative terms, as any since the Depression.

In these hard years, many in the world of education have been ready to sing one or another of two songs: that the great universities (especially the private universities) are doomed in any event, or that their one salvation lies in a vast rescue operation by the federal government.

We hold neither view. The major research universities of the country will not die. They have come through periods of anxiety and austerity before now, and already most of them have moved energetically to meet the economic crisis of the last few years. The political turmoil and social anguish of the late sixties have faded away, and forecasts of permanent damage from that turmoil appear to have been much exaggerated. A cruel price in suffering and distraction from learning was paid by students and faculties in those years, but the experience of World War II suggests the possibility of recovery from even larger disruptions of ordinary academic life.

Nor do we believe that the major research universities can be saved only by the federal government. In defending their basic financial integrity, both public and private universities must look to all their many traditional sources of support, and they are doing so. It would be a grave mistake for them to lose the autonomy and diversity that they have gained over a century. Their growth has reflected the choices of large-scale private philanthropy, the commitments of state governments, the preferences of tuition-payers, and the affections of alumni, as well as more recent federal support.

The research universities thus come to the federal government not for their own survival, but to make it plain that central parts of their natural work have the following two characteristics:

1. They are of critical importance not just to the university world, but to the quality and even the security of American life.
2. Outside the federal government, there is no adequate source of supplemental support at the level they need today.

In later sections of this report we argue that these twin propositions now hold in at least four fields: basic scientific research, graduate education, research libraries, and international studies. Although leaving the detailed argument to those later sections, we would make it plain here that what is operating to create these critical needs for federal action is a set of forces at once historical, technical, and economic.

Some of these forces we have glimpsed already. In this age of continuing explosive expansion of the range of what we need to know, the costs of experimental equipment, of data collection, and of library service have also exploded far beyond the resources that have ever been available to major research universities from any source other than the federal government. In international studies, for example, it takes years of intense effort to produce even a junior specialist on China or Africa, and the total costs of the necessary time and materials for training, travel, and research make training in this field probably more expensive than that in any other in all

* In speaking thus of the world of the major research universities, we must not exclude or deprecate the importance of other institutions that have made extraordinary contributions. To cite only two: in science, the Carnegie Institution of Washington and, among research libraries, the New York Public Library (whose research collection is mainly a private achievement) are national assets whose claims to national support are closely parallel to those we make for university scholars and laboratories. Such independent institutions constitute another fruitful element in our higher learning. They too have a claim on national support.
the humanities and social sciences. No private source can meet such costs, and yet a strong supply of qualified specialists, in and out of government, is quite literally indispensable to the nation's safety in the increasingly interdependent world of the future.

In the basic sciences the need for federal action first became fully evident in World War II, and in that area the ups and downs of federal support have been increasingly decisive ever since. In the other three fields we have mentioned, the recognition of a critical federal role has come more recently and less plainly. Indeed, in one case, that of the research libraries, adequate recognition has not yet been given, and in consequence serious damage has already been suffered by what are in fact priceless assets of society as a whole.

So let us here take the case of basic scientific research as a brief model for our general argument. The most authoritative analyses of all forms of support for basic research are those of the National Science Board. Its description of the history and justifications of the dominant role of the federal government is definitive: “The Federal Government assumed prime responsibility for support of basic research after World War II. This policy recognized the decisive role played by scientific knowledge in the war effort, and sought to strengthen the Nation’s basic research capability for peacetime pursuits. Over the past 30 years, the policy has come to be predicated on the broad and varied role of basic research in advancing the country’s defense, economy, health, and technology, as well as upon its general cultural value, in education and in the intellectual life of the Nation.”

Under these guiding principles, federal support for basic scientific research, of all sorts in all institutions, had by 1968 reached an annual level of $2.3 billion and amounted to about 70 percent of all such support, with the rest of the money coming from industry, from colleges and universities themselves, and from other nonprofit institutions. It is no coincidence that in that same period American basic science became easily first in the world. Moreover, it was the habit, from World War II to the late sixties, for both the government and the scientific world to take public and justified pride in their enormously productive partnership.

Unfortunately, since 1968 the situation has been different. The simplest and most powerful change is in the decline of federal support for basic research. Inflation and other forces reduced support from all sources at one time or another in this period, but support from the federal government declined first and most, while that from colleges and universities declined last and least. By 1976 federal support for basic research, measured in constant dollars, had declined by almost 15 percent, although there was an encouraging upturn in fiscal 1977 which is projected to continue into fiscal 1978.

Nor has the damage been merely economic. In constantly increasing measure, the notion of a partnership for common basic purposes has been replaced, in many parts of the government, by the concept of a mere purchase of services. This is partly the consequence of tight budgets, which always lead to hard bargaining. It is also partly the consequence of an excessive effort to connect research to quick results. But in a deeper sense it reflects a misconception of the elemental character both of basic research in universities and of universities themselves. What has happened, especially in the critically important Office of Management and Budget, is that the concepts of the commercial market have been applied to a world they do not fit. As one striking consequence, OMB has adopted a general policy of opposition to federal grants for graduate-student support, and the number of doctoral fellowships funded by grants, which reached 50,000 in 1968, has fallen by more than 70 percent.

The authoritative final report of the National Board on Graduate Education explains the thinking behind this result. Describing the attitude of OMB, it says: “The dominant view expressed by this key agency in recent years is that graduate education is a form of investment in human capital, with the benefits primarily private, not social. Consequently . . . there is little justification for federal subsidy in the form of fellowships; instead, the student-investor should pay for his/her own education, borrowing if necessary or working as a research assistant.”

This view runs flatly against the historic practice of the best graduate schools with their best students and flatly against the historic distinction between commerce as a paying proposition and scientific work of the first rank as an essentially nonprofit activity. And this view of graduate education has its parallel in the view of university research: With regard to the support of research, universities are viewed as one among many types of competing institutions that can provide useful information to mission-oriented federal agencies. Research results are a commodity that the agencies can purchase as necessary from universities or any other competent supplier.

It would be hard to misunderstand the matter more thoroughly. Certainly some great science comes from commercial laboratories and some university research makes money, but the driving and decisive truth is that basic scientific research as a whole is not profitable in the ordinary commercial sense. Neither basic research nor the university that is its principal American home can flourish if subjected to the tests and values of the commercial marketplace. Nor can the long-run needs and interests of the federal government itself be met merely by purchase of mission-oriented “research results.” This is not what basic research is, or how it works.

Fortunately the true view of the matter is neither strange nor hard to articulate. Nor is it new. No better statement of the appropriate federal posture has ever been made than the following, which comes from a report submitted to, and warmly welcomed by, President Dwight D. Eisenhower in 1958. Here is what the President’s Science Advisory Committee then argued:
This year’s Federal money will pay for about one half of all the scientific research, engineering, and development carried out in the United States. . . . It is apparent from the size of this effort that the Government exerts a powerful shaping influence on all U.S. science and technology. Not only the nation’s security but its long-term health and economic welfare, the excellence of its scientific life, and the quality of American higher education are now fatefully bound up with the care and thoughtfulness with which the Government supports research. If this support is halting and erratic, if it emphasizes mechanism and “hardware” to the neglect of fundamental understanding, if it lavishes money on a few popular fields and starves others of importance, if it fails to encourage exceptional men and exceptional programs, the net result could be an impoverished science and a second-rate technology.

One of the clearest lessons to emerge from the history of science is that various scientific disciplines—seemingly unrelated—have a way of stimulating and fructifying each other in an unexpected manner. This complex back-and-forth interplay is the life and soul of science and technology—there can never be too much of it. The most impractical thing that can be done in designing and directing programs of scientific research is to worry overmuch about how “practical” they are. The secrets and treasures of Nature are hidden in the most obscure and unexpected places. It is clear, therefore, that the strongest scientific program is the program with the greatest breadth and scope. It is impossible to predict from which quarter the next scientific advance will come; but we can try to make sure that the Nation has able people at work across the whole scientific frontier.3

This account of the matter does not speak of narrow specific needs or of payment for services rendered. It does not make the mistake (which the universities themselves have sometimes made) of arguing that all current hard problems can be “solved” by a quick research “fix.” It speaks of the support of science in all its range and quality because of what that range and quality can mean in ways that are as sure, in general, as they are unpredictable in particular cases. The paradox of basic research is the paradox of the research university itself: it will never be a money-making proposition, but our society will always be poorer, in every way, where it is weak.

Adequate, open, sustained support for basic research is essential, and so is one thing more: a renewed emphasis on quality. This principle applies to all four of the areas of the universities’ work that we consider in this report.

It is sometimes argued that the federal government is ill-fitted to demand excellence in return for support, and in recent years there has been some tendency in Washington to emphasize quantity at the expense of quality. But the full record, running back to 1941, is evidence that there is no inherent conflict between the federal dollar and truly distinguished achievement. The work of tens of winners of Nobel Prizes was supported by federal funds over long periods before the winners were honored, and there are laboratories under direct federal management that are great. There is also the plain record of a number of agencies, and particularly of the National Science Foundation, that where political authorities do emphasize quality, the agencies know how to respond.

The principal instrument for achieving high quality, in all of the fields discussed in this report, is a simple one: it is reliance on the judgment of those best placed to judge. In basic research that will usually mean a jury of an investigator’s scientific peers, although it is important not to let the peer-review process wither into mutual backscratching. In the distribution of support of graduate training for a limited number of college graduates, it is today’s researchers and scholars who are best equipped to select the winners, through a genuinely competitive process. After that it is the accepted candidates, and no one else, who should have the right to decide where to go for their advanced training. The best available judges of the quality of graduate education are the graduate students themselves, and the country is not so large nor its communications system so weak that they are not able to make their own well-informed choices.

Similarly, we can say that as and when the federal government addresses itself adequately to the pressing national need for help in making our great libraries equal to the test of the next generation, and as and when it properly recognizes the national need for sustained support of advanced international studies, it will be able to find judges, and also mechanisms, to help it put its money where it will support what gives most promise of excellence.

The major research universities themselves, we believe, would be greatly reinforced by federal action in the general spirit outlined in this overview and more explicitly defined in the sections of our report that follow. We do not apologize for this predicted result, and indeed we believe that the national interest in first-class research and scholarship implies a national interest in the health of the institutions that are their main source.

In the section on basic scientific research, we argue for a broader approach by the federal government to all aspects of the academic sciences. We believe that federal funding patterns must reflect the nature of the long-term commitment that institutions make when they engage in basic research. To our mind, the annual funding arrangements currently in force create severe disruptions. We offer several alternatives that would assure greater continuity for the taxing search for new knowledge. The basic-science section also recommends that the sensitive and complex issues associated with overhead payments to universities be reexamined and treated differently by the funding agencies. We recommend that effective opportunities for dialogue between research universities and government officials responsible for research planning and funding be created, and that the Office of Science and Technology and the President’s Science Advisor consider ways to encourage such dialogue. We also call for significant increases in the number of individual grants to scientists at all levels — graduate students, junior faculty members, and senior professors.
The call for more fellowships is echoed in the section dealing with graduate-student support. We also argue there that eligibility for merit awards should be broadened to include graduate students pursuing advanced degrees in the social sciences and the humanities. This section also calls special attention to the need to increase the participation of minority students in graduate studies to ensure that future academics come from all groups in our society. We recommend that federal policy on other student-support grants and on existing loan programs be reexamined.

The third section deals with the condition and needs of research libraries and provides a broad analysis of the problems these important institutions now face. We recommend in that essay that the federal government pay urgent attention to the needs of research libraries and that the necessary funding be provided for part C of Title II of the Higher Education Act of 1965 as amended in 1976, which authorizes federal grants for the country’s leading research libraries. We also call on the Library of Congress to take a leadership role in formulating and implementing policies that would lead to the more efficient management and preservation of the significant collections housed in research libraries.

Our report on international studies addresses the need for federal government support of scholarly activities concerned with foreign areas. It points out that the rationale for federal involvement is the importance of maintaining and further developing our national competence in international affairs. While we recognize that universities must continue to bear the brunt of the costs of international studies, we believe that two types of federal assistance are required. The first is direct subvention to between thirty-five and fifty university centers of international affairs selected on the basis of merit by nationwide competition. The second consists of programs that include pre- and postdoctoral fellowships for American scholars, as well as activities aimed at improving international studies in schools by the development of lively teaching materials and by providing fellowships for schoolteachers.

But we must emphasize once more that while we believe there is a deep national interest in the well-being of the major research universities of this country, we do not urge the adoption of our four sets of recommendations on anyone who is not persuaded, in each case, that the programs themselves are in the nation’s service. We have considered and rejected the proposals of some distinguished Americans that direct institutional grants be made to a limited number of “national” universities. Aside from the difficulties of choice—where is the jury of peers for the task?—we perceive in any such program grave long-run dangers, both to the universities themselves and to the integrity of federal decision-making.

The universities are and should be autonomous. Their members will, and should, do things that irritate the temporary holders of political power. The means of reprisal should never be easily at hand. Ours is not a society in which small groups with a single perspective will be happily trusted to make massive direct institutional grants to the jostling and ever-changing set of universities that someone thinks are at the top. There is no solid ground for a decision that, among the dozens that see themselves as leaders, some and not others should be baptized “national.”

The competitive method—or set of methods—is better. In this respect the analogy to the open markets of commercial competition is entirely right. As long as the test of excellence is applied, those who think they are leaders will have only themselves to blame if they do not earn a share in truly competitive programs, while at the same time the door will remain open to those institutions with newly achieved excellence to offer.

What is essential is to turn away from mistrust and back to the concept of partnership, away from misplaced short-run standards and back to the idea of excellence, away from profit-and-loss accounting and back to the rousing conviction that there can be no good and free society, still less a great one, where the university’s not-for-profit science and scholarship do not flourish.

Notes

1. National Science Board, *Science Indicators 1974* (Washington, D.C., National Science Foundation, 1975). The figures for universities do not include another, highly important 7 percent spent in Federally Funded Research and Development Centers (FFRDC), administered by universities and dependent on the university connection for much of their excellence.

2. Ibid.


4. Ibid.

APPENDIX C

Further Thoughts on Prudent Unrestricted Investment Income Distribution†

ABSTRACT

This paper interrelates investment payout rates and total return rates to sustainable inflation rates. The paper shows that the lower the payout rate, the higher the inflation rate which can be sustained and the greater the residual capital after a period of years. The devastating effects of inflation rates as high as 10% are demonstrated. Investment “total return” (dividends and interest, plus capital gains plus new capital additions) of at least 15% is shown to be necessary to sustain even relatively modest inflation rates if the payout rate is to be as high as 5% or 6%. If investment payout is required to provide growth in payout at a higher rate than inflation, the payout rate must be even lower. Criteria for evaluating over-all investment performance in the face of significant inflation rates are developed. Lower payout rates are shown in many circumstances to support more total “program” over a period of years than do higher payout rates.

INTRODUCTION

Suppose that we possess a capital sum P₀ that we wish to invest in such a way that we can live on the income derived from the investment. The capital sum is totally unrestricted, so that we can spend principal, if we wish, as well as interest and dividends. What should our payout be each year in order to maintain as high a standard of living as possible, but at the same time assuring that for the indefinite future we can maintain an equally high standard of living?

DEFINITIONS

1. P₀ is the initially invested capital fund.

2. g is the fractional annual gain in the fund before any distribution, and includes capital appreciation (i.e., the increase in market value of our assets over the year) plus the additions to our capital fund during the year (from gifts and bequests) plus the dividends and interest earned by our assets during the year (before any distribution); g is called the “total return” in this paper.

3. p is the payout (i.e., the distribution) we make at year’s end; pₙ is the payout at the end of the nth year.

4. iₚ is the fractional growth in the payout from one year to the next; i.e., if pₙ is the payout at the end of year n, the payout Pₙ₊₁ at the end of year (n+1) is (1+iₚ)pₙ.

5. r is the fraction of our total year-end capital which we pay out at the end of each year.

† This paper is a simplification and extension of an earlier paper with the same title dated February 11, 1973.
6. i is the fractional annual inflation rate — i.e., if a given number of dollars will buy a given amount of goods and services in a particular year, it will require (1+i) as many dollars to buy the same amount of goods and services the following year.

**ASSUMPTIONS**

1. During the course of a year, the capital sum available at the beginning of the year will grow through capital appreciation (i.e., the market value of our assets increases during the year) plus additions to capital through gifts and bequests plus dividends and interest where we consider dividends and interest prior to distribution as added capital. The total rate of growth for the year is g, so that if we start with a capital sum $P_0$ at the beginning of the year we have

   $$P = P_0 (1+g)$$

   at the end of the year before we have made any distribution. For the purposes of this paper we will call g the **total return**.

2. We pay no taxes.

3. All our capital is totally unrestricted, so that we are free to pay out at the end of the year the interest and dividends deriving from our investments plus whatever fraction of our year-end capital we deem prudent.

4. We live with an economy subject to a constant inflationary rate i; i.e., if we pay out $p_n$ at the end of the nth year in order to buy the goods and services we consume during the year, the payout $P_{n+1}$ at the end of the following year to pay for the same goods and services is

   $$P_{n+1} = (1+i) p_n$$

5. We want to set a rate of payout $r$ at the end of each year

   $$p = r P$$

   where P is the total year-end capital, such that $r$ is the same every year.

**THE PROBLEM**

The problem is: for a given total annual rate of capital growth g, and for a specified payout rate r, how does the payout change from year to year? We also want to know what inflation does to our standard of living — i.e. will we always be able to buy the same amount of goods and services from year to year?

We can write down the problem in the following terms, remembering that the capital at the start of year n is the capital remaining at the end of year (n-1) after the payout $P_{n-1}$ for that year.

**TABLE I‡**

<table>
<thead>
<tr>
<th>Year No.</th>
<th>Capital at Start of Year</th>
<th>Capital at End of Year</th>
<th>Payout p at End of Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$P_0$</td>
<td>$P_0 (1+g)$</td>
<td>$P_0 (1+g) r$</td>
</tr>
<tr>
<td>2</td>
<td>$P_0 (1+g) (1-r)$</td>
<td>$P_0 (1+g)^2 (1-r)$</td>
<td>$P_0 (1+g)^2 (1-r) r$</td>
</tr>
<tr>
<td>3</td>
<td>$P_0 (1+g)^2 (1-r)^2$</td>
<td>$P_0 (1+g)^3 (1-r)^2$</td>
<td>$P_0 (1+g)^3 (1-r)^2 r$</td>
</tr>
<tr>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>n-1</td>
<td>$P_0 (1+g)^{n-2} (1-r)^{n-2}$</td>
<td>$P_0 (1+g)^{n-1} (1-r)^{n-2}$</td>
<td>$P_0 (1+g)^{n-1} (1-r)^{n-2} r$</td>
</tr>
<tr>
<td>n</td>
<td>$P_0 (1+g)^{n-1} (1-r)^{n-1}$</td>
<td>$P_0 (1+g)^n (1-r)^{n-1}$</td>
<td>$P_0 (1+g)^n (1-r)^{n-1} r$</td>
</tr>
</tbody>
</table>

The ratio of the payout at the end of year n to the payout at the end of year (n-1) is

$$\frac{P_n}{P_{n-1}} = (1 + g)(1 - r)$$

and is the same year after year as long as the total return rate g and the payout rate r remain the same. If $i_p$ is the fractional annual increase in the payout rate, we have

$$1 + i_p = (1+g) (1-r)$$

‡ It is unnecessary to understand any mathematical derivations in this paper unless the reader wishes to verify the validity of the conclusion. All mathematical relationships are collected together in Appendix III.
ANY TWO OF THE THREE QUANTITIES (\(i_p\), \(r\) and \(g\)) DETERMINES THE THIRD

There are three different questions we can ask regarding \(i_p\), \(g\), and \(r\):

1) With the total return rate \(g\) and the payout rate \(r\) specified, what will be the growth rate \(i_p\) in the payout?

2) With the total return rate \(g\) specified, what must the payout rate be in order to produce a specified payout growth \(i_p\)?

3) With the payout rate \(r\) and the payout growth rate \(i_p\) specified, what must be the total return \(g\) in the capital fund to support the given \(r\) and \(i_p\)?

In algebraic terms the corresponding statements are

1) \[ i_p = g - (1 + g)r \]

2) \[ r = \frac{g - i_p}{g + 1} \]

3) \[ g = \frac{i_p + r}{1 - r} \]

The interrelationship among \(i_p\), \(r\), and \(g\) can be represented in a nomogram as in Figure 1. A straightedge laid across the chart connects consistent values of \(g\), \(r\) and \(i_p\). Several features of the relationship are evident. For example, with a given total return \(g\) (i.e. pivot the straightedge at the given \(g\)) the payout rate \(r\) decreases as its rate of growth \(i_p\) increases. Also, the total return rate required to support a specified payout rate \(r\) and a specified growth \(i_p\) in the payout is always larger than the sum of \(r\) and \(i_p\). Also, for a fixed payout rate \(r\) (i.e. pivot the straightedge about the specified \(r\)) the smaller the total return rate \(g\) the smaller the rate of increase \(i_p\) in the payout.

Specific values for the interrelationship of the three quantities \(g\), \(r\) and \(i_p\) are tabulated in Tables II, III, and IV.
### TABLE II

**Payout Rate r Corresponding to Various Total Return Rates g and Various Payout Growth Rates i_p**

<table>
<thead>
<tr>
<th>i_p</th>
<th>g</th>
<th>.05</th>
<th>.06</th>
<th>.07</th>
<th>.08</th>
<th>.09</th>
<th>.10</th>
<th>.11</th>
<th>.12</th>
<th>.13</th>
<th>.14</th>
<th>.15</th>
</tr>
</thead>
<tbody>
<tr>
<td>.03</td>
<td>.05</td>
<td>.019</td>
<td>.028</td>
<td>.037</td>
<td>.046</td>
<td>.055</td>
<td>.064</td>
<td>.072</td>
<td>.080</td>
<td>.089</td>
<td>.097</td>
<td>.104</td>
</tr>
<tr>
<td>.04</td>
<td>.06</td>
<td>.010</td>
<td>.019</td>
<td>.028</td>
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<td>.046</td>
<td>.055</td>
<td>.063</td>
<td>.071</td>
<td>.080</td>
<td>.088</td>
<td>.096</td>
</tr>
<tr>
<td>.05</td>
<td>.07</td>
<td>-</td>
<td>.009</td>
<td>.019</td>
<td>.028</td>
<td>.037</td>
<td>.046</td>
<td>.054</td>
<td>.063</td>
<td>.071</td>
<td>.079</td>
<td>.087</td>
</tr>
<tr>
<td>.06</td>
<td>.08</td>
<td>-</td>
<td>.009</td>
<td>.019</td>
<td>.028</td>
<td>.036</td>
<td>.045</td>
<td>.054</td>
<td>.062</td>
<td>.070</td>
<td>.078</td>
<td></td>
</tr>
<tr>
<td>.07</td>
<td>.09</td>
<td>-</td>
<td>.009</td>
<td>.018</td>
<td>.027</td>
<td>.036</td>
<td>.045</td>
<td>.053</td>
<td>.061</td>
<td>.070</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.08</td>
<td>.10</td>
<td>-</td>
<td>.009</td>
<td>.018</td>
<td>.027</td>
<td>.036</td>
<td>.044</td>
<td>.053</td>
<td>.061</td>
<td>.069</td>
<td>.052</td>
<td></td>
</tr>
<tr>
<td>.09</td>
<td></td>
<td>-</td>
<td>.009</td>
<td>.018</td>
<td>.027</td>
<td>.035</td>
<td>.044</td>
<td>.053</td>
<td>.061</td>
<td>.069</td>
<td>.052</td>
<td></td>
</tr>
</tbody>
</table>

To understand how the various quantities and their rates of change are interrelated it is useful to examine some specific examples. Table V represents the case of a total return rate g = 0.10 and a payout rate r = 0.06, starting with a capital fund of $1 million. From Table III we see that the corresponding growth rate in payout is i_p = 0.034.

### TABLE IV

**Total Return Rate g Necessary to Support Various Combinations of Payout Rate r and Payout Growth Rate i_p**

<table>
<thead>
<tr>
<th>r</th>
<th>i_p</th>
<th>.03</th>
<th>.04</th>
<th>.05</th>
<th>.06</th>
<th>.07</th>
<th>.08</th>
<th>.09</th>
<th>.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>.03</td>
<td>.03</td>
<td>.062</td>
<td>.072</td>
<td>.083</td>
<td>.093</td>
<td>.10</td>
<td>.113</td>
<td>.124</td>
<td>.134</td>
</tr>
<tr>
<td>.04</td>
<td>.04</td>
<td>.073</td>
<td>.083</td>
<td>.094</td>
<td>.104</td>
<td>.115</td>
<td>.125</td>
<td>.135</td>
<td>.146</td>
</tr>
<tr>
<td>.05</td>
<td>.05</td>
<td>.084</td>
<td>.095</td>
<td>.105</td>
<td>.116</td>
<td>.126</td>
<td>.137</td>
<td>.147</td>
<td>.158</td>
</tr>
<tr>
<td>.06</td>
<td>.06</td>
<td>.096</td>
<td>.106</td>
<td>.117</td>
<td>.128</td>
<td>.138</td>
<td>.149</td>
<td>.160</td>
<td>.170</td>
</tr>
<tr>
<td>.07</td>
<td>.07</td>
<td>.108</td>
<td>.118</td>
<td>.129</td>
<td>.140</td>
<td>.151</td>
<td>.161</td>
<td>.172</td>
<td>.183</td>
</tr>
<tr>
<td>.08</td>
<td>.08</td>
<td>.120</td>
<td>.130</td>
<td>.141</td>
<td>.152</td>
<td>.163</td>
<td>.174</td>
<td>.185</td>
<td>.196</td>
</tr>
<tr>
<td>.09</td>
<td>.09</td>
<td>.132</td>
<td>.143</td>
<td>.154</td>
<td>.165</td>
<td>.176</td>
<td>.187</td>
<td>.198</td>
<td>.209</td>
</tr>
<tr>
<td>.10</td>
<td>.10</td>
<td>.144</td>
<td>.156</td>
<td>.167</td>
<td>.178</td>
<td>.189</td>
<td>.200</td>
<td>.211</td>
<td>.222</td>
</tr>
</tbody>
</table>
### TABLE V

**Payout Growth and Capital Growth**

Note: \( g = 0.10 \), \( r = 0.06 \), \( i_p = 0.034 \)

<table>
<thead>
<tr>
<th>Year No.</th>
<th>Capital at Start of Year</th>
<th>Capital at End of Year</th>
<th>Payout at End of Year</th>
<th>Ratio to Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$1,000,000</td>
<td>$1,100,000</td>
<td>$66,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1,034,000</td>
<td>1,137,400</td>
<td>68,244</td>
<td>1.034</td>
</tr>
<tr>
<td>3</td>
<td>1,069,156</td>
<td>1,176,072</td>
<td>70,564</td>
<td>1.034</td>
</tr>
<tr>
<td>4</td>
<td>1,105,507</td>
<td>1,216,058</td>
<td>72,963</td>
<td>1.034</td>
</tr>
<tr>
<td>5</td>
<td>1,143,095</td>
<td>1,257,404</td>
<td>75,444</td>
<td>1.034</td>
</tr>
<tr>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>10</td>
<td>1,351,092</td>
<td>1,486,201</td>
<td>89,172</td>
<td>( (1.034)^5 = 1.182 )</td>
</tr>
</tbody>
</table>

Note in Table V that \( i_p = 0.034 \) is not only the rate at which the payout grows but it also is the rate at which everything else grows; i.e., the capital at the start of the year and the capital at the end of the year.

### AS THE PAYOUT RATE INCREASES THE RATE OF GROWTH FROM YEAR TO YEAR DECREASES

Let us look at another example, this time with the payout rate \( r = 0.08 \) and with the total return rate still \( g = 0.10 \). From Table III we see that the corresponding \( i_p \) is \( i_p = 0.012 \).

### TABLE VI

**Payout Growth and Capital Growth**

Note: \( g = 0.10 \), \( r = 0.08 \), \( i_p = 0.012 \)

<table>
<thead>
<tr>
<th>Year No.</th>
<th>Capital at Start of Year</th>
<th>Capital at End of Year</th>
<th>Payout at End of Year</th>
<th>Ratio to Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$1,000,000</td>
<td>$1,100,000</td>
<td>$88,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1,012,000</td>
<td>1,113,200</td>
<td>89,056</td>
<td>1.012</td>
</tr>
<tr>
<td>3</td>
<td>1,024,144</td>
<td>1,126,558</td>
<td>90,125</td>
<td>1.012</td>
</tr>
<tr>
<td>4</td>
<td>1,036,434</td>
<td>1,140,077</td>
<td>91,206</td>
<td>1.012</td>
</tr>
<tr>
<td>5</td>
<td>1,048,871</td>
<td>1,153,758</td>
<td>92,301</td>
<td>1.012</td>
</tr>
<tr>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>10</td>
<td>1,113,332</td>
<td>1,224,665</td>
<td>97,973</td>
<td>( (1.012)^5 = 1.062 )</td>
</tr>
</tbody>
</table>

Note in this example that the payout is large \( (r = 0.08) \) but the total return \( g = 0.10 \) can barely sustain it; \( i_p = 0.012 \). This is a universal feature: **as the payout rate increases, the rate of growth of the payout from year to year decreases.**

Let us examine the situation with a larger total return: \( g = 0.15 \), first with a 6% payout and then with 8%. From Table III we find \( i_p = 0.081 \) and \( i_p = 0.058 \) for the two cases.
TABLE VII

Payout Growth and Capital Growth

Note: $g = 0.15$  $r = 0.06$  $i_p = 0.081$

<table>
<thead>
<tr>
<th>Year No.</th>
<th>Capital at Start of Year</th>
<th>Capital at End of Year</th>
<th>Payout at End of Year</th>
<th>Ratio to Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$1,000,000</td>
<td>$1,150,000</td>
<td>$69,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1,081,000</td>
<td>1,243,150</td>
<td>74,589</td>
<td>1.081</td>
</tr>
<tr>
<td>3</td>
<td>1,168,561</td>
<td>1,343,845</td>
<td>80,631</td>
<td>1.081</td>
</tr>
<tr>
<td>4</td>
<td>1,263,214</td>
<td>1,452,697</td>
<td>87,162</td>
<td>1.081</td>
</tr>
<tr>
<td>5</td>
<td>1,365,535</td>
<td>1,570,365</td>
<td>94,222</td>
<td>1.081</td>
</tr>
<tr>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>10</td>
<td>2,015,725</td>
<td>2,318,084</td>
<td>139,085</td>
<td>$(1.081)^5 = 1.476$</td>
</tr>
</tbody>
</table>

TABLE VIII

Payout Growth and Capital Growth

Note: $g = 0.15$  $r = 0.08$  $i_p = 0.058$

<table>
<thead>
<tr>
<th>Year No.</th>
<th>Capital at Start of Year</th>
<th>Capital at End of Year</th>
<th>Payout at End of Year</th>
<th>Ratio to Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$1,000,000</td>
<td>$1,150,000</td>
<td>$92,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1,058,000</td>
<td>1,216,700</td>
<td>97,336</td>
<td>1.058</td>
</tr>
<tr>
<td>3</td>
<td>1,119,364</td>
<td>1,287,269</td>
<td>102,981</td>
<td>1.058</td>
</tr>
<tr>
<td>4</td>
<td>1,184,287</td>
<td>1,361,930</td>
<td>108,954</td>
<td>1.058</td>
</tr>
<tr>
<td>5</td>
<td>1,252,976</td>
<td>1,440,922</td>
<td>115,274</td>
<td>1.058</td>
</tr>
<tr>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>10</td>
<td>1,661,005</td>
<td>1,910,156</td>
<td>152,812</td>
<td>$(1.058)^5 = 1.326$</td>
</tr>
</tbody>
</table>

Tables VII and VIII demonstrate again that the higher the payout rate (8% vs. 6%), the lower the annual rate of growth in the payout (5.8% vs. 8.1%). These tables also demonstrate that a high total return (i.e., capital gains plus dividends and interest plus additions of new capital) is essential to support either a high payout rate $r$ or a high rate of growth $i_p$ in the payout. Table IX indicates the relationships among the rates.

TABLE IX

Total Return, Payout Rate, Growth Rate in Payout

<table>
<thead>
<tr>
<th>$g$</th>
<th>$r$</th>
<th>$i_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.06</td>
<td>0.034</td>
</tr>
<tr>
<td>0.10</td>
<td>0.08</td>
<td>0.012</td>
</tr>
<tr>
<td>0.15</td>
<td>0.06</td>
<td>0.081</td>
</tr>
<tr>
<td>0.15</td>
<td>0.08</td>
<td>0.058</td>
</tr>
</tbody>
</table>

Thus we see that a 10% total return and an 8% payout rate produces only a 1.2% rate of increase in the payout from year to year, whereas with the same 8% payout rate, a 15% total return produces 5.8% annual growth in the payout.
HIGH PAYOUT RATE PRODUCES HIGH INITIAL PAYOUT BUT SLOW GROWTH IN PAYOUT FROM YEAR TO YEAR

In these various examples, a high payout rate always produces high initial payout but slow growth in payout over time, while a low payout rate produces a smaller initial payout amount but a higher growth rate. In Table VII (with $g = 0.15$) a 6% payout rate produces $69,000 the first year, but the payout grows at an annual rate of 8.1%. Table VIII shows that in the same circumstance, an 8% payout rate produces $92,000 the first year, but the payout growth rate is only 5.8% per year.

A LOW PAYOUT RATE CAN PAY OUT MORE TOTAL DOLLARS OVER A PERIOD OF YEARS THAN A HIGH PAYOUT RATE CAN

We can ask, “Will the 6% payout rate ever catch up with the 8% case in the annual payout?” The answer is “Yes,” because at 6% we are “plowing back” more of our total return into the capital fund, thereby providing a more rapidly growing base from which to make the payout. Table X shows the payouts over a 25-year period for the 6% case and for the 8% case.

<table>
<thead>
<tr>
<th>Year No</th>
<th>Payout Rate</th>
<th>Payout at End of Year</th>
<th>Payout Rate</th>
<th>Payout at End of Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.06</td>
<td>$ 69,000</td>
<td>0.08</td>
<td>$ 92,000</td>
</tr>
<tr>
<td>5</td>
<td>0.08</td>
<td>74,589</td>
<td>0.115</td>
<td>115,274</td>
</tr>
<tr>
<td>10</td>
<td>0.104</td>
<td>139,085</td>
<td>0.152</td>
<td>152,812</td>
</tr>
<tr>
<td>15</td>
<td>0.205</td>
<td>205,309</td>
<td>0.202</td>
<td>202,576</td>
</tr>
<tr>
<td>20</td>
<td>0.303</td>
<td>303,066</td>
<td>0.268</td>
<td>268,544</td>
</tr>
<tr>
<td>25</td>
<td>0.447</td>
<td>447,369</td>
<td>0.356</td>
<td>355,995</td>
</tr>
</tbody>
</table>

Thus we see that by the 15th year the 6% payout rate is producing more payout dollars than is the 8% rate – $205,309 vs. $202,576.

We can also ask, “Will the sum of the annual payouts at the lower rate over a period of years ever exceed the sum at the high payout rate?” Again the answer is “Yes.” Adding the payouts over a period of n years produces a cumulative total

$$S_n = P_0 r (1 + g)^n (1 - r)^{-1} \left( \frac{1 + i_r}{1 + g} \right)$$

Table XI shows the cumulative payout totals for the same cases recorded in Table X.

<table>
<thead>
<tr>
<th>Year No.</th>
<th>Payout Rate</th>
<th>Cumulative Payout at End of Year</th>
<th>Payout Rate</th>
<th>Cumulative Payout at End of Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.06</td>
<td>$ 69</td>
<td>0.08</td>
<td>$ 92</td>
</tr>
<tr>
<td>5</td>
<td>0.08</td>
<td>406</td>
<td>0.115</td>
<td>517</td>
</tr>
<tr>
<td>10</td>
<td>0.104</td>
<td>1,004</td>
<td>0.152</td>
<td>1,201</td>
</tr>
<tr>
<td>15</td>
<td>0.205</td>
<td>1,888</td>
<td>0.202</td>
<td>2,109</td>
</tr>
<tr>
<td>20</td>
<td>0.303</td>
<td>3,193</td>
<td>0.268</td>
<td>3,312</td>
</tr>
<tr>
<td>25</td>
<td>0.447</td>
<td>5,119</td>
<td>0.356</td>
<td>4,908</td>
</tr>
</tbody>
</table>

So we see that by the end of the 25th year the 6% payout has produced more cumulative payout ($5,119,000) than has the 8% payout ($4,908,000).
HIGHER RESIDUAL CAPITAL DOES NOT MEAN LOWER CUMULATIVE PAYOUT

There is one more fact to note: a higher residual capital after a period of years does not necessarily mean that there has been less total payout over the period. Table XII shows the residual capital after the payout at year’s end for the same cases considered in Tables X and XI.

### TABLE XII

**Residual Capital**

<table>
<thead>
<tr>
<th>Year No</th>
<th>Payout Rate</th>
<th>Cumulative Payout at End of Year</th>
<th>Payout Rate</th>
<th>Cumulative Payout at End of Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.06</td>
<td>$1,081</td>
<td>0.08</td>
<td>$1,058</td>
</tr>
<tr>
<td>5</td>
<td>1,476</td>
<td>1,326</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2,179</td>
<td>1,757</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>3,217</td>
<td>2,330</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>4,748</td>
<td>3,088</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>7,009</td>
<td>4,095</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We see that the 6% payout rate always leaves a higher residual capital than does the 8% rate. After 25 years, not only has the 6% rate left the capital fund with almost $3 million more capital, but it has also produced the most total payout (cf Table XI).

Appendix I lists payouts, cumulative payouts and residual capital after payout for a variety of total returns $g$, payout rates $r$, and payout increase rates $i_p$.

INFLATION ERODES PURCHASING POWER SEVERELY

The problem is not as simple, however, as which payout rate produces the most dollars in a given situation. What really matters is what these dollars will buy. In a period of inflation the value of the dollar, in terms of goods and services which can be purchased, is continuously eroded. If the inflation rate is $i$, then if a given number of dollars will buy a specified amount of goods and services in a particular year, it will take $(1 + i)$ times as many dollars to purchase the same goods and services in the following year. Let us make the assumption that if we buy a given amount of goods and services in a particular year, we want to be able to buy the same goods and services in all subsequent years. This is to say that the investment payout must grow from year to year at the inflation rate $- i$, i.e., $i_p$ must be the same as $i$:

$$i_p = i$$

Going back to Table II, we can see immediately what the payout rate can be, given a growth rate $g$ in the capital fund, in order to support a specified inflation rate $i$. E.g., if the inflation rate $i = 0.07$ and the capital fund grows during a year at a rate $g = 0.15$, we can pay out at a rate $r = 0.07$ and keep up with inflation.

### TABLE XIII

**Payout Rate Determined by Inflation Rate**

<table>
<thead>
<tr>
<th>Year No</th>
<th>Payout at End of Year</th>
<th>Ratio to Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$80,500</td>
<td>1.07</td>
</tr>
<tr>
<td>2</td>
<td>86,095</td>
<td>1.07</td>
</tr>
<tr>
<td>3</td>
<td>92,078</td>
<td>1.07</td>
</tr>
<tr>
<td>4</td>
<td>98,478</td>
<td>1.07</td>
</tr>
<tr>
<td>5</td>
<td>105,322</td>
<td>1.07</td>
</tr>
<tr>
<td>:</td>
<td>:</td>
<td>:</td>
</tr>
<tr>
<td>10</td>
<td>147,375</td>
<td>(1.07)^5 = 1.40</td>
</tr>
</tbody>
</table>

In this case, given a 7% inflation and a total return rate of 15%, we can pay out 7% every year and always buy the same amount...
of goods and services for which we pay $80,500 the first year. That amount of goods and services costs $86,095 the second year, $92,078 the third year, etc.

In Table V the total return rate is only 10% and the table shows that a 6% payout rate will only support a 3.4% inflation rate. In Table VI g = 0.10 still, but the payout rate is 8% and the table shows that only a 1.2% inflation rate can be sustained. In Table VII g = 0.15, in which case a 6% payout rate r will support an 8.1% inflation rate. In Table VIII r is up to 8% and the supportable inflation rate is down to 5.8%.

These tables illustrate the general principles evident in Table II: for a given total return g, the higher the inflation rate to be sustained, the lower must be the payout rate. For a given inflation rate, the higher must be the total return g to support a higher payout rate r. Furthermore, there is no way to support a high inflation rate with any significant payout rate without a high total return rate g. E.g., it takes g = 15% to support a 10% inflation rate with a payout rate r = 4.4%.

A BONUS WHICH PROVIDES PROGRAM FLEXIBILITY IS AVAILABLE WHEN PAYOUT GROWTH RATE \( i_p \) EXCEEDS THE INFLATION RATE \( i \)

In the case where the payout rate r is low enough so that \( i_p \), the rate of increase of the payout, exceeds the inflation rate, there is an excess of payout each year over what is required to maintain a constant program of goods and services. For this discussion, let us call the excess payout the "bonus". Knowing the bonus for each year, we can find how much it will buy in terms of year-one dollars by reducing it each year by the appropriate inflation factor. This inflation-reduced bonus is called the "eroded" bonus here.

As examples, take the cases in Table X where the total return g = 0.15 and the payout rate r is 0.06 and 0.08. Table XIV gives the data for the r = 0.06 case and Table XV for the 0.08 case. Each table is for an inflation rate \( i = 0.04 \).

### TABLE XIV

<table>
<thead>
<tr>
<th>Year</th>
<th>Payout at End of Year</th>
<th>Payout Required To Meet Inflation</th>
<th>Bonus</th>
<th>Eroded Bonus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$ 69</td>
<td>$ 69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>75</td>
<td>72</td>
<td>2.8</td>
<td>2.7</td>
</tr>
<tr>
<td>3</td>
<td>81</td>
<td>75</td>
<td>6.0</td>
<td>5.5</td>
</tr>
<tr>
<td>4</td>
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<td>77</td>
<td>9.5</td>
<td>8.5</td>
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<tr>
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<td>:</td>
</tr>
<tr>
<td>10</td>
<td>139</td>
<td>98</td>
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<td>29</td>
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<tr>
<td>15</td>
<td>205</td>
<td>119</td>
<td>86</td>
<td>75</td>
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<tr>
<td>20</td>
<td>303</td>
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<td>158</td>
<td>75</td>
</tr>
<tr>
<td>25</td>
<td>447</td>
<td>177</td>
<td>270</td>
<td>106</td>
</tr>
</tbody>
</table>
### TABLE XV

**Payout Bonus**

Note: \( P_0 = \$1 \text{ million}, \ g = 0.15, \ r = 0.08, \ i = 0.04 \)  (\$'s in 000's)

<table>
<thead>
<tr>
<th>Year</th>
<th>Payout at End of Year</th>
<th>Payout Required To Meet Inflation</th>
<th>Bonus</th>
<th>Eroded Bonus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$ 92</td>
<td>$ 92</td>
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<td>2</td>
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<td>3.2</td>
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<tr>
<td>4</td>
<td>109</td>
<td>103</td>
<td>5.5</td>
<td>4.9</td>
</tr>
<tr>
<td>5</td>
<td>115</td>
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<td>7.6</td>
<td>6.5</td>
</tr>
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<td>:</td>
</tr>
<tr>
<td>10</td>
<td>153</td>
<td>131</td>
<td>22</td>
<td>15</td>
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<tr>
<td>15</td>
<td>202</td>
<td>159</td>
<td>43</td>
<td>25</td>
</tr>
<tr>
<td>20</td>
<td>269</td>
<td>194</td>
<td>75</td>
<td>35</td>
</tr>
<tr>
<td>25</td>
<td>356</td>
<td>236</td>
<td>120</td>
<td>47</td>
</tr>
</tbody>
</table>

To understand the significance of these numbers, consider Table XIV. The payout at the end of the first year is $69,000. At the end of the second year, it is $74,589 (shown as $75,000 in the table). With a 4% inflation rate $71,760 is required in the second year to buy the same goods and services that $69,000 bought the first year. Since the payout was slightly larger than that demanded to keep up with inflation, there is a small bonus ($2,829) which can be used to raise our standard of living — i.e., to buy more goods and services the second year than were bought the first year. In terms of year-one dollars, the $2,829 bonus is only worth $2,720. This is the eroded bonus.

In the tenth year the payout is $139,085 (more than double the year-one payout), and $98,209 is required to buy the same goods and services $69,000 bought the first year. The difference, $40,876 is bonus, but it is only worth $28,719 year-one dollars.

Table XV lists the numbers for the 8% payout case. Note that, while the initial payout is large, the bonuses are small. This fact can be seen more readily by looking at cumulative totals, as in Tables XVI and XVII.

### TABLE XVI

**Payout Bonus**

Note: \( P_0 = \$1 \text{ million}, \ g = 0.15, \ r = 0.06, \ i = 0.04 \)  (\$'s in 000's)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cumulative Payout</th>
<th>Cumulative Payout To Meet Inflation</th>
<th>Cumulative Bonus</th>
<th>Cumulative Eroded Bonus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$ 69</td>
<td>$ 69</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>406</td>
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<td>828</td>
<td>176</td>
<td>136</td>
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<tr>
<td>15</td>
<td>1,888</td>
<td>1,382</td>
<td>506</td>
<td>341</td>
</tr>
<tr>
<td>20</td>
<td>3,193</td>
<td>2,055</td>
<td>1,138</td>
<td>662</td>
</tr>
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<td>25</td>
<td>5,119</td>
<td>2,874</td>
<td>2,245</td>
<td>1,126</td>
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</table>
TABLE XVII
Cumulative Total Program

Note: \( P_0 = $1 \text{ million}, g = 0.15, r = 0.06, i = 0.04 \) \hspace{1cm} ($’s in 000’s)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
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<td>1</td>
<td>$69.0</td>
<td>$69.0</td>
<td>$69.0</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$69</td>
<td>$69</td>
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<tr>
<td>2</td>
<td>74.6</td>
<td>143.6</td>
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<td>2.8</td>
<td>2.7</td>
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<td>141</td>
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<tr>
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<td>74.6</td>
<td>6.0</td>
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<td>5.6</td>
<td>8.3</td>
<td>207</td>
<td>215</td>
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<tr>
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<td>9.6</td>
<td>18.4</td>
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<td>16.8</td>
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<td>293</td>
</tr>
<tr>
<td>5</td>
<td>94.2</td>
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<td>11.5</td>
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<td>158</td>
<td>1138</td>
<td>75</td>
<td>662</td>
<td>1380</td>
<td>2042</td>
</tr>
<tr>
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<td>447</td>
<td>5119</td>
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<td>271</td>
<td>2245</td>
<td>106</td>
<td>1126</td>
<td>1725</td>
<td>2851</td>
</tr>
</tbody>
</table>

Table XVI says that by the end of the 5th year, the total payout is $406,000, with a total of $374,000 being required over the five-year period to buy the same goods and services each year that $69,000 bought the first year. This leaves $32,000 as the cumulative bonus. If this bonus is used to buy at the end of each year as much as the bonus will buy at that time, the total bought by the end of the fifth year is $28,000 worth in terms of year-one dollars. The total “program” we will have been able to buy by the end of year five is five years of the first year’s program – i.e., \( 5 \times 69,000 = 345,000 \), plus $28,000 of expanded program for a total 5-year program of $373,000. The corresponding total program for 15 years is $1,376,000 and for 25 years is $2,851,000. Note that the “program” is always measured in terms of year-one dollars.

Table XVII is a more detailed statement for the \( g = 0.15, r = 0.06, i = 0.04 \) case. From this table we see that in the first year the payout is $69,000 and is used to support a $69,000 “program”; i.e., $69,000 worth of goods and services are purchased at the end of year one. At the end of year two the payout is $74,600, making a cumulative payout of $143,600 for the first two years. With the $74,600 payout, we require $71,800 to buy the same goods and services purchased for $69,000 the first year. The excess payout of $2,800 is a bonus, but it will buy only $2,700 worth of goods and services in terms of year-one dollars. This is the eroded bonus. The total program we will have been able to support is two years of the initial $69,000 program plus $2,700 more with the bonus. The cumulative total program is then $69,000 worth in year one, plus $69,000 worth the second year plus $2,700 more the second year for a total of $141,000 worth, always measured in year-one dollars.

In the third year we support a third year of the original $69,000 program plus $5,600 worth of extra program ($6,000 of excess payout eroded by two years of 4% inflation) for a total third year program of $74,600 (always measuring in year one dollars). Adding this to the cumulative total program of $141,000 at the end of year two gives a cumulative total program for the three years of $215,000. This is about the same as the cumulative first (third?) year program ($207,000) plus the cumulative eroded bonus at the end of the third year ($8,300).

Going to the last line of the table, by the end of the 25th year the cumulative payout is $5,119,000, but this will have bought only $2,851,000 worth of year one goods and services — and this with only a 4% inflation rate.

Table XVIII is for the same case as Table XVII, except with an 8% payout. After 25 years, the cumulative payout is $4,908,000 and it has purchased $2,848,000 worth of program.

A LOWER PAYOUT RATE ALWAYS PRODUCES A LARGER RESIDUAL CAPITAL FOR A GIVEN TOTAL RETURN

Referring back to Table XII, we see that with the 6% rate the residual capital at the end of the 25-year period is $7 million, while with the 8% rate it is only $4.1 million. When viewed from a 25-year perspective, the lower payout rate is much preferable to the higher one for this case (\( g = 0.15, i = 0.04 \)): we buy the same total program over the 25-year period, but with the 6% rate we end up with $3 million in residual capital.
million more in our capital fund. For a given total return \( g \), a lower payout rate always produces a larger residual capital at the end of any specified period.

**CUMULATIVE ERODED PAYOUT IS SIMPLEST WAY TO COMPARE DIFFERENT PAYOUT OPTIONS**

The simplest way to compare different payout options is to compare

**TABLE XVIII**

**Cumulative Total Program**

Note: \( P_0 = $1 \text{ million}, g = 0.15, r = 0.08, i = 0.04 \) ($'s in 000's)

<table>
<thead>
<tr>
<th>Year</th>
<th>Payout</th>
<th>Cumulative Payout</th>
<th>Payout to Maintain First Year Program</th>
<th>Bonus</th>
<th>Cumulative Bonus</th>
<th>Eroded Bonus</th>
<th>Cumulative Eroded Bonus</th>
<th>Cumulative First Year Program</th>
<th>Cumulative Total Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$92</td>
<td>$92</td>
<td>$92</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>2</td>
<td>97</td>
<td>189</td>
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<td>1.7</td>
<td>1.7</td>
<td>1.6</td>
<td>1.6</td>
<td>92</td>
<td>92</td>
</tr>
<tr>
<td>3</td>
<td>103</td>
<td>292</td>
<td>100</td>
<td>3.5</td>
<td>5.2</td>
<td>3.2</td>
<td>4.8</td>
<td>276</td>
<td>281</td>
</tr>
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<td>4.9</td>
<td>9.7</td>
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<td>378</td>
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<td>108</td>
<td>7.7</td>
<td>18.4</td>
<td>6.5</td>
<td>16.2</td>
<td>460</td>
<td>476</td>
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<td>131</td>
<td>22</td>
<td>97</td>
<td>15</td>
<td>75</td>
<td>920</td>
<td>995</td>
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<td>15</td>
<td>203</td>
<td>2109</td>
<td>159</td>
<td>44</td>
<td>267</td>
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<td>180</td>
<td>1380</td>
<td>1560</td>
</tr>
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<td>269</td>
<td>3312</td>
<td>194</td>
<td>75</td>
<td>573</td>
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<td>336</td>
<td>1840</td>
<td>2176</td>
</tr>
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<td>47</td>
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<td>2300</td>
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</tr>
</tbody>
</table>

cumulative eroded payouts and to compare cumulative eroded payouts with cumulative “year-one program”, where the latter is the year-one program multiplied by the number of years over which the comparison is extended; it is the cost in year-one dollars of maintaining the year-one program over the specified number of years. If the cumulative eroded payout exceeds the cumulative year-one program, inflation can be withstood with a surplus of funds to expand the program. If the cumulative eroded payout over a period of years falls short of the cumulative year-one program cost, the initial program cannot be sustained. Table XIX is an example of an initial program which can be maintained and expanded. Table XX is an example of a case where the initial program cannot be maintained.
TABLE XIX
Cumulative Eroded Payout

Note:  \( P_o = 1 \text{ million}, \ g = 0.15, \ r = 0.06, \ i = 0.06 \)  ($'s in 000's)

<table>
<thead>
<tr>
<th></th>
<th>Cumulative Payout</th>
<th>Cumulative Year-One Program</th>
<th>Cumulative Eroded Payout</th>
</tr>
</thead>
<tbody>
<tr>
<td>.06</td>
<td>406</td>
<td>345</td>
<td>359</td>
</tr>
<tr>
<td>5</td>
<td>1,004</td>
<td>690</td>
<td>755</td>
</tr>
<tr>
<td>10</td>
<td>1,888</td>
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</tr>
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<td>15</td>
<td>3,193</td>
<td>1,380</td>
<td>1,673</td>
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<td>20</td>
<td>5,119</td>
<td>1,725</td>
<td>2,205</td>
</tr>
<tr>
<td>25</td>
<td>69</td>
<td>69</td>
<td>69</td>
</tr>
</tbody>
</table>

In Table XIX we see that the first-year program is that which can be bought for $69,000. To maintain this same program with no change over five years costs $345,000 in terms of year-one dollars. Under the conditions prevailing in Table XIX (\( g = 0.15, \ r = 0.06, \ i = 0.06 \)) the total inflation-eroded payout after five years is $359,000 so that the initial program can be maintained and expanded with the $14,000 year-one dollars available over the five-year period. After 25 years, the excess of payout in terms of year-one dollars over that required just to maintain the year-one program is $480,000 year-one dollars, so that over this extended period the expanded program can be nearly a third larger than the original program.

TABLE XX
Cumulative Eroded Payout

Note:  \( P_o = 1 \text{ million}, \ i = 0.10, \ g = 0.10, \ r = 0.05 \)  ($'s in 000's)

<table>
<thead>
<tr>
<th></th>
<th>Cumulative Payout</th>
<th>Cumulative Year-One Program</th>
<th>Cumulative Eroded Payout</th>
</tr>
</thead>
<tbody>
<tr>
<td>.10</td>
<td>406</td>
<td>275</td>
<td>249</td>
</tr>
<tr>
<td>5</td>
<td>1,004</td>
<td>550</td>
<td>441</td>
</tr>
<tr>
<td>10</td>
<td>1,888</td>
<td>825</td>
<td>590</td>
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<td>706</td>
</tr>
<tr>
<td>20</td>
<td>5,119</td>
<td>1,375</td>
<td>795</td>
</tr>
<tr>
<td>25</td>
<td>69</td>
<td>55</td>
<td>55</td>
</tr>
</tbody>
</table>

In Table XX the initial program is only $55,000 but the payout is unable to support the program in the face of a 10% inflation rate. After five years the $1 million fund will have paid out $301,000, but that sum is worth only $249,000 in year-one dollars, whereas maintenance of the original $55,000 program requires $275,000 in year-one dollars. After 25 years a cumulative payout of $2,450,000 has produced over the period only $795,000 in year-one dollars against a requirement for $1,375,000 in year-one dollars to support the initial $55,000 annual program.

A USEFUL OVERALL INDEX IS THE “TOTAL ERODED WORTH”

A good overall index of investment performance is the sum of the cumulative eroded payout (over whatever period of years is of concern) and the residual capital appropriately reduced for inflation, remaining at the end of that period. Let us call the resultant sum the “total eroded worth.” It represents the total goods and services which can be bought, as measured in terms of year-one dollars, by all the annual payouts plus liquidation of the capital fund at the end of the period. Table XXI compares two representative cases.

Table XXI shows that the 6% payout rate is preferable from the beginning. After 5 years the 6% rate yields a total eroded worth of $1,528,000 while the 8% rate yields $1,508,000. After 25 years the 6% rate yields $3,936,000 and the 8% rate yields $3,260,000. The difference of $676,000 is more than seven times the year-one program at the 8% rate.
The lower half of Table XXI shows the devastating effect of a 10% inflation. Again the 6% payout is preferable, although the difference is smaller. The eroded residual capital falls rapidly and the total eroded worth is much smaller than with the 6% inflation rate. Note that the $7,009,000 residual capital after 25 years with 6% payout is worth only 712,000 year-one dollars. In the 8% case the $4,094,000 residual capital is worth only 416,000 year-one dollars -- nearly a 10-fold erosion.

Appendix II is a compilation of comparative data for a variety of inflation rates, total return rates and payout rates.

**GENERAL CONDITION FOR KEEPING UP WITH INFLATION**

In order for the investment payout to keep up with inflation, the rate \( i_p \) at which the payout increases from year to year must match the inflationary rate \( i; \) i.e.

\[
i_p = i
\]

### TABLE XXI
**Total Eroded Worth**

<table>
<thead>
<tr>
<th>g</th>
<th>i</th>
<th>r</th>
<th>n</th>
<th>Residual Capital</th>
<th>Eroded Res. Capital</th>
<th>Cum. Eroded Payout</th>
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<tbody>
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<td>.06</td>
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<td>$1,081</td>
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\[ i_p = i \]
There are two ways to increase \( i \). One is to increase the total return \( g \). The other is to decrease the payout rate \( r \). We can see from Table III the possible ranges of total return rate \( g \) and payout rate \( r \) corresponding to a specified inflationary rate \( i \). Table XXII shows the achievable portion of Table III for a 6% inflation rate.

**TABLE XXII**

**Possible Total Returns and Payout Rates for 6% Inflation**

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We see that there is no way to support a 6% inflation rate with a payout larger than 7% unless the total return \( g \) exceeds 15%. If \( g \) is as low as 10% the payout rate \( r \) can be no larger than 3%.

For an 8% inflation rate the possible range of variables is above and to the right of the solid stepped line. There can be no payout larger than 6% unless \( g \) is greater than 15%. If the total return is as low as 12%, the payout can be no larger than 3%.

For a 10% inflation rate, the possible region of the table is defined by the dotted stepped line. If the payout rate is to be no lower than 3%, the total return \( g \) must be at least 14%. If \( g \) is no larger than 15%, the payout can be no larger than 4%.

If the payout rate is to be as high as 5% or 6% and inflation is 10% or higher, there is no possible way to "keep up with inflation" unless the total return (including additions of new capital) exceeds 15%.

**CONCLUSIONS**

1. If we start with the premise that the investment payout must keep up with inflation, we are severely limited in the payout rate we can afford. Even with a total return rate \( g \) as high as 15%, we can pay out no more than 4% if we are to keep pace with a 10% inflation rate. With an inflation rate of only 8%, the payout can be only as high as 6%. (cf Table XXII). The investment payout is likely to be inadequate in the face of a 10% or higher inflation rate, no matter what the payout rate.

2. To achieve the “total return” required to support a significant inflation rate (e.g., \( g = 0.15 \)), especially if there is to be any margin for supporting any program expansion, we must augment dividends plus interest and capital gains with substantial additions of new capital each year.

3. Excessively low payout rates should be avoided. While the growth \( i \) in the payout is much larger with a low payout (e.g., with \( g = 0.15, i = 0.116 \) for \( r = 0.03 \)) the initial program is so low that an extended period is required for the cumulative eroded payout to catch up with that produced by a higher payout rate. For example, with an 8% inflation, the 3% payout rate produces a cumulative eroded payout of $1,306,000 over a 25-year period, while a 6% payout rate produces $1,744,000 over the same period.

4. In many circumstances a lower payout rate is preferable over periods of several years (say 10) than is a higher payout rate because the total program over the period can be higher with the lower payout, because the lower payout rate provides much more flexibility in terms of expanded program as time goes on, and because the lower payout rate leaves more residual capital at the end of the period.
APPENDIX I

Annual Payout, Residual Capital after Payout Cumulative Payout

Note: $P_o = $1 million  ($'s in 000's)

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### APPENDIX I (continued)

**Annual Payout, Residual Capital after Payout Cumulative Payout**

Note: $P_o = \$1$ million  
$\$'s$ in 000's)

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APPENDIX I (continued)

Annual Payout, Residual Capital after Payout Cumulative Payout

Note: $P_o = $1 million ($'s in 000's)

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APPENDIX II

Cumulative Payout, Cumulative Year-One Program, and Cumulative Year-One Payout

Note: \( P_0 = \$1 \text{ million} \)  \( (\$\text{s in 000's}) \)

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**APPENDIX II (continued)**

Cumulative Payout, Cumulative Year-One Program, and Cumulative Year-One Payout

Note: \( P_o = \$1 \text{ million} \) \((\$'s \text{ in } 000's)\)

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### APPENDIX II (continued)

**Cumulative Payout, Cumulative Year-One Program, and Cumulative Year-One Payout**

**Note:** $P_o = 1$ million

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Mathematical Relationships

Annual growth rate of payout:

\[ i_p = (1 + g)(1 - r) - 1 \]

Bonus at end of nth year:

\[ P_{nb} = r P_0 (1 + g) \left[ (1 + i_p)^n - (1 + i)^n \right] \]

Cumulative eroded payout:

\[ S_{ne} = \frac{r P_0 (1 + g) \left[ \left( \frac{1 + i_p}{1 + i} \right)^n - 1 \right]}{\left( \frac{1 + i_p}{1 + i} \right)^n - 1} \]

Cumulative payout by the end of nth year:

\[ S_n = r P_0 (1 + g) \left[ \left( \frac{1 + i_p}{1 + i} \right)^n - 1 \right] \]

Cumulative payout over period of n years to keep up with inflation:

\[ S_{ni} = P_1 \left[ \left( \frac{1 + i}{1 + i_p} \right)^n - 1 \right] \]

Eroded bonus at end of nth year:

\[ P_{nb} = P_1 \left[ \left( \frac{1 + i_p}{1 + i} \right)^n - 1 \right] \]

Eroded Residual Capital:

\[ P_n = \frac{P_0 (1 + g)^n (1 - r)^n}{(1 + i)^n} = \frac{P_0 (1 + i_p)^n}{(1 + i)^n} \cdot \frac{(1 - r)}{r(1 + i)^n} \cdot P_0 \]

Payout at end of nth year:

\[ P_n = r P_0 (1 + g)^n (1 + i_p)^n = r P_0 (1 + g)^n (1 - r)^n \]

Payout required at end of nth year to keep up with inflation:

\[ P_{ni} = P_1 (1 + i)^n \]

Where \( p_1 \) is first year payout.

Residual capital after payout at end of nth year:

\[ P_n = P_0 (1 + g)^n (1 - r)^n = P_0 (1 + i_p)^n = \left( \frac{1 - r}{r} \right) P_0 \]

Total eroded worth:

\[ W_{ne} = \text{Cumulative eroded payout} + \text{eroded residual capital} \]

\[ = r P_0 (1 + g) \left[ \left( \frac{1 + i_p}{1 + i} \right)^n - 1 \right] + P_0 \left( \frac{1 + i_p}{1 + i} \right)^n (1 + i) \]
APPENDIX IV

Glossary of Terms

Bonus at end of year n, $P_{bn}$: payout at end of year n in excess of payout required to purchase same goods and services purchased by initial payout at end of year one.

Cumulative bonus at end of year n, $S_{nb}$: sum of all annual bonuses by end of year n.

Cumulative eroded bonus at end of year n, $S_{neb}$: sum of all annual bonuses, each appropriately reduced by inflationary factor to give purchasing power in terms of year-one dollars.

Cumulative eroded payout, $S_{ne}$: sum of all annual payouts, each appropriately reduced by inflationary factor to give purchasing power in terms of year-one dollars.

Cumulative first-year program at end of year n: amount of goods and services purchased at end of year one multiplied by n.

Cumulative total program at end of year n: total amount of goods and services, measured in year-one dollars, purchased over the period of n years.

Cumulative payout $S_n$: sum of all annual payouts after specified starting time.

Eroded bonus at end of year n, $P_{neb}$: bonus reduced by inflationary factor $(1 + i)^{n-1}$ to give purchasing power in terms of year-one dollars.

Eroded payout at end of year n, $P_{ne}$: payout at end of year n reduced by inflationary factor $(1 + i)^{n-1}$ to give purchasing power in year-one dollars.

Eroded residual capital at end of year n, $P_{ne}$: capital remaining at end of year n after distribution, reduced by inflationary factor $(1 + i)^{n-1}$ to give purchasing power in terms of year-one dollars.

Inflation rate i: fractional increase from year to year in number of dollars required to purchase a given amount of goods and services.

Payout growth rate $i_p$: fractional growth in payout from one year to the next.

Payout rate r: fraction of capital fund paid out at year end.

Payout $P_n$, required at end of year n to “keep up with inflation”, i.e., to purchase same goods and services purchased by $P_1$ at end of first year: year-one payout increased by inflationary factor $(1 + i)^{n-1}$.

Program: total amount of goods and services purchased with a specified number of dollars.

Residual capital $P_{r}$: capital remaining in capital fund after year-end distribution.

Total eroded worth at end of year n, $W_{ne}$: sum of cumulative eroded payout and eroded residual capital.

Total return, g: fractional gain in capital fund during a year before any distribution. Includes capital appreciation, dividends and interest and new capital additions.
Preface

This was an invited paper at a symposium at the University of Rochester on the occasion of the 50th anniversary of Dr. DuBridge's move from Washington University in St. Louis to Rochester. It may have been organized as an American Physical Society event.

In 1940 DuBridge had been chosen to be director of the Radiation Laboratory at MIT, newly created to develop microwave radar systems, looking toward U.S. involvement in World War II. After the war, DuBridge went to Cal Tech as president. He served in that position until the second Nixon administration in 1971, when he was chosen to be the President's Science Advisor. The whole Science Advisory mechanism was abandoned by Nixon after about a year.

At the Rochester symposium, someone spoke about DuBridge's Washington University career before going to Rochester. I spoke about the war years at MIT, and the Institute Archivist spoke about the Cal Tech years.

Dale R. Corson
September 21, 1984
I am pleased to participate in this symposium honoring Lee DuBridge, and to talk about the MIT Radiation Laboratory. I was a staff member there for two years, almost from the beginning, and I was closely involved for another two and one-half years. It is an honor to be here and, after all, Lee did come from the other Cornell.

Before discussing the Radiation Lab, I want to set the stage, to try to convey some sense of those times, and of the atmosphere we lived in then. I will illustrate life in the Lab with my own experiences.

During the 1930s, most of my friends and associates were pacifists, and we were determined not to get involved in any war. I remember the revulsion I felt in going through the B-17 Flying Fortress on display at the Golden Gate International Exposition in 1939 – revulsion at the idea of spending our resources on such an instrument of destruction. I could never in a thousand years have imagined that in two years I would be flying in such machines in a war zone.

We were all well aware of Adolph Hitler, of course, and we had been disturbed, shaken even, by Neville Chamberlain and Munich in 1938. I have vivid memories of mornings in the lab at Berkeley in the spring of 1939, when we were building a new cyclotron, with the radio broadcasting speeches by Hitler – long, shouted, raving, insane speeches.

The turning point, for me and, I think, for many of my colleagues, came on Labor Day weekend of 1939. My wife and I went camping in the redwoods on the Russian River north of San Francisco. Hitler attacked Poland on Friday and on Sunday morning we went into town to buy a Sunday paper, to learn what had happened. I can still see those headlines, two inches high, in the San Francisco Chronicle lying there on the sidewalk in front of the drug store: “Great Britain Declares War.” Without ever articulating it, we knew that our world had changed and that our lives would never again be the same.

The tensions grew during the 1939-1940 academic year. It was the year of the “phony” war and of the Maginot Line. The Russians invaded Finland. The Graf Spee was scuttled in Montevideo harbor. In the late spring and early summer of 1940 the Nazis invaded the Low Countries, France fell, and there was Dunkirk.

Late in the summer we moved to the University of Missouri, and as we drove across the country the Battle of Britain was on. Each day we read about the incredible number of German bombers — and about the large number shot down. It was clear that air defense was pivotal.

In this country both the Navy and the Army, independently, had worked on radio detection techniques, with considerable success, and by 1939 both services had operational systems of one sort or another.

British radar development had paralleled our own to a considerable degree, again completely independent of anyone else’s. The British did not even tell the other commonwealth nations about their developments until 1939, and there was no joint effort with us until 1940.

The British had decided in 1935 that Air Defense was a matter of vital importance to them and they established a committee of civilian scientists and military leaders, under the leadership of Professor Henry Tizard, the Rector of Imperial College. Robert Watson-Watt from the National Physical Laboratory was charged with studying the possibility of using radio waves as a disabling ray. He reported back that the suggestion was without merit, but detection of airplanes at a considerable distance was possible. As a result of the Tizard Committee work, an effort on radio detection was undertaken under the leadership of Watson-Watt. One of his primary assistants was E. G. Bowen, a young Welsh physicist, who was to become an influential figure in subsequent radar development, both in Britain and in the United States. After the war Bowen went to Australia and built the Australian radio astronomy program.
The Watson-Watt enterprise was established at once, still in 1935, on the east coast of Britain, and it was extraordinarily successful from the beginning. Before 1935 had ended, they had achieved aircraft detection ranges of 80 km using a frequency of 12 MHz with 25-microsecond, 100-kw pulses.

The British developments proceeded apace in the 1936-39 period, with moves to higher frequencies, to higher powers, and to new uses.

Bowen concentrated on airborne equipment for AI – Aircraft Interception – and this interest influenced early work at MIT. ASV – air to surface vessel – uses were explored. By early 1940, attempts were being made to stretch the frequency capability to 50 cms, (i.e. 600 megahertz). This latter effort was led by Denis Robinson, one of the founders, after the war, of High Voltage Engineering on Route 128 near Boston.

In January 1940 construction was begun on a chain of stations, known as CH (Chain Home) stations, along the east and south coasts of England. These stations operated on frequencies in the 20 to 50 MHz range and used large, fixed antenna arrays. Coverage of the south and southwest coasts was not completed until after the fall of France in June, barely two months before the Battle of Britain began.

Those stations were critical in the defense of Britain during that terrible period. They gave warning time sufficient to allow the small Fighter Command squadrons of Spitfires and Hurricanes to fly from their home bases to other bases in the track of the incoming raid, to refuel and to be at altitude to meet the raid when it arrived. What might the outcome have been if the CH installations had been delayed six months, or the Germans had struck six months earlier?

It was obvious that higher frequencies would vastly improve the radar capability – shorter pulses and better range information, narrower beams and better angle information, smaller and maneuverable antennas. Denis Robinson's 50-cm effort was a move in this direction, but it was not particularly successful. The standard technology was being stretched about as far as it would go.

By the late 1930s there was interest in microwaves by several groups in this country, including that of Alfred Loomis, a remarkable amateur scientist who was a member of the National Academy of Sciences and who had his own laboratory in Tuxedo Park, New York. Loomis was a Wall Street lawyer and investment banker. He was an MIT trustee and was widely acquainted in the scientific world – with K.T. Compton, the president of MIT, with James Conant, the president of Harvard, with Ernest Lawrence and, through Ernest, the whole Berkeley entourage. He was acquainted with Edward Bowles, an MIT electrical engineer specializing in communications and with interest and experience in microwaves.

This small group of people, together with Vannevar Bush, then President of the Carnegie Institution of Washington, and Frank Jewett, President of the National Academy of Sciences, played the key roles in organizing the American war research effort.

Microwave radar would never have been particularly successful without a new and better way to generate power at frequencies in the 3,000-MHz region. The British set about to find such a way and succeeded in brilliant fashion with the cavity magnetron. This was the product of effort, under the direction of M.L. Oliphant, at Birmingham. They started in the fall of 1939 and by February 1940 they had arrived at the magnetron essentially as we know it today. Those given the primary credit are J.T. Randall and H.A.H. Boot.

By the fall of France in June 1940 the magnetron was ready to go and effort was concentrated on microwaves. At the same time a group of nuclear physicists from the Cavendish and from other universities was brought to the laboratory, which was shortly to be known as the Telecommunications Research Establishment, or TRE. Included in the new group were P.I. Dee, W.E. Burcham, S.C. Curran, and H.W.B. Skinner. Henry Guerlac, official historian of the Radiation Laboratory and my colleague at Cornell, writes about this group: “The new arrivals paid little attention to administrative formalities and set to work in their inimitable fashion. They were picturesquely undisciplined. They worked at off hours and far into the night, filling the hut with tobacco smoke and conversation, struggling without much plan or organization....”

Under Bowen's influence there was heavy emphasis on airborne equipment for aircraft interception by night fighters, and progress was rapid.

It was about this time that British-American cooperation began. Professor A.V. Hill, a Nobel laureate in medicine and Secretary of the Royal Society, was dispatched to Washington as a Scientific Attaché. He appears to have been something of a spy, sent to find out what was going on in this country, and he apparently reported that excessive secrecy was impeding progress in war-related research and development. In May the Tizard Committee discussed the possibility of approaching the U.S. formally.

In the meantime, events in Europe gave impetus to war-oriented military research on both sides of the Atlantic. In this country, the National Defense Research Committee was established. This organization, which was to play such a big role in the war effort, was the work of the Bush, Conant, Compton, Lawrence, Loomis, and Jewett group. The final step was a 15-minute conversation between Bush and President Roosevelt which ended with the notation “O.K. FDR” on the paper Bush had prepared.

The NDRC organized itself to undertake research in many areas, including microwaves. Alfred Loomis was Chairman of the Microwave Committee, which included E.L. Bowles, from MIT, Ernest Lawrence and scientific leaders from Bell Labs, GE, RCA, Westing-
There was only one problem: there was no adequate microwave power source.

In September a Tizard-led British Technical Mission, for which the way had been prepared at the highest levels of government, came to Washington. In addition to Tizard there were two other civilian members: E.G. Bowen and J.D. Cockcroft. They described their radar developments and exhibited the cavity magnetron. The key to the American effort was at hand.

During early October, with Bowen playing an influential advisory role, an American civilian microwave laboratory organization was worked out, following the British model to a considerable degree, including staffing primarily by physicists.

Why physicists? I don’t know. There was the British success to point to. There was the physics influence on Alfred Loomis’ committee. Physicists were probably better equipped to deal with microwave technology than were chemists, say. But why not electrical engineers, who were more directed to transmission lines and impedance matching and antennas? Maybe Lee knows.

MIT was chosen as the site of the laboratory. It offered good administrative support, there were numerous people with microwave experience, the atmosphere was congenial — and Karl Compton was a key member of the NDRC.

The Laboratory began with three primary missions: air interception for night fighters, precision gun laying, and navigation.

Ernest Lawrence was the key personnel recruiter. The Microwave Committee, including Ernest and working with Kenneth Bainbridge of Harvard, selected and recruited Lee DuBridge to be the Laboratory Director.

Why DuBridge? I have no sure insight into that decision. The Microwave Committee was made up of wise people. But still, here was this 39-year-old man from a good but relatively small place in upstate New York, without major administrative experience. He had never run a large laboratory of any kind. Why not one of the giants? Why not Ernest Lawrence himself? He was a great organizer who had demonstrated his capacity for great achievement. Why not Karl Compton, also a great organizer and achiever? Surely it was a more important job than running MIT. Why not I.I. Rabi, another person of great ability and with an established record of organizing and directing a laboratory of great productivity? Whatever the thinking behind DuBridge’s selection, it was a brilliant move.

I regret that so little has been written about the Radiation Laboratory and that there is so little public information bearing on such questions.

Before October was gone, Lee was on the job, 12,000 square feet of space (Room 4-133) had been selected, and a first-year budget of $455,000 had been adopted. A lab of 50 people, including technicians and secretaries, was projected. At V-E day the laboratory personnel numbered nearly 4,000.

At the end of October there was a three-day symposium on applied nuclear physics at MIT and 600 physicists attended. That conference turned into a briefing and recruiting session for those who were invited to join the Laboratory.

Ernest Lawrence made a recruiting trip around the country during the last half of November. I received a telegram from him, telling me to meet him in St. Louis on a specified date in connection with an important matter. I went, and he told me about the project and asked me to join – I think for three months. I was ready to go.

I reported for work on Monday morning, January 6, 1941. Lee set my salary himself, at nearly twice my Missouri salary. Average salaries were higher during that brief period, when Lee set them personally, than they ever were again.

The Laboratory was organized along component lines. There was a Receiver Group, a Transmitter Group, an Indicator Group, a Modulator Group, an Antenna Group, and a Systems Group. I was assigned to the Systems Group on the roof of Building Six – the roof building having been built during the month of December. That systems assignment dictated my radar involvement right up to the middle of 1945.

Almost from the beginning, the Laboratory was guided by a Steering Committee, which met with the Director, and which included the Group Leaders and a few others.

The first operation of the first American microwave radar system was on January 6th, my first day, and I was shown the Boston skyline, viewed with 10-cm radiation. Developments and improvements came rapidly. Before long, we were seeing aircraft echoes between the building echoes.

The Army Air Corps supplied an aircraft for the first tests of an airborne configuration and I was assigned to that project, under the leadership of Edwin McMillan. The aircraft was a B-18, a military version of the DC-3. In a steep dive it could do 120 miles an hour. In a flight on March 10, which included Ed McMillan, me, and a few others, we saw the first American echo from another aircraft with an airborne microwave radar.
From the first days of flight testing it was clear that echoes from ships were going to be useful and the Systems Group, sometime along the way, undertook an ASV (Air to Surface Vessel) project. There was also a shipborne project and I was transferred to that. I worked for a time on a World War I destroyer based in New London, and gained some experience at sea on one- and two-day trials.

While I was stationed at New London, Lee called me one night at my hotel and said, “How would you like to go across the water?” He proposed that I take our latest AI equipment, then installed in a Boeing 247D (the airlines predecessor of the DC-3), to England for a set of comparison tests with the corresponding British equipment.

E.G. Bowen, Fred Heath (who was a Canadian engineer) and I spent the summer working at TRE, testing the equipment, flying the experimental British equipment with the RAF, and flying our own equipment. We were able to identify which of our components were superior to the British ones and which were inferior. In the end we married the best of the British equipment with the best of ours and the resultant system was produced by Western Electric for combat use by both the British and American night fighter forces.

I don’t remember what I worked on after I returned from England. What I do remember is Pearl Harbor. I have a vivid memory of the entire Lab staff gathering in a big lecture room – it may have been Room 10-250 — on December 8th to hear the Roosevelt speech. “Yesterday, December 7, 1941, a date that will live in infamy.”

Laboratory attention turned to ASV and anti-submarine warfare after Pearl Harbor. I do not know where I fitted into the Lab organization, but I seem to have taken my orders directly from Lee. The military wanted help with the submarine threat, and I was assigned to the project.

To illustrate some of the military confusion of those days I can relate some of my own experiences. I believe my first assignment after Pearl Harbor was to organize ASV equipment to go to Panama to protect the Canal. I started on this only to be shifted to the Aleutian Islands, where the greatest danger was now thought to be. I believe I had tickets and airline reservations in my pocket, ready to go there, when interest was shifted to the West Coast of the U.S.

By this time I had a truck with a great deal of test equipment, all ready to operate. I dispatched my technician with the truck and the test equipment to San Francisco. On arrival there he telephoned, saying: “Here I am. What do I do now?” I took a deep breath and said: “Go to West Palm Beach, Florida.” When he arrived there I sent him to Jacksonville, Florida. I think Lee was the one giving me my instructions, based on requests for help from the military. Perhaps this type of confusion was one of the reasons why he and other Lab leaders finally decided that there had to be a Laboratory presence in Washington.

By the time we reached the Florida part of this episode, my partner was Byron Havens, a Cal Tech undergraduate who had come straight from his B.S. to the Lab.

We now had a squadron of B-18s equipped with laboratory equipment and we actually hunted submarines from Jacksonville. The first night out the crews found three surfaced submarines, but they failed in the attempt to report the findings until they returned to base. That kind of disorganization and failure of procedures plagued much of the early war effort involving complex technical equipment.

Soon after the Jacksonville sorties we were transferred to Langley Field, Virginia, where I spent much of the spring and summer of 1942. There were plenty of submarines to find there. Havens and I were on easy terms with everyone, from enlisted technicians to the commanding officers. We flew with the crews, we maintained the equipment, and we gained experience.

One of the problems that soon became evident was the inability to hit anything with a bomb once the submarine had been detected. Working with one of the more imaginative bombardiers in the group, we experimented with the idea of giving the bombardier a radar indicator to use in connection with his visual bombsight.

To work on this project we had to have DuBridge and Steering Committee approval. They were a bit skeptical, but we finally received permission and the system we developed there was adopted by Bell Labs as a model for their own low altitude blind bombing system, which was produced by Western Electric and used to great effect in the Pacific.

In the summer (1942) Lee told me he wanted me to go to Washington as a Laboratory representative to the Air Force. I was to be a technical advisor to a Brigadier General who was responsible for all communications and electronic technology. His title, at least later, was Air Communications Officer.

An advisory office to the Secretary of War, Henry Stimson, had already been set up by E.L. Bowles from MIT and he took with him J.A. Stratton and David Griggs, a former geologist from Harvard. Bowles and his people dealt with large strategy issues, while I was more concerned with detailed operational matters involving complex equipment, particularly radar equipment.

In the Washington role I organized tests of equipment, helped expedite production schedules, and coordinated priorities between the Laboratory and the Military Services. I prepared position papers for the General, organized air crew training programs, and visited theaters of war to study the operation of complex equipment in combat, where the performance was far degraded from laboratory standards.
In all these war efforts, and many others, the Radiation Laboratory was highly successful and its equipment played a significant role in winning the war. Why was it so successful?

Before trying to answer this question, however, I should mention one not-so-great achievement. That was the K-band fiasco. Early on, a development was undertaken to go to a 1-cm wavelength, with the magnetron development at Columbia University. A wavelength of 1.25 cm was chosen almost by accident, because that was the frequency the early magnetrons happened to oscillate at. The whole system was developed successfully, with the ability to resolve individual streets in a city.

There was only one trouble: 1.25 cm is right at the peak of a water absorption band, and so clouds obscured the ground, and water vapor seriously degraded the performance. Theoretical calculations, based on infrared data, by J.A. VanVleck, George Uhlenbeck, and David Dennison revealed the shape and position of the band. The experimental cart was way out ahead of the theoretical horse in this case.

Now back to reasons for the successes.

Leadership was a major factor. Lee DuBridge knew science, and his judgment was sound. He had an easy way with people. He was a good listener. He was a good compromiser in the best sense of the word. After Pearl Harbor the Laboratory grew to a size and a complexity that required a more adequate organizational structure. Faced with sharp disagreements within the senior staff, Lee resolved the issue with a logical combination of opposing ideas. It was easy for Lee to let others have their way when he agreed with that way, but he was firm when he felt the Laboratory was likely to be deflected from its primary mission.

The people who constituted the Laboratory staff were all-important. It is an impressive list: Luis Alvarez, Ed Purcell, Ed McMillan, Hans Bethe, Robert Bacher, Curry Street, Ken Bainbridge, Ernest Pollard, Ray Herb, Julian Schwinger, Robert Dicke, Jerrold Zacharias. Some effective people were graduate students when they came and some were undergraduates. One, Andy Longacre, was a physics teacher at Exeter Academy. Another, Britton Chance, was a biologist and one of the Lab’s most productive people.

With people such as these, some of whom were brilliant inventors, Lee had a large problem knowing which projects to commit resources to. Which were based on solid ideas? Which had a chance to reach the operational stage in time? Which of the requests from the military were reasonable and should be accepted for Lab effort and which were best put aside as gently as possible? How could good ideas that originated in the Lab be sold to the military?

In arriving at decisions, he had the formal help of the Steering Committee and he had the help, in particular, of Wheeler Loomis and I.I. Rabi. Both were Associate Directors. Loomis, who came from Illinois, handled personnel matters and the various shops and support services. He made things go smoothly and provided the infrastructure needed to support the Lab. Rabi was an idea and policy man. He had sound judgment and he was forceful in establishing what he considered a proper relationship with the military. He would never take orders from the military. It was a powerful leadership group.

I think that the formal mechanisms set up for liaison with the military were important. Each service had representatives in the Laboratory. The Bowles office advising Secretary Stimson played an important role in over-all technological strategy. I and a few others like me, such as Norman Ramsey for a time, and Glenn Fowler for a longer period, provided an easy link to military requirements and operations that would have been hard to provide otherwise. Lee was wise in seeing the need for such ties. By 1944 there was a British Branch of the Radiation Laboratory, under John Trump, that played an enormous role before, during, and after the invasion of the continent.

One remarkable fact: with all the Lab personnel in war zones, and with all the flying in less than ideal conditions, there was only one Laboratory fatality during the whole war, and that was in a crash at Salt Lake City of a plane on a scheduled air line flight.

Another important success factor was the close working relationships with industry. We all knew our industrial counterparts at Bell Labs, GE, RCA, Sperry, Westinghouse, and Raytheon. The organization of the NDRC Microwave Committee guaranteed easy rapport with such groups. Cooperation was easy and effective.

Important as well, I think, was the pioneer nature of the venture. Existing technology was not being improved a little at a time. Entirely new technology was being developed, and it was being done by people who were unencumbered with the older ways of doing things. One does not develop a jet engine by improving a piston engine. It takes new ideas and new people. So too with radar.

Writing about the early days of the Laboratory, Henry Guerlac says:

“A word should be said about the manner of work. The Laboratory was loosely and informally organized, small enough for constant interaction of the various parts, and even for frequent exchange of personnel. The spirit and the morale were very high. The lines separating the different sections were anything but formal barriers. Men drifted across them freely, to aid one another in a tight spot, even sometimes to trespass to good effect upon someone else’s preserve. It was a picked group, fully conscious of its undiluted strength, as yet untroubled by problems of production and higher diplomacy, unencumbered by administrative routine.
“These men shared with the industrial laboratories, chief among them the Bell Telephone Laboratories, the experience of laying the foundations of a new engineering art. The conditions and objectives of research were widely different from what most had been accustomed to. It was applied science; and it was also wartime science. Especially the first year the men relied upon empirical investigation of the cut-and-try variety, guided by their theoretical training and insight, but without benefit of much practical experience in radio engineering. The rediscovery, en route, of familiar engineering practices was not an uncommon experience. On the other hand, they were free from a heavy accumulated load of engineering rules of thumb not always adaptable to this new field. The wartime urgency of their work meant that a wholly logical, planned attack on a problem as in peacetime, was almost never feasible. Speed was the all-important consideration and there was no time for leisurely theoretical exploration or fundamental research. Most of the knowledge was acquired by building something as quickly as possible and trying it out. Theoretical knowledge grew pari passu to be plowed back into the work at a later date.”

At another point Guerlac writes:

“No full understanding of the administrative eccentricities of the Radiation Laboratory is possible without recognizing that one of its outstanding merits, in the eyes of its own management, was that it was a physicist’s world, run for, and as completely as possible by, physicists. Everything was subordinated to producing an environment for research as free and untrammeled as in a university and to preventing research from becoming entangled or impeded by the growing responsibilities thrust upon the organization. One consequence of this basic article of policy was that physicists assumed a large number of administrative duties, which might perhaps have been assigned to the lay brethren, and carried them out in some instances with extraordinary success, in other cases not quite so effectively. A second consequence, was that when service departments were set up, they operated at something of a disadvantage, and not without justice felt that insufficient confidence was reposed in them. On the other hand no policy could have been better designed to rid the research man of unwise interference, and to give him unsurpassed opportunities for creative work. The Radiation Laboratory came close to realizing a scientist’s dream of a scientific republic, whose only limitation was the supply of scientists.”

All this nostalgia, and all these reminiscences, are fine for a group of old men remembering what now seem like some of their best days. It is possible that that there is a bit, but only a tiny bit, of course, of the aging athlete’s recollection of his youthful exploits. The older we get, the better we were. Still, the fate of the world was at issue in those days, and Lee DuBridge and the Radiation Laboratory played major, and probably, decisive roles.

If this is to be more than recollections of long ago, we must ask what lessons those days hold for us today. In a similar crisis could we find equally effective ways to respond? Perhaps. Is it possible for a group of a half dozen wise people to influence events so dramatically, and so importantly, as Bush and his associates did in organizing the National Defense Research Committee? The answer is certainly “no”. Our bureaucratic accretions are far too great.

Would it be possible to organize a laboratory to tackle some vital problem and to do it so effectively? Maybe, depending on the problem and its degree of urgency. Are there ways to make science policy at the national level which are as effective as were the ways in the Bush days, both before and after the war? The answer is certainly “no”. Are those making science policy today as obviously the best and the brightest as were the Bushes, the Comptons, the Conants, and the Lawrences of half a century ago? Almost certainly “no”, but then I’m not sure who the modern-day Bushes are. Are there leaders of the DuBridge caliber to guide whatever efforts we undertake now? The answer is surely “yes”. The world is filled with highly competent young people.

Overall, we have vastly superior technology today, and yet we seem less capable of bringing it to bear effectively on our national needs. Perhaps it is only that I am too much out of the action and too myopic.

There is only one absolutely certain thing here today, and that is the magnificent job Lee did at the Radiation Laboratory — and Lee, we thank you.
Preface

Sigma Xi is an honorary society that recognizes those who perform significant research. It was founded at Cornell in 1886; the official Centennial was at Cornell in 1986. Several Sigma Xi organizations in the Washington area, when I was spending much of my time working at the National Academy of Sciences, organized a three-day symposium at NIH. I was the keynote speaker at the symposium.

I talked about how I thought science had developed over the century and where I thought it was going in the future. It makes points I thought scientists should think about and that I thought were significant to Washington policy-makers.

Sigma Xi Symposium
National Institutes of Health
October 9, 1986

Dale R. Corson
Introduction

Sigma Xi was founded at Cornell University 100 years ago by a group of nine people dedicated to research and scholarship in areas of inquiry that were relatively new on the American University scene. The post-Civil War period was one of ferment and change in higher education. Cornell was founded in 1865 with “agriculture and the mechanic arts” as part of its structure. Johns Hopkins was founded a few years later as a graduate university. Some of the state universities were building strong programs in new directions. Sigma Xi was an expression of the new dedication.

I have been actively involved, one way or another, with science, engineering and research for 50 of those 100 years since Sigma Xi was founded. Fifty years ago I was a third-year graduate student in physics at Berkeley and I was inducted into Sigma Xi 48 years ago.

It is coincidental that 40 of those 50 years have been spent at Cornell.

In this discussion today I want to look at the way science has evolved over the last 50 and 100 years, to make some judgments about the manner in which it has developed, to assess some of the problems and opportunities of the present moment, and to speculate a bit about the future. In doing this I will quote numbers and make assertions you may not agree with. That is fair enough, but if I do not make you think about the issues, I will have failed in my objective.

Science Was Relatively Simple 100 Years Ago.

I would like to take a brief look at science 100 years ago. For me, however, it is more interesting to start in 1893 rather than 1886, because the principal physics journal, the Physical Review, was founded at Cornell as well, in 1893, and was published there for the first 20 years of its life. Mounted on my office wall in Ithaca is the lead plate from which the cover of Volume One, Number One was printed. The papers included in that first issue are the following:

- Relation Between the Length of the Yard and the Meter.
- Infra Red Spectra of Alkalies.
- Critical Current Densities for Copper Deposition.

I call your attention to the nature of the research reported there. It was, of course, addressing the important problems of the time, but it was simple by today’s standards. The experiments reported required simple equipment — three ammeters, for example, or a simple spectroscope. Few people were involved with the research. There was no professional physics association with meetings where research results were reported. The American Physical Society was not founded until 1899.

Science Was Advancing Rapidly 50 Years Ago.

If we look to 1938, when I received the Ph.D., the picture is very different. We see big laboratories with many people, although research teams were usually only two or three people. We had big machines — cyclotrons, for example.

The American Physical Society had 3,000 members. A few dozen people attended each of the various sessions at the annual Washington meeting at the old Bureau of Standards on Connecticut Avenue. A great deal of information was exchanged while people sat
on the lawn, talking with their colleagues from other institutions. Science was international. At Berkeley we had extended visits by Bohr, Fermi, and many others.

There was little money for research. Most of the support came from the university itself. There was donated equipment. Salaries were small — I worked my first year as a postdoctoral fellow for $1,200. There were some foundation grants. The Rockefeller Foundation had committed several million dollars, for example, to build the 200-inch telescope at Mount Palomar.

The equipment of scientific investigation used the vacuum tubes and associated electronics of the day and was, for the most part, crude by today’s standards. There were few technicians, so the investigators built their own equipment.

In spite of the simple equipment, some of the experiments were beautifully conceived and can only be described as elegant.

Let us look at the state of science itself fifty years ago — in the June 26, 1936 issue of Science magazine, for example, where the 50th anniversary Sigma Xi celebration was reported. There is discussion of the expanding universe and the tobacco mosaic virus. When I was inducted into Sigma Xi, the initiation lecture was about genes. Chromosomes were already known to have a substructure, although the number of human chromosome pairs was thought to be 24, not the 23 we know now. The 1920s had been an exciting period of consolidation for the quantum theory. The neutron had been discovered in 1932 and the positron in 1934. Artificial radioactivity had been discovered only a few years before.

In astronomy the red shift and the expanding universe were being established. The 100-inch telescope at Mt. Wilson provided the frontier observations, and the 200-inch was in its early stages. Only in astronomy had the tools of science moved to a scale beyond the reach of a single institution, and Mt. Wilson was the first instance of a large national facility to which the scientists travelled to do their work.

Looking now at that period, against the background of our National Institutes of Health, our National Science Foundation, and more than 100 major research universities, the work of 50 years ago appears as a tiny effort, with almost no money, and only a few brilliant people. It was an exciting period, however. There was a feeling that a curtain was going up on a window revealing the nature of the physical and biological world.

When we compare the science of 50 years ago with the science of 100 years ago, the achievements were great, but when we compare the science of today with that of 50 years ago, the achievements are enormous.

It is mind-boggling to think about the depth of our understanding of the physical and biological worlds. It is equally mind-boggling, however, to think about the depth of our ignorance.

**Our Civilization Is Characterized By Exponential Growth.**

I want to make three points about this growth in our understanding over the past 100 years:

1. The growth in scientific achievement has been enormous and it has been exponential.

2. Science has become enormously expensive and cost has also risen exponentially.

3. The exponential character of the growth in both scientific achievement and cost was inevitable, and the same explosive growth will continue in the future, if we will only let it.

Let me remind you that an exponential quantity is one that increases ever more rapidly, always doubling in magnitude over a characteristic time known as the “doubling time”.

I will cite a few quantitative measures to document these assertions. One is the rate of growth in the number of technical journals, a subject once studied by Derek Price. The first scientific journal was Philosophical Transactions, founded in 1665 in London. Since that time, the number of journals is a remarkably straight line on a semi-logarithmic plot — i.e., it is exponential, with the number of journals doubling every 15 years right up to World War II. Since the war, the curve has turned upward. At the time of Price’s study the doubling time was about eight years. The growth, incidentally, is largely through the emergence of new disciplines and sub-disciplines, each with its new journals.

Another measure of growth is the number of Sigma Xi chapters and clubs. The Society started with one chapter in 1886, had 28 chapters in 1911, 68 in 1936, and 265 chapters and 244 clubs in 1986. These numbers fit an approximate exponential curve with a doubling time of about 18 years.

Another example is the number of American Physical Society members. This body started in 1899, had about 3,000 members in 1936, and about 37,000 now. This, too, is roughly exponential, with a doubling time of about 14 years.

Exponential growth characterizes this stage in the evolution of our civilization. Take the world’s population, which is doubling now every 35 or 40 years, representing an annual growth rate of 1.5 or 2 percent.
The population growth did not begin until about 1600, and it has exploded since. Fred Hoyle once pointed out that the growth in population in any planetary civilization has to be rapid if it is to survive. It is necessary to develop a sophisticated energy supply before all the cheap energy is used up — and that requires a large population, quickly.

The exponential growth in scientific achievement is related to the growth in the population, but it also derives from the way research progresses. Most simply stated, the amount of research which gets done in a given time is proportional to the number of investigators.

Looked at in more detail, research at any given time builds on the existing science and technology. New technologies, built on new science, open entirely new fields of science. Fifty years ago the crude electronics of the time made possible the scientific instruments of the day. Building on the ideas and the equipment of the time, solid-state physicists developed the transistor (in the 1940s) and this opened entirely new opportunities for all the experimental sciences. Understanding the properties of the electron opened the way for the development of the electron microscope, which opened entirely new fields of biology. The invention of the computer, based on the transistor and other solid-state devices, opened the door for powerful new ways of attacking a host of problems.

It is a simple case of the rate of change (in this case of the amount of research) being proportional to the results already achieved — the classic exponential relationship.

Let me now look at the cost of doing research. There are more people working, so more money is required. Each investigator, however, costs ever more money. It can now take a hundred thousand dollars or more to establish a new assistant professor in a university research setting.

As scientific achievement progresses, the equipment becomes ever more complex and expensive. Today’s research equipment is yesterday’s research frontier. And the more rapid the progress, the more rapid the obsolescence of the equipment. One hundred years, ago three ammeters, or a simple prism spectroscope, provided enough equipment for significant measurements. The molecular beams of the 1930s, 40s, and 50s led to the nuclear magnetic resonance developments of the 50s, 60s, and 70s, and today no up-to-date analytical laboratory can exist without a half-million-dollar or million-dollar NMR instrument. The cost of particle accelerators to maintain our progress in particle physics is measured in the billions.

So where do we go from here? Will the scientific productivity continue at the present rate and will the expense continue to grow in exponential fashion? Will society continue to support science at these rates? We must think carefully about these questions.

Some Limiting Factor Will Eventually Limit The Exponential Growth.

Any exponential growth must eventually reach some limiting factor. Let us look at the population. Right now we are doubling our numbers every 35 or 40 years — which represents about one new Bangladesh every year, some 85 million people added to the world's population. We can look at the problem in some startling ways. Now we have about 15 acres of the earth's land surface for each individual — a surprisingly small area. In 40 years the number will be 7.5 acres. In 40 more years after that, it will be 3.75 acres at the present rate. It is easy to calculate how long until the amount of the earth's surface per individual is only one square yard, and it is only about 500 years. That is the time since Christopher Columbus.

Obviously, the population will not continue to grow at the present rate for 500 years. Something will limit it. What will it be? Since the time of Malthus 200 years ago, we have said that it would be the available food supply, and I have believed that, but I am now willing to listen to other arguments. What raises doubts in my mind is the new biotechnology. World food production is growing at about 3% per year while the population is growing at 2% or less, and this is happening before the new biotechnology has hardly taken root. Perhaps molecules can be restructured in factories to produce food in whatever amounts we need.

I am quick to point out that food supply increasing faster than population does not mean the end of malnutrition and starvation. Social and political problems must also be solved before there are no more hungry people.

So some other factor may ultimately limit the growth. What will it be? Climate changes? Inter-group conflict? New diseases? Your guess is as good as mine. The only thing I am sure of is the ultimate limitation.

Scientific Achievement Will Be Limited By Human And Financial Resources.

So much for speculation about the population. What about the continued growth in scientific achievement? I assert that it too will reach some limiting factor or, at least slow up. At worst, progress could stop. Is there some natural place for progress to slow up or stop? I say “no”. It seems reasonable to think that progress will slow up when the population growth slows up, but that is not any time soon. Looking at the depth of our ignorance about the nature of the universe, it seems to me that we have an infinite amount of work ahead of us as we continue to try to understand. We sit in the middle, between the nearly infinitely large and the nearly infinitely small. Do we really exist this way, or does it only seem that way because of the limitations in our means of observation? In any case, there is still a great deal of discovery ahead of us.
Inadequate Human Resources May Be A Limiting Factor At An Early Date.

The obvious limiting factor in our future progress is the amount of our available capital resources — human and financial. Right now we are in danger of being limited by human resources. We are not attracting an adequate number of young people into scientific and engineering careers.

There is no way to predict the future, either the demand for scientific and engineering personnel or the production of such people. All we can do is to project the current and recent past trends to see how they look. What we see is disturbing.

We can look at the projected demand in some general ways. We know that the employment of scientists and engineers by industry has been increasing, and we know that we are approaching the stage in our economic and social evolution when the number of “white-collar” jobs will exceed the number of “blue-collar” jobs. If we look at specific disciplines, however, it is impossible to say how many Ph.D.s, for example, will be required. This is partly because we cannot predict with any certainty how technology will develop, and partly because of the interchangeability of disciplinary backgrounds in many fields.

In physics the annual number of new Ph.D.s is now only about two-thirds what it was in 1972. It is stabilized at this level only because of the growing numbers of foreign nationals in our graduate schools. The entering graduate class in physics is now about 40% foreign. A decade ago it was 20%. Other fields show similar patterns. In engineering, the number of Ph.D.s produced is now more than half foreign.

This is not a matter of major concern, provided that these people remain in the country. More than half do stay for at least five years. It is a precarious situation, however, and we cannot be sanguine about it.

There is gross underrepresentation of women and minorities, other than Asian minorities, in our scientific and technical disciplines. There are about 30,000 Ph.D. physicists in this country, but only about 2% of them are women. Our current production rate is perhaps 10% of the total. The number of black and other non-Asian minorities going into science and engineering is appallingly few. In 1985 only about 110 Ph.D.s in all the science and engineering fields went to black candidates. Half of them were in biology; 33 were in engineering and the physical sciences. The representation of black and Hispanic students in our science and engineering schools is low and it is falling, while the relative numbers of these groups is growing. We are failing to tap a large segment of our talent pool.

Coupled with these concerns is the demographic factor — the number of 22-year-olds in our population will fall by about 25% by the year 2000, further reducing the available pool.

We are failing to attract adequate numbers of students, and especially of the best students, right from the first day of first grade. Many influences are diverting minorities and women right from that first day, and white males are also being diverted from the science and mathematics track. The problem is an enormous one and demands the best attention the country can give it.

Scientific Progress Is Already Limited By Allocated Resources.

Gross National Product is a measure of our national resource base. It grows a few percent per year, and relative to the population growth and to the increase in productivity, which in turn depends on technical progress. GNP growth, however, is not as fast as the scientific achievement rate. At some stage, the cost curve must cross the resource line.

In the early years after Sputnik in 1957, the investment in research and development in this country grew at a rate which extrapolated to reach the gross national product in a finite time. Of course, it slowed in a few years at a level of perhaps 3% of GNP. Since that time, and in particular since about 1968, it has fallen slowly to something like 2%. In the meantime, the investment by our major competitors has risen from about 2% to about 3%.

During the period since 1968, the investment in our research and graduate education enterprise has fallen, especially when measured in constant dollars. We are no longer investing in people as we did in the 1960s. There are fewer graduate fellowships, which brought so many talented young people into our graduate schools. Perhaps this is one of the reasons young people are not attracted to science careers in adequate numbers. The opportunity cost — i.e., the foregone income during graduate school careers — is high and the psychological impact of the fellowships, indicating a national priority for the relevant fields, is diminished.

Since 1968, the research and graduate education infrastructure has deteriorated. Modern instruments of research are unavailable in adequate numbers. Slowly but surely, our base for competing with our international competitors is eroding.

What is the correct fraction of the GNP that can be profitably invested in research and graduate education? What level of investment will sustain our economic health and our place in the community of nations? What level of investment will assure our military security? What level of investment will produce a level of scientific achievement which will enrich our lives and contribute to an esprit that will make us a vital and admirable society?
At this point I will make three more assertions:

1. As the world population grows at an ever-increasing rate, the stress in the lives of human beings everywhere increases and there is ever more trouble in the world.

2. Part of the stress is related to growing scientific and technical problems, exacerbated by the growing population; these must be solved if we are to survive in any kind of reasonable way.

3. The resources allocated to these problems are insufficient to deal with them adequately on a long-term basis, and the longer the under-investment persists, the larger the problems become.

There Are Great Opportunities For Research Which Will Enrich Our National Life.

The opportunity for rapid scientific progress has never been greater. In biology, the understanding of biological processes, including ways to control some of those processes, has opened the door to greater food production and to elimination of disease. The development with the greatest hold on public attention is the conquest of cancer. We are closing in on it, but the quarry is elusive. It appears within the reach of our research capability — if not within my lifetime, then within yours. We are learning how to design materials which can lead to achievements never before possible. There appears to be a good possibility of slowing our use of materials in declining supply — iron, for example.

In information-processing technology, some of the prospects are almost unbelievable. In the arts, we have learned, and are learning, how to bring music and drama to the public in ways that enrich our lives as never before.


There are big scientific and technical problems which we must address if our civilization is to survive. I want to talk about some of these problems only enough to give some flavor to their nature.

The problem which commands our highest national priority is our military defense. Defense is based on advanced technology and it exploits the most recent scientific achievements. For our military defense to be assured, we must "run faster" than our adversaries in science and technology. It is ironic that our investment in people and in the infrastructure of science and engineering should give way to military equipment and preparedness, when that equipment and preparedness depend directly on our scientific and technical health.

Going on to some large scientific problems, let me take air pollution first. The biggest problem here is the "greenhouse effect" and potential changes in the climate brought about by increasing concentrations of carbon dioxide in the atmosphere. Some predictions indicate a serious problem within the next 50 years.

Our energy supply presents another huge problem. Oil appears headed for exhaustion in another 50 years. We have a great deal of coal — enough to last for hundreds of years — but burning it puts carbon dioxide in the atmosphere, and if the greenhouse problem proves serious we will not be able to use the coal — at least not in a straightforward combustion mode. Nuclear power appears doomed for the time being by political forces — the public does not trust it. Conventional nuclear power could only provide a solution for 50 or 100 years, in any case, before the supply of uranium was exhausted. Breeder reactor technology, which could extend the useful life by a large factor, has hardly been considered in the United States. Fusion energy may well be our saviour, but it will be decades before we can be sure. Other alternative sources appear likely to meet no more than a fraction of our requirements.

In the health area, we still have major diseases to conquer. A great deal of human suffering could be avoided if the genetic diseases could be cured. There are clouds on the horizon concerning new diseases, a prospect made real by the current AIDS problem. Furthermore, the widespread use of antibiotics the last 40 or 50 years has led to the growth of mutant strains of bacteria that are resistant to our present array of drugs.

Is there a chance that in historical perspective the last half of the 20th century will be viewed as only an incident when the human race was relatively free of infectious disease?

I have confidence that we will be able to deal with these threats, but only by reaching a stage in our knowledge of life processes where we understand in detail how disease agents operate and where we can design effective interventions, an understanding that requires a great deal of basic research.

These scientific and technical developments and many others like them can make our future safer, more rewarding, and less painful.

Adequate Technology Requires Investment In All Areas Of Scientific Endeavor.

To sum up the situation as I see it: we have great opportunities, we have great societal needs, but we have limited resources. What can we do about it?
Perhaps we can accomplish our most important research by using our limited resources more efficiently. Perhaps we can decide which are the highest priority problems and direct our resources at only these. There are questions about this approach, however. Who is to set the priorities? Those who believe that only the best scientists and engineers, as judged by their peers, should set the priorities are likely to be viewed by the public and by Congress as elitists who probably should not be trusted. If the politicians set the agenda, the decisions will be politically well-informed but not scientifically optimal.

Furthermore, can research really be directed? We have many examples to point to. The directed effort during World War II was highly successful, but it was built almost entirely on existing science and was really development. After the war there was a great deal of catching up to do. Such a directed effort is probably, at best, a short-term solution.

The real question is: “Can any field of science or engineering prosper for long without opportunities to exploit the achievements in other, sometimes seemingly unrelated, fields?” I think not.

At this point I will make another set of assertions:

1. Major opportunities cannot be exploited and serious societal problems cannot be confronted successfully for long by directing resources to a limited set of priorities.
2. The only way to assure a scientific and engineering base capable of addressing any technological problem likely to emerge, is through investment in all promising scientific and engineering fields.

To know how to direct our resources most effectively, we must have informed political decision-making mechanisms. Let us look at these processes.

Science Policy Decisions Were Simply And Wisely Made In Earlier Times.

Right up to World War II, research was investigator-driven. The scientist himself or herself decided where the pay-off areas were likely to be. The more competent the investigator, the better the judgment about the critical problems and about the best approaches to them. University administrators and state legislatures had to be convinced that general areas were worth supporting, but they had to rely on the judgment of the scientists.

The mechanisms for making research and development policy decisions at the beginning of, and during, World War II were extraordinarily effective. A few wise people devised a national policy and took it to the highest levels of government. The people were Vannevar Bush, the president of the Carnegie Institution; Karl Compton, the president of MIT; James Conant, the president of Harvard; Ernest Lawrence, the Berkeley physicist; and Frank Jewett, the president of the National Academy of Sciences.

The creation of the Office of Scientific Research and Development in 1940 took place in a 15-minute conversation between Bush and President Roosevelt. The President wrote “O.K. FDR” in the margin of a brief paper Bush and his associates had prepared.

After the war the public, and Congress, believed that science and technology could solve nearly every problem. When Bush produced his “Science, the Endless Frontier” after the war, his suggestions were implemented and a magnificent system of research support was established.


Today the world is more complex than it was in the years immediately after World War II. Decisions are more difficult and the allocation of resources among competing claims is troublesome.

It was only with the advent of significant federal support in the post-war period that priorities began to be set by federal agencies and Congress. Other than the National Institutes of Health, only the Office of Naval Research supported research in a significant way in the years immediately following the war. With the creation of the National Science Foundation, the government took a large step to support and guide American research.

The creation of the Office of Science and Technology (OST) during the Eisenhower administration, along with the President’s Science Adviser and the President’s Science Advisory Committee (PSAC), provided us with an effective means for defining and recommending considered science and engineering initiatives for a decade and a half — until these institutions were abolished during the Nixon administration.

OST and PSAC played an important, and in some matters a decisive, role. Creation of what is now the position of Undersecretary of Defense for Science and Engineering was a PSAC initiative. So was establishment of what is now the Defense Advanced Research Projects Agency. Development of missile-carrying submarines was promoted by PSAC. Various intelligence-gathering means originated there. It initiated important research in detection of underground nuclear tests. Revitalization of research and education after Sputnik in 1957 received a big boost from these bodies.
President Nixon abolished the office and the committee in 1972 because, as far as I know, they opposed creation of an anti-ballistic missile system and they opposed construction of the supersonic transport. Moves were made to restore the office to its former position during the Ford Administration, and we have had throughout the Carter and Reagan administrations an Office of Science and Technology Policy and a President’s Science Adviser. From the beginning of 1986 until a few days ago, however, there was no Adviser, and the influence of the Office appears to have deteriorated.

From the beginning, the role of the Science Adviser has appeared, to me at least, somewhat ill-defined. There appears to have been confusion as to whether the role of the Adviser was to bring carefully studied analyses and recommendations from the scientific community to the President and the Administration, or whether the role was to take positions already adopted to the scientific community.

There are other means of bringing informed opinion to bear on important scientific and technological problems. The Office of Technology Assessment provides in-depth studies of problems directed to it by Congress. The National Research Council (NRC), representing the operating arm of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, brings the best talent in the country for consideration of matters put before it by the government. It also pursues interests growing out of its own initiative. Various ad hoc mechanisms initiated by the funding agencies and by the NRC are also effective. These include the High Energy Physics Advisory Panel, which is a standing body, and ad hoc groups assessing the opportunities and suggesting priorities in individual disciplines such as physics, chemistry, and astronomy.

In addition to providing informed advice about scientific and technical problems to the government, there is also the problem of making the government – research community relationship one of maximum productivity. The national interest can be served most effectively only if the relationship is a true partnership and if funds devoted to research are viewed as an investment in the future of the country. With growth and aging of the system over the past 40 years, and with the changing nature of the research enterprise, the system has become bureaucratized and inflexible. There is need to revitalize the operation and to remove features that contribute little to the research mission.

One of the hopeful developments in this direction, it seems to me, was the organization three years ago of the Government-University-Industry Research Roundtable, which I represent. This is a body, under the sponsorship of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, in which leaders from universities, industry, and federal agencies come together to identify the important policy problems bearing on scientific and engineering research and to define options for dealing with the problems. The Roundtable does not make recommendations. Its principal output is a series of forums at which topics are presented, analyzed, and discussed with representatives of relevant constituencies. The participation and cooperation of the funding agencies is exemplary. There is Congressional involvement, but I believe that much more is needed.

**Decisions Are Necessarily Based On Political Expediency And Perceived National Need.**

As a nation we have a large problem of national competitiveness, particularly in the industrial area. Commitment of research resources which address the problem of Japanese automobiles and cameras and Korean textiles command high priorities. Industrial competitiveness has become a symbol of perceived deteriorating American leadership, and there is overwhelming political priority for restoring that leadership. If research can play a part in the restoration, it can have a legitimate claim to its share of the federal dollar.

Competition extends beyond industrial competition, however. The exploration and use of space is a symbol of American world leadership. There are intellectual areas where American leadership is important. One is the number of Nobel prizes. American leadership in astronomy is another valuable asset. Preserving our standing in these areas is important.

Questions of national prestige often enter into decisions about research and development priorities. Important elements in the priority debate these days are the “mega” projects: the space station; the superconducting, super-collider particle accelerator; the strategic defense initiative, and the hypersonic airplane (the Orient Express). Prior to the Challenger accident, the shuttle program appeared spectacularly successful and the public, including Congress, viewed shuttle activities as “science”. Our space achievements represent American prestige and scientific dominance. We are certain to continue support for programs such as these, whether or not they speak to our greatest needs.

Congress is one of the most important bodies, and it is particularly hard for this body to make technically informed decisions. Few of the individual members are qualified to make independent judgments. Congressional committees and sub-committees develop policies based on testimony in hearings which the committees hold. There are policy-oriented committees such as the House Science and Technology Committee.

All too often, however, Congressional action is based on short-term political considerations. The mechanisms for making decisions which reflect long-term priorities and objectives are too often missing. I believe it is all-important to reestablish these mechanisms, either through reconstitution of old arrangements or through invention of new ones.
Public opinion plays an important role in determining political priorities. The public has basic understanding of the need to address these priorities and understands that, in the long run at least, research in scientific and engineering fields is required to deal with the basic issues. Everyone understands the progress that has been made in the treatment of disease since World War II, and everyone wants the progress to continue.

Everyone has some degree of understanding of environmental problems and wants these problems to be solved. Few, however, understand what is required to deal with toxic waste disposal on a long-term basis, and few understand the potentially serious impact of atmospheric pollution, as with carbon dioxide.

Everyone has some degree of understanding of the energy problem, but no one is likely to take it seriously until the lines at the gasoline pumps reappear. Few understand the importance of maintaining an ongoing program of basic research in relevant fields so that when the inevitable crisis comes, we have a base from which to attack the problem. As with many technological problems, the required long-term research lacks the immediacy required for strong public support.

There is a question of public scientific literacy. A recent study of this problem by Jon Miller of Northern Illinois University, under a grant from NSF, reports some discouraging information. Only about one in four people appears to understand the meaning of the word “molecule” when they graduate from high school, and only about a third of American adults feel they have a clear understanding of the concept. Nearly 60% of adults admit that they have little or no understanding of “DNA” and only one in six appears to have a clear understanding of the term. Given these facts, how can there be intelligent public debate about genetic engineering and the testing and use of genetically engineered products?

**Better Mechanisms For Making Informed Political Decisions About Science And Technical Policy Are Needed at The Highest Levels of Government.**

Given the rapidly evolving scientific achievement and the ever-growing cost of research, and given the pressing societal problems we face, we must have informed political judgments at the highest level of government and we must have a sustained policy over extended periods.

And so I come to my final set of points and assertions:

1. Scientific achievement is progressing at an ever-faster rate and there are great opportunities in every corner of the physical and biological sciences.

2. There are troubling problems on the horizon and only a vigorous research program with assured resources can cope with them.

3. We are not likely to see the light until we feel the heat. Our best defense when the crisis comes, from whatever direction, will be strong science in every field.

4. We are underinvesting in the research required to provide this insurance.

5. Only the informed judgment of scientists and engineers working with political leaders can lead to reliable decisions about priorities and the required level of funding.

6. We need a more effective mechanism for achieving this decision-making partnership at the highest levels of government.

With those assertions I will stop and leave the subject in your hands.
Preface

I believe that this is a paper that had wide circulation in the Engineering College and also at Cal Tech. They invited us to speak there, but I was never able to find a date that worked.

This was written in the months after the Sigma Xi symposium. I was thinking out loud about questions raised in that talk.

Dale R. Corson
December 5, 1987
Introduction

My intent is to think aloud about some of the problems facing universities like Cornell — i.e., universities with a heavy commitment to graduate education and research as well as to undergraduate education. I think they are facing serious challenges and I think they may never again be the kind of institution that Cornell was, say, in the 1950s or even the 1970s. I am not saying that this will be good or bad, only that it will be different. Along with the change in character is likely to come major organizational and financial challenges for those who manage universities.

I claim no special insight into these problems. I think I can see the outline, at least, of some of the forces at work, but I see through the glass darkly. I lack the data necessary to speak reliably about many of the topics I will discuss. I may have identified the factors at work, but I may have the relative importances wrong.

Background

I will begin with some comments about the nature of contemporary civilization. We are dealing with ever-growing complexity, ever-growing problems, ever-growing tensions, as well as ever-growing opportunities to make life safer, more rewarding, and less painful.

We are living in a world of exponentials. “Exponential” is the mathematician’s word for a quantity which increases faster and faster as time goes on. It is a geometric progression, as opposed to an arithmetic or linear progression. The population of the world is such a quantity — the number of people in the world increases at an ever-faster rate. It is characteristic of such a variation that the number, no matter what it is, always doubles in a characteristic time. The world population is doubling about every 40 years. Right now we have five billion people on the Earth and 40 years from now, in 2027 if the present trends continue, we will have 10 billion. Forty years from then — i.e., in 2067, there will be 20 billion.

Such rapid growth brings many problems. The demand for food, for example. As the population rises faster and faster, greater strains are placed on human life everywhere. More people crowded into finite spaces, at a rate too fast to be accommodated readily, inevitably leads to dislocations, to conflict, and to hardship. Nellie and I spent three weeks in East Africa in 1971. Since that time, the population of Kenya, one of the more advanced of the developing countries, has grown at 4% per year, corresponding to a doubling time of about 18 years. It does not take much arithmetic to see that the population is now nearly double what it was 16 1/2 years ago. One consequence is the competition of the people with the wild animals for agricultural land, and the inevitable decline in the animal populations. The black rhino census now is about 15% of what it was when we were there. It will take heroic steps to preserve any wild animals at all 50 years or 100 years from now.

Another exponential is research productivity. There are more people doing research now than there were, say, 50 years ago when I was a student, but in addition, the very nature of research and of science leads to exponential growth. Science builds on everything that has gone before. The bigger the base to build on, the greater the accomplishment. We can see this in some simple ways: in the number technological journals in the world (now in the hundreds of thousands), in the number of pages per year in a given journal, in the number of scientists in the world. With this ever-faster growth in scientific understanding goes an ever-faster-growing technology. In my lifetime, the speed of common transport has increased from about 60 miles an hour to a few thousand miles an hour. Until the 1860s — not much more than 100 years ago — the fastest mail service had the speed of a running horse. Now it is the speed of light, and communication from one point on the Earth is instantaneously available to any other point on the Earth.

Still another exponential is the cost of doing research. Not only are there more and more investigators, but the unit cost is growing ever faster. It is common for the cost of a new assistant professor’s laboratory to be $100,000 or more. No good chemistry depart-
ment can be without a nuclear magnetic resonance instrument costing half a million or a million dollars. Machines necessary for work at the frontiers of particle physics cost billions of dollars.

There are other exponentials in our civilization. The growing number of AIDS victims is one (no longer true 3/97).

Such explosive growths lead to instabilities and to the danger that we will be overwhelmed by some problem before we can prepare ourselves adequately. AIDS is the best example.

Going with the growth of problems is the growth of opportunities. At the most basic level is the provision of food. The world’s food supply has been growing over the past 30 or 40 years at about 3% per year while the population rate has been less than two percent. The conquest of disease is another great research achievement. Before 50 years ago, there were no antibiotics and infectious disease was uncontrolled. Only with the sulfa drugs and penicillin did we gain control of bacterial infections. Now there is real hope for controlling cancer; the essential basic understanding appears to be just around the corner. No one can say when it will all come together, but if not in our lifetime, then in that of our children.

The achievements in electronics during the past half century, and especially in the past couple of decades, are breathtaking. We can do things that were unthinkable two decades ago.

**Social And Economic Impact**

With the growth of technological capabilities in other parts of the world, our American economic and technological dominance is coming to an end, with a big impact on us, both psychologically and economically. We have believed ourselves the dominant force in the world for so long that it is difficult for us to think that it may not always be so. We have lost a significant share, perhaps 20%, of the automobile market to foreign manufacturers, and the consumer electronics market is nearly totally in the hands of the Japanese.

Even in science we see trends that are disturbing. No more than perhaps 35% of the world’s physics research papers are of American origin, and that fraction is declining. Chemistry is going the same way. One of the great discoveries of the past year, that of high-temperature superconductivity, was made in Switzerland. Within four months, there were at least 50 research papers in Japanese journals.

I believe that the industrial competitiveness views held by American industry for the past decade are simplistic and are likely to lead us further down the slippery slope. About two and a half years ago I was in a meeting with Roger Smith, the chairman of General Motors. He made strong and belligerent statements such as that in the Saturn project GM was going to take on the Japanese on their own terms and beat them. It was reminiscent of Khrushchev’s “we will bury you” boast. Now, two and a half years later, the Saturn project is behind schedule and appears to be dragging and GM is traveling a rocky road.

The social, political, and economic factors which have led to this situation are so deep-seated and so difficult to modify that, it seems to me it will be decades before we can change the trends in any significant way. I hope I am wrong, but American labor and management practices, investment policy, and a myriad of other factors have lagged so far behind that it becomes a monumental task to change them.

**Impact on the Universities**

I set out to talk about universities, so what does all this have to do with them? It has to do with societal expectations of the universities. We are seen as the solution for competitiveness problems, and society wants us to get going fast. Again, the ideas may be simplistic. It may be that doing more and better research in areas with market potential will not beat the Japanese. It may be that getting ideas to market faster will not be the answer. It may be that interdisciplinary research centers will not be the answer. It may be that greater per-capita savings to provide investment capital for new industrial developments is more important. It may be that willingness to undertake developments with no more than 5% annual return on invested capital, rather than 15% or 20%, is more important. It may be that getting labor and management together to plan production strategies is more important. It may be that an investment climate that permits investment for long-term benefit, rather than for maximum short-term gain, is more important.

In spite of these reservations about current national attitudes concerning industrial competitiveness, there are some compelling reasons for society to look to universities. Science has progressed rapidly and far in the post-World War II era, and the predominant part of that progress has been made in the universities. Industry must necessarily look to the universities for help.

In a field such as biotechnology, most of the basic developments have been in universities. These developments make possible the engineering of specific products, or specific organisms, capable of performing specific tasks of social and economic importance. The product may be a drug to dissolve blood clots, with the potential of saving the lives of heart attack victims. It may be a modified gene to make an economically important plant resistant to frost damage for several degrees below freezing. Or it may be a modified plant able to fix nitrogen from the air, instead of obtaining it from nitrogen fertilizer spread on the field.
To exploit the economic potential of such developments, industry must have a window into the universities where these basic discoveries and developments take place.

There are many ways of providing this window, but they all involve increased cooperation of universities with industry. Most of the biotechnology companies have been formed by or with university scientists. Other companies make contracts with universities so that industrial scientists and university scientists cooperate in joint research efforts. Industry supports universities with substantial grants to make these arrangements work. Monsanto supports Washington University in a joint program at a $5 million a year level. Monsanto also has such a program, at a lower level, at the Harvard Medical College. The big German pharmaceutical company, Hoechst, has a large program with Massachusetts General Hospital. MGH, incidentally, is a place where some of the best work on field crop nitrogen fixation is being done. Exxon has a program in combustion technology with MIT. There are many others.

There are other ways in which industry becomes involved with universities. The microelectronics industry has a consortium which supports advanced microelectronic research at many universities. I believe that Cornell is the largest single beneficiary of this particular program. The Center for Integrated Circuits at Stanford is heavily supported by industry. Industry sees this type of university support to be in its interest.

Even though society looks to universities to help solve national industrial and economic problems, the actual industrial support of academic research is small. Industry now supports about 5% or 6% of the basic research at universities, and the industrial research leaders I know see no way that support can grow beyond perhaps 7% or 8%. The salvation of the universities’ financial problems is not likely to come from industry.

Society looks to the research universities to continue the dizzy pace of scientific discovery so that we can remain at the front of the technology race. Society also looks to the universities to provide the hand-holding of industry which will improve our competitive place in the world. These are great expectations, but the resources to achieve them are inadequate. Furthermore, the attempt to respond to the expectations is changing the very nature of the universities.

Inadequate Resources

Let me look at the resource situation first. To do that, I want to start with the consideration of the exponential factors I began with. Every exponential growth eventually reaches a limit of one type or another. The bacterial colony on the Petri dish runs out of nutrient, for example.

Take the world’s human population. If we extrapolate the present growth rate, it is only about 500 years until the part of the Earth’s land surface available to each individual is about one square yard. That is only as long as the time since Christopher Columbus. It is clear that the exponential growth will not continue that long, but it is not clear what will limit it. For 200 years, since the time of Malthus, we have said that the available food supply will limit it. That does not now seem so clear, at least for the next 50 years. The world food supply has been growing at the rate of 3% per year while the population has grown at less than 2% per year. Perhaps, using the new biotechnology, we can even rearrange molecules in factories to make all the food we need.

A more likely population-limiting factor lies in the social, economic, and political problems bearing on the distribution of food. There are adequate food supplies to take care of any threat of starvation in Ethiopia, but when guerrilla forces can destroy a relief convoy, people are going to starve.

To come back to science, the continuing growth in research productivity will be limited at some point by resources — human resources and financial resources. As long as the research productivity and the cost of research grow faster than the GNP, as they have done for a long time, the cost will eventually exceed the GNP. That final state, of course, will never be reached. In fact, the limiting factor has already appeared through political action.

From about 1968 to the beginning of the Reagan administration, there was no real growth in the support of basic research. There was, in fact, a decline. Beginning in 1982, there was an increase, but primarily in research for the military. Not only have we had inadequate resources to fund the good research opportunities that exist, but the infrastructure of research has deteriorated. Instrumentation, which is more expensive every year than it was the year before, is inadequate for exploitation of all the good ideas. Facilities, in the form of buildings and specialized laboratories, are deteriorating. There has been no real federal program to build facilities since the 1960s. We could improve our situation materially through the rehabilitation of old buildings, but some new disciplines, such as biotechnology and microelectronics, require new and specialized facilities.

The leveling of federal support over the past 20 years has meant unexploited opportunities in many fields, and it has meant inadequate attention to pressing technological problems. Among the latter are air pollution, notably acid rain and the carbon dioxide and atmospheric heating problems. These are among the problems that can overwhelm us before we can respond adequately.

Who Is To Pay?

We in the universities find ourselves under pressure to undertake important new ventures in the interest of industrial competitiveness. We also have opportunities for important and exciting research which will advance fundamental science. Furthermore, the
future of civilization requires vigorous research in critical areas. But the available resources are inadequate.

What shall we do? Shall we give up and say we are not going to play the game any longer? Shall we say that we are not going to fulfill our role in the solution of important societal problems? No quality university is going to respond that way. We are going to respond in the most intelligent way we can, using all the resources available to us.

This brings me to one of my biggest concerns: who is going to pay? And this gets me back to my ever worrisome exponentials.

Incrementing anything by fixed percentages on a regular schedule produces the exponentials I have discussed. Inflation goes this way. Salary increments go this way. When I had the responsibility I explored, albeit gingerly, the possibility of making salary increments on a fixed dollar basis rather than on a fixed percentage basis. Should a full professor at $50,000 and an assistant professor at $30,000 both receive a 5% increase, which yields $2,500 for the one who needs the increase least and $1,500 for the one who needs it most? Or should they both receive $1,500?

What disturbs me most in the university case are differential inflation rates. Major private university operating costs have inflated somewhat faster, perhaps by 2% per year on the average, than has the inflation in the general economy since before World War II. The only exception was in the period of double-digit inflation.

We operate this way because of our very nature. We could not maintain our vitality if we did not start new ventures, with their demands for new people, new facilities, and new library resources. In starting these new ventures, we seldom close out anything old, and even if we did, we would still require the new library resources and new equipment. We have a tenure system, which means we build new programs with a ratchet system, always advancing and never retreating. We also have a tendency not to recycle faculty positions — i.e., fill a vacancy created by the retirement of a full professor with an assistant professor. Strict recycling is required to operate at the general inflation rate. As a consequence of these considerations, we find ourselves operating with an inflation rate higher than the Consumer Price Index.

Any inflation rate is bad and can produce serious dislocations. In Argentina, when inflation was 150%, I saw construction on new buildings abandoned. Money appropriated at one time was inadequate to meet the costs at a later time. At Cornell, when we constructed the Social Sciences building 15 or 20 years ago, the bids came in about one million dollars above the $8 million construction budget. We spent a year taking about 12% of the space out of the building, but in the meantime, construction costs had inflated at one percent per month, so that we ended up with a building 12% smaller than the design called for and we still paid a million dollars above budget to get it.

Hard as it is, ordinary inflation can be coped with, provided it is no more than a few percent per year. I want to examine particularly what the differential inflation rates do to us.

Before doing that, however, let us look at who is paying now. It is hard to escape the conclusion that the undergraduates are paying a major share of the research cost. There was a recent Cornell study of national experience in recovering indirect, or overhead, costs incurred in the course of doing research. The study showed that we are losing a great deal of money because federal regulations require us to do many things for which we are inadequately reimbursed.

Beyond this, however, is the direct cost of unreimbursed faculty salaries. We appoint faculty members with the understanding that they will devote half their time to research and half to teaching. Only a small fraction of the research half of the salary is recovered. One year in the 1960s, NSF imposed a spending ceiling in the fall, after we had made all our appointments for the year. It was painful when we had to pick up some salary costs on “hard money.” I had a study done to see what fraction of our salary budget was recovered through charges to research grants and contracts. It turned out to be about 2% of the entire faculty salary budget, which means that about 4% of the salary cost of doing research was recovered. Tuition pays most of the faculty salary costs.

So we use all the means at our disposal to finance the things that we want to do and that society demands that we do. We charge the undergraduates. We seek gifts. We borrow money. Ten years ago Cornell was about $70 million in debt. Now the debt is about $250 million ($450 million in 3/97). Where there are revenue streams to support the debt service, as with dormitories, there is no particular problem, except that board and room charges climb ever higher. Where there is no revenue stream, the undergraduates pay the amortization costs.

Now back to the differential inflation rates. The question is: How long can we sustain an inflation rate higher than that in the general economy? Let me take a simple example of tuition rate vs. a parent’s ability to pay. Let us look at a salary growth of 5% per year and a tuition growth of 7% per year. The 5% for salary is about what Cornell salaries have averaged over the past 40 years. An assistant professor’s salary was about $4,000, on the average, in 1946 and last year, it was a little over $30,000. That is 5.2% per year.

For my parent/tuition example, I will take the parent who, 20 years ago, earned $15,000 per year and paid, let us say, $2,500 in tuition. Tuition represented 17% of his salary.

Ten years later, in 1977, he was earning $24,000 and tuition was $5,000, or 21% of salary.
Ten years later, in 1987, he earns $40,000 and pays tuition of $10,000, or 25% of salary. (Cornell's tuition is actually about $12,000 this year.)

Ten years later, in 1997, he will earn $65,000 and will pay tuition of $20,000, or 31% of salary.

Ten years later, in 2007, he will earn $106,000 and will pay tuition of $40,000, or 38% of salary.

Ten years later, in 2017, he will earn $172,000 and will pay tuition of $80,000, or 47% of salary.

Suppose he has two children. What then? I believe that the differential tuition rate cannot continue for long. What shall we do about it? How will we finance our operation? That is the question.

To carry my example to an absurd limit, let us look at a hundred-year span — from 1967 to 2067. The $15,000 salary and the $2,500 tuition become a $2-million salary and a $2.2-million tuition. It seems safe to assume that tuition increases a couple of percent above the general inflation rate will not go on for 100 years. But who is going to stop it and how?

In about 1970, I had a call from a New York Times reporter saying he was writing a story on the cost of higher education and wanted to check a statement attributed to me. He had heard that a Cornell trustee, in a trustee meeting, had asked me what tuition was going to be in 1990. I was reported to have taken out my pocket calculator, made a quick calculation, and said "$14,278.67", or some number like that. He wanted to know if the story was true. I said that it was. I simply took the tuition level at that time and inflated it at the 7% figure, or whatever the appropriate number was, for 20 years. The story landed me on the front page of the Times with what seemed an outrageous, although inescapable, projection.

One of the hardest things in the world is to change the course of some practice to which whole institutions are committed. What would happen if someone refused to adopt the differential tuition rate at some point? There would be major dislocations. Salary schedules could not be maintained. New laboratories, necessary to start new programs, could not be provided. Danger lies in the unintended and the unexpected results. The best people might begin to leave — to go to institutions that had not faced up to the inevitable and were following the old policies. The British are in this situation right now, and I will discuss their problems later.

What is the chance that the federal government will provide the missing resources? As long as there are huge federal deficits, there is not likely to be much relief. The science and engineering statesmen in the country — David Packard, Roland Schmitt, Simon Ramo, and one or two others — have done a good job of convincing Administration officials that the budget of the National Science Foundation should be doubled in five years. The President’s budgets the past two years have reflected that commitment, but Congress has made major cuts. There is no prospect at all for a federal program to provide badly needed facilities.

State governments have undertaken new programs in advanced technology areas in the interest of economic development. They often focus their efforts on the universities in their states. New Jersey had a $90-million bond issue a couple of years ago. That state funds an interdisciplinary ceramics research center at Rutgers, among other state ventures. Arizona has an advanced microelectronics center at Arizona State University at Tempe. Ohio has its Thomas Edison program, and Pennsylvania its Benjamin Franklin program. All are directed to supporting college and university research that bears on economic development. New York supported the move of the Boyce Thompson Institute to Cornell in the 1970s, and New York is supporting the Biotech Center and the Theory Center in relatively small but important ways.

State support is not likely to replace federal support in any major way, but it is important, and it is vital for universities and states to work together closely.

I have already indicated that industry is not likely to go much farther than it has already gone in supporting basic research at universities, even though industry’s welfare depends on universities more now than it has in the past.

So the federal government, the state governments, and industry together are unlikely to meet our needs. Where shall we turn? I wish I had an answer. I think we are facing a serious problem.

The British Solution

Since 1919, British universities have been allocated government funds by the University Grants Committee (UGC) on the basis of the number of students. Since World War II, the UGC has also provided support of the infrastructure, the buildings, the special facilities, and the other necessary support for the university research enterprise. Research projects have been supported by funds allocated by half a dozen Research Councils. In the mid-1960s, on the basis of a recommendation to the Labour Government by a national commission headed by an economist named Lord Robbins, Britain undertook a large expansion of its university system on an egalitarian basis. Every faculty member was presumed, apparently, to do research.

The government has found it increasingly difficult to support the expanded system, and for the past eight years the universities have been operating with no-growth budgets and, in fact, government grants to universities appear to have declined by 10 or 15%, when measured in constant dollars (or pounds), over the past four years. It is not surprising that morale has declined. There has been a significant brain drain, primarily to this country. I have heard 700 mentioned as the number of scientists who have left.
With Mrs. Thatcher’s reelection to a third term last spring the Government decided to do something about the universities. The officials moved to exercise much more governmental control and to abandon the egalitarianism of earlier governments. Last April the new program was published in a white paper on higher education. Mrs. Thatcher, a scientist herself, seeks to impose more discipline and accountability on the research community. The new program focuses on the importance of university ties to industry and on research which is believed to have importance for economic development. Last August an editorial in Nature, Britain’s most important scientific journal, stated that “both major parties in the House of Commons share the view that research is for making ordinary people more prosperous.”

In the new structure, the UGC will be replaced by a new University Finance Council which will allocate money will be allocated to universities on a contract basis only after they have demonstrated what they intend to do with it.

A central element in the new scheme is an Advisory Committee on Science and Technology, headed by the chairman of Rolls Royce. This committee will work closely with another new entity, the Centre for the Exploitation of Science and Technology, which is intended to give industry, government, and the universities advice on the most commercially promising areas of science. The Centre will be financed, at least in part, by industry. Still one more innovation is the Advisory Board for the Research Councils, which is intended to bring “purposeful direction, nationally, in the redeployment of university research effort, both between and within universities”.

The Advisory Board for the Research Councils proposed last summer that universities be categorized in three types: (1) Type R includes those offering undergraduate and graduate teaching with “research activity across the range of fields”. Ten or a dozen universities appear to be included in this category. (2) type X includes those whose teaching is less broad and whose research is less broad still. Perhaps 15 fall in this category. (3) type T includes all the remainder, those that teach undergraduates and Master of Science students, but who lack advanced research facilities.

The Advisory Board for the Research Councils expects that a series of interdisciplinary research centers will eventually receive a large portion of the Research Councils’ research funds. Last August the Science and Engineering Research Council announced a list of seven areas, ranging from molecular engineering to high-temperature superconductors, in which the Council would receive bids from universities for the establishment of interdisciplinary research centers. Type T institutions are presumably ineligible to bid for these centers.

Will the British scheme work? My initial reaction is “no”. Science cannot be directed in this fashion. There is talk of killing the goose that lays the golden egg and there appears to be recognition of the need “to maintain some active research capacity across a wide range of basic work”. A Cambridge biochemist has commented that seminal ideas come from the work of individual scientists pursuing their own curiosities. “The birth of a new scientific idea,” he says, “is like the birth of a baby — what one woman can do in nine months cannot be done by nine women in one month”.

The reaction from the university world appears muted. I would have expected a greater protest. Perhaps the academics have accepted as fact the government assertion that wide support across a wide spread of scientific research is no longer sustainable. The chairman of the Advisory Board for the Research Councils — Sir David Phillips, a professor of biophysics at Oxford — in a meeting two other leaders of the new system six weeks ago, made a strong case for the necessity, and the efficacy, of the new system. The vice chancellors — i.e., the presidents, of the universities have been particularly meek according to what I have read.

Mrs. Thatcher’s science advisor, John Fairclough, incidentally, is a computer specialist who worked for many years at IBM in this country.

It all appears ominous to me. The brain drain has been going on for several years. There is a reported flight, also going on for several years, of young people away from science and engineering. At University College, Cardiff, the Microbiology Department is one of six to be closed in the interests of economy, in spite of a heavy demand for microbiology. Oxford is reported likely to abolish 140 posts, while Cambridge is contemplating closing its department of Applied Biology.

Could such a move to control universities happen here? It seems quite unlikely, at least now. The Reagan Administration is committed to strong science and engineering and has moved to strengthen them. This, of course, is against the background of level and declining funding, measured in constant dollars, over the past 20 years. There is little prospect that there will be any substantial federal facility programs any time soon. Still, the Administration is trying to double the NSF budget in five years, as I have already pointed out. What happens to the economy will be all-important. If there is a recession, anything can happen.

In the mid-1960s I traveled frequently in Latin America and I watched the student uprisings — particularly in Peru and Argentina — and told myself how fortunate we were, knowing that such reactions were impossible in the United States. And then, almost overnight, in December 1964, the uprisings erupted here. We can never be complacent.

Are There Too Many Research Universities?

In some respects we share the British university experience over the past 25 years. In 1961, when the country was still reacting strongly to the Sputnik challenge, the President’s Science Advisory Committee wrote a report which stated that we had perhaps 20
research universities and we needed possibly double that number. Now we have over 100 universities which have strong science and engineering in at least some fields and which deserve to call themselves research universities. The available funds are spread over this large number, each one capable of using much more money that it receives. Cornell, incidentally, now stands number three in the total volume of research, with about $250 million per year. For the NSF, we are the leading grantees institution.

In the post-Sputnik era there was a thrust to respond to the problem PSAC identified. The NSF had a “New Centers of Excellence” program in the mid-60s. I served on the Advisory Committee for that program for four or five years, and we helped in the distribution of more than $200 million. Most of the money went in $5 million grants to second-tier institutions. Some of the programs thrived and persist to this day and others faltered along the way. Now, the big question is: “Was it a good idea”?

Geographic distribution in the allocation of federal funds is always a consideration, with Congressmen from the Midwest, the South, and the mountain states, railing at the East Coast-West Coast cabal that gets most of the money. There is not recognition that, in science, the best is far superior to the second best. I have heard important Congressmen defend vigorously the practice of distributing research funds widely around the country, without significant regard to the capacity of institutions to use the funds profitably. It is good for the economy and therefore for the country, they say. “Peer review”, in which experts review the merit of research proposals, is a bad term to some Congressmen. They see scientists who serve on research proposal review committees as members of a scientific elite, whose object is to maintain and support the “old boy” network in a selfish manner. Hundreds of millions of dollars in support of university facilities, and even in support of some research programs, have been voted by Congress in recent years through floor amendment of appropriation or authorization bills, in a pure pork-barrel manner, with no merit review whatever.

These pressures and strategies have brought us now to the large number of research universities that we have, somewhat reminiscent of the Robbins Commission expansion in Britain. Do they all deserve support? Can we support them, and are we likely to support them? These are difficult but vital questions.

Most of these nouveau riche institutions probably do deserve support, at least in the areas where they have built particular strength. Furthermore, not all science is “big science”. The discovery of high-temperature superconductors a year ago led to important work at the University of Houston. Houston is not one of the country’s leading research universities, but should competent people there be denied the opportunity to do significant work in such an important field?

Our ability to support them is questionable. We do it only by limiting support of the leading institutions to levels well below their capacity. Is it better to have a large number of institutions scattered around the country with somewhat limited support, or is it better to have a smaller number of the best institutions, each receiving adequate support?

I think this is a question that is of academic interest only. I do not see how anyone can muster the political strength, at this point, to change the system. We cannot do in the United States what the British have done. There, the Cabinet can do what it wishes. There is no legislative way Parliament can thwart the Prime Minister and the Cabinet. Parliament can protest loudly, and does protest what the Cabinet does, but it cannot block Cabinet actions. Only the next election can change things. Here, Congress has control through the appropriation process. In short, we are going to continue to support the wide geographic distribution of research universities because Congress wants it that way. And all of us are going to have less money than we could use effectively.

**The Shortage of Talent**

I have discussed at some length the fund shortages which limit our ability to respond to the good opportunities. There is also a growing limitation in the amount of available talent. We are not attracting enough talented young people to science and engineering. It is difficult to forecast what the needs will be 10, 20 or 30 years from now, but there are ominous signs. The production of Ph.D.s in mathematics and the physical sciences is falling, while the demand is rising. In physics we reached peak production in 1972 with about 1,600. By now the annual number has fallen to something like 1,000, and it is stable there only because of the rising number of foreign nationals in our graduate schools. The entering graduate class in physics is now about 40% foreign. Ten years ago it was 20%. In engineering, more than half our Ph.D. graduates are foreign nationals, and more than half our new faculty appointees are foreign.

One of the weaknesses of our system is our inability to attract women and minorities, other than Asian minorities, to science and engineering. There are about 30,000 physics Ph.D.s in the country and only about two percent of them are women. Our production rate now is somewhere in the 5% to 10% range. The number of black and Hispanic Ph.D.s in the sciences is small and the number entering these fields is declining, while the representation of these groups in the population is growing. In 1985 there were 110 new black Ph.D.s in science and engineering. Most were in biology; 33 were in the physical sciences and engineering. That is fewer than one per state. We are missing an important part of our talent pool.

In the push after Sputnik there were fine graduate fellowship programs, sponsored by NSF and others. Those programs largely disappeared after the 60s and the number now is relatively small. Perhaps this conveys a message to young people that science careers are not valued in our society. Furthermore, the opportunity cost — i.e., the income lost by attending graduate school, is large and unacceptable to many people.

Until we find ways to attract more talented young people, our science and engineering programs are likely to be people-limited.
The Nature and Mission of the University

One pressure on the research university is to reorganize itself along interdisciplinary lines in order to deal better with the real-life problems the university is being asked to solve. Universities do not make such organizational changes easily. The traditional departmental organization is the comfortable one, and there is good reason for it to continue. In an interdisciplinary center a glass chemist, for example, can come together with a magnetic resonance expert from physics and the team can be productive in understanding the structure of glasses and ceramics. The physicist, however, can never gain from the glass chemist any new insights into the subtle atomic and molecular magnetic interactions. To do that he must go back home, to the physics department, to discuss such details with his physics associates. Sometimes a body of learning in an interdisciplinary area will evolve into a new field of specialization in its own right. Biochemistry is an example.

There are administrative problems in operating interdisciplinary centers. A person working in such a center has no place to look for evaluation of his work when it comes time for promotion or for salary adjustments. His home department is apt to say, “We cannot evaluate his research. He does not do his work here.” The Center administration is apt to say “We do not control promotions. That is done in his home department. And besides, we do not know anything about his teaching”.

Cornell has done well with interdisciplinary programs. We must have a couple dozen of them now. The first was the Center for International Studies, which was organized by Mario Einaudi and Steven Muller, of the Government Department, in the late 1950s. I immediately became interested, because I was sensitive to the criticism that academics do research on esoteric problems having little to do with real life. Why not bring all the relative disciplines together so that we can really deal with important problems? I was involved, about 1960, with organizing the Materials Science Center and the Center for Radiophysics and Space Research. Other centers followed in short order. The ones that represented good ideas, and which attracted funds, survived and prospered. Those that represented bad ideas faltered and failed.

Teaching has always been the raison d'etre of universities. At the undergraduate level we teach young people what those who have gone before have thought and have done. We teach young people the common intellectual heritage of our civilization. At the graduate level we teach people to solve difficult, novel problems. We teach them by apprenticing them to people who are themselves solving difficult, novel problems — i.e. to the best research scholars. In the process, much of the best research in the world is done.

I think this concept may be changing now. Society may be looking to the universities to do research for its own sake, over and above the teaching function. The problems of applied research, the emphasis on interdisciplinary research, and the pressure to get new discoveries to the marketplace faster may make teaching a secondary mission.

We are already expanding the need for non-faculty research staff and research support staff. In 1950 at Cornell there were probably no more than three support staff — i.e., presidents, deans, secretaries, technicians, for each faculty member. By 1970 the number was more like five or six. I do not know what it is now, but it is greater still. Included in the new staff are highly qualified research people without a faculty role.

The undergraduate enrollment and the size of the faculty are not likely to increase much because the number of college-age young people will decline markedly over the next 15 years. However, as we expand the number and scope of the Theory Centers, the Biotech centers, and the national facilities such as the Submicron Center (now called the National Nanofabrication Facility), the number of these research scientists will grow. Where will they fit in our organization? Will they have tenure? Will they supervise graduate students? How will their salaries compare to faculty salaries? Will we have a faculty tenure track and a non-faculty track? What will we do when one of our best research scientists must be given a faculty position with tenure in order to keep him here when some other university offers him such a position?

The Non-Science Fields

At the end of World War II the United States made a conscious decision to combine teaching and research in the major universities and we have built the strongest basic research and graduate teaching enterprise in the world. The decision was also made, however, to exclude the social sciences from significant federal funding. Because of that decision, we do not now have a large body of scholars who have thought deeply, and explored widely, the great social problems of our time — crime, poverty, drugs, the family.

The humanities have also been left without much funding. The channeling of resources to the physical and biological sciences and engineering has characterized the entire post-war period. With the present directions and pressures, is there danger of run-away emphasis on science and technology?

What will this do to the social sciences and the humanities? Will it result in warped values on the part of our young people? Will it mean that those pursuing the science and engineering fields will not have the opportunity to learn about the common heritage of our civilization? In order to provide the facilities to meet the opportunities and the requirements in the technological fields, will the universities shortchange the non-science areas by failure to build buildings and to provide adequate libraries? Will universities become technological and scientific institutes?
Finally, as the ability to provide the necessary funds wanes in the private universities, are we likely to see a slow transformation of private institutions to public institutions, as in the case of Rutgers and the University of Buffalo? If only the strongest of the private universities remain 50 or 100 years from now, will they be able to influence the standards for the entire higher educational establishment as the private universities have been able to do for the past 100 years?

Perhaps the relatively coherent, collegial universities of the past are giving way to more narrowly specialized institutes, with loyalties focused outwardly rather than inwardly. Perhaps we will not have the luxury of selecting the research projects where the richest scientific returns appear to lie. Perhaps we will have to do research in the areas that seem most immediately transferable to commercial products—if we want outside funding. Perhaps we at Cornell will find ourselves in an even more complex relationship with New York State than we have now.

On the other hand, the new challenges and the new opportunities can still be rewarding. Some things I have discussed are certain to happen. We are certain to have more ties to industry. We are certain to have difficulties financing our universities. There are certain to be fewer young people of college age. If we begin to make adjustments now, if we think twice before we respond to any new pressure, if we put our new organizational structures in place carefully, while we have time for reasoned change, the future can be built on firm ground.

**Conclusion**

In conclusion, I have raised many questions. Perhaps some are important. Perhaps some are not. I hope we can find satisfactory answers to the ones that do prove important.
Preface

Cornell Alumni News
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A former president identifies four challenges to higher education that defy easy resolution. In an article initially titled “Universities Are in Trouble”, I raised questions concerning what the public thought about research universities, and about the research universities’ ability to deal with the problems society was experiencing.

Dale R. Corson
March 1990

The High Cost of Quality
BY DALE CORSON

The major universities of America, universities like Cornell, are in trouble, perhaps serious trouble. They do not have enough income, their general economic outlook is grim, the public is losing confidence in universities, and yet society is expecting more of them than ever. The problems are greatest in the private universities but exist in the public ones as well.

A good measure of the money problem is the rate of rise in tuition, which has exceeded the rise in the consumer price index (CPI), perhaps by a couple of percent on average, for a long time. When I became president in 1969 Cornell’s endowed college tuition was $2,350 per year. For 1989-90 it is $14,040. That is an average increase of 9.3 percent per year over the twenty-year period. Now the rate is about 7 percent per year, with the CPI rate less than 5 percent.

A family that earned $20,000 per year in 1969 and paid $2,350 tuition was paying 12 percent of its salary. In 1989 the comparable salary had increased to perhaps $55,000 and tuition to $14,040 or 26 percent of salary. Where will it end? After a time, tuition exceeds salary, and sooner than you think. At the present rate tuition will be $500,000 in fifty years. The differential inflation cannot continue indefinitely and ways must be found to eliminate it or to provide the funds from other sources.

Why does tuition increase faster than the CPI? There are many factors, some of which can be changed and some of which cannot. In recent times burgeoning student financial aid is the dominant factor with its 15 percent per year increase over the past decade. In earlier times other factors dominated. There is a built-in ratchet effect that increases costs by adding new programs without removing old ones. In 1960, when I was dean of the Engineering college, there were about 135 faculty members in the college. Now there are 225. The expanded graduate study and research program requires the 90 extra faculty positions. In 1960, Cornell Engineering was not educating adequate numbers of students qualified to address the growing technological problems the country faced. Now it is. Meanwhile the 90 new faculty positions have been added with no possibility of subtracting a comparable number somewhere else.

The cost of new books for the Library increases much faster than the CPI. Also, we buy a large fraction of our new books abroad and the weak dollar has sent those costs sky-high.

Societal interest forces some of the added cost on us. It is important for everyone to have universities interacting with industry in, say, a Biotech Center. Adding that facility, however, requires added parking, more telephone lines, more heat and electricity. There is no way to recover all those costs so the university becomes more expensive to operate.

The public becomes disenchanted as the financial problems grow. The “public” includes, particularly, the Congress, federal officials, and state officials. William Bennett, secretary of education in the Reagan administration, led the charge, focusing on spiraling costs. “Higher education is not underfunded,” he said, “it is under-accountable and underproductive.” He missed no opportunities to lash out at professors who teach too little and at “lush” administrative budgets. A few months ago I was present at a meeting where a university official presented Cornell problems to a group of industrial leaders, problems that included the differential inflation rate. After the presentation the industrialists discussed the problem among themselves, indicating the way they would go about solving it. They would organize a study group, or hire consultants, to analyze the problem and define options for eliminating the differential rate. They would then cut programs and dismiss people until they solved the problem and they would do this forthwith. They seem not to understand how a university operates. We cannot do those things without disastrous consequences. If we attempted to eliminate the differential totally, our best faculty would move to universities that had not yet taken such a bold step. Still, can the universities continue to disregard such attitudes?

There is a growing perception that undergraduate education is inadequate, that it is not worth the high tuition in the private institutions. The Cornell emphasis on teaching has always pleased me. We have Nobel laureates teaching freshmen. We have few if
Student uses a dissecting microscope in biopsychology lab.
any faculty members who are strictly research professors. Teaching is the major part of the job. Still, there are the complaints about large classes (for example, when a popular teacher lectures in Bailey Hall) and about teaching assistants who do not speak English adequately.

Some critics of undergraduate education believe, with Allan Bloom, that we should go back to the “great books” type of liberal education that highlights social and moral values. Others, I among them, believe that we are producing a population of scientific and technological illiterates. Those who are going to be our business and political leaders will be required to make important decisions, affecting us all, about technological problems they do not understand. No matter how ill-defined the criticism is, debate about the proper role for the university intensifies and any institution that neglects undergraduate education will do so at its peril.

There is disenchantment with the “publish or perish” label often pinned on university promotion practices. Scholars do publish too much, sometimes on less than the most important subjects. Publishing is not an end in itself although it is the way our civilization progresses with the ever more difficult problems it faces. What if there had not been extensive research, and widespread publication of results, on viruses when the AIDS epidemic began?

The university’s job is to teach students. At the undergraduate level we teach the common body of knowledge and understanding that is our heritage and we try to teach students to think clearly. At the graduate level we teach students to solve difficult, novel problems for which society requires solutions. We teach graduate students by apprenticing them to scholars who are solving difficult, novel problems themselves, and who are contributing the new insight and understanding by which civilization progresses.

Publishing is a way to be sure that the individual faculty member is teaching graduate students how to solve the problems society faces and will face in the future. It is the way a faculty member’s peers judge the quality of the work. If it does not measure up by the peer test, if it does not influence the work of others in similar fields, then he or she is incapable of teaching his or her students adequately.

While these troubles beset universities, society is expecting more. Science and technology are advancing faster and faster, much of it coming from research in the universities. Biotechnology is an example. No major industry can afford to maintain research capacity to cover all the important fields and so it seeks “windows” into the universities. Here it can keep abreast of developments and know at an early stage where the opportunities are.

Universities enter into industrial agreements to promote this interaction but, in some ways, the liaison is an unnatural one. Universities do basic research, the “pay-off” of which is long-term, while industry must show near-term profits. The corporate world is fast-moving these days, with takeovers, threats of takeovers, and mergers dominating business pages. New managements may not support commitments made by old managements. One of Cornell’s corporate partners in the new Biotech Center withdrew before the center even went into operation. Another sold its biotechnology group to a foreign corporation and a third was taken over and the biotechnology initiative eliminated.
How are we going to come to grips with these problems? Let us start with the money problem. Higher education carries a high priority in our country so why cannot the university get more money from its patrons? Universities such as Cornell are pushing every button on the console to do just that, but without complete success. The federal government is not going to be the solution. Federal deficits guarantee it.

The government has never paid the full cost of its sponsored research. Overhead costs (for secretaries, library resources, snow removal, grant administrators, telephones, etcetera) are not fully reimbursed. Even so tension between universities and governmental agencies over ever-increasing overhead rates is growing. Furthermore, the government reimburses only a fraction of the faculty research salary costs, leaving most of the salary burden for support by tuition. Finally, the federal government has backed away from provision of facilities required for its sponsored research.

The federal government has also cut back its student financial aid programs. In the 1960s, in the days of the “Great Society” the universities and colleges made a social contract with the government to provide a university or college education for all qualified students, regardless of ability to pay. Federal and state financial aid programs, with what the institutions could provide, made the dream a reality. At the peak enrollments in the 1970s more than 40 percent of the college-age population was enrolled in higher educational institutions. Now the federal programs are largely gone, the student aid program has not kept pace and the universities and colleges honor the earlier commitments with their own funds. Financial assistance at Cornell has grown at 15 percent per year, doubling every five years, for the past decade. Now it exceeds the income from Cornell’s entire unrestricted endowment (i.e., that available for any university purpose). Tuition makes up the difference.

The economic outlook is grim. The public resents our tax-exempt status. The tax-exempt bond market is already partially closed to us and may become totally so. Our research overhead rate (now 75 percent in the endowed colleges and going up) is under siege. More narrowly defined “unrelated businesses” and business taxes will limit revenue-generating capacity. The Tax Act of 1986 limited the tax deductibility of gifts to universities and additional limitations are possible. There is a federal district court suit charging a group of major universities, Cornell among them, with violation of anti-trust legislation for alleged tuition price fixing.

Why not get the money from industry, which is a major beneficiary of university education and research? For the most part industry pays for well-educated man- and woman-power only through taxes, little of which returns to the universities, at least the private ones. Industry now pays for about 6 percent of the basic research in universities and the corporate research directors I know say that number cannot go higher than 8 percent. Why not? One reason is the need to show a short-term return on an investment—otherwise a company’s stockholders become restive and takeover artists move in. Universities are not in a position to provide high short-term returns.

What about foundations? Cornell has benefited greatly from foundation support for a long time, but that support is seldom for ongoing operating expenses. Foundations support innovative ideas that can be exported to other institutions for maximum impact. They support a new enterprise for a time and then the university must pick up the tab. Also, foundation grants (and other program-supporting gifts) carry no overhead reimbursement. The university is a better institution but its costs go up.

What about gifts? Cornell has done well in this category of support. Cornell alumni have responded to our need in generous fashion, with total gifts (alumni, endowment gifts, foundation grants) for 1988-89 of more than $150 million. Over the past twenty-five years Cornell has moved up among the gift leaders—Harvard, Stanford, Yale. Only Harvard- and Stanford exceed us now. Without these gifts Cornell would be a much lesser institution, but more than 80 percent of gifts are for designated purposes and Cornell has little flexible use of them.

When we put all these sources together we still come up short of the need. Tuition is the only way to make up the shortfall, therefore the increasing burden on students. For capital projects we borrow. Ten years ago Cornell’s debt was $70 million. Now it is $250 million. When the debt supports income-producing projects, such as student housing, tuition does not bear the burden. Student housing and dining fees do.
Catherine Rombout, Grad, works on her degree dissertation in French literature in the music room of Willard Straight Hall.
What can the universities do to turn around the trends? Start with the differential inflation rate. Can we cut costs to bring the tuition rate down to the CPI? This means greater productivity. Can we teach the same number of students with fewer faculty? Of course we can, but it would not be Cornell. In spite of our student/faculty ratio of 10/1 there are complaints about large classes and about too many sections taught by teaching assistants. Can we cut our research costs by doing the same work with fewer people? Absolutely not.

Can we streamline the whole operation to avoid duplication? Four of Cornell's colleges have economics departments. Could we eliminate duplication with one department? Can we save money by further computerizing our operations as the Library has done? Corson's First Law of Computer Economics says that one never cuts costs by computerizing an operation. It always costs more. What one does is increase the quality of the service offered.

Can we eliminate departments? Washington University in St. Louis has abandoned its sociology department. Johns Hopkins has abandoned its classics department. Can universities specialize, with one maintaining excellence in one area, say science and engineering, with other universities specializing in something else? I view this as a bad idea. The quality of education would surely decline with such a move.

Can we turn around the public image? Not for a long time, I think. The misconceptions are so deep and the universities' character so set in concrete that it will take a long time to change either.

Will society continue to look to the universities for solutions to growing problems? I think it is inevitable. Industrial research capacity is declining while research progress is faster than ever before and there is great pressure to get new technology from the laboratory to the market place ever faster. Universities, public and private, have done more than 50 percent of the nation's basic research for a long time and the share is going up. Competitiveness is a household word and successful competition surely involves new science and technology.

Also, because of federal funding practice for the past forty years, there has been relatively little research in the social sciences. Now we have staggering social problems—drugs, crime, poverty, disintegration of the family. We desperately need a body of scholars who have thought deeply about these problems and who have ideas about how to deal with them.

What is likely to happen? Cornell can keep going as it is now for a time. The number of students seeking admission is about seven times the number of available places, in spite of the cost. The trend probably will be toward a more affluent student body—a move away from the traditional Cornell. I see no way Cornell can continue the "needs-blind" admission policy and meet the full need of every student, given the abrogation of the social contract by the federal government. It seems essential to me that the faculty and administration work together to consolidate multiple programs that have evolved, in economics and sociology, for example. Surely there can be savings without discarding logical departmental organizations.

By cutting administrative costs at every corner, progress can be made. From the 1988-89 to the 1989-90 budget the Cornell administration cut $4 million from the administrative cost base—a remarkable achievement. The differential gap is not going to go away, however, without radical surgery that is not likely to happen soon.

Part of the differential can be removed by increased productivity. The other part is not amenable to productivity increases. Eric Ashby, former vice chancellor (i.e., president) of Cambridge University put it aptly when he pointed out that it always has and always will take four people forty-five minutes to play a Beethoven string quartet. Much of the teaching process resembles quartet playing.

The most likely move, I think, is toward more public higher education. There has been a slow trend in that direction for a long time. In 1958 private institutions awarded about 43 percent of all bachelor's degrees. In 1988 the fraction was about 35 percent. In recent decades we have seen private universities become state institutions, Buffalo and Rutgers for example. As the financial problems become more difficult the burden shifts from individuals who are the beneficiaries of an institution to the whole population.

If we go the public route will the remaining private universities retain their capacity to influence the quality of education as they have in the past?

My biggest worry is that we will go the British way, with radical changes forced on us by the federal government if we want federal funding. In 1987 the British government sought to impose discipline and accountability on the university community through radical reorganization of the whole funding process. The new program focuses on the importance of university-industry ties. There are advisory bodies with a heavy industrial emphasis. There are new institutions, such as a Center for the Exploitation of Science and Technology, which seek to define the research fields with the greatest potential for economic development. Universities are categorized as "research" and as "teaching" institutions. (There are also hybrids.) The government announces the fields where it will entertain proposals for research projects to be funded; and it grants funds on a contract basis. An institution's continued funding depends on its contract performance. The government forces streamlining on university organization, departments are eliminated, and teaching patterns are modified.

"The number of applicants is about seven times the number of available places, in spite of the cost. The trend will probably be toward a more affluent student body"
From the information I have, the system appears to work with some success but it seems to me that it must fail in the end. Science does not progress in such programmed ways. If Lord Rutherford had had to justify his research on its economic potential in 1911 he would never have discovered the nucleus of the atom.

These days are difficult for higher education and particularly for the private universities. I see through the glass darkly but I see a troubled future. The American people and their government have a problem. They want the universities to provide ever more service. They want quality education to be available to any qualified person, but they are unwilling to pay for it.

As a faculty member, a dean, and as president I learned how much we need the alumni's help. Alumni giving is magnificent. The more the giving is unrestricted, the better the administration can use available funds to meet all the needs.

I have confidence in the Cornell administration. They understand the problems and they are addressing them. Where operations can be streamlined and productivity increased, it will be done. Where productivity cannot be increased, other ways must be found to solve the problem. This becomes society's problem as well as Cornell's.

However this story ends, the Cornell of the future is likely to differ from the Cornell that our alumni know. This is not to say that it will be an operation of less quality. Only that it will be different.
Preface

Throughout the 1980s and early 90s I was rather heavily involved with U.S.-Japan Science and Technology Policy issues. There were, in that period, about a dozen bilateral agreements between the U.S. and Japan. One concerned basic research, and I was the chairman of the U.S. end of that operation. I was appointed by the State Department, but the working agency was the National Science Foundation. We supported graduate students who wanted to work in Japanese laboratories, and Japanese scientists who wanted to work in U.S. labs, as well as other mutual programs.

During my time in this effort, I organized two Science and Technology Policy seminars on the subject in Hawaii, one in Honolulu and the second, in the early 1990s, at a resort hotel on the north shore of Oahu. Each side sent perhaps six or eight participants. Each side presented a series of position papers prepared by the participants.

In a final plenary session at the end of several days of deliberations, there was a summing up of what had been said and debated. I presented what I considered the consensus of the American papers, consolidated into an organized whole. The attached paper is what I said in that session.

Dale R. Corson
November 10, 1993
Introduction

Since World War II, basic research operation of the United States has been characterized by a partnership between the academic world and the federal government, with more than half the basic research performed in the universities. At the same time, major industrial concerns have supported large and important central research laboratories. Companies falling in this category include the Bell Telephone Laboratories, the General Electric Company, Westinghouse, The Radio Corporation of America, the Corning Glass Company, and the major pharmaceutical companies such as Upjohn, Squibb, Pfizer, and others.

Research support in the universities has been provided by a diverse group of federal agencies including the National Science Foundation, the National Institutes of Health, the Office of Naval Research, the Office of Scientific Research in the U.S. Army, the Advanced Research Projects Agency in the Department of Defense, the United States Department of Agriculture, and several other agencies with smaller research budgets. Relatively little support for basic research in the universities has been provided by industry, probably no more five or six percent of the university total.

One of the principal features of this system has been the combination of graduate education with the research effort in the universities. The primary function of the research faculty in the universities has been to teach students to solve difficult, novel problems by apprenticing the students to investigators who themselves are solving difficult, novel problems. In the process, some of the best research in the world has been accomplished.

Over the past ten or twenty years, this system has begun to change, and its effectiveness has eroded. In the first place, the cold war ended and national security is no longer the driving force behind the basic research effort; the support has faltered. Large federal deficits developed when governmental fiscal policy changed during the Reagan and Bush administrations. The country, and the world, has been hit by a deep and persistent economic recession in recent years, further pressuring the availability of funds for research purposes. On top of everything else, the emergence of other countries, primarily Japan, as dominant world economic powers has taken away markets and shifted the focus of research and development emphasis in the country.

The result of these combined forces over the past decade or two has been to shift the emphasis from basic research to development of products and processes that have quick economic payoff, and to shift the research emphasis toward directed ends perceived to have strategic advantage in confronting the industrial competitive problem presented by Japanese, German, Southeast Asian, and other new economic giants.

American industry has found itself faced with declining markets and the requirement to reorganize itself, often into smaller decentralized units, with a consequent decline in the importance of the centralized, high-quality research laboratory. The result has been loss of the ability to provide the large amount of basic research that undergirded American industry’s economic dominance.

While all this has been going on, the stature of American universities and their perceived importance in the whole American economic scheme has been undermined by a series of developments that threaten their effectiveness in the future. Foremost among these developments has been the rise in cost of doing research, as well as in the cost of providing education to the undergraduates they also serve.

The American research scene has also witnessed a certain amount of fraud, including both scientific fraud in the reporting of research results and financial fraud in the stewardship of governmental funds intended for research. All these factors, while they have characterized a minuscule portion of the entire effort, have combined to undermine the public confidence in the universities, leading to a growing reluctance to provide support in adequate amounts.
For most of this century the cost of American higher education, including the cost of doing research, has increased two or three percent, on the average, faster than the rate of increase that has characterized the general inflation rate in the economy. The most readily evident part of the rising cost has been an ever larger fraction of the total cost of doing research going to “indirect costs” — i.e., to the “overhead” costs of doing business — the supporting services and supplies. Much of the relative increase in indirect costs has arisen from governmental regulations requiring increased attention to worker safety, to the care of animals used for research purposes, and to supervision of the use of human subjects for research purposes; from environmental pollution control; and from many other research-related activities mandated by governmental regulations.

Rising indirect costs and pressure to contain them have led to assumption of more and more of the costs by the universities themselves, with the money to cover the costs coming from the tuition undergraduates pay in the case of private universities or from public appropriations in state-provided budgets in the case of public universities.

At the same time that the indirect costs have risen, the direct costs of doing research have also risen as the research has become more complex and the facilities and instruments required have increased in cost at a rate that has also exceeded the general inflation rate.

The response of the universities to the growing public pressure to contain the costs and to eliminate whatever fraud exists in the system has sometimes further eroded public confidence. The universities believe that if they are to serve the public through the provision of high-quality research and the education of graduate students, the public should reimburse the universities for the costs. Unfortunately, university perception and public perception of what the real costs are diverge widely.

The “public” in this situation is most directly the United States Congress, which is much the most important institution in the provision of public funds for research purposes. The result is that Congress is now in the “driver’s seat” and there is a broad gap between university and Congressional perceptions of the problems. Confidence has been lost and it will take time to heal the wounds.

These developments over the past ten or twenty years have left a number of important but unanswered questions concerning the future of the American research effort. I can list some of the questions here, but I do not know the answers.

Who is going to do the research that the high-tech economy we are developing around the world requires for future development? There is a widespread conception in the United States that Japan has based its highly successful high-tech developments on American basic research. If American research falters, will Japanese high-tech industry also falter? American industry is cutting back its own research concentration for a number of reasons, and the universities appear to be in no position to produce results as they have in the past. It is a problem.

Can high-tech development continue to thrive on the reservoir of basic research results which now exists? Is there a sufficient body of results available in our libraries and in our scientific journals to sustain us into the foreseeable future with the diminishing replacement rate we think we see now? I doubt it.

As research funds become less available, there will be inevitable pressures to support research projects which are perceived to have the most economic potential. By adopting a policy of such directed research in an effort to make the research dollars go farther, are we jeopardizing the future? I tend to believe that the answer is “yes”. Some twenty or more years ago, The National Science Foundation conducted a study called “TRACES” which sought out the research origins of a number of economically important new technologies, such as the contraceptive pill and the laser. The study found that the economically important development had its roots in every case in a broad base of fundamental research, often in many different fields, all of them vital to the eventual development of the product in question. Had someone 100 years ago, begun a search targeted narrowly on a contraceptive pill, it would have been unlikely to succeed. Only by bringing together an array of results across many fields was the final product realized.

Can universities and industry form partnerships of sufficient capacity and relationships to provide, between them, the essential basic research? In the United States this has not happened in the past. It is becoming of more interest now, given the rapid development in some fields and the inability of industry to provide the wide-ranging research required. The new field of biotechnology is perhaps the best example. Much of the important work has been done in universities, and industry must have “windows” into the university work, so partnerships and cooperative efforts have developed in many places. Monsanto with Washington University in St. Louis is one example. The large German pharmaceutical firm Hoechst and Massachusetts General Hospital in Boston is another. It seems to me that this avenue must be pursued vigorously.

Will graduate education and research continue together as they have in the past in the United States? This practice is by no means required for research success — witness the German Max Planck Institutes where much of the research is performed and which are only loosely tied to the universities. The Japanese universities have not played nearly the important role in performance of research and the training of investigators that the universities have played in the United States. It seems now that American research and graduate education will continue closely tied together, but the situation could change.

Can American universities contain the costs, not only of supporting research, but also of providing education to undergraduates? It is going to be difficult in the extreme. We have 125 or 150 years experience doing things the way they are done now and it will be
hard to change. It seems to me, however, that we must find new ways of containing costs if we are to survive in a vigorous state. We must find ways to abandon the old things we do so that we can undertake the new things that society demands of us.

Can we continue to attract the brightest and the best of our young people to science and technology? This is by no means certain, in my mind. We fail to attract significant numbers of women in many fields — physics and mathematics, for example. We have a large minority population and, with the exception of Asians, we are not attracting them to technical fields. We are missing large reservoirs of talent that we will surely need in the future. In my opinion, not enough effort is directed in this direction.

How can we rebuild the infrastructure that supports our research effort? Following the launching of the Soviet Sputnik in 1957 there was great emphasis on science and technology in the United States, lest we lose the economic and intellectual war to the Soviets. Facilities and research equipment that were provided by the government served us well for many years. Now there are few programs to replace the aging facilities and the outmoded instruments. The only place replacements can come from, other than those that industry can provide for itself, is the government, and there is little motion in that direction. This seems a big problem to me.

I have outlined here the nature of the large problems we have heard about from those on the American side who have presented their views to us. I have also made brief commentaries on where I see the United States standing at the moment and where I see it going. I believe that the future of the high-tech industry of the entire world depends to a considerable degree on how we in the United States deal with these problems. I believe it is important that the Japanese, in particular, contribute a larger share of the basic research we require for the future. I hope we can approach these problems cooperatively and work together for the welfare of the entire world.
Preface

In 1994 (June 22-23) the UCLA Vice President for Research, Kumar Patel, a former Bell Labs leader and inventor of the high-power Carbon Dioxide Laser, organized a two- or three-day symposium on “Reinventing the Research University.” Attendance was by invitation, and I was one of the invitees. The papers presented were published in a book (1994), edited by C. Kumar N. Patel. I submitted a paper on the organization and operation of multidisciplinary centers that was published as an appendix to Kumar Patel’s book (277-286) and is reprinted here.

This paper originated as the report of a committee that Provost Robert Barker asked me to chair. He appointed an excellent faculty committee and the report, written by me and approved by the committee, is the result of deliberations there.

Dale R. Corson
June 1994
Introduction

Universities address the problems of society and civilization both in their teaching programs and in their research programs. As populations rise and resources decline, the problems that beset us become ever more complex, and they are not easily approached by traditional academic disciplines in isolation. In response, there has been rapid growth in most universities over the past 30 years in multidisciplinary and interdisciplinary programs of both teaching and research, seeking to deal with the “real life” problems.

The engine for much of the social, political, economic, and technical pressure is population growth. As populations rise, resources are depleted: the soil eroded, the land deforested, the minerals consumed. Water pollution rises and water tables fall. Land and water are contaminated with herbicides and pesticides, but resistant insect strains emerge. Atmospheric “greenhouse” gases increase and ozone levels fall. Consumption rises, but ability to cope with waste falls. Urban violence rises and the quality of education falls. New diseases arise and the efficacy of old antibiotics falls. Food production rises, but starvation abounds. Arms proliferate and international tensions grow. The list goes on.

Rapid population growth, plus ever-more-intensive energy use, plus growing interdependence, plus new technological challenges, plus growing social complexity — all these combine to produce severe social dislocations.

What to do about it? These problems are with us, they are growing bigger and they must be dealt with. Universities are a good place to start. The university can equip its students with the necessary backgrounds to understand the problems and, through its graduate study and research programs, can come to grips with the problems and contribute to their amelioration. Above all, the programs produce a body of informed citizens, as well as a body of scholars who have thought deeply about the issues. These informed citizens and scholars can influence those who make decisions. As time progresses, we must have more such people.

To contribute significantly, the university must bring to bear its total strength, which means bringing the relevant academic disciplines to the problems. This leads to multidisciplinary and interdisciplinary research and curricula.

Definitions

I will define at the beginning the distinction I make between “multidisciplinary” and “interdisciplinary.” In most such programs, individuals from different disciplinary specialties come together, each bringing his or her own disciplinary skills and insights. Together, they can supply the necessary skills required for an impact on the problem in question. On the other hand, occasionally a problem can be defined at the interface of two disciplines — as in the case of toxic-waste disposal and the law — where the rare person who has depth of insight and skill in more than one discipline can be invaluable. Examples are the sociologist or the ecologist with mathematical skills, the engineer with a degree in economics, and the physicist with a law degree. These individuals are able to cope by themselves, and the work is interdisciplinary. They are true interdisciplinarians, and academic organizational arrangements must accommodate them.

The multi- and interdisciplinary programs are here to stay, and they will grow in importance. Universities must learn to organize themselves accordingly.
Traditional Departmental Structure Is Important

I want to state here, however, that replacing traditional disciplinary organizations with new multidisciplinary groupings is often a bad idea. Participants in multidisciplinary efforts need to return to the association of their own specialist colleagues to gain new insights into the complex matters they are dealing with. An example, out of my own experience, is that of the glass chemist and nuclear magnetic resonance physicist coming together to explore the structure of glasses and ceramics. Using the magnetic techniques, the two together can illuminate the quasi-crystalline structure of the materials they are studying, find how the structure changes with time, and generally find ways to understand the strange physical behavior they see and devise ways to make the materials more useful for engineering purposes. If the physicist is left to associate permanently with the chemist, however, he/she will never gain new insights into the subtleties of magnetic interactions between atoms and molecules in condensed matter. To gain those new insights, the physicist must go back to association with his/her physics colleagues to discuss and explore new ways to use magnetic techniques. Likewise, the chemist can never learn new ways to create glassy and ceramic materials by talking only to the physicist. He/she must go back to his/her chemist friends for that.

To make the most of their association, the chemist and the physicist must come together in a research setting where each can apply his/her own particular skills and insights, but their basic organizational associations remain the disciplinary departmental structures.

Centers, Institutes, and Programs

The appropriate research organizations take the form of “centers” or “institutes” or “programs.” At Cornell, the term “institute” has not been generally used because it is thought to connote a research operation alone, without teaching responsibilities — an arrangement not looked on favorably where teaching is considered a major part of nearly every enterprise.

My experience has been with “centers” primarily, although I have had experience with smaller efforts labeled “programs.” The centers bring together specialists from a variety of disciplines who work together, under some type of governance arrangement, to pursue research and teaching programs in such fields as “Materials Science,” “Environmental Research” and “International Studies.” Under these general umbrellas, there are sometimes smaller, coherent subsets called “Programs,” such as the “Southeast Asia Program” under the “Center of International Studies” umbrella. In the discussion here, I use the term “program” for whatever the organization: center, institute or program.

In each case of multidisciplinary center, the individual faculty member keeps his/her departmental home. The department’s responsibility, vis-à-vis the center, for the individuals’ well-being must be clearly spelled out. Who is to evaluate the quality of the research? Who is to recommend salary increases? Who is to recommend promotions? What are the criteria that are going to be applied in each of these cases?

Good Governance Is Essential

A clear charter is sine qua non for a successful multidisciplinary operation. The charter must state the objectives of the program, how it operates, what the governance mechanism is, how the steering committee is selected, what the review procedures and all other relevant organizational and operation features are. As situations change, the charter must be kept up to date.

The second feature of good governance is an active steering committee. The committee must be built on a solid representation of participating faculty members, appointed on a rotating basis. They are the ones who know best what the program is and what the opportunities are. Participation of faculty from other disciplines and fields provides a broader perspective. Senior university administration representation, at both central and college levels, is essential. These academic officers are the only ones who can make comparative judgments about different programs and allocate financial and space resources. The steering committee must meet at regular intervals, and regular senior administrative participation is vital.

The steering committee’s role is to affirm the program’s objective and to help the director define the program’s agenda. The steering committee is also important in recommending and securing appropriate financial and space resource support.

Mandated periodic review, at intervals of no more than five years and with outside participation, is essential. Such review can assess the vitality of the program and the quality of the leadership, as well as ensure that all-important research directions and funding opportunities are identified. Sometimes, periodic reviews conducted entirely by an outside group are mandated by a federal agency or by the decision of the center itself.

Periodic reviews should allow for the possibility of program termination. Times change, programs evolve, priorities come and go and faculty interests shift. Indefinite life is not necessarily appropriate for any program. Periodic reviews can determine the vitality of the effort and its continued importance. If the time comes when it appears that a different effort would be more productive, there should be ways to terminate the program gracefully, with any attached faculty positions appropriately cared for through membership in a departmental faculty or some other suitable way.
Appropriate Appointment Procedures are Vital

In the great majority of cases, faculty appointments of persons participating in a multidisciplinary program will be joint with a department, and the appointment is made through normal college and departmental procedures, with program participation in the search process. When both the program and the department wish to appoint the same person, there is no problem. If the appointment carries tenure, tenure will be in the department.

Two circumstances may dictate modified procedures: 1) the priorities in the department and those of the program may not coincide; and 2) a true interdisciplinarian, professionally qualified in both the departmental discipline and in the program field, may be proposed for appointment. Again, if the department is willing to appoint the person under normal procedures, no problem arises. Problems arise when the department’s priorities differ from those of the program, or when the department may be uncomfortable with a person admittedly qualified in the discipline but whose interests diverge from traditional lines. In such a case, special procedures are required and the appointment must be made somewhere other than in the department. The following is a suggested way to do that.

Programs that want to initiate new appointments outside any department should be required to explain in writing to the dean and provost why such an appointment could not be made through a department, and explain how it would affect the teaching and research missions of both the program and the relevant departments. The dean should make this report available to the relevant departments and solicit their comments on how such an appointment would affect them before deciding if the appointment is appropriate and, if so, where it should be lodged.

If, for whichever reason, the dean of the relevant college believes that the proposed appointment is inappropriate for an existing department, he/she may decide that an interdisciplinary search and college appointment procedure is called for.

The dean will appoint a search committee with membership from relevant departments and from the proposing program. The search committee will conduct a competitive search following the standards normally used by the college.

A vote on the candidate by the department or departments in which his/her courses will be listed and the recommendation of the search committee are the best assurances of a quality appointment. If a tenured appointment is proposed, the qualifications of the candidate should be reviewed by an ad hoc committee appointed by the dean.

If the search is successful, there are several options available. In descending order of preference, these are:

1. A tenured or tenure-track appointment in a relevant department.
2. A tenured or tenure-track appointment in the college with full membership in a relevant department.
3. A tenured or tenure-track appointment in the college with membership in a department apart from the right to vote on appointments and promotion cases.
4. A tenured or tenure-track appointment in the college with membership in one or more graduate fields (graduate fields at Cornell include faculty members with common research interests, but the fields are not necessarily the same as departmental groupings).

If an offer of appointment under any of the above options is made, the offering letter should describe in detail the role the candidate is to play in the department and in the program. This letter must also contain a careful description of the procedures to be used in evaluating the faculty member for promotion.

I have some concerns about the above procedure. I am concerned about nontenured faculty members who are appointed without a departmental home. I can imagine circumstances in which it may become necessary at some time to have such a home. For example, if the appointee gains tenure in the college and the program is subsequently discontinued, a departmental home is essential. This problem can be avoided to a considerable degree if every college appointee is required to have a departmental appointment, even if only a courtesy one. I believe strongly that it would be a good idea to require such an appointment, but I recognize that there may be rare cases where circumstances militate against it.

Three Types of University Funding Are Important

I believe that a multidisciplinary program can be successful only if it has adequate funding from the university in addition to all other funding. Further, programs should be able to launch new initiatives using grants and gifts.

The funds from the university are needed for administrative support and annual operating funds. In addition, they can be used to fund faculty positions. This latter use falls into two categories: 1) to support one or more faculty positions permanently, either in departments or as college appointments; and 2) to seed new faculty appointments with the understanding that after a specified period a department will provide the necessary permanent funding. I believe that this latter approach to the funding of appointments is the more desirable. It allows a program to recover its university funds and seed another new appointment.
The former use commits funds indefinitely and hence diminishes both flexibility and the influence of the program. A program can also use grant or gift funds to seed new appointments, provided these resources are secure for the required period.

In suggesting annual “hard” money sufficient to support some appointments, I seek to avoid the circumstance of a program feeling that it must beg for cooperation by a department. It must be able to proceed with its own priorities at some minimum level. The carrot of a revolving fund strengthens the program’s hand in bargaining for departmental support. Half or full support for a limited period will often give the department time to accommodate its immediate priorities and will give everyone time to plan ahead.

**A More Coherent Overall Organization?**

If the university has many multidisciplinary programs, some overall organizational arrangement to give them a structured and sympathetic home may be useful. The programs vary so widely that no simple organizational arrangement is apparent. Some are primarily research and extension efforts, some emphasize undergraduate teaching, some are primarily graduate study and research enterprises. They do not easily fit a single mold. On the other hand, they do share some common elements that make it possible to think about possible new arrangements.

They all need the attention of senior academic administrators, both at the central administration level and at the college level. Only at these levels can priorities be judged and resources allocated. To be effective in setting priorities and in guiding programs, this attention must be as continuous as possible. I can think of a number of options for providing such help and guidance:

1. Appoint a new vice president with responsibility for all multidisciplinary programs in the university.

2. Create a Division of Multidisciplinary Studies that sits between colleges, with a director who operates at the dean level.

3. Assign each program to the most appropriate college, with the dean of that college responsible for the program’s welfare.

4. Assign responsibility for a program jointly to the deans of the participating colleges (a “gaggle of deans”), with a rotating chair chosen from among the deans or with the provost or a vice president as the chair.

5. Leave the traditional administrative arrangements in place and admonish the appropriate senior administrative officers to become involved in the programs and to attend steering committee meetings.

None of these options is the obvious and natural solution to the problems I see. The large number and disparate nature of the multidisciplinary programs militate against likely success of a new vice president office. It may be that a subset of programs might have enough intellectual coherence to be administered successfully by a single individual.

Creating still more bureaucracy in the university has little appeal, unless one wants to think about major new activities and programs. One way to accommodate the burgeoning environmental programs might be through the addition of a new vice president responsible for the organization and coordination of all environmental work. If such an office were established, perhaps some of the other multidisciplinary programs could be assigned to it. I have little enthusiasm for this option, but I do see a need for more high-level attention.

If major administrative changes are appropriate, the division option should be considered. The success of the biology division indicates that such an operation can be successful at Cornell. It would bring the disparate programs to a focus in one office, with a director who could move easily among the deans of all the colleges. Coordination of programs and maintenance of standards would be easy. Judging priorities among multidisciplinary programs and departmental efforts and allocating resources according to well thought-out priorities would proceed in parallel with the same activities in the colleges. A division could succeed, perhaps, only if it embraced a subset of programs with intellectual coherence, as in the case of the environmental area.

Assigning each multidisciplinary program to a dean and to a college is the simplest solution and has the most appeal from an administrative standpoint. It has the advantage that the mechanisms for developing budgets, for making appointments, and for recommending promotions are all in place in the college. The dean is the administrative officer who best understands the “culture” of his college and its educational needs, and he/she is the one who will have to live with the consequences of his/her actions. For programs residing predominantly in one college, it is a natural arrangement. On the other hand, it ill suits programs whose multidisciplinary work cuts across college boundaries. The Science, Technology and Society program at MIT operates in this way in spite of the disadvantages.

I see many advantages to the “gaggle of deans” arrangement for programs residing in several colleges. It brings together those with the most direct interest in the programs and with the most immediate authority to allocate funds and assign space. It makes inter-college collaboration easy. For programs bridging colleges, this organizational arrangement, plus some formal way for top administrative collaboration, has appeal.

I believe that asking the provost and the appropriate vice presidents to expand their efforts in order to place multidisciplinary programs among their high priorities is inappropriate and not likely to work. Few in the university bear heavier burdens, and no one can expect them to add more.
The logical conclusion to this line of reasoning is belief in the need for some modified administrative arrangement. Which of the organizational arrangements is preferable depends to a considerable degree on what the senior university administrative officers believe the importance of multidisciplinary programs will be a decade or two decades from now. How committed is the university to this type of study and research? I cannot answer such questions, but I believe that interdisciplinary programs will become increasingly important.

**Departmental Status Can Become Appropriate**

I can conceive of circumstances in which one or another of these programs, or others like them, might be elevated to normal departmental status. Biochemistry is perhaps the best example from the past. Biophysics is evolving in a similar way. To consider such a move, one must ask who are the most appropriate everyday associates of the participants in the program. If they seldom need to talk to anyone other than their program associates, if they have no need to return to their disciplinary base to gain insights into the problems that confront them, then departmental status might be considered. Ancillary to this consideration is the question of common scholarly techniques and a substantial body of scholarly material around which the new discipline might be built.

**Emphasis on Teaching Is Important**

As a general feature of multidisciplinary programs, I believe more teaching might be in order. The various programs address problems that will more and more affect the way people live and conduct their affairs. Informed discussion and action depends on an informed populace. The informed populace is now small and it must grow. Universities are good starting places. Undergraduate and graduate instruction in multi- and interdisciplinary fields, added to instruction in the traditional disciplines, has a chance of producing graduates able to think intelligently and in new ways about new subjects.

Multidisciplinary teaching of undergraduates can be done in two quite different ways. One is by creation of new interdisciplinary courses. Some of them may be best taught by a faculty team. This works well only if the team integrates its efforts carefully. The other is by deliberate introduction of multidisciplinary material into existing courses. This may well require faculty to take part in special workshops or seminars where they can learn in depth about new multidisciplinary approaches relevant to their teaching. This second approach is the infusion of multidisciplinary material into the existing curriculum. Summer faculty workshops with this objective, if they can be funded, are excellent ways to develop the curricular materials.
Preface

I assert that we have reached the crisis state in the high cost of higher education and my purpose here is to examine how we fell into this trap, what we might have done about it a long time ago, and what we are likely to do now.

Dale Corson
May 18, 1998
Introduction. In 1968 the Carnegie Commission on the Future of Higher Education, under the leadership of Clark Kerr, published an important study on “The Economics of the Major Private Universities” by William Bowen, an economist and the provost, and later president, at Princeton. He is now president of the Mellon Foundation. He showed that the cost of higher education, both public and private, in the United States had increased faster than inflation by something like 2% or 3% on average for most of this century. This startled me and led me to think about the problem with increasing concern from that day to this. I came to realize that sooner or later, crisis was inevitable.

I assert that we have reached the crisis state and my purpose here is to examine how we fell into this trap, what we might have done about it a long time ago, and what we are likely to do now. I’m quick to emphasize that I’m not a higher education economist, but I’m an arithmetician, even a world-class arithmetician, and my concerns derive from the arithmetic involved.

Geometric Growth. To understand the problem, I’ll begin at the beginning, with the problem of geometric, or exponential, growth. There are features of such growth the reader must have clearly in mind. Consider a fund into which we pay a penny the first day, two pennies the second day, four the third, always doubling the amount each day. Figure 1 shows the sequence. (See the plot in Figure 1a.) The payment on the 31st day is almost $11 million. Note that if I go to the 38th day, the payment is more than a billion dollars. The third column shows the cumulative payment up to the beginning of the day in question. On each day the payment equals everything that has been paid to that point.

This table shows three features to remember: 1) the growth is trivial at first, only pennies per day for the first week, and then it explodes; 2) there is a characteristic doubling time, one day in this case; no matter where I look in the sequence, each day’s payment is double that of the day before; and 3) the payment on any day equals everything that has been paid to that point.

In addition to the characteristic doubling time, there is also a characteristic tripling time, quadrupling time, ten-folding time, etc. For small growths per unit time (say 5 to 10%) these characteristic times are shown in Figure 2. For a 7% annual growth, the doubling time is about 10 years. The ten-folding time is about 34 years.

Any quantity that increases by a fixed percentage per unit time displays these characteristics and is known as a geometric or exponential sequence.

Sometime in 1970 I received a telephone call from a New York Times reporter who was writing a piece about the high cost of higher education, and he wanted to check a statement attributed to me. He had heard that a Cornell trustee, in a trustee meeting, had asked me what tuition was going to be in 1990. I was reported to have taken my hand-held calculator, made a quick calculation, and replied $14,432.79. He wanted to know if the story was true. I said that it was. I had simply taken tuition at the time ($2,350) and projected it ahead 20 years at what I thought the tuition inflation rate would be. This story landed me on the front page of the Times with what seemed an absurd, if inescapable, number. Tuition in 1990 was actually more than $15,000.

To see where these concepts can lead, let’s look at U.S. oil consumption from the time oil was discovered at Titusville, Pennsylvania in 1859 until the Arab oil embargo in 1973. Consumption grew at a nearly constant rate of about 7% per year. The doubling time was close to 10 years, so that in each decade the consumption closely equaled everything that has been consumed to that point. This can be represented graphically in Figure 3, where the area of each block, representing the consumption in a decade, is equal in area to all the preceding blocks.

Another example of geometric growth is demonstrated in a fable first published by Professor Albert Bartlett of the University of Colorado. A bottle contains a colony of bacteria whose doubling time is one minute — i.e., each bacterium divides each minute. At 11 o’clock a single bacterium is placed in the bottle. At 12 o’clock the bottle is full. When was it half full? 11:59. The colony has
far-sighted leaders and when it is beginning to fill significantly, say at 11:55 when it is about 3% full, the leaders decide to search for more living space, more bottles. They look offshore. They look on the North Slope. They look in Russia. They look everywhere. At 11:59, when their bottle is half full, they find three more bottles, so now they have four times as much living room as they ever had before and they relax, put their feet up and enjoy a few beers. How much time did they buy? Two minutes. At 12:00 the original bottle is full. At 12:01 a second bottle is full. At 12:02 two more bottles are full.

### Geometric Growth

<table>
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<th>Day</th>
<th>Payment</th>
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</tr>
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</tr>
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<td>0.08</td>
<td>0.07</td>
</tr>
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<td>0.15</td>
</tr>
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<td>0.31</td>
</tr>
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<td>0.63</td>
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<tr>
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<td>1.27</td>
</tr>
<tr>
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<td>27</td>
<td>671088.64</td>
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<td>2684354.56</td>
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<td>30</td>
<td>5368709.12</td>
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<td>31</td>
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<td>10,737,418.23</td>
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<td>37</td>
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<td>687,194,767.35</td>
</tr>
<tr>
<td>38</td>
<td>1,374,389,534.72</td>
<td>1,374,389,534.71</td>
</tr>
</tbody>
</table>

**Figure 1 Geometric Growth**

![Cumulative vs Days Geometric Growth](image)

**Figure 1a**

<table>
<thead>
<tr>
<th>For Geometric Growth</th>
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<tbody>
<tr>
<td>Doubling Time</td>
</tr>
<tr>
<td>Tripling Time</td>
</tr>
<tr>
<td>Quadrupling Time</td>
</tr>
<tr>
<td>Ten-Fold Time</td>
</tr>
</tbody>
</table>

**Figure 2**
Differential Exponentials. Difficult as exponential growths are to live with, we can manage it if the growth rates are relatively small. We do it every day with ordinary economic inflation, where revenue and expense more or less keep pace. When the inflation rate reaches double-digit proportions, life becomes difficult, but we survive. In the 1960s I traveled a few times in Argentina where the inflation rate was 150%. Buenos Aires had many buildings half-built and abandoned; the money originally assigned a project was far too little by the time the building was half completed.

It is really differential exponentials that kill us, however, and it is this problem that concerns me here. Let me take library acquisition budgets as an example. One year in the 1970s the Cornell Library came in with a budget request that had acquisitions growing at 15% while the university budget as a whole was growing about 7% a year. Figure 4 shows the problem. I don’t know what the university budget was that year, nor do I know the acquisitions budget, but it does not matter what they were. The problem is the same. The significant numbers are the 7% and 15% growth figures. The table shows that in 50 years the acquisitions budget will exceed the entire university budget. I said that we were not going to do business that way and we would have to find a different way to operate, no matter how painful. The assistant librarian responsible for acquisitions wrote an angry letter to the Cornell Daily Sun, saying I had no concept of what a university is, and he resigned and went elsewhere.
Financial aid is another example. Throughout the decade of the 1980s, Cornell’s financial aid grew at 15% per year, quadrupling in the decade. Figure 5 is a table showing the consequences. Again, I have not taken the time to find the real numbers. It does not matter, however. It’s the 15% vs. the 7% growth rates that matter. In 30 years financial aid exceeds the entire university budget. At the end of the 80s, it already exceeded the entire unrestricted endowment income. For the past decade, General Purpose Financial Aid Grants from hard Cornell dollars have increased at an average annual growth rate of 12.6%, from $12 million to $40 million.

### Figure 4

<table>
<thead>
<tr>
<th>Year (Years)</th>
<th>University Budget (Millions) 7%</th>
<th>Acquisitions Budget (Millions) 15%</th>
</tr>
</thead>
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<tr>
<td>0</td>
<td>200</td>
<td>0.2</td>
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<tr>
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<td>40</td>
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<tr>
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<td>5,891</td>
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<td>60</td>
<td>11,589</td>
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<tr>
<td>70</td>
<td>22,798</td>
<td>472,392.8</td>
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### Figure 5

At the March 1998 Cornell Board meeting, the Board reaffirmed its policy of “need-blind” admissions policy (i.e., admission without consideration of the ability to pay, with commitment to provide the necessary financial aid) according to the *Ithaca Journal*. The Board committed itself to increasing financial aid significantly faster than the rate of tuition increase. The *Journal* story suggested 7% annual rate for financial aid, while tuition is going at 4.5% now. The University budget is going more or less as tuition goes, and Figure 6 shows the result. It is the same story — in 40 or 50 years, financial aid will exceed the entire University budget.

### Figure 6
I do not know the strategy to cope with this problem, but let’s imagine how we might proceed. Figure 7 illustrates an augmented financial aid strategy in which the financial aid pool is divided into two parts: a “normal” pool which begins, in this example, at $50 million and grows at 4.5% per year (assumed to be the University budget growth rate) and a supplemental pool that provides “extra” funds for financial aid. The “normal” pool is assumed to be there through whatever normal means Cornell hard dollars are provided for financial aid. The “extra” fund is assumed to be raised by special means, perhaps a special annual fund drive or through creation of a special endowment limited to aid purposes. The special pool is assumed to provide enough extra money so that the total financial aid pool, from all Cornell sources, can grow at 7% per year.

In the example shown in Figure 7, the extra pool provides a million dollars in the beginning. In the 10th year the “normal” pool provides about $78 million, up from $50 million, and the “extra” pool provides about $23 million, up from $1 million, so that the total is about $100 million. By the 30th year each pool provides about the same, around $180 to $190 million for a total fund of $380 million. To provide these growth rates, the “extra” pool has to provide funds that grow from 2% of the “normal” contribution at the beginning to 100% at the end of 30 years — a formidable challenge. If one were to finance the “extra” funds from endowment, that fund would have to start at 20 million the first year and grow to nearly $4 billion after 30 years. Cornell has a superb development program and gifts are growing rapidly these days, but this type of supplemental operation focused on financial aid doesn’t appear to be “in the cards.”

<table>
<thead>
<tr>
<th>Yr</th>
<th>PP 4.5%</th>
<th>Extra pool</th>
<th>PTot 7.0%</th>
<th>Ext/PP</th>
<th>Endow</th>
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<td>1.00</td>
<td>51</td>
<td>0.02</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>52.25</td>
<td>2.32</td>
<td>54.57</td>
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<td>76.77</td>
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<td>1.57</td>
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<td>1,021.22</td>
<td>1472.85</td>
<td>2.26</td>
<td>20,424</td>
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</table>

**Figure 7**

Let me turn to Cornell tuition vs. the Consumer Price Index, which is the focus of this paper. I have tuition data all the way back to the $60 figure for the University’s first year in 1868, but I have CPI figures only to 1914. Perhaps that is as far back as this particular index has been calculated. Figure 8 shows the data (for representative years only, to keep the table manageable). (See also the graph in Figure 8a.) The averages, for the years since 1925, are shown at the bottom of the figure; they include data for all the years, not just the ones displayed.

For the 70+ years since 1925, the annual increase in tuition (I include fees here) has averaged 6.2% while the Consumer Price Index has averaged 3.3%, for a “real” increase in tuition of 2.9% on average. There has been discussion recently about whether or not the CPI is a reliable measure of inflation. The Bureau of Labor Statistics has decided to use an inflation rate 0.2% lower than the CPI for governmental indexing. Perhaps, to be on the safe side, one should say that tuition has outrun inflation by about 2% per year over this period, and this is the number I will use in the arguments that follow.

I will look first at how tuition and salary have tracked since World War II. When I came to Cornell in 1946, an associate professor’s salary, even at the high end of the scale, might have been $7,000. I know that the highest full professor’s salary for the ‘46-‘47 academic year was $10,000 and I know that the highest associate professor’s salary in 1948 was $8,000. I use the $7,000 figure because a faculty member sending a child to college that year could have been earning about that much. Cornell tuition for the ‘46-‘47 year was $570.
<table>
<thead>
<tr>
<th>Year</th>
<th>Tuition, $</th>
<th>Nominal</th>
<th>CPI</th>
<th>Real</th>
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<td>1.2</td>
<td>-1.2</td>
</tr>
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<td>1916-17</td>
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<td>-7.4</td>
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<td>1917-18</td>
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<td>35.9</td>
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<td>11.5</td>
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<td>1998-99</td>
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</tr>
<tr>
<td>AVG</td>
<td></td>
<td></td>
<td>6.2</td>
<td>3.3</td>
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</table>

**Figure 8**

I am in the ballpark if I take 5% as the average annual salary increase and 7% as the average annual tuition increase since 1946. Figure 9 shows tuition and salary since then, plus projection for another 50 years into the future. In 1946 tuition was about 8% of salary. By 1966, when I was well settled in the provost’s chair, it was about 12%. By now it is around 25%. If we go another 50 years, it is more than 50%, and if we go another 50 years beyond that, to 2076, tuition and salary are about the same at around $4 million a year. This is, of course, far beyond any reliable projection. The differential inflation problem, however, will remain until someone does something serious about it.

A few years ago the Cornell Board, according to the news stories, committed itself to annual tuition increases no greater than two percent more than inflation, thus laying the groundwork for the continued ever more rapidly deepening hole we are digging for ourselves. It seems safe to assume that tuition increases a couple of percent above the general inflation rate will not go on for 100 years. But who is going to stop it and how?

We faced this problem all during my 14 years as provost and president, and we dismissed it then because we said that “disposable income” was increasing faster than tuition. That was the situation for at least part of that period, although that happy state has long since passed. Even then it was a poor platform to stand on. Let’s examine the consequences of that policy. Figure 10 shows a case with salary increasing at a 5% rate, disposable income growing at 7% and tuition at 7%. I start with a case where disposable income is 10% of the total. This represents a family where, after all the bills are paid, money for a new car has been set aside, and normal

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**Disclaimer Statement:** The use of the term “disposable income” in this paper is invalid. Arguments based on the concept of “disposable” use a definition of the term different from that commonly used by economists. The reader is advised to skip any paragraph using the term. Other arguments remain valid. **Added April 2009**
recreation has been paid for, there remains 10% for luxuries: foreign travel, January ski trips, and rising tuition costs. Look where this gets us after a time. The disposable difference keeps climbing. After 50 years it is 25% of income. After my always-unreasonable projection to 100 years, it is two thirds of income.

Figure 8a

<table>
<thead>
<tr>
<th>Year</th>
<th>Salary 5%</th>
<th>Tuition 7%</th>
<th>T/S %</th>
<th>Actual Tuition</th>
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<tbody>
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<td>1946</td>
<td>7,000</td>
<td>570</td>
<td>8.1</td>
<td>570</td>
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<td>11,402</td>
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<td>1,100</td>
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<td>17.3</td>
<td>11,500</td>
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<td>20,900</td>
</tr>
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Figure 9
Disposable Income (see footnote 1)

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<th>Year</th>
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<th>Tuition 7%</th>
<th>Disposable 7%</th>
<th>D/S %</th>
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</table>

Figure 10

What kind of family is it that has two thirds of its income available for luxuries? Is that the kind of student we want to make up our student body? Rich kids? This is not the Cornell we seek to build and maintain. We want a cross section of the population, so we are going to be admitting students who come from far more modest backgrounds and we cannot rely on disposable income to pay the tuition. If we had thought about it hard enough, we might not have relied on it in the 1970s. I should note that right now personal income is once again outrunning inflation.

Why Has Tuition Risen in This Differential Manner? In seeking to analyze the situation to see how we might have avoided the crisis (my word) and, especially, to look for guidance for the future, it is tempting to divide the causes into “unavoidable” and “avoidable” categories.

Unavoidable Cost Increases. A large area of unavoidable expense derives from governmental regulations. In 1978, on my retirement from the presidency, I addressed a report to the trustees on matters I thought needed attention and where I believed it easier for me to bring up the issues than it would be for my successor. In that 1978 report I wrote:

“In the past fifteen years we have seen a vast network of regulatory legislation and Executive orders emerge, all in the name of socially desirable objectives. I can find no fault with the objectives, which include social justice, health and safety, fair employment practices, and accountability for the proper use of state and federal funds ....There can be no argument with the (accountability) principle. The argument is with the mode of accountability.

“Among the specific areas where these regulations have heavy impact are the following: ....[and I listed a lengthy array of regulated areas--Equal employment opportunity and affirmative action, Safety and Health Act (OSHA), protection of human and animal subjects, many others].

“I can make no reliable estimate of the cost to Cornell in complying with the regulations that have emerged from both the state and federal. It amounts to millions of dollars per year, however, and these regulations have required administrative machinery that is out of proportion to the traditional concept of the bureaucracy necessary to administer an educational institution. Behind every report required by regulatory legislation lie thousands of hours of clerical time compiling data, thousands of hours of computer-programming time, thousands of dollars to assemble the data, and thousands of dollars of supervisory effort to make sure that the reports are properly constructed and submitted....

“Perhaps the biggest penalty of all in the administration of the new regulatory world is the atmosphere, the ambience, in which we work. The University is changing from a personal, a friendly, and a humane institution to one where the relationship among constituent groups is formal and distant and where operation is strictly “by the book.” The character of an institution changes when such formalism becomes necessary.”

That was 1978. In the years since, the detailed problems have shifted from one thing to another, but the basic nature of the trouble remains. Every time there is an allegation of academic or scientific fraud, there is a new push for tighter regulations. The University has put in place a bureaucracy, a large bureaucracy if one judges by the standards of 30 or 40 years ago, to deal with the problem in a relatively smooth-working manner. Every new clerk, every new office, however, adds costs that do not directly relate to the academic mission.

Another significant and unavoidable cost is the direct cost of faculty salaries, passed along to tuition, for time spent on research. When we appoint a new faculty member in a research-intensive field, we tell him or her that 50% of his/her time is available for research, but we recover little of the associated salary costs. I once commissioned a study of faculty salary recovered from research grants and contracts, and it turned out to be about 2% of the faculty payroll. Perhaps it is more now. I always lived in fear that undergraduates would discover they were paying for federally sponsored research.
There are a group of costs that are unavoidable but which, at the same time, are academic in nature. The ratcheting nature of changing student interest is such a problem, perhaps a relatively small one compared to some others. At one period in the 60s and early 70s, at the height of the Vietnam War, students were turning away from physical science. For a while they turned to sociology and then a large fraction indicated a preference for biology for a time; perhaps they still do. There is only one response to this pressure: add new faculty in the burgeoning field without decreasing the number in the old field. Although there was a shift away from physics, we could never decrease the size of that faculty: most of them had tenure. We would not have wanted to decrease our emphasis, in any case. It takes a critical size to make a successful program. Had we not maintained our strength in physics, we might not have had the 1996 Nobel Prize in that field.

Avoidable Costs, But… The “Unavoidable” and “Avoidable” categories may be too simplistic. Some of the “avoidable” things might have been avoidable, all right, but we would not have been willing to avoid them. Take the Cornell Engineering College in 1959 when I became Dean. Its curricular program focussed heavily on undergraduate education and the College, on the whole, did a fine job. There were strong pressures, especially from alumni, to keep Cornell’s emphasis right where it was, but I believed that the engineering problems we faced were much too complex to be handled adequately by people with bachelor’s degrees only.

I believed that if Cornell was to hold a major position in the Engineering world, we had to have emphasis on graduate education and the research that goes with it. In 1959 the College had about 130 faculty members. I made a major push for graduate education and the College began to move in that direction. Fortunately, it was a time when money was available – we had a $4.3 million Ford Foundation grant, for example, and in 1960 $4 million bought more than peanuts. A decade or two later, the College had about 225 faculty members and had moved into the front ranks. Those extra 100 faculty members have cost us an enormous amount of money. Was it worth it? Could we have turned our back on the problem?

Multidisciplinary programs and centers represent another new academic focus. I and others were sensitive to the commonly held view that academics undertake research programs on narrowly defined, esoteric problems. It became common in the 60s, 70s, and 80s for Washington bureaucrats to ask why we did not approach important problems in real-life terms. “If you are going to undertake research on management of environmental problems, why do you not bring to bear all your guns: science, law, psychology, sociology, political science?” was the type of question frequently asked. We have often replied by forming centers and multidisciplinary efforts, some of them highly successful. Every time we do this we add telephone, secretarial, parking, and heating and cooling costs that are part of the overhead for which we are never reimbursed.

What about new facilities? Did we need a new Johnson Museum, a new Uris Hall of Social Sciences, a new Theater Arts building, a new Biotech facility, a new Snee Hall for Geology? In the 1970s I knew that every square foot of new building space we added would add $8 to our annual operating budget. We could have avoided those costs, but we undertook them consciously and the students pay for them.

We added whole new areas of interest and study. Minority programs, for example. Again, we could have avoided them, but it would have been irresponsible to do so.

An expensive, very expensive, move was to a professional level of computing. All during my time, we sought to provide the essential computing for the campus at minimal cost, and it was a big mistake. It was not until Frank Rhodes came and Keith Kennedy moved into the provost’s office that Cornell decided to go first-class, and we went first-class at a very high cost. CORSON’S first law of computing: a new Biotech facility, a new Snee Hall for Geology? In the 1970s I knew that every square foot of new building space we added would add $8 to our annual operating budget. We could have avoided those costs, but we undertook them consciously and the students pay for them.

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Avoidable Costs. I was once waited on by the Arts College department chairmen with the charge that Cornell had no salary policy. From my standpoint, we did have a salary policy, and it was an unfortunate one. I gave my view of the problem and some of the steps we should be taking, steps that would work to their considerable disadvantage.

To see what is involved, look at Figure 11. This is the essence of what I presented to the chairmen. We begin with a zero-inflation economy and we determine how much we want a faculty member’s standard of living to increase from beginning to end of his career. A factor of three used to be typical, but I'll take a factor of four here, over a 40-year career, now that we retire later. If we were to advance salaries on average by 3.5% annually, this would do it. I've never favored a constant percentage increase, however, whereby an assistant professor gets, let us say, a $1,500 increase and a full professor a $2,500 one. I prefer fixed increments, as indicated in the figure, providing larger percentage increments in the early years and smaller ones in the later years. Salaries are higher throughout the career, and the scheme still provides the specified real increase in standard of living over a career. (I never made much progress, even with my own budget director, in implementing the uniform increment policy).

If we now add inflation, the whole graph is tilted upward to correspond to the inflation rate and, of course, the starting salary will be higher. The inflated salary pool each year is just equal to the one the year before plus the inflationary addition. To make it operate this way, positions must be recycled. When a full professor retires, the slot must be filled by a new assistant professor. I once allowed myself to be talked into replacing a distinguished retiring full professor with another full professor with a salary increment of $5,000, so that we could be really distinguished in the field. A big mistake. The administration of my scheme is somewhat complex, involving tenure policy and age distribution among the faculty.
One of our weaknesses is our inability to stop things. We often add important new fields, or new programs. We added a Computer Science Department in the 1960s and a Department of Science and Technology Studies more recently. We have added many Centers, each with significant unreimbursed costs. They have been important additions to our academic and research programs, but when we added them we stopped nothing.

The Inevitable End. Every differential exponential problem eventually reaches a crisis state when things are going to change, one way or the other. One definition says that the crisis has arrived when Congress gets into the act, and Congress is now in this one. More about that later. Through changing federal policies and cutbacks in funding, and through our policies of continuing in our established track, we have growing costs and falling revenues. Take financial aid. In the days of the “Great Society” we — i.e., the whole country, committed ourselves to providing higher education for anyone capable of benefiting from it. There were great federal and state student aid programs. Public funds added to our own provided support for every needy student we admitted, and we admitted them without regard to financial need — “need blind” admissions. When the public funds began to fall away, we picked up the deficit ourselves, and we are still doing that. There are comparable problems in research funding. Even if government funding stays at its present level, and some of our wisest leaders have been telling us it is going to fall significantly in real terms, the exponential growth in the cost of doing research will limit us. Research is inherently an exponential venture: the amount we achieve this year is proportional to the total past achievement — the basic definition of an exponential quantity. It can now cost a million dollars to equip a new laboratory for a new faculty member. Something has to change, even though the political atmosphere for science is favorable at the moment.

Could We Have Avoided the Trouble? This is where I have problems. I have outlined areas where the costs have outrun inflation by a significant margin, but where it would have been nearly impossible to avoid the costs that added the differential: governmental regulation, for instance. We could have learned to stop things when we added new ones, and this must be pursued in the future. Perhaps we could have eliminated some of the bureaucracy.
Six years ago I spoke at Robert Plane’s inauguration as president of Wells College. Wells was then in a state at which the faculty appeared to want to teach everything they had ever taught before, as well as many new things, and I sought to address that problem in my talk:

“We do not need to do all those things we keep doing year after year and generation after generation. We must do the things that keep our academic programs vital. New understandings, new insights, new ways of teaching demand our attention. At the same time, we must recognize that the rapidly advancing edge of obsolescence is keeping pace.”

In 1991 Frederick Starr, the president of Oberlin College, had an op-ed piece in the New York Times discussing these problems. He discussed ways we might go about eliminating the excess cost. His primary suggestion was to reduce the four-year undergraduate program to three years. He suggested we could do this by eliminating the remedial work we do, by winnowing out the curricular frills, and by demanding that our students be more mature so that they could handle more intense programs. I am sympathetic, but the basic idea will not work unless we stop the excessive growth in what remains. If we leave the differential inflation in place, going to a three-year program will only delay the time until we are overwhelmed once more. The solution must come in other ways. We must learn to stop things.

Let me think about the remedial work for a minute. Our secondary schools do some things well these days. Mathematics, in my experience, is one of them. We have many freshmen that have already learned calculus when they come to college. Computer literacy is another, although I wish the secondary schools would instill a little humility in the computer jocks.

I’m not so sure about the English language and English composition. It seems to me I had a superior education in the public high school in the small Kansas town where I grew up. I learned grammar and I learned to write sentences with both a noun and a verb. Sometimes I think that students do not learn that in secondary school now, so that we must necessarily organize freshman writing seminars. I would like to eliminate those seminars, if I could.

Unfortunately, we sometimes seem not to teach writing skills even in college, and our graduates sometimes find their ways to important places where writing skills are important. How many times a day do we hear statements such as “no one in their right mind,” or “he gave it to you and I.” Does it matter? Perhaps not, but when the computer-software user’s guide says, “unreadable data is replaced by asterisks”, it is nearly certain that the same guide is going to provide complex instructions in such mangled English and confused syntax that I’m ready to throw the whole thing in the wastebasket.

The best, or the worst, example I’ve seen was in a brochure from one of the largest Wall Street firms, promoting estate planning and emphasizing the benefits and hazards of different types of property ownership. One of the types discussed was “joint tenancy.” I think they meant “joint tenancy.” “When my wife and I fall asleep watching television, it may be a joint tendency.”

In thinking about removing material from the curriculum, it is important to remember that just removing a block of material does not solve the problem. It is the excessive growth rate of the remaining material that causes the problem.

All problems are easier to solve when they are small, and our differential exponentials are no exception. In the penny-per-day example I gave at the beginning, forgetting a daily payment the first week is a small problem, it takes only pennies to make a back payment. Forgetting a daily payment at the end of the month is a $10 million problem. Had we stopped to think about where we were heading with higher education inflation 30 or 40 years ago, and begun to address it then, it would have been easier than it is today when university budgets are measured in billions of dollars. I served on the governing boards of the American Council on Education and the Land Grant Association. Why didn’t I point out the problem and urge study and publicity about what we were getting ourselves into? I didn’t think enough about the problem, although I did recognize it at the time, thanks to Bill Bowen.

**Where Do We Find Ourselves Now?** We are now in a situation in which the rich institutions (as measured by endowment per student, for instance) can find ways to proceed, although they too will be in trouble sooner or later. Princeton, which is the richest of all with an endowment of more than $750,000 per student, compared to something like $100,000 for Cornell, has adopted a financial-aid policy according to which no low-income student will have to borrow money. Cornell students borrow $35 million a year from federal sources alone. I don’t know what they borrow privately. We are losing the recruiting competition for new faculty and for outstanding graduate students to some of the richer universities. Stanford has undertaken a new endowment drive for several hundred million dollars, just to allow for supplemented stipends for selected graduate student and faculty recruiting competitions.

Meanwhile, Congress has begun to act. Last fall it created the Commission on the Cost of Higher Education. Last January 21 the Commission released its report, “Straight Talk About College Costs and Prices.” The report contains 42 recommendations, organized around five different policy goals: 1) strengthening institutional cost controls, 2) improving market information and public accountability, 3) deregulating higher education, 4) rethinking accreditation, and 5) enhancing and simplifying federal student aid. For the most part, the report addresses the high cost, not the excessive growth rate.

The educational associations are beginning to think about the problem. In his annual letter to members, Peter McGrath, president of the National Association of State Universities and Land Grant Colleges (he is a Cornell alumnus and former president of the University of Minnesota) devotes a section to “A Big Challenge: College Costs.” He reports that the six major higher-education associations have created an Advisory Committee to examine the problem. The committee has hired a polling firm to find out what the public thinks and what it understands about the problem. The poll shows that the public 1) believes that the price of a university education...
is too high, and 2) believes that the price is far greater than it actually is, and is uninformed and confused about the availability of various forms of financial assistance. There is no mention of the widening gap between price and family income.

**Where Do We Go From Here?** To sum up the situation as I see it: the price of higher education has outrun inflation (and therefore family income) to the point where the public is rebelling and Congress is getting into the act. The situation is going to get worse before it gets better.

To better understand the problem, we must look at the revenues that support the universities. Fund accounting is an esoteric discipline, and understanding it in detail is beyond most people, but for general understanding we can divide Cornell’s operating revenues into five categories: 1) Student Charges (these include tuition, board and room, and everything the student buys from Cornell); 2) Sponsored Programs (this includes all research funding); 3) Government Appropriations (these include New York appropriations for statutory college operations, and federal appropriations — through Land Grant provisions, for example); 4) Gifts, and 5) Investment Income. The total revenue is now more than $1 billion per year.

Over the past 25 years, Student Charges have grown from less than 30% of the total revenue to about 40%, Sponsored Programs have remained more or less constant in the 20% to 25% range, Government Appropriations have fallen from 30% to 15%, Gifts have gone up and down but have remained in the 5% to 10% range throughout the period, with 10% prevailing for the past decade, and Investment Income has remained more or less constant in the 5% range.

Several facts stand out in this general pattern: 1) the student share of the cost has risen steadily, 2) the appropriated government share has declined steadily, 3) gifts are an important factor, and 4) endowment provides only a small fraction of the whole.

Several colleges and universities have taken bold steps to cut both tuition levels and financial aid. I think Muskingum College in Ohio was the first to make this move. For students entering in the fall of 1996, tuition was dropped from $13,850 to $9,850. The cut was announced in the fall of 1995 and Muskingum’s admission applications increased by 30%. Others have followed Muskingum’s lead. North Carolina Wesleyan cut its tuition by $2,000, Massachusetts State Colleges cut their tuition by 5%, and Community Colleges by 10%. The University of Rochester has begun awarding $5,000 grants to selected students to alleviate tuition costs. Wells College has now moved to cut its tuition substantially.

I cannot predict what Congress will do, but it could be significant and we will not like it.

The corporate world, which pays for all its raw materials except personnel (other than through taxes), is not likely to come to our rescue. Industry now pays for about 6% to 8% of the basic research done in universities, and the corporate research leaders I know say it is not going any higher than that. We must work hard to develop joint programs with industry, but they must be programs that serve the needs of industry — needs that do not always match the academic culture.

The federal government should be a major part of the solution, but I don’t think it’s going to be. It is ironic that Congress is now considering action to limit the high cost of higher education, when one of the principal sources of the high cost is Congressionally-mandated regulation and withdrawal of Congressionally-created student-aid programs.

From 1974 to 1977, a group of 14 university presidents and half a dozen foundation presidents, all under the leadership of McGeorge Bundy, explored those parts of the academic teaching and research enterprise which were properly, and necessarily, the responsibility of the federal government. The group, in a report entitled “Research Universities and the National Interest,” identified four areas: basic research, research libraries, graduate student support, and international affairs instruction and research. These were thought to be of such importance to the welfare of the country, and represented such large investments, that only the federal government could provide adequate resources. Nothing came of this study, other than some interesting conversations with 1976 presidential candidates — in my case, with Ronald Reagan.

There has been much publicity about alleged excessive greed on the part of universities in recovering indirect costs from research contracts, but the recovery is always less than the expenses incurred in performing the research. I’ve already discussed the failure to recover direct salary costs. Failure to provide adequate support for research vital to the national welfare nearly always results in passing costs along to the students in the form of tuition charges in the private universities, and to state appropriations and, increasingly, to the students, in public universities.

If there is to be serious reform in the universities in order to reduce inflation to the CPI level, it will have to embrace large changes indeed in the way we do business: larger student/faculty ratios, heavier teaching loads, strict administrative discipline (recycling faculty positions, for example), decreased the bureaucracy, refusal to undertake any new construction without an endowed means of operating and maintaining it, commitment to no new programs without stopping something else, more attention to undergraduates.

I think none of this is likely to happen until applications for admission begin to decline markedly, just as this country is going to have no rational energy policy until there are lines at the gasoline pumps.
In the meantime, rising tuition, it seems to me, will put Cornell education further out of the reach of students from middle-class families (and commitment to a needs-blind admissions policy can prevail only for a limited period). More and more students will graduate with a heavy debt load and they will choose to enter the most lucrative fields, fields that do not necessarily benefit society, in order to pay off the debt. Concern will grow that Cornell will become a university for the very rich and the very poor. We will continue to lose some of our best faculty, and we will begin to lose the competition for the recruitment of the best new faculty and graduate students. Gifts will become an ever more important part of our operation. Fortunately, we have one of the best development operations in the business. The slow student migration from private to public institutions, which has been going on for a long time, will continue and perhaps accelerate.

**Some Larger Questions.** It's impossible to ponder these questions without raising some issues that are at the very core of our American system of higher education. What fraction of our population should undertake higher education? I believe we should provide an opportunity for anyone who can benefit from the experience. This view may be unique to this country. Throughout most of the 1980s and early 90s I was heavily involved with some large World Bank programs to upgrade Chinese universities. The Chinese were struggling to increase the fraction of the age group attending colleges and universities from 1% to 2%. A distinguished former German University Rector and former Minister of Science and Culture in his state, who served on the International Advisory Committee I chaired, told the Chinese not to make the mistake the Germans made by getting the fraction up to 12% (I think the fraction may be higher now).

How much should a student pay for a university education? Clearly, if the public rebels, and if Congress imposes unhappy limitations on us, it becomes academic to ask such a question. Nonetheless, we need some understanding of the issue if we are to think clearly about, and argue rationally for, our position.

In a 1986 essay, “Thinking about Tuition,” William Bowen makes a logical argument about the distinction between cost and price and argues that the students are getting a bargain because price is only about 60% of cost. This subsidy is justified, he argues, because education confers indirect benefits on the whole society in addition to direct benefits to the individual student, and society should bear some of the costs. Direct government support and favorable tax treatment contribute to such subsidy. Bowen estimates, further, that the purely monetary return on an individual's investment in education is something like 9.5% per year. He argues still further that the non-monetary benefits are at least as great. He cites heightened appreciation of art, music, other cultures, and the world around us among the benefits.

Bowen argues that comparisons of the cost of education with current income can be highly misleading. Education is the most important investment any family will ever make and must be looked at in terms of a long-term financing scheme, just as families do for other major investments, as for a home. In thinking about appropriate price level, we should examine not just fairness for an individual student, but implications for broader objectives, such as diversity within academic communities, and even larger national goals of promoting equal opportunity, justice, and social harmony. This set of questions, he states, can be addressed only by considering tuition and financial aid together.

Bowen points out “internal” inflation rates that we cannot control: the price of library materials, for example. The cost of outfitting and maintaining science laboratories has escalated dramatically, and the demise of federal programs to provide these ever more expensive facilities has added enormous costs at the institutional level. Universities react slowly to shifts in economic trends. During the double-digit inflation days, the real incomes of faculties fell by 20 to 25%, and that had to be corrected with consequent rather large differential inflation rates for a time. The shift of the burden of financial aid from external to internal sources has added large costs to the university operating budget.

Finally, Bowen argues, “It is clearly in the national interest that a number of universities pursue the highest possible quality in teaching and research, even if that is costly and necessitates high tuition charges.”

Bowen-type arguments, rational as they are, address only the high cost, not the differential inflation rate.

Marina Whitman, former vice president and chief economist at General Motors (and a Princeton trustee), has pointed out some different concerns. There is no “equity market” for investment in education because there is no asset that investors can exchange in the way they can buy and sell property. Individuals cannot sell themselves. “Human Capital” markets are difficult to deal with and can lead to levels of fixed debt that in turn may influence career choices in disturbing ways. I can only leave these deeper economic problems to the economists. I must stay with the arithmetic, which says that any approach or any solution that ignores the differential inflation problem is in for trouble, sooner or later.

This leads me to my final question: Do we have too many research universities? In 1961, when we were still reacting to Sputnik, the President’s Science Advisory Committee wrote a report stating that we had perhaps 20 research universities and we needed possibly double that number. Now we have over 100 institutions that deserve to call themselves research universities. The available funds are spread over this large number, each one capable of using much more money than it receives.

Has this “New Centers of Excellence” development been a good idea? I think the question is purely academic at this point. I see no one mustering the political muscle to change the system. We are going to continue the wide geographic distribution of federal funds because Congress wants it that way.
Conclusion. To quote Josiah Royce, the late nineteenth century Harvard philosopher, “Everything is mismanaged in proportion to its significance.” We have failed, both for unavoidable reasons and for avoidable ones, to limit the higher educational inflation rate to that characteristic of the general economy, with the result that the price of a college education has reached levels that probably cannot be tolerated into the indefinite future. We have two problems: 1) the high price and 2) the continuing differential inflation rate. The public, particularly in the form of the Congress, is demanding to be heard on the high price and we may be in for regulation we are not going to like. The penalty for failure to adhere to any mandated regulations will inevitably be withdrawal of federal funds.

We made a mistake, as an industry, in not addressing the problem sooner, seeking a solution of our own making. To make revisions that will have an impact now will require heroic efforts and may lead to changes in the very nature of our superb educational system. The higher educational establishment should get out in front of the pack and lead the reforms. The most important task is elimination of the differential inflation.

Are There Useful Steps We Can Take? I believe that the principal educational associations (The American Council on Education, the Association of State Universities and Land Grant Colleges, and the Association of American Universities) should be the bodies leading the effort at reform. I think it important to have a concerted and unified attack on the problem. We must be careful to seek solutions that will not make the rich richer and the less-rich poorer.

I see responsibility lying equally in the hands of the educational establishment and in the hands of government. Our place in the world depends on the educational achievement of our citizenry and is surely of great national security import and therefore of major concern to Congress and the federal agencies. At the same time, it is unrealistic and shortsighted for the educational world to be blind to its own responsibilities.

A step that would make a big and important impact would be restoration of some of the excellent student-aid programs created in the 1960s. Most people still believe in giving an opportunity to everyone capable of benefiting from a college or university education, regardless of economic background. Individual colleges and universities have made important efforts to keep this ideal alive, often against large odds. Continued provision of such opportunity is a proper call on public funds.

Is there a chance of achieving an overall reform goal? Do we have a chance, at a minimum, of eliminating the excess inflationary rate? I think not, without a great deal of joint effort by the educational establishment and the Congress. The chasm separating the universities, particularly the private ones, and the Congress is wider than the Grand Canyon. Attitudes are typified by those expressed by William Bennett when he was Secretary of Education in the 1980s. “Higher education is not underfunded,” he said, “it is underaccountable and underproductive.” He missed no opportunity to lash out at professors who teach too little and at “lush” administrative budgets.

Higher education cannot expect support from the public and from Congress unless it addresses the Bennett concerns seriously. The university world must tackle the problem, in my opinion, on both the faculty side and on the administration side. Administrative bureaucracy has grown enormously in recent decades, much of it because of federal regulatory pressures, but much of it for other reasons as well. Some of it must be rolled back if we are to have any chance at progress.

While excessive administrative growth is undergoing the scalpel, faculty practices—teaching loads, undergraduate curricula, attention to undergraduates generally—must also receive productive attention.

Until the academic world responds to the Bennett-type allegations in positive ways, we are not going to get anywhere with Congress. The national welfare and national security are at issue, so let us get on with the task.
Preface

In December 1999 a Cornell symposium examined fundamental issues facing research universities, such as Cornell, at the beginning of a new century, and honored Cornell’s eighth president, Dale R. Corson.

These speeches of appreciation (Part 1) were delivered at the gala banquet and the closing luncheon.

Part 2 presents the transcripts of the symposium speeches.

December 6 & 7, 1999
About Dale and Nellie Corson  (from the Gala Banquet Program)

Tributes at Gala Banquet, December 6, 1999

Frank Press
Robert L. Sproull
Jean Gortzig
J. Robert Cooke

Response, December 6, 1999

Dale R. Corson

Tribute at Closing Luncheon, December 7, 1999

Frank H. T. Rhodes

Audio recordings of these tributes are on the DVD:
The Corson Symposium: Strategy for a Great Research University

Banquet photos: University Photography/Kountoupes
About Dale and Nellie Corson

A New E-flat Bell for the Cornell Chimes with a New Inscription:

In Honor of Dale and Nellie Corson
that their extraordinary commitment to
each other, to their family, and to this
institution may ring out forever!

Presented to Cornell University
by their children and grandchildren
on the occasion of their 60th wedding anniversary
June 17, 1998

Dale R. Corson
Assistant Professor, Associate Professor,
Professor, Department Chairman, Dean,
Provost, President, and Chancellor
of Cornell University

Nellie E. Corson
As spouse, companion, and a friend to all,
she too shared these offices
and served this institution with
unique dedication, care and affection

The Highlights

• Dale Corson is a native of Pittsburg, Kansas. He received a bachelor of arts degree from the College of Emporia in 1934, a master of arts degree from the University of Kansas in 1935, and a doctor of philosophy degree in physics from the University of California, Berkeley in 1938.

• In 1940 he discovered astatine, one last missing element on the Periodic Table, while he was a postdoctoral fellow at the University of California at Berkeley.

• He was a staff member of the Massachusetts Institute of Technology Radiation Laboratory in 1941-43.

• He served as a technical advisor in the Air Force headquarters in Washington, 1943-45, and received a Commendation for his achievements during World War II for the introduction of new radar techniques into military air operations.

• At the end of the war, he joined the staff of Los Alamos Scientific Laboratory, with primary responsibility for the organization of the Sandia Laboratory.

Note: See an additional reference to this inscription in the tribute by Jean Gortzig [page 305].
• He received a Presidential Certificate of Merit in 1948 for his contributions to national defense.

• Corson joined the Cornell faculty in 1946 as an assistant professor of physics. He helped design the Cornell synchrotron, which is housed in Newman Laboratory of Nuclear Studies.

• From 1951 to 1965 he served on many national commissions, panels, and committees including the Department of Defense, the National Advisory Committee on Aeronautics, and the Department of Commerce.

• He became a full professor in 1952.

• He became chairman of the Department of Physics in 1956.

• He was dean of the College of Engineering from 1959 to 1963.

• He was appointed provost in 1963.

• Corson became Cornell’s eighth president in 1969, and the second president of Cornell to have risen from the faculty ranks.

• Many new interdisciplinary approaches to research and study were started or expanded under his leadership, such as materials science, international studies, biological sciences, and women’s studies.

• As president, he led Cornell through the most difficult times of student protests and campus unrest — the Straight takeover of 1969 and the Vietnam War protests — and restored the university to stability and a return to concentration on research, teaching, and scholarship.

• He received an honorary doctor of laws degree from Columbia University and a citation from the University of Kansas in 1972.

• He served as chancellor from 1977 to 1979.

• Upon retiring from the Cornell administration, he continued to work as a consultant in the fields of engineering and physics and to lead many national efforts, including the collaboration of government, universities, and industry.

• He founded the Government-University-Industry Research Roundtable in 1984.

• Corson was elected to the National Academy of Engineering in 1981.

• He headed a study sponsored by the National Academy of Sciences, “Scientific Communication and National Security,” which was published in 1982. It defined research universities’ concern about gray-area research those areas that are not classified, but are deemed militarily useful.

• Corson was awarded the 1987 National Academy of Sciences Public Welfare Medal. The medal is awarded annually by the Council of the Academy “in recognition of distinguished contributions in the application of science to the public welfare.”

• He was awarded the Arthur M. Bueche Award of the National Academy of Engineering in 1988 for “statesmanship in the field of technology.”

• He co-authored a book, Introduction to Electromagnetic Fields and Waves, and wrote numerous papers for physics journals. His article, “Particle Accelerators,” was published in the Encyclopedia Americana.

• He helped to found Kendal at Ithaca, a retirement community, in the 1990s.

• He is married to the former Nellie E. Griswold, and they have four children.

• Photography has been his consistent hobby.
Thomas Huxley said that a man of science after the age of 60 does more harm than good. He didn’t know about Dale Corson. I would like to tell you why Huxley was wrong from the perspectives of the National Academies of Science and Engineering and the National Research Council.

To begin with, Dale is a member of the NAE – in itself, recognition of distinction. He was also awarded the Public Service Medal of the NAS, as you saw in the film, and the inscription read, “Distinguished Contributions to the Application of Science to the Public Welfare.”

That makes Dale an honorary member invited to participate in all Academy of Science activities. He is, therefore, one of the few people in the country in the ranks of both organizations.

As a medalist, he joins the company of Goethals and Gorgas (the builders of the Panama Canal), Vannevar Bush, Karl Compton, David Packard, Jerry Wiesner, Carl Sagan, and Arnold Beckman, among other illustrious figures in the history of American science, technology, and public affairs.

When Dale retired from the Cornell presidency, he may have exited with a fanfare; but there was a discreet reentry into the world of public affairs through another door — by participating on the committees of the National Research Council and the Academies — typically as chair.

During my term of office alone as president of the NAS, chair of the National Research Council, Dale served on twelve of the most important committees of the Academy complex, and that has to be a record.

It means that he had to ask Nellie twelve times for permission — because whenever I called and asked him for his help, he would say, “I will have to ask Nellie.”

Because of executive orders signed by Presidents Lincoln, Wilson, Eisenhower, and Bush — all still in effect — and legislation passed by Congress as early as 1863 and as late as 1997, the Academy complex has a special status in our country as an official advisor to the government.

It has been called the most influential advisory group in the world.

I tell you all of this to place in perspective Dale’s work with the Academies and his contributions to the nation.

I will give two examples, but first let me say something about Dale’s unique qualities as a leader of Academy and NRC panels. These committees are made up of scientists, engineers, executives from academia and industry, government officials with a heavy sprinkling of economists, and other social scientists and lawyers.
They are typically successful — these people are successful — and over committed, independent, and self-confident, and they hold strong opinions; yet Dale in his quiet way, with his soft voice that is almost monotone in demeanor, in this way he could inspire them to work beyond where they would or could; he could bring consensus not at the lowest common denominator, but at a high level where committee advice could have an impact. In effect, it was akin to milking sacred cows with cold hands. And that's leadership!

Now let me give you two examples. Joe Wyatt mentioned the Government–University–Industry Roundtable. When we started that at the Academies, we knew that we had to find a chair who could make it work — without such a person, such an extraordinary idea couldn't possibly succeed in Washington with all the legal reasons why you couldn't do such a thing.

And Dale, of course was our choice.

Joe mentioned all of the contributions, but there was one that I remembered that Dale brought off when he chaired that roundtable.

If you remember receiving government grants back in the 80's, if you wanted permission as the grantee to make a trip to a meeting that you didn't describe in your original proposal or if you wanted to switch from a graduate student to a postdoc, you had to send a letter to Washington and get permission; and if you were lucky, it would come back three or four months later, after the meeting date or after the postdoc went somewhere else.

So we had to find a way, without advising the government because that was illegal, to tell them how significant this bureaucratic restriction was in reducing the productivity of American scientists.

Well, we just discussed it with them and described these difficulties and they went away on their own — NIH deputy director, OMB people — and they came back with an experiment. Let's see if we can reduce these restrictions, have the scientists ask for local permission on their campus, rather than having to write to a Washington office.

Well, that proved successful, and the program was expanded and now it covers all of the scientists working today.

Another example — and that's Dale's chairmanship of the panel on Scientific Communication and National Security. Some of you may remember that early in the Reagan administration there were some executives and assistant secretaries in the Defense Department who wanted to restrict the publication of unclassified material in many areas of physics, electrical engineering, mathematics, and so on. This was unclassified stuff that we would publish normally in any way — but they thought this was a way of using government money to send “know how” to countries that might be potential enemies — and, of course, there was a large outcry by the scientific community. Well, again we called upon Dale to chair this Academies committee, and that committee came in with a report that was so persuasive that I think it was the most important event in convincing the government to make a change.

Dale, I don't know if you remember, but at the evening dinner where we released the report to the government officials and members of Congress, Ed Meese showed up and was in the audience. We were so persuasive — you were so persuasive — that within a few weeks that potential restriction on free communication of science was removed.

So, Dale, you have functioned in difficult times but you always finished in style and with influence.

You helped our government by preventing mistakes and adopting better policies. You made all of us at the Academies and the Research Council look good, and for that you have our deep appreciation.

For that matter, the nation is in your debt.
I have the distinct privilege of adding a tribute to Dale Corson. But to do that in the five minutes that is given me, reminds me of a spoof issue of a Columbia University student magazine some years ago. This issue lampooned the Reader’s Digest by copying its format. For the book to condense, it chose the Encyclopedia Britannica.

Dale started a professional life by being the co-discoverer of a new element. Had it not been for the crowding by other Berkeley achievements, it probably would have rated him a share in a Nobel prize.

During the war, he contributed to both U.S. and British radar.

Characteristically, to alleviate boredom while flying the Atlantic in piston engine airplanes, he invented a slide rule to enable navigators to harvest the predictions of the geostrophic wind equation.

At the end of the war and in preparation for precarious peace, he was the architect of the Sandia Corporation, an institution which is still flourishing even after long outliving its original mission.

But beginning in 1946, these accomplishments were quickly eclipsed by his service to Cornell. The physics department in 1946 consisted of a strong nuclear-studies group and a tiny, but ambitious, condensed-matter group. Dale was respected by both groups, and more than any other individual, was responsible for the character of the department – harmonious, effective, and even enjoyable.

And so he was the natural choice to continue this leadership as Chair and then Dean of Engineering. A number of Cornell faculty members questioned whether Dale was a real engineer, since most of his engineering experience was off-campus, and, therefore, almost invisible —experiences such as high-level evaluation of engineering projects in Washington.

But I testified that his concrete work was the work of a great professional engineer.

Of his many accomplishments as dean, I celebrate especially his role in Washington and in Ithaca in founding the Materials Science Center. He set the stage for and orchestrated Cornell’s successful bid for a large and unique federal contract. Again, the center was widely copied and survives mutatis mutandis as the Cornell Center for Materials Research nearly 40 years later.

Dale became provost in 1963, and quickly became the chief operating officer of the university. Now, a university, unlike a corporation, should not need a chief operating officer. Its strength is in distributed form, in the faculty and their associates, rather than centralized. But increasingly from 1963 onward, Cornell required a strong and capable chief. James Perkins was a most capable academic theorist, but he was often absent, impatient, and less interested in the many currents and countercurrents that were capturing the campus.

The need for capable, dedicated, on campus operations leadership became overwhelming in 1969. Dale as provost, acting president, and president brought Cornell back from the edge of chaos.
Everyone knew, as Dale went from meeting to meeting and wrote down commitments in his journal, that he listened, that he understood the problems and the opportunities, and that if he made a commitment, he would keep it, prompting others to do likewise.

Cornell alumni everywhere are lavish in their praise for his service.

Despite the enormous distractions, Dale, as president, led a university that was nevertheless developing in quality and service. Of his many achievements, I cite only one, the biology division. This was like the two divisions in the physics department, but on a grand scale and complicated by the public private boundary, since strengths resided on both the upper and lower campuses.

I will not dwell on Dale’s post-retirement leadership of the GUIRR [the Government University Industry Research Roundtable], since you have heard about that. I would only emphasize, again, that bringing leaders from the three worlds together into an effective working organization is a rare achievement.

Finally, I should like to express my personal indebtedness to Dale and Nellie for many years as friends and neighbors, with our children growing up together as an extended family. I have enjoyed every minute of 53 years of association with Dale and his family, and not solely because there is no one with whom I’d rather share a snow blower.

So I ask you now to raise your glasses to Nellie and Dale Corson, architect, founder and preserver of enduring institutions.
In 1969 Dale Corson was appointed President, and Nellie Corson became the First Lady of Cornell University. As the University needed his extraordinary brand of leadership, it would benefit from her integrity, warmth, and caring for individuals and the institution.

Twenty-three years ago, in 1976, the last academic year of Dale Corson’s presidency, the Cornell Campus Club, an organization of women associated with the University, recognized Nellie Corson for her devotion to the campus community. She was honored by a tree-planting ceremony and a reception that was attended by hundreds of her friends and admirers. Four black oak trees were planted in front of Balch Hall and they remain there today in an ongoing tribute. The bronze plaque reads, “These Black Oaks Honor Nellie Griswold Corson, whose consistent caring and dedicated service have earned her the special affection of the Cornell Community.”

In Nellie’s response she said, “I’m delighted to be honored in this way. My friends in the Campus Club not only honor me, but they remind me that in this predominantly male institution, women also make a contribution to Cornell.” She went on to say, “There are many ways to help Cornell – we can be friends and counselors to students, newcomers, and retirees. We can even say a kind word to an administrator.”

Remarks honoring Nellie that day were made by a special and longtime friend, Barbara Kennedy. I share these with you because the thoughts so aptly reflect Nellie’s character. Barbara said, “As a friend of Nellie’s during these past twenty-seven years, I have known her as the wife of a faculty member, department chairman, dean, provost and president. As time has brought these changes to the Corson careers, Nellie has given much of herself to the communities of Ithaca and Cornell. It is most fitting that the Campus Club has planted these trees to honor Mrs. Corson’s special interest in the splendor of this campus and her devotion to Cornell and the people who are part of it.”

Nellie Corson believes that serving is an important ingredient in life. Through the years, she has committed herself to distinguished service to the Cornell and the Ithaca communities.
Her efforts were the result of her deep caring for people — not because it was the right thing to do or for any recognition she might receive. At Cornell, in addition to her responsibilities as a spouse of a faculty member and administrator, through her leadership in the Campus Club, she devoted many years to the “kind works” of the Sage Auxiliary — the focus being students in need of love and support during illnesses. For over twenty-five years, Ithaca community institutions benefited from her involvement. She served on the Board of Directors of Ithacare in its formative years, and those responsibilities governed her calendar. She was an integral part of the success of the Friends of the Library and a trustee of the Tompkins County Library. During Nellie’s tenure as a trustee, the current building was discussed, planned, and built, and she was very involved in the construction of that critical community resource.

In all of her good works, Nellie has been her “own person.” She demonstrated the value of being a supportive partner, sharing responsibilities while making her own significant, independent contributions.

I know she has been a role model for many women. Through her leadership and participation in every aspect of Cornell’s life, she set a standard for her successors.

Our beloved Nellie means so much to the University and, in a very personal way, to many of us.

In closing, I share the inscription on the Cornell chimes, E-flat bell — the Corson bell — written by their children [See page 298]:

“In Honor of Dale and Nellie Corson that their extraordinary commitment to each other, to their family, and to this institution may ring out forever!

Presented to Cornell University by their children and grandchildren on the occasion of their 60th Wedding Anniversary, June 17, 1998.

Dale R. Corson
Assistant Professor, Associate Professor, Professor, Department Chairman, Dean, Provost, President, and Chancellor of Cornell University.

Nellie E. Corson
As a spouse, companion, and a friend to all, she too shared these offices and served this institution with unique dedication, care and affection.”
The faculty of Cornell University have a very, very special fondness and respect for Dale Corson. For the life that was portrayed in the video a few moments ago, for the superb leadership and service that he gave to the people of this university in so many capacities, and for his leadership as citizen-at-large of this nation, we salute you, Dale.

On the occasion of Cornell's 1977 commencement, which was Dale's final commencement as president, my predecessor at the time, Byron Saunders, presented a salute to Dale that is reproduced on page 18 in the Gala Banquet booklet for you to read. I cannot improve on the eloquence or the content of that statement, so I asked that it be made available for you; but do allow me to make a few sentences in behalf of our respect for Dale.

I have been privileged to watch Dale's leadership firsthand. I was a member of the faculty in the early days of his presidency. In fact, the photograph on page 20 shows the meeting of the university faculty, and at that time I happened to be speaker of the university faculty. You can see that the picture shows a standing ovation. Our respect goes back a very long way. I do offer an update on that statement.

Two decades after the completion of Dale's term as president, we know that Dale's textbooks on electricity and magnetism, the two of them, are still in print nearly forty years later. That is a profound accomplishment and speaks to the quality of his scholarship.

However, I am awed as much by his personal qualities as I am by his numerous and very significant professional achievements. He is an unmatched optimist. For example, he designed a world-class sundial for the campus. This illustrates his ability to blend art and technology, but consider his optimism – a sundial in Ithaca? Dale, parenthetically I should ask you if this thing has been checked for Y2K compliance, or do we need to shut it down on New Year's Eve?

We have a gift for you, which I will bring to you in a moment. The gift is a digital camera, a 2.1 megapixel digital camera, supposedly capable of quality comparable to traditional photography. This gift symbolizes for the faculty our respect for Dale's wonderful capacity to blend science, technology and art. As has been mentioned earlier today he is indeed an accomplished photographer. Dale, we present this to you, but we also trust that through your hands it will be a gift for Nellie and for the other members of your family.

Thank you for being "Dale Corson: Cornell's good fortune."

We have enormous respect and love for you, Dale.
Statement from the Faculty on the Occasion of the Cornell University Commencement of May 30, 1977

“Since Cornell University’s founding more than a century ago, only two of our Faculty have come to serve as the University’s president. You – sometime assistant professor, associate professor, professor, department chairman, dean, and provost – have the distinction of being one of those two. Moreover, as no one will forget, you came to the presidency at a time of unprecedented disquiet, and have suffered the frustrations of having to carry on through a period of deepening financial, educational, and social crises.

“We have not made, or tried to make, your task an easy one. Our cherished individualism, our disparate priorities, and our need for searching debate have enfiladed your office according to the deathless custom of those who, in Carl Becker’s phrase, ‘think otherwise.’ But Dale, we cannot let you leave that office without your hearing words of affection moved by your quiet grace, or words of respect for your absolute integrity, or words of gratitude for your long and selfless commitment to our institution. Your presidency has helped us regain our perspective, resume our ancient dialogs, and prepare for new challenges.

“Few individuals have discovered one of the elements of which the universe is made, as you have. Even fewer have served as President of Cornell University, whose condition must at times have reminded you of the name chosen for your discovery: astatine [from the Greek astatos] ‘unstable.’ We congratulate you for having done both: you embody the singularity we often like to claim for ourselves. We look forward to your rejoining us.”

Presented by Byron W. Saunders
Dean of the University Faculty
1977
Preface

In December 1999 a Cornell symposium examined fundamental issues facing research universities, such as Cornell, at the beginning of a new century, and honored Cornell’s eighth president, Dale R. Corson.

This speech of appreciation was delivered by Dale R. Corson at the gala banquet, despite a considerable personal health challenge.

Response

Dean Cooke, friends, thank you very much for your thoughtfulness. I have moved into the digital photography business, but not at the camera level. I’ve been using conventional silver-based negatives and slides, scanning them into my computer, and printing them from there. The quality possible that way is just enormous, and the new cameras now becoming available have moved rapidly into a much higher quality level than they enjoyed even two or three years ago. Thank you very much for your thoughtfulness. A couple of days ago, Dean Cooke sent me by e-mail some photographs that he had of him and me together, and I hope that before long I can send him back something from this red box. Thank you.
I hope you will forgive me for sitting down tonight. I have two doctors here. One is my daughter, who is the director of Gannett Clinic and Cornell Health Service, and when she says sit down, I sit. My other doctor is Dr. Fred Plum, who was one of the speakers this afternoon and who, for longer than my time, has been the Chief Neurologist at New York Hospital-Cornell Medical Center in New York. He is now retired from that position and is a University Professor there. He has been looking after me for 30 years and he told me to sit down. So here I am.

I don't know how to respond to such a warm and generous affair as this tonight. It is easy for me to say that I don't believe all the stuff you heard here. I have respect for the people who said it, and they do not often lie about things, but I think the wine got to them a little bit tonight. Getting up in the morning, going to work, and trying to do my job as well as I could, would not seem to call for an occasion like this; and who would ever want to make a video of me? We once had an alumnus who had 13 surgical procedures for a complex malignancy before he died in his 90s, and he said, "They just practice on me and save the real thing for someone more deserving." I think that applies here. I think the filmmakers were just practicing on me. I thank David Rose and Molly Cummings and their associates for this film, and I think they are here someplace. Would you please stand? And I would also like to recognize our own Cornell producers of this film, Ed Hershey and Carol Stone. Will you please stand up? Ed Hershey has many professions; he has just been elected to the Ithaca Common Council for a second term, defeating a Cornell undergraduate. Now he's going to start practicing for the next election, where he will undoubtedly have to run against a graduate student. All I can say is thank you for your kindness. Nellie and I are pleased, of course, but embarrassed. I particularly thank Jean Gortzig for what she said about Nellie. I am especially grateful for that. Thank you, Jean.

I can tell you a story. She presented the trees in front of Balch Hall the Campus Club dedicated to Nellie, and she read the plaque that went with the gift. She was standing right beside me and I could read the plaque as she was talking, and I could see that there was an error, a mistake in the casting, and I wondered what she would do when she got to that point. When she reached the error, she handled it very well. She hesitated only about a millisecond, and went right on reading but she didn't let anyone see the plaque. She took it right away and had it recast. The plaque is over in front of Balch. You can go see it and see the trees sometime if you wish.

I also want to thank the outside speakers for coming to talk about questions that are at the top of our national agenda. This was an extraordinary series of talks today and I am impressed. I also want to thank all the people who had anything to do with selecting the speakers. I particularly appreciate your time. I particularly thank Dean Cooke and Vice Provost Richardson, who were the chief organizers of this event. I also thank Tina Snead for all she did to put the pieces together. She has been particularly helpful to me in my part of this affair. There was a formal organizational committee, but I think it never met as a whole committee. We met in pieces at different times and Tina is the one who made all this committee work come out the way it has today. She has already been recognized, but you can stand up again, Tina.

I remind everyone here, however, that our chief mission in this affair is to look forward. Satchel Paige, one of my baseball heroes, said, "Never look back; something might be gaining on you."

I always try to operate on principle, and over time I’ve developed a set of administrative principles that I’ve talked about at other times. I will relate some of those principles to you tonight.

1) The Principle of Fences and Bases. It takes less time to touch bases than it does to mend fences.
2) The Impossibility of Solution. Most problems, if not all, are impossible to solve. All you can do is resolve the issues.
3) The Golden Rule. He who has the gold makes the rules.
4) The Principle of Necessary Evil. To maintain a modicum of humility, look in the mirror every morning and say, "I am an evil, but am I a necessary one?"
5) The Principle of Equal and Opposite Unpopularity. If you find a resolution of a problem that makes you unpopular with everyone or popular with everyone, you have the wrong solution. If you have a resolution that makes you unpopular with half your constituency and popular with the other half, you have probably found a reasonable solution.
6) The Principle of Appreciated Cost. It always costs more than they say it will.
7) The Principle of Controlled Boldness. Be bold. Nothing ventured, nothing gained. But it is like the three rules for courting a woman: the first rule is to be bold; the second rule is be bold; the third rule is don't be too bold.

The final three rules come from a Russian fable. One bitter cold, winter day a Russian peasant was walking home across the frozen steppes when he came on a bird that was about to expire. He picked up the bird, put it under his coat, and set out for home with it. On the way he began to worry that the bird might have some terrible disease that would threaten his family. He looked for a place to leave the bird where it would be safe and he came across what the British call a cow pat. He put the bird down in the middle of the warm, steaming pat. Revived, the bird began to sing at the top of its lungs. That attracted the ever-present Russian wolf who ate the bird at one gulp.

This story has three lessons:

1) If you get into trouble, do not despair. Help may be on the way.
2) If you get out of trouble, do not be complacent. You may not be out of the woods yet.
3) If you find yourself in a real mess, keep your mouth shut.
Nellie and I have done a great deal of traveling, much of it on Cornell business, and later, on Washington business. Occasionally we travel for pleasure. Six years ago, returning from Australia, we stopped overnight in Los Angeles just in time for the Northridge earthquake. The airport reopened before noon and our flight left for Pittsburgh on schedule. We knew we could not stay overnight in Pittsburgh because there were no hotel rooms because of so many canceled flights. We took a chance on Syracuse and arrived there about midnight with a temperature of -10° and two feet of snow with only summer clothes and no topcoats.

There was another time that winter when Pittsburgh was closed and the terminal was wall-to-wall people because there were no hotel rooms. Three people fell into conversation with the camaraderie generated by shared adversity. One asked another, “Where you from?” “I’m from Ely, Minnesota. It’s a small town about 100 miles north of Duluth.” “It gets pretty cold there, doesn’t it?” “Yes, it’s cold all right, but it’s a dry cold and it’s not too bad.” “Where you from?” “I’m from Yuma, Arizona. It’s a small town on the Colorado River, in the southwest corner of the state.” “It’s pretty hot down there, isn’t it?” “It’s hot all right, but it’s a dry heat and it’s not too bad.” The third person did not even wait to be asked. She said, “I’m from Ithaca, New York. It’s a small town in upstate New York and it rains a lot there, but it’s a dry rain.”

It is impossible to be president of a major university and not meet a lot of people, from the president of the United States on down. You meet foreign dignitaries. I may be the only person in this room who ever sat at his bedside and discussed world affairs with Sir Anthony Eden when he had the flu.

One person I met and came to know to some degree was Carlos Romulo, the Philippine scholar, diplomat, and soldier. He had degrees from Columbia University and Notre Dame and he was completely Americanized. He had been Gen. McArthur’s aide at Corregidor and Bataan. After independence he was the Philippine Ambassador to the United States and then to the UN, where he served as president of both the Security Council and the General Assembly. When I first met him, he was president of the University of the Philippines. I had gone to visit the Cornell project at Los Banos and I called on him in his office. Later he came to Cornell for a couple of days and I spent more time with him. He left a big impression on me, partly because of his martini jokes. One he told had to do with a man who had a hard day at the office and on the way home stopped at a bar, where he ordered five martinis and lined them up in front of him, 1,2,3,4,5. He tossed the first one over his shoulder then drank the second, third, and fourth ones and tossed the fifth over his shoulder. The next day it was the same routine, and when he paid the bill the bartender said, “Why in the world did you throw away those two perfectly good martinis?” The reply was, “The first one never tastes good and the fifth one makes you drunk.”

There was another one about a young minister who was just starting out in his first church when the bishop came to visit one Sunday. After the service, everybody moved into the parish hall for coffee, and the bishop took the minister aside and said, “Son, I may have heard a duller sermon in my life, but I can’t remember when. I have a suggestion for you. Make yourself a martini, put it in an ordinary water tumbler, set it there on the pulpit, and take an occasional sip. I think you’ll find this will relax you, and that’s going to help your sermons.” A year went by and the bishop announced another visit, and at the last minute the minister remembered that he had never tried the advice. He quickly made a martini, put it in a brown paper bag, and took it to church with him. After the service, everybody went to the parish hall for coffee and the bishop took the minister aside and said, “Son, I have just three comments. The first is that you didn’t have to put an olive in it. The second is I said sip it, not gulp it. The third is that Daniel slew the lion. He didn’t beat the hell out of it.”

There is a third martini story that goes back to McCarthy days in the 1960s. A university professor had been summoned to appear before the House Un-American Activities Committee in the federal courthouse in Foley Square in downtown Manhattan, near City Hall. The committee grilled him without mercy about his leftist activities and he told them everything about himself but refused to disclose the names of any of his friends or colleagues. They threatened him with contempt and finally, in the end, ordered him to return the next day. He left the courthouse, walked down the street to Chambers Street and around the corner to find a bar, and ordered a double martini. He sat down, totally dejected, sipping his drink, and when he finished, he started nibbling the glass and he nibbled it right down to the stem. The second day was worse than the first and they ended up citing him for contempt. He left the courthouse, went back to the same bar, ordered another martini and sat there drinking it in a totally dejected way, and again nibbling the glass right down to the stem. He looked up and noticed that the bartender was staring at him and said, “I guess you think I’m odd.” And the bartender said, “Yes as a matter of fact, I do. The stem is the best part.”

Some of my most rewarding activities were in Washington after I retired in 1979. These involved various roles in the National Academy of Sciences, the National Academy of Engineering (things that Frank Press talked about), the National Science Foundation, the World Bank, the State Department, and the White House. I was once appointed chairman of the U.S. end of a U.S./Japan bilateral agreement on basic research. This program was operated out of the National Science Foundation, although I was appointed by the State Department, and we did good things. The only trouble was a lack of funds, but it was a rewarding experience. I finally decided that I was contributing too little to justify all the travel, and I sent a letter of resignation to the State Department office that had appointed me. After a few months, I received a reply saying, “You cannot resign because your appointment has run out but will you please stay on for another year”, which I did. There were about a dozen such bilateral agreements between the U.S. and Japan on science and technology policy, and there was an umbrella oversight group on which I served for a time. It was called a Joint High-Level Panel on Science and Technology.

At the U.S. end, it operated out of the White House with the President’s Science Adviser as the chief figure. The Japanese participants were bankers, former ambassadors, and other dignitaries, and it was absolutely the most useless body I ever served on. I’ve been
to Japan a dozen or fifteen times, but I’ve never traveled far beyond the Tokyo-Kyoto-Osaka corridor, and I decided I would stay on
the panel for one more meeting in Tokyo and then do some traveling while I was in Japan. Before the next meeting, the President’s
Science Adviser called me to say they were reorganizing the panel and reconstituting it entirely with industrial people and retiring
the academics — so no travel in Japan.

I had the most satisfaction out of my work for the National Academies of Science and Engineering, and I owe Frank Press a great
many thanks for this opportunity, although at the beginning of the Research Roundtable, I had a number of serious arguments with
his governing Council, who did not like what I was doing. Frank bore the brunt of these arguments and he received flak from both
sides — from me and from his Council. In the end it was mostly love and kisses.

One day in 1982 I had a call from Frank’s Foreign Secretary, who said that the World Bank was making a big loan to the People’s
Republic of China to strengthen Chinese science and engineering universities, and the Bank had specified that there was to be an
International Advisory Panel to oversee the loan operation. The chairman was to be an American who was to be nominated by the
National Academy of Sciences, and was I interested? I said I might be, but I needed to know more. He told me they would nominate
two or three people, and the bank and the Chinese would select. He would keep me informed. Several weeks went by and I heard
nothing. Finally, he called again to say that the bank and the Chinese had accepted me and a Chinese delegation would be in Wash-
ington in ten days to meet with me. I ended up as the chairman of the panel with a Japanese physicist, a French chemist, a German
engineer, a British computer scientist who was really Polish, and a Dutch biochemist who was really Australian. It was an interesting
and unusual enterprise. I made ten trips to China, each usually for three or four weeks.

We also met with the Chinese numerous times in Europe and in this country. At the conclusion of the project, I continued on a similar
panel for a separate project and altogether we helped spend about half a billion dollars. Frank let us operate these panels out of
the National Academy complex, using all the built-in support structure that exists there. Looking back on it now, I tremble when I
think about what would have happened if I’d tried to operate that program out of my crowded little office in Clark Hall at Cornell
University. I thank you, Frank.

Altogether, I spent about ten years in this enterprise. Earlier, in the 1960s, I had spent about eight years as a Ford Foundation con-
sultant helping build science and engineering programs in universities in Latin America. I learned to do business in Spanish, but I
can tell you I never learned to do business in Chinese.

Now, just a word about Cornell. We survived the troubles of late 60s and early 70s well. We succeeded because everybody pulled to-
gether. It was remarkable. I am forever indebted to my administrative colleagues, the trustees, the deans, the staff, the department
chairmen, and the faculties who made it happen. Without that help and cooperation, I could have achieved little.

I have been fortunate in the extreme in my life. It’s light years from that one-room country school you saw on the video, where I rode
my horse two and a half miles to school every day, to this room here tonight. I’m grateful. I thank you for your support during difficult
times, and I thank you for this symposium. It was an impressive session today and we have enjoyed every minute of it. I thank you.
The Glee Club serenaded at the Gala Banquet that was held in the recently-rennovated Dyson Atrium of Sage Hall.

All stand for their closing number: The Cornell Alma Mater

Note: If you are reading this from a digital file (rather than printed book), click here to listen to an audio recording [8:20] of the Glee Club on 6 December 1999.
James E. Turner, former director of Africana Studies and Research Center, greets Dale.

Cornell provost Don Randel chats with SUNY provost Peter Salins and Charlotte Kuh.
Cornell vice president Susan Murphy with Walter F. and Sandy LaFeber.

Cornell president Hunter R. Rawlings III
A symbolic chocolate desert was served.
I said this morning without knowing that Dale was not then in the audience, that as we consider the health of the university in the new millennium, the foundation on which we build is the foundation that has been forged by those who have loved learning and advanced its boundaries and defended it well. No one fits those three categories of requirement more nobly than Dale Corson.

I had the immense good fortune to succeed Dale Corson in the presidency of Cornell. There is a story told that in 1784 Thomas Jefferson succeeded Benjamin Franklin as Resident U.S. minister in France, and a French diplomat came up at the time and said, “Mr. Jefferson, you are the one, I gather, who is to replace Minister Franklin.” And Jefferson replied, “No sir, no one can replace Mr. Franklin, I merely succeed him.” I had the good fortune to not replace but to succeed Dale Corson, and the immense good fortune to build on the foundation that he had created.

There is a story told of a young and inexperienced individual going into the university presidency and being given sage advice by his predecessor. That advice consisted of a very simple suggestion that he should prepare three envelopes and that he should open them only in times dire need. For three months things went swimmingly and then a major crisis erupted — over faculty parking, in this particular case. The new president opened the first envelope, and it said, “Blame the previous administration.” Which he did, and things quietened down.

And six months later, another even more profound crisis emerged, closing a center, and so he opened the second envelope that said, “Reorganize your administration.” He did that and things calmed down again.

Until a year later a major, major crisis emerged, and he opened the third envelope that said, “Prepare three envelopes”.

It’s my debt to Dale that I still have the first and the second and the third of those envelopes unopened after succeeding him.

You have heard, from that marvelous video that we saw, the astonishing career that Dale has had. Coming from a wonderful Midwestern rural background in Kansas, he graduated from Emporia and then from Berkeley and came to Cornell in 1946. Within ten years of his Ph.D., he had placed a new element on the periodic table, something given to few individuals. Coming to Cornell, he had a series of careers, as a faculty member in physics — and how appropriate that we gather together today in Rockefeller for our meetings — then as chair of the physics department, leading that department wisely and well, and then remarkably — in perhaps the only case of its kind — crossing lines and becoming Dean of Engineering. In days when interdisciplinarity reigns and is commonly honored and respected, that seems unheard of. Then from Dean of Engineering to Provost of the university during its most troubled days.

When Dale became President in 1969, he said at the time of his appointment, “I am an educator and I plan to make it my business to pay attention to education as the priority and the needs of students, faculty, and staff”.

And no one in those dark days who did not command the trust, on the one hand, and the understanding, on the other, that Dale did could possibly have succeeded in healing the wounds which were so deep. It is a tribute to that healing process and to Dale’s skill in leading it and nurturing it that Cornell enjoys the strength it has today. You have heard from Austin Kiplinger and Walt LaFeber and others something of Dale’s immense contribution as president, but Dale’s contribution went far beyond the campus; and I am so glad that Frank Press was here yesterday and today in the video to speak of that wider career that Dale had, not just during his years as president, but in the subsequent years of his retirement when the whole commonwealth of learning benefited from the contributions he made in things as different as governmental policy, or lack of it, in science and in technology, to opening up relationships with countries in Asia.

In all those ways and more, we continue to benefit from the leadership that Dale has given.
And in this and more, Nellie has been the full and complete partner — not simply a gracious and beloved first lady, but somebody who was part of the Cornell community in the most significant and continuing way. And Nellie, we salute you, too, as we honor Dale.

Ted Hesburgh, who was the president of Notre Dame, the longest serving of any recent university president — he served for 35 years, was one of Dale's contemporaries, and because of his long service, was also one of mine — knew more perhaps about the presidency than most people. And he once commented, “The greatest legacy a university president can leave to his university is the legacy of the example of his own life.”

Dale, we thank you not simply for the legacy that you left us in buildings and programs as different as Materials Science, Biological Sciences, and Computer Graphics, not simply for the buildings you dreamed into existence and the relationships you rekindled and reforged, but also for the legacy of your person and your life.

We salute you and thank you and congratulate you.

Thank you, Dale.

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The Cornell Sundial

An Engineering Statement

“I felt that it shouldn't be just a garden ornament. Precision was one quality it had to have.”

Dale R. Corson

With its six-foot diameter and artistic, sculptural appearance, the Cornell Sundial stands radiantly in the Joseph N. Pew, Jr. Engineering Quadrangle. Created by Dale Corson, it is one of the most accurate in existence, with an error of 30 seconds or less. The complicated adjustments for day-to-day astronomical variations are made by the internal mechanism, which has been called “a marvel of engineering design.” To use it, set a dial for the correct date and read the time directly on a simple scale, provided the sun is shining.

It was completed in November, 1980.
Editor’s note: The following transcripts have been edited lightly only. A companion DVD contains the audio recordings of the actual lectures.
Symposium Lectures

The Role of the Humanities in a Research University
Hunter R. Rawlings III, President, Cornell University

The Research University: Some Observations and Admonitions
John Brademas, President Emeritus, New York University
Chairman, President’s Committee on the Arts and the Humanities

Science, Policy, and Politics
Vernon J. Ehlers, U.S. House of Representative (Michigan)
Vice Chair of the Committee on Science

Graduate Education in Research Universities: A Look to the Future
Charlotte V. Kuh, Executive Director, Office of Scientific and Engineering Personnel,
National Research Council

The Government-University Industry Research Nexus
Joe B. Wyatt, Chancellor, Vanderbilt University

Medical Neuroscience in the 21st Century
Fred Plum, Professor of neuroscience, Weill Medical College of Cornell University

Virtual Universities: Real Boundaries
Donald P. Greenberg, Professor of Computer Graphics, Cornell University

Issues for the 21st Century
Frank H.T. Rhodes, President Emeritus, Cornell University

Why Can’t Colleges Control Their Costs?
Ronald G. Ehrenberg, Irving M. Ives Professor of Industrial and Labor Relations and Economics, Cornell University
**Financing Cornell in the 21st Century**  
Donald F. Holcomb, Professor Emeritus of Physics, Cornell University

**The Genomics Revolution: What Role for Cornell?**  
Steven D. Tanksley, Liberty Hyde Bailey Professor of Plant Breeding, Cornell University

**Centers: Collaboration, Coordination, Competition, Collegiality, Cost, and Continuity**  
Joseph M. Ballantyne, Professor of Electrical Engineering, Cornell University

**Video:** Dale Corson: Cornell’s Good Fortune

**NOTE:** The Corson Symposium: Strategy for a Great Research University DVD includes an 18-minute video tribute and the audio recordings of the tributes at the gala banquet, the luncheon, and all the major speeches of the Symposium – for a total DVD running time of about 10 hours. News stories about the Symposium, photos of the Corson family and many of their friends who attended the Symposium are contained in its DVD ROM.

The transcripts of these tributes and speeches are included in this book.

Frank Press, Hunter Rawlings III, John Brademas, and Vernon Ehlers during discussion session.
I have a very great pleasure to welcome all of you to the Dale Raymond Corson Symposium and the title of this symposium is “Strategy for a Great Research University”. I want to pause for a few minutes to tell you about the origin of the symposium and then describe what it is we are attempting to do at this symposium. About a year and a half ago, Bob Cooke, just after he was elected as Dean of the Faculty, came to see me and said, “you know what I would like to do is have a celebration here, a celebration of Cornell as a research University and I would like to dedicate it to Dale Corson.” And I thought that was a terrific idea and the theme of the symposium would be to pause and reflect upon the opportunities and challenges of great American research universities.

Now my brief definition of a research university or the mission of a research University is that a research University is an institution for the creation of new knowledge and to transfer that knowledge to the next generation. Research universities are very complex places, and I assert that there is no more complex research University than Cornell University because of the true diversity of the mission as well as the people in the community we serve. I think it is great fun though to think at this particular time about the directions we should take as a society and we at Cornell should take as an institution, to continue as a service to society and see to our successful future existence.

It is very appropriate that Dale Corson be our honoree at this symposium for two reasons. First he served as president of Cornell University, probably during its most trying times and the reason we are here as a successful University today, in no small part, is a consequence of the wise leadership that Dale Corson exercised as president of Cornell University.

But another remarkable thing that we want to celebrate is the contributions that Dale made after he retired as president of Cornell University, because he exercised some extremely important leadership for the nation in directions of the science policy and education policy. With those comments then, I would like to begin our program this morning. I hope all of you have picked up a program this morning because in the programs we have a brief biography of all the guest speakers that we are privileged to have join us for the symposium.

I want to say one other thing. We are delighted that Dale Corson is right here with us in the front row and I would like to recognize him.

Our first speaker this morning then is president Hunter R. Rawlings III and his presentation will be “The Role of Humanities and Research at a Research University.”
The Role of the Humanities in a Research University

A Tribute to Dale R. Corson

I am pleased to welcome you to this symposium held in honor of a superb scientist, a wise academic leader, and, above all, a great Cornellian: Dale R. Corson. Others will talk about Dale’s accomplishments as a scientist, a policy maker, and an adviser to governments and to industry, but the point I want to underline is that Dale Corson is an outstanding university citizen in the broad, traditional, and most valuable sense. Dale assumed the presidency of Cornell at a time when universities nationally were struggling for their identities within society at large, and when Cornell, in particular, was fractured to an extent never equaled before or since. Dale – while mindful of national issues and deeply immersed in the complexities of the situation at Cornell – understood the nature of the university and stood for its essential values: freedom of thought and responsibility of action; and with extraordinary deftness he pulled the fractured university back together by reminding all its members of the university’s commitment to academic freedom and to civil discourse – values that transcend the other purposes of the university to which we all belong.

Dale began as a faculty member, and he remains a faculty member. Today he is a remarkably engaged emeritus professor, quietly building Kendal into one of the strongest academic institutions in the Northeast. And although he has earned a great deal of professional acclaim as a physicist and as a national spokesperson for research universities, his greatest contribution, I believe, has been his dedication to the idea of the university as a community – an academic community whose mission is to pursue truth and to assist each new generation in its pursuit.

I find it revealing that Dale assumed the Cornell presidency not because he had aspirations to become a university president, but because he loved Cornell. Academic leadership, not administration, is what interested him, and he has often said that he was happiest at Cornell not as president, but as provost, when he was the academic leader, responsible for appointing, retaining, and inspiring a strong faculty. As provost and as president, Dale Corson led Cornell with superb academic taste and high standards. He had a remarkable ability to endure ambiguity, to tolerate disagreement, and to harness argument and the force of strong personalities to create constructive dialogue and to reach wise decisions – recognizing, as only a faculty member can, that a certain amount of contentiousness is essential in a great university.

More than 50 years ago, Cornell’s distinguished historian Carl Becker grasped this aspect of the university when he characterized professors as people “who think otherwise … (T)he essential quality of a great university,” Becker maintained, “derives from the corporate activities of such a community of otherwise-thinking men (and women). By virtue of a divergence, as well as of a community of interests, by the sharp impress of their minds and temperaments and eccentricities upon each other and upon their pupils, there is created a continuing tradition of ideas and attitudes and habitual responses that has a life of its own. It is this continuing tradition
that gives to a university its corporate character or personality – that intangible but living and dynamic influence which is the richest and most durable gift any university can confer upon those who come to it for instruction and guidance."

Becker goes on to relate a story about a well-known professor of history: “passionate defender of majority rule, who, foreseeing that he would be outvoted in the faculty on the question of the location of Risley Hall, declared with emotion that he felt so strongly on the subject that he thought he ought to have two votes.”

Dale Corson’s Cornell also had its share of colorful and passionate characters, not all of whom comported themselves with the decorum and civility that was expected in Becker’s day. But Dale understood, far better than most, what it takes to make a great university: a strong and “otherwise-thinking” faculty with deep loyalty to the university, a willingness to take students seriously, and above all, a commitment to academic freedom, to informed debate, and a critical spirit which recognizes differences of opinion not as disasters, but as opportunities for dialogue that can lead to new understanding. Here is a physicist and an academic leader with the sensitivities and the sensibilities of a humanist.

I want to argue that many of the qualities that Dale Corson embodies will remain central to the success of America’s research universities in the 21st century, even as we move into an era of large and rapid change. And I will argue that, though science will make remarkable discoveries and many headlines in the new century, the humanities will be crucial to understanding, preserving, and extending the essential qualities of a great university. They, perhaps more than any other constellation of fields, can help guide us – but only if they can reclaim their central place within the university and return to purposes that are both broad and deep.

A Historical Perspective

But first, a bit of history. More than 50 years ago, as World War II was ending, President Franklin D. Roosevelt asked Vannevar Bush, who was then directing the federal Office of Scientific Research and Development, to suggest how science, which had contributed so dramatically to the Allied victory in World War II, could best serve the nation in the post-war era. Bush’s report, Science: The Endless Frontier, completed after Roosevelt’s death and delivered to his successor, President Harry S. Truman, made the case that the federal government could best strengthen American industry by supporting basic research and developing scientific talent at American universities. The Endless Frontier set the stage for the development of the National Science Foundation and for a partnership between the federal government and American research universities that continues to this day. That partnership, which has endured for 50 years, has helped create great science at America’s universities and made them the envy of the world.

Through this potent collaboration – not only with NSF, but also with the National Institutes of Health, the Department of Energy, the Office of Naval Research, NASA and others – American universities have pursued research and graduate teaching hand in hand, thus reaping the benefits of a remarkable synergy that cannot be found in government research laboratories or in liberal arts colleges without graduate and research programs. These universities now attract the best young minds from the entire world, and they have spawned the lion’s share of Nobel Prizes and other research awards that testify to scientific leadership. Cornell has been a key player in the federal government-university research partnership and one of its major beneficiaries, as well as one of its major contributors.

Dale Corson played a major role in positioning Cornell for leadership in several important research areas, including materials science. Some 40 years ago, during a trip to Washington, he learned that the nuclear power industry was finding that materials didn’t hold up in the high-radiation, high-temperature atmosphere of their reactors. In an article in The Cornell Magazine, Dale recalled, “I had a friend on the Atomic Energy Commission who told me what was going on. So I visited the AEC and talked to some of my old friends in the Defense Department. When I came back, I went straight to Day Hall and said, ‘Here are the possibilities and here’s what we ought to be doing.’” Cornell’s Center for Materials Research, and also the Wilson Laboratory, the Cornell High Energy Synchrotron Source, the Cornell Nanofabrication Facility, and other facilities, continue to be recognized as national and world leaders in their fields. So productive was the university-government-industry partnership, as evidenced by Cornell’s success, that when Dale Corson finished his term as president, he and Nellie moved to Washington, D.C., where he founded the Government University Industry Research Roundtable and led efforts to encourage more collaboration among those three sectors.

From 1950 to 1990, then, we saw an expanding university-government partnership and a healthy injection of industrial participation, from which American universities have benefited enormously. But in the past ten years – from roughly 1990 to the present – we have experienced a dramatic acceleration of this trend, owing to several concurrent developments.

Accelerating Revolutions in Science and Technology and in Global Capitalism

First of all, we are witnessing two simultaneous revolutions in science and technology: the computing and information science revolution and the communications revolution. It is true that these revolutions began well before 1990, but they have exploded in the last ten years. Each is significant in its own right. But because they are mutually reinforcing, they have become incredibly powerful tools, with a huge capacity to create change. There is no need to rehearse the elements of these revolutions, but I think all of us would acknowledge their potency and their tremendous impact on universities and on every other part of society.
In particular, they are fueling a third force: the conversion of multinational companies into powerful and truly "transnational" corporations, and the consequent emergence of American economic dominance. We live at a time when global capitalism, as carried out by transnational corporations, has become the principal driver of nearly everyone's agenda – from national governments making policy, to individuals seeking jobs and their place in the world. The booming stock market of the past six years has created a huge amount of wealth in America. Transnational corporations such as Microsoft, Citigroup, GE, and Time-Warner are reshaping the economic geography of the United States and the world.

It is true that multinational corporations have been a feature of the global landscape for a century, but the old-style multinational corporations were headquartered in the United States and sold most of their goods here. That made them accountable to the federal government to a considerable degree. In contrast, as Prof. Walter LaFeber notes in his recent book, *Michael Jordan and the New Global Capitalism*, the new transnationals have become so global – and so large – that any one government has power over only a limited part of their operations. In fact, some have argued that the influence of global capitalism is so strong that it has supplanted the nation-state. Of the 100 largest economic units in the world today, fewer than half are nations.

The rise of global capitalism is helping to drive the revolutions in communications and computing, and those revolutions, in turn, are fueling each other and also the market economy. These movements are powerful and difficult for governments to control. In fact, governments are starting to join them, as evidenced by the recent repeal of the Glass-Steagall Act, a repeal that permits companies to offer once-prohibited constellations of products and services under one roof.

It is not surprising that the rise of very large, merged corporations, with their global economic power and weight, is beginning to occasion anxiety and alarm among a lot of people. Hence the real and symbolic power of the events in Seattle last week. The World Trade Organization, a group few people paid attention to five years ago, met to develop ways to reduce barriers to global trade through negotiations largely shielded from public scrutiny. And while it was billed by the Clinton Administration as a way to showcase the benefits of free trade, it also showcased the fears that global capitalism is generating. More than 40,000 protesters, from more than 500 different organizations and from several countries, descended on Seattle to make their voices heard on issues ranging from environmental protection to human and worker rights. We have not seen that level of protest since the Vietnam War. There were representatives of organized labor – the teamsters, the United Steel Workers, and the AFL-CIO. There were environmental groups such as the Sierra Club and Friends of the Earth. There were farm organizations and fundamentalists and fringe groups ranging from the Ruckus Society to the Raging Grannies. They spanned the political spectrum – from the far left to the far right. A great many people seem uneasy about the implications of world trade, which, it is clear, is symbolic of, a surrogate for, triumphant global capitalism. That is what people were in Seattle to air their grievances about last week.

**The Rise of the University-Industrial Complex**

That, in turn, should give us pause, because universities have been willing participants in, and beneficiaries of, the scientific and economic revolutions which are generating such economic momentum and power. By harnessing the two scientific revolutions and by hitching themselves to the global economic enterprise, research universities have met, and exceeded, the expectations of Vannevar Bush's *Endless Frontier*. We have linked ourselves directly and productively not only to government, but to American industry and global capitalism. Research universities are among the most ardent and successful exponents of the computing-communications revolution. Because universities are heavily engaged in science, and because science, in many of its most exciting domains, requires large infusions of capital, we seek funds not only from governments, which used to provide almost all of what(568,761),(763,823)

Large research universities are thus becoming a major driver of economic development. Colleges and universities in the United States collected more than $576 million in royalties from inventions licensed to industry in fiscal 1998, and were awarded more than 2,681 patents. And not only do our discoveries lead to patents and licenses as they have in the past, but now they are spawning startup companies and partnering with corporations to produce and improve products and processes across a wide spectrum of commercial activity. We are expected by our states to be part of their economic development agenda, and we are, as a result, setting up research foundations, biotechnology centers, and incubator facilities on and off campus.

We have thus become complicit in the creation of a university-industrial complex that produces tangible benefits for universities and for American society at large. At the turn of the century and the millennium, universities and industries have become willing collaborators, with government playing a supporting role. We can expect the university-industrial complex to expand its influence as the Internet and other communication technologies make national borders transparent and make possible global exchange and collaboration in both teaching and research.

And we have only just begun. For-profit cyber-universities and other ventures, enabled by the Internet, are going to impact the university-industrial complex with a vengeance in the new millennium as universities and private industry team up to offer for-profit instruction on a global scale. University teaching using the Internet and other advanced communication technology is already raising troubling questions.
Many of you probably saw the front-page article in the November 22 Wall Street Journal about the Harvard Law Professor, Arthur Miller, who is embroiled in a dispute with his dean over a series of eleven lectures he videotaped last summer for use in a course offered by the Concord University School of Law, an on-line degree-granting entity set up by the Washington Post’s Kaplan Educational Centers. Harvard contends that Prof. Miller is violating its policy that bars its faculty members from teaching at another university, without permission, during the academic year. Prof. Miller maintains that he isn’t teaching, since he doesn’t deal directly with students, and asks how his Internet involvement differs from freelance work he has done for television.

The Research University in the “Age of Money”

The rise of the university-industrial complex raises significant concerns about our role, about our very identity, as an independent discoverer and conveyer of knowledge. Have we, in fact, become part of the global entrepreneurial enterprise, a transnational corporation with many of the same attributes as companies like GE, Citigroup, and Microsoft?

In my view, the answer is “Yes, we have.” The ascendancy of science and the rise of the university-industrial complex contributing to and serving the needs of global capitalism have many attractions and benefits on many levels. In fact, they are nearly irresistible for universities. Who can complain about a booming economy and expanding markets and the resources universities receive from them? And who can object when universities, particularly land-grant universities like Cornell, contribute to economic development and technological advances?

But while we reap many advantages from the revolutions we are helping to drive, we must also be aware of the risks and the downsides. The research university is increasingly abandoning its historical role as independent thinker and critic, and is embracing a new role as collaborator with, beneficiary of, and enabler of, government, business and industry.

As early as 1920, Max Weber saw universities becoming “state capitalist enterprises” in which free inquiry had given way to the production of knowledge useful to the state for economic or technological reasons, thereby helping to legitimize state authority. But what he envisioned then is trivial compared to what we see now.

Money has always been important to universities, but never so much as today in our information-based, highly competitive research and teaching environment. The revolutions in which we are ourselves complicit mean that the hallowed idea of the campus has just about disappeared. We are no longer “removed from the every-day nature of American life – we are part of that life.” We have been, in Bill Chace’s words, “desanctified.”

One of the risks of our new status is that we will be so driven by financial considerations that we will make an unbalanced situation even more so by favoring the fields that attract resources and spawn economic activity, as opposed to fields that participate very little in economic development. James Engell, a Harvard professor, and Anthony Dangerfield, a Cornell Ph.D., wrote about “the market-model university” in an article entitled “Humanities in the Age of Money,” which appeared not long ago in Harvard Magazine.

“In the Age of Money,” they assert, “the royal road to success [in the university] is to offer at least one of the following:

- **A Promise of Money.** That is, the field is popularly linked to improved chances of securing an occupation or profession that promises above-average lifetime earnings.

- **A Knowledge of Money** – either practical or theoretical, as in the study of fiscal, business, financial, or economic matters.

- **A Source of Money** – such as support from research contracts, federal grants, corporate underwriting, or other external sources.”

This formulation may be a little glib, but I cannot argue that it is altogether wrong. The humanities – with rare exceptions – meet none of Engell’s and Dangerfield’s criteria, and, therefore, have, in their words, lost “respect, students, and, yes, money.”

Viewed from any perspective, the humanities have fallen behind their more worldly disciplinary cousins in the contemporary university. We could ignore this trend altogether, or simply lament it and move along, confident that the pragmatic disciplines in the university will prosper, whatever happens to the humanities. That would be, in my view, a tragic error, for universities and for society.
at large.


“Ways must be found to assure continuing attention for those aspects of culture and learning that are important but, in a commercial sense, not necessarily in fashion. . . . Uncritical adherence to the concept of information as a commodity will distort the agendas of institutions and disciplines alike. . . . Public interest in the principle of open access must appropriately influence the structure of the information system and its components. It is certain that the information needs of society cannot be defined by the marketplace alone.”

**The Centrality of the Humanities in the New Millennium**

The humanities remain central to research universities for several compelling and interrelated reasons: First, the humanities play a crucial role as the keepers and conveyors of culture in its many forms. The old aphorism is true: those who are ignorant of the past are indeed condemned to repeat it. It is essential in a democratic society that citizens be informed about the forces that have made them who they are.

Second, the humanities, in the past twenty-five years or so, have opened our eyes to formerly marginalized cultures and led in the development of gender studies and ethnic studies, which have enlarged the worldview of all of us. And while these fields have generated a certain amount of contentiousness within the academy and in political life, those earning university degrees today are far more capable of broad thinking than those who graduated twenty-five years ago.

Third, the humanities, and the arts, help mediate between high culture and mass culture, between elitism and populism. They thus expand our cultural reach, address problems of social structures, and raise enduring questions about what is worthy of our students’ study.

Fourth, the humanities have become especially important, given what we have spent the past twenty minutes talking about. Humanists, more than other scholars, have historically looked for insights in other areas of endeavor and used them to inform judgments of human value, relevance, and historical significance. As James Engell has pointed out, “The humanities absorb and interpret the results of science, knowledge, and technology for our inner lives, values, and ideals.”

Humanists give us not only a greater depth of knowledge and understanding for its own sake; they are also catalysts for change. “It has been the province of the humanities to preserve in order to reform,” Engell writes, “to pay attention, even homage, to the past, but to criticize what we inherit, calibrating the fact that social and individual lives change in the present, and that the education of character, the shaping of society, balance what has been known with the pressure of what is discovered. The humanities openly cherish and brazenly criticize and see no contradiction in the two.”

In the Age of Money, with the commodification of nearly everything, and entirely too much information, we desperately need critique – informed, disinterested, ethically-based, with the eye fixed steadily on long-term consequences. We require this critique for the global society, and, in particular, for research universities themselves.

The humanities, ever since Socrates, have had not only a critical method, but a critical spirit, a mind set upon argument, antithesis, and an urge, as Becker put it, to think “otherwise.” As universities speed into the new millennium on the backs of government and global corporations, they need to ask where they are going. A critique of global culture should come not only from Luddites, fundamentalists, trade unions, and Friends of the Earth; it should come from academic critics who think rationally and carefully about “why,” not just about “how.”

Finally, the arts and humanities perform a deep and essential role that goes to the heart of universities, and to the heart of individual women and men. As Max Weber argued in “Science as a Vocation”: “Scientific work is chained to the course of progress; whereas in the realm of art there is no progress in the same sense. . . .”

We generally see this as a problem, perhaps the problem for the arts and humanities. But as Weber goes on to say, “A work of art which is genuine ‘fulfillment’ is never surpassed; it will never be antiquated. Individuals may differ in appreciating the personal significance of works of art, but no one will ever be able to say of such a work that it is outstripped by another work which is also ‘fulfillment.’”

A work of art or literature, when “read” by an informed observer, contains within itself a kind of knowledge that is different from other kinds that depend upon the incremental buildup of information: it has a human, moral dimension at its center.

**The Development of Moral Knowledge**

As W. Robert Connor, director of the National Humanities Center, has written (in “Moral Knowledge in the Modern University,” *Ideas*, Vol. 6, No. 1), moral knowledge differs in fundamental ways from knowledge of the natural world. It is not of a body of facts or gen-
eralizations, but rather an activity, “ongoing, constantly reacting to experience, monitoring responses, contemplating alternatives, seeking ways to understand how things appear to affect others, confirming or revising patterns of actions and habits of the heart, searching for ways to change . . . It is, in other words, a heuristic, a way of finding out, rather than a content or a set of rigid moral laws.” It requires imagination as well as logic. “There are methods that work,” Connor notes, “but the knowledge can never be totally separated from the practice.”

Moral knowledge develops very slowly. While it is never actually stagnant, “glacial” might be a fair description of its pace. It grows, Connor writes, “through a slow, sometimes agonizing examination of individual cases, in the hope of eliminating obfuscatory and tendentious language, cutting through self-deception, and trying to weigh alternative outcomes.”

It is informed through studying history, reading a poem or novel, attending a play, looking at a painting, or listening to music, all of which help us imagine what it might be like to have a life different from our own. History and literature are particularly well-suited to developing a moral imagination because they challenge us to examine characters, both real and imagined, who confront difficult choices, and to reflect on how those characters behave.

As Mike Abrams has said, “The necessity, vitality, and vexatiousness of literary and other humanistic studies lies in the fact that they raise and reraise questions about the concerns we live by, to which they offer and reoffer answers that, however strongly supported, turn out never to be the last word.”

**Implications for Undergraduate Education**

In the final analysis, the development of moral knowledge demands that each of us answer the ultimate Socratic question: “Who am I, and what should I do with my life?”

In universities, we must remember, a major part of our obligation is to help 18-year-olds answer that question. In so doing, the example of the teacher is critical. As Alexander Nehamas of Princeton has written, “Teachers have to embody the principles that we are to teach our students . . .” Socrates was great because he did not just have theories – he lived and died for them. His power comes from being able to appear as a believable and admirable human type, not just because he claimed that reason is important.

In recent years many of us have lamented the quality and level of our public discourse. This is not simply a complaint about scandals and gaffes; it is a deep concern about the increasingly superficial, sound-bite, public-polling approach to complex issues that we see in our public debates, in our political campaigns, and in our broadcast media generally. As the issues that confront us become more complex, our rhetoric becomes more simplistic. All of us are properly worried about the seemingly irresistible tide of materialism and the concomitant decline of intellectual life in America.

We see these trends even on college campuses, where undergraduate life is often a series of formal academic challenges followed by a mad-dash seeking for relief in the form of games, drink, and social activity. That is why Cornell, along with a few of its peers, is embarked on a program to raise the level of the undergraduate experience by focusing attention upon the quality of that experience in everyday life. As the “Report on the State of the Humanities at Cornell” well said last year, Cornell “should attempt a fundamental reorientation of undergraduate culture in a more intellectually challenging direction, and the humanities have a central role to play in the creation of an improved climate for undergraduate life at Cornell. Such a reorientation is a major undertaking, and it will require commitment and a sense of direction.”

Walt Whitman captured the spirit of what needs to be done in a memorable formulation:

“Books are to be called for and supplied on the assumption that the process of reading is not a half-sleep, but, in the highest sense, a gymnast’s struggle; that the reader is to do something for himself, must be on the alert, must himself or herself construct indeed the poem, argument, history, metaphysical essay – the texts furnishing the hints, the clue, the start of the framework. Not the book so much needs to be the complete thing, but the reader of the book does. That was to make a nation of supple and athletic minds, well-trained, intuitive, used to depend on themselves and not on a few coteries of writers.”

In the age of transnational corporations and global capitalism, and remarkable scientific and technological progress, the humanities have a more central place than ever in our struggle to become whole. It is time for the humanities themselves to shake off the ever-increasing specialization that has not served them nearly as well as it has served the sciences, and to reclaim the broad and deep perspective, the personal example, and the integrating role, on which the development of moral knowledge – and of morally grounded 18-year-olds – depends.

Only then can we insure that we will maintain what Carl Becker called “the essential quality of a great university” — its character and personality.

*Note: The text of this speech also appeared in the Cornell Chronicle.*
The Research University: Some Observations and Admonitions

by John Brademas
President Emeritus, New York University
Chairman, President’s Committee on the Arts and the Humanities

Introduction by Robert C. Richardson: At the end of this morning’s session we will have a discussion period, which Frank Press will lead us in, but right now I would like to turn to our next speaker, John Brademas. He is also a humanist. He currently serves as chair of the President’s Committee on arts and humanities, among his many other activities. Prior to that, between 1982 and 1991, he was the President of New York University and prior to that he served the third congressional district of Indiana as a congress-man for 22 years and he’s widely known for his thoughtful leadership as a congressman, as a university president and now as a leader of the humanities and arts community, among other communities, in the United States. John…

John Brademas: I must say, as I’ve told Hunter, that I thought he offered us a most profound discussion of the role of the research university in the United States and it is a statement that I hope will find a wider audience. Although I’ve been involved with higher education for most of my life, as student, teacher, legislator, or university president, I must confess this is the first time I have visited Ithaca and I’m delighted to be here. For Cornell is one of the most respected institutions of higher learning in the world with great academic strength in a wide range of fields. I have had, let me say, the privilege of knowing several of Cornell’s leaders over the years; Jim Perkins with whom I shared a keen interest in international studies; Frank Rhodes with his wife Rosa, as well as with another speaker at this symposium, Chancellor Joe Wyatt of Vanderbilt and his wife, Fay, and my contemporary as a student at Oxford of nearly 50 years ago, Steve Muller – my wife and I several years ago had a fascinating trip to the People’s Republic of China. Urie Bronfenbrenner whom I saw this morning, who often testified before my congressional committee on Headstart and other child development issues and Hank Dullea with whom I worked during his service on the administration of Governors Cuomo and Carey and with whom I also earlier worked on the National Commission on Financing Post Secondary Education. Finally, of course, I feel privileged to join you in honoring an eminent statesman of American science and engineering and former president of this university, who adds luster to the name of Cornell, Dale Corson.

Now I’m going to address the subject of this conference from the perspective of my own experiences. I was, as you have been told, for 22 years, a member of the United States Congress where, on the Committee on Education and Labor, I took part in writing all of the legislation enacted during that period, to assist schools, colleges, and universities, libraries, museums, the arts and humanities and to provide services for the very young, the elderly, and the disabled. Yesterday, I was delighted to be greeted at the airport by one of my former constituents in Indiana, Cornell’s distinguished, diplomatic historian of whom Dr. Rawlings spoke earlier, Walter LaFeber, as well as to see another eminent Cornellian whom I have known since having come to New York, the famed neuroscientist Fred Plum. I was also glad to see, also this morning, Frank Press and although I haven’t seen him yet I see that Bill Bowen is also scheduled to take part in these proceedings.

In 1980 I was defeated for election for a 12th term in Ronald Reagan’s landslide victory over President Jimmy Carter. I may say as an aside, as a working politician for much of my life that as I was the majority whip, at the time number three in the hierarchy of leadership, and as Tip O’Neill the speaker who appointed me, I think I was the last appointed whip voluntarily retired from congress and as Jim Wright of Texas, the then majority leader was forced out, had I been re-elected, I’d have been Speaker of the House of Representatives — and my name is not Newt Gingrich. Shortly thereafter, I was invited to become president of New York University, the nation’s the largest private or independent university, a position in which I served for 11 years and succinctly put, my goal for NYU was to transform what had been a regional, that is to say, New York, New Jersey and Connecticut commuter school into a national and international residential, research university and I think it’s fair to say that goal has been accomplished. Beyond experience as a legislator and university leader, I have searched on several college and university boards of trustees and as I said, on
the National Commission on Financing Post Secondary Education where I chaired the subcommittee on graduate education, the American Council on Education Commissions on National Challenges to Higher Education, and the Carnegie Commission on Science, Technology and Government. Today, as you’ve also been told, I chair by appointment by President Clinton, the President’s Committee on the Arts and Humanities, which is a group of some forty persons, private citizens, and heads of federal departments and agencies with some cultural program. Our mission is to make recommendations for generating more support, both public and private, for these two fields in the United States. Two years ago, the President’s Committee, of which the First Lady Hillary Rodham Clinton is honorary chair, released “Creative America,” a report containing over fifty specific recommendations to generate support and our proposals are subsumed in several categories. We called for a renewal for American philanthropy for the Arts and Humanities and an assessment of the nation’s preservation needs and a plan to protect our cultural legacy — a public/private partnership to digitize cultural materials, to make them available through the new technologies, a series of measures to strengthen education in the arts and the humanities, significant increases in funds for the national endowments for the Arts, the Humanities and the museum services program and a national forum on enhancing knowledge of other cultures, including educational and cultural exchanges. I chair as well, the National Endowment for Democracy which is a federally funded non-governmental organization, that makes grants to private organizations working for free and fair elections, independent, judiciary, independent media and the other components of democracy in countries where democracy either does not exist or is struggling to survive. In fact, last week I was in Amman, Jordan speaking about just these matters at the World Conference on Religion and Peace.

I shall not here recite a further litany of such engagements but rather against the background of involvements of this kind make some observations about the research university in the United States as we look to the next century and the next millennium. I’ll not pretend to be exhaustive — I hope instructive — and I want to say something of the following subjects: international education, the impact of technology on higher education, liberal arts education, the financing of universities with particular attention to philanthropic support, and finally a suggestion for university attention to a subject I believe important, but neglected. I don’t intend to say much about science. Others here, far more knowledgeable than I, will address that question.

In respect of each of these matters as I say, I’ll refer to my own experience. An important concern of mine in congress was international education. A generation ago, in 1966, I authored and President Lyndon Johnson signed into law the International Education
Act to provide federal funds to colleges and universities in the United States for teaching and research about countries and cultures other than our own. Although President Johnson signed the bill into law, congress never appropriated funds to implement it and I think that at least one of the reasons, I do not say the only one, for the troubles the United States has suffered in recent years in Iraq, Vietnam, central American and elsewhere, is ignorance of those peoples and societies. Commitment to international studies is, I know, deep at Cornell, where you have a most impressive range of such programs both here and abroad.

Indeed I’m sure that all of us will agree, as Hunter Rawlings was suggesting, that the changing structure of the international economy demands that the United States prepare men and women to be knowledgeable about other countries, but international markets are not the only reason. As the lone political and military superpower in the world, we also need persons who understand other nations and their cultures in positions of leadership in our government and I hope that will not, in this election season, be taken as a partisan observation. Think for a moment, of some of the trouble spots in the world, that in recent years have engaged the interest of the United States and in some cases, still do – Vietnam, Iraq, Iran, India, Indonesia, China and Korea. How well do we really know these countries – their languages, their histories, their cultures? Do we really understand the origins of the fighting in Kosovo? The background of the battle between the Serbs and Albanians? Do we even know how to find Kyrgyzstan and Kazakhstan on the map? And why these newly independent republics may be important to our own national security. Before recent developments how many Americans had ever heard of East Timor? Certainly as President of New York University I worked to bolster the university’s international offerings. Already strong in the study of French civilization, we established the Alexander S. Onassis Center for Hellenic Studies. We created a Center for Japan/US Business and Economics studies and the Skirball Department of Hebrew and Judaic Studies. Because I had written my Ph.D. at Oxford on the Anarchic Movement in Spain, from the mid 1920’s through the first year of the Spanish Civil War, I obviously had a particular interest in Spain. In 1983, I awarded his first honorary degree from a foreign university to King Juan Carlos. Two years ago, in the presence of their majesties the King and Queen Sophia and of the first lady of the United States, Mrs. Clinton, we dedicated the King Juan Carlos Center of NYU, a center dedicated to the study of economics, history and politics of modern Spain and of the Spanish speaking world. I am pleased to say that already, in its brief life, the King Juan Carlos Center has mounted a rich and lively program of lectures, seminars, and other activities. I add that I myself have five times this year, visited Spain to speak at El Teladaes, Barcelona, and Ilica and Madrid.

Here let me tell you of a venture that may illustrate what I believe American colleges and universities can and should increasingly do. Thirty-eight years ago, as a young congressman with another member of the education Committee of the House of Representatives, I visited Argentina to inquire into the potential contribution of universities in Latin American to President Kennedy’s Alliance for Progress. In Buenos Aires we met the president of the republic, director of the international university, who happen to have been brothers, as well as other prominent figures in Argentine life and on our return to Washington, wrote a report with recommendations for United States policy toward higher education in Latin America. Last year, nearly four decades later, I was invited to return to Buenos Aires, to address the National Academy of Education of Argentina and in my talk, I argued for forging what I described as triangular relationships among colleges and universities in the United States, Latin America and Spain.

For as modern, democratic Spain more and more engaged economically in Latin America, and with continuing U.S. investment in the region, why not add to these triangular economic links, triangular college and university connections as well? Consider if you will, that with 28M Spanish speakers, Spanish is now the second language of the United States. In fact, within a few years, there will be more Spanish speakers in the United States than Spain. This fact for institutions of higher learning in our country means new and exciting opportunities. Why not explore them? I’m glad to say that we, at NYU, are already planning a three-way collaboration with the University of Buenos Aires and universities in Barcelona to focus on the study of urban problems. Hunter, there is always a danger if you make a speech somebody may pay attention to it.

I’m sure that you at Cornell have similar relationships that you find appropriate to your own academic mission. I believe that research universities in the United States generally should invest serious resources in teaching and research about other societies, cultures and languages. Here surely the United States should lead, yet I am distressed to say with respect to a significant dimension of international education, cultural and scholarly exchanges, US government support is at it’s lowest in years. Some programs such as Arts America that makes possible our sending cultural groups abroad have been abolished and others such as the Fulbright Exchanges
have been seriously diminished. Indeed, you may be interested to know that the Executive Director the President’s Committee in the Arts and Humanities is Harriet Mayor Fulbright, the Senator’s widow. It is, indeed, because of concern about this declining support that we on the President’s Committee, in cooperation with another Oxford contemporary and friend, the distinguished Librarian of Congress, James H. Billington, will be hosting a conference at the library early next year to bring together persons knowledgeable about cultural and educational exchanges to develop some constructive approaches for approaching this situation.

Only a few months ago in Madrid, I spoke to European and Latin American university directors about new developments in international education and among the matters I discussed was the rise of profit-making educational ventures — often, if not usually, utilizing technology. For one cannot pick up an issue of the Chronicle of Higher Education or for that matter, perhaps *The Economist* without seeing articles describing new applications of technology to post secondary education as well as advertisements of business firms offering education courses through one form or another of information technology. Indeed, I could take the rest of my time this morning with you citing specific examples of distance learning courses being offered in various countries aimed at both domestic users and across national borders. Some of the sponsors will be familiar to you, to cite just three. In the United States, Phoenix University and the Sylvan Learning Systems and in the United Kingdom, The Open University. To illustrate the aim of Sylvan Learning, it’s leaders say, is to build a network of private for-profit universities in Europe and Latin America and Joseph Duffy the former director of the United States Information Agency now, as you may know, leads the Sylvan Learning, which he says is a response to a combination of exploding demand for education, and the lack of resources and political will on the part of governments to invest in higher education. Says Duffy, “we are not here about some great wave of the future but a broadening of the education marketplace to increase access”.

Another instance of innovation in international education is the current move by research universities in seven countries to form a commercial corporation university, Universitas 21. The purpose of the network will be to enable it’s member universities to take advantage of business opportunities too complex or large for any one of them. In fact, I must add a distance-learning project from my own NY University because this year we are inaugurating NYU online, a for-profit subsidiary corporation to be operated by our school of continuing and professional studies which is already the leading private center of non-profit continuing education in the United States with some 60K students currently taking courses. The factors driving NYU online are not, surprisingly, identical to the ones fueling such projects elsewhere. The availability of innovative technologies that make distance learning possible. The need for a workforce prepared to compete in the new knowledge-based economy. The importance of developing modes that are more cost effective than traditional classroom-based models of teaching. Moreover, I observe that NYU is one of fifteen of the largest research universities in the United States including MIT, Stanford, Illinois, Pennsylvania, UCLA and the University of California at Berkeley that will work together to market their distance education efforts through a central directory on the World Wide Web listing all their online programs coordinated by the University of Washington (R1edu.org) new portal for distance learning courses that will hit the web, I understand, within a few months.

Now I shall certainly not attempt to pass judgment on the impact and quality of these or other instances of distance learning, or technology based forms of education. The reasons I have listed for them represent their potential advantages. But you and I know that critics of cyberspace learning have already voiced apprehension at these developments. How the web will affect the quality of education is probably the number one question. How, for example, are such courses to be accredited? Because accreditation can be the most effective means of measuring academic quality and can directly influence allocation of institution resources, accreditation will be key to the future of distance learning. I have, in fact, just agreed to serve on a committee to evaluate procedures for accreditation of universities in Latin America.

Another question: will steps be taken especially where the university program is linked to the for-profit company to prevent conflicts of interest and protect the institution’s academic integrity. Yet another: what about the lack of face to face human interaction between and among students and professors which characterizes the traditional campus experiences. All these questions are relevant to distance learning programs whether domestic or international in scope. I believe that a challenge for some of us who are champions of international education is to devise ways and means of discussing such issues and others and developing effective approaches to dealing with them. If wisely harnessed, the new technologies coupled with the globalized economy, of which Dr. Rawlings was speaking, and sharply rising demands for knowledge can bring great benefit to millions of people in every part of the world.

I’ve touched both on international education and technology as factors that both do and should affect the shape of research universities in the United States. Let me turn to another matter: money. During my years in congress we fashioned a variety of measures to help students finance a college or university education. Student guaranteed loans. Pell Grants, work-study programs, for example, and of course as most of you here know better than I, the federal government expends billions of dollars for university-based research, especially in the sciences and especially more still for the medical research.

On the House Committee with the responsibility for higher education legislation, I was a strong champion of federal support for both public and private colleges and universities and I still am. One of the reasons for the strength of American post-secondary institutions is their diversity, their pluralistic base, both in the ways in which they are governed and are financed. In my judgment we need vigorously to seek support for higher education from both government, federal and state, and private philanthropy, individuals, businesses, and foundations. Certainly one of the responsibilities of university presidents in this country is to pay careful
attention to what's happening in Washington D.C. and state capitals and to make their voices heard on decisions by governments that affect their institutions.

I want this morning to focus on philanthropy because we all know too that one of the principal obligations of an American college or university president is to raise private funds for his/her campus. When I came to NYU in 1981 I learned that NYU had received contributions from private sources the year before my arrival for a total of $23M which I thought far too low for a university of its size and location. So I announced a fund-raising target of $1M a week for 100 weeks and we achieved that goal and then in 1984, I said that NYU would seek to raise in private contributions by the year 2000 – a total of $1B and we did so, not in the fifteen years but in ten and it was due in large measure to the generation of private funds and sums unprecedented in the history of the university that we were able to make great progress at New York University in recent years in building student housing, thereby changing radically the demographics of the student body, endowing professorial chairs, providing student loans and scholarships, creating laboratories, telecommunications and computing facilities, and establishing international study centers. I’m pleased to say that in the last academic year NYU received gifts totaling $247M – a new record.

So seriously do we take fund raising at NYU that our school of continuing and professional studies in now starting courses in philanthropy. We want to prepare persons for careers in non-profit organizations with a curriculum that includes how to write proposals, understand the tax implications of contributions, and work with foundations, corporations, and governments. So strongly do I feel about the indispensable place of philanthropy in American life, especially for colleges and universities of course, that whenever I have the opportunity to speak at universities in other countries I preach the gospel of giving. More concretely I urge that university leaders abroad press their political leaders to adopt tax incentives to encourage contributions to cultural, educational and health institutions. So I was delighted to read last week in the Financial Times, an article indicating that the British government will at long last change the law to allow benefactors a cut in tax bills while making large gifts in shares and bonds, a step, says the FT that could revolutionize the funding of Britain's elite universities. I was pleased too that one of the authorities cited as championing this move was C. Duncan Rice, Principal of the University of Aberdeen and someone I had appointed several years ago as Dean of the Faculty of Arts and Sciences at NYU. As a matter of fact, you may remember some years ago, when Margaret Thatcher started cutting the government funds for colleges and universities in the UK, there was a response at part of Oxford University, my own university, that involved a campaign to raise private money, never done before and I was the only American who took part in the launch campaign with the Sheldonian Theatre and I said I had two messages for you. First, you must make the point that Oxford is indispensable to the future of this country, which I believe. Second, I said, words that will not fall easily on British ears, you have to ask, and Oxford began to ask, and now they're doing very well, thank you very much. They had not understood the power of the name of Oxford – the magnet that it represents. It seems to me that with the development of a common market, common currency and common central bank, the time has come for the European union to shape a Europe-wide policy of tax incentives to stimulate philanthropy and here I remind you that the chief recommendations on the Committee on Arts and Humanities was for a renewal for philanthropic support for these fields.

According to the latest issue of “Giving USA 1999”, contributions to human services in the United States reached $16B and in 1998 up 27% from 1997. But giving, on the other hand, to the arts, culture and humanities was $10.5B in 1998 – a decline adjusted for inflation of over 2% and with such trends you can better understand why the President's Committee urges that in their decisions on giving, benefactors (individuals, corporations, foundations) include arts and humanities organizations and activities, and of course, among the citadels of humanities in the United States, as Hunter was saying, art universities. Indeed the Committee found the arts and the humanities depending on private giving and many other segments of the non-profit community in our country. For example, many performing arts groups receive as much as 40% of their total income from donations, compared to 3 to 5% for hospitals and an average of less than 20% for many other non-profit organizations.

Now why at a conference on the research university, where so much of the discussion will be directed I'm sure to the importance of financing the sciences, to speak of the Arts and the Humanities. I do so not only because it is far more difficult to raise money for these fields in the United States than for the sciences (and here I speak of both government and philanthropic dollars) but also because of the central role of liberal education in a university that pretends to be serious. When in 1981 when I was inaugurated 13th president of New York University and I made the point that letter 13 did not really upset me – you know the phrase – triskaidekaphobia, which means fear of the number 13 although I'm glad to say my office was on the 12th Floor and that there is no 13th floor in the library. One of my pledges was to strengthen the liberal arts because I believed that and I still do that through the requirements of a first class, liberal arts education our colleges and universities provide society it’s most valuable resource – people who can think logically and write lucidly. It is the arts and sciences that prepare people, not only to enter the world equipped to pursue their careers, but also to act as intelligent, creative and honorable human beings. Now you and I know that during the last generation, the liberal arts fell out of favor, at least in part because they were seen as poorly suited to the challenges of the contemporary world. How could the study of philosophy, or history or English literature prepare one for a career? Yet I would remind such students that many of them will have more than one career during their lifetimes and that learning how to learn, one of the fruits of a liberal education, endows individuals with the flexibility to change careers as their interests, needs, and ambitions change. I do not mean to imply that the arts and the humanities serve solely to enhance professional competency, although I am prepared to make such a case, but a broadly based liberal arts education is exceedingly useful in enabling us to decide what we want to do and understand the implications of our choices. For without a liberal education as a foundation, we run the risk of having scientists, engineers, makers of social policy and military and political leaders who see problems as obstructions rather than as opportunities.
There is another reason that a humanistic education is important. Since the golden age of Greece, and your president is an authority on that period and, as I told him, my father was born in Greece and I was the first native American born of Greek origin elected to Congress, what we now call liberal learning has been expected to contribute to developing an individual sense of civic responsibility and certainly no democracy can survive unless those who express their choices are able to choose wisely. No democracy can survive unless we rely on the processes of reason, accommodation, and civil discourse, processes made possible only with an educated populace. And I suggest to you that the kinds of problems with which we in the United States must now deal make a broadly based liberal education not a luxury but a necessity. The issues that the American people face today, indeed all of human kind, the threat of nuclear war, the ethics of genetic engineering, the care of the aging, the very young, the poor, the handicapped of our society cannot be left solely to the experts. We, all of us, must educate ourselves to participate fully and intelligently in the public debate over these and other crucial social and ethical questions.

Now as we consider the future of the research university, I've been speaking of international education, the impact of technology on colleges and universities, the importance of philanthropic support, place of liberal learning and the life of the university — and I've taken the liberty of illustrating my observations from personal experience. The experience of the research universities in the United States are, again to recall what President Rawlings said, the envy of the world. But we cannot take them for granted. We must continue to press for the resources essential to their work even as we must also insist on criticizing them and where necessary taking steps to improve them.

Now I told you at the outset of my remarks that I would also touch on a subject I believe worthy of attention by at least some of America's research universities but one that gets very little. It is an issue that I addressed in 1982 at the first commencement ceremonies at which I presided over as president of NYU. I observed that the preamble to the constitution of the United States declares that one of the basic purposes of our government is to provide for the common defense, using the familiar phrase, that there is a wide spread consensus in our country today that we must have a strong national defense to assure our freedoms in a dangerous world. I believe few would deny. But in recent years, during the administrations of both political parties, there have been more and more questions about the objectives of our defense policy and the methods by which we, as a nation, make decisions about our security needs.

Consider these headlines from only recent weeks from the New York Times, the Washington Post and Wall Street Journal. Wall Street Journal, front page, “Ground Zero: Military Must Change for the 21st Century, the Question is How? US Choice, Terminator, Peace Keeping Global Cop, or Combination of Roles? Military must change for the 21st Century but How?” Again, this one from also the Wall Street Journal op-ed page, “Prepare for the Last Cold War. The Pentagon has never really come to terms with it's new day-to-day duty what one might term imperial policing, keeping the peace in places like Bosnia and Kosovo and Kuwait. Again in the Washington Post, front page, “Panel Faults Anti-Missile Program on Many Issues. Report by Experts Cite High Risk of Failure”. And only last week in the New York Times, “US and NATO Allies Divided over Defense Needs”. Clearly there are very important questions here to be asked. It should be obvious, but I think it is not, that the billions we expend on national security affect the country in a diversity of ways. The defense budget has an impact on the national economy, on jobs, business, on local communities, on scientific and industrial research, on race relations, on our supply of educated manpower, on our college and universities. The defense budget directly affects the lives of each of us in one way or another. Indeed the budget of the Defense sector of the United States has become so consequential to the lives of us all, to the economy of our nation, and the nature of our society, that in my judgment, we must lift the subject to a far higher level of visibility in the arena of national debate. In one of the articles I cited, this front page piece in a series of Wall Street Journal articles on military spending, the question is posed, “What sort of military would we build for the 21st century?”. The answer, says the writer, depends on what role America wants to play in the world adding, “in Pentagon offices, war college classrooms, and think tank outposts, three major options have emerged.” What I think striking in that analysis is that not cited as engaged in considering so profoundly complex and important matters are the research universities of the nation. In my judgment it is high time for us to bring the capabilities of at least some of our research universities to bear on the entire spectrum of issues raised by the making of policy for our national defense. And I am not arguing for or against any particular weapons system. As a member of Congress, unless one was on the Defense Appropriations Subcommittee or the Armed Services Committee, one had very little idea of what was in the defense budget and went off to pay attention to whether or not a particular amendment offered had an impact on the production of a weapons item in one’s own congressional district or state in making a judgment.

In my view, we need to find ways to encourage a broader, deeper, more thorough understanding of the structure of decision making for the security policy of our country. I have in mind a variety of mechanisms — seminars, lectures, conferences, courses. Among the participants, such efforts should include persons who have served in key positions in the White House, the Departments of Defense and State and our intelligence agencies as well as members of the House and Senate recognized as knowledgeable in defense matters. And although indispensable to such dialog, persons like these will not be enough. We need also to engage leaders in business and industry, labor and we certainly must include members of our university faculties from the disciplines of economics, political science, physics and mathematics, sociology and psychology, history and anthropology, and philosophy and theology, as well.

The involvement of America's research universities in the consideration of how our defense policy is made would bring much more openness, illumination and deeper insight to a dimension of American life that, while of fundamental importance to our own citi-
zens and all humanity, remain so little understood. Perhaps you here at Cornell, where I know you have some of the world’s leading authorities in these disciplines that I have mentioned, could take the lead.

Ladies and gentlemen, let me conclude with these remarks. I have attempted, based on my own experiences, to touch on just a few of the issues I think significant as we look to the future of research universities in the United States. In doing so I recall that just 49 years ago this fall, a group of American students, ready to set sail from New York for Southampton and Oxford, were honored at a reception for the Institute of Study at Princeton. Our host was Frank Aydelotte, then director of the institute; he was also the secretary of the American Rhodes Scholarships. Among the persons who greeted us were J. Robert Oppenheimer and John von Neumann. We were in tall grass. Expecting a visit from a school mate from South Bend, my home town, then studying at Princeton, I had my eye on the door when in walked a man wearing a wool pullover hat, chinos, heavy sweater and sandals. We fell back as if a divinity had entered the room. It was Albert Einstein. Aydelotte, a fellow Hoosier by the way, said, not Professor Einstein or Doctor Einstein but, as if addressing an institution which indeed he was, “Einstein, what have you got to tell these boys”? The room hushed. Einstein paused and then uttered just one sentence. “The most important thing”, he said, “is that they think for themselves”.

Well, if we who are leaders of America’s institutions of higher learning, can more powerfully teach people throughout their lives to think for themselves, we shall, I believe, be fulfilling the purposes of a liberal education and of a research university.

Thank you very much.
**Science, Policy, and Politics**

by Vernon J. Ehlers

U.S. House of Representative (Michigan), Vice Chair of the Committee on Science

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**Introduction by Robert C. Richardson:** Our next speaker is an especially appropriate participant in the symposium for a whole lot of reasons, and I’m going to mention a couple of them. He's currently serving in Congress and he led, in a series of hearings and a study, entitled “Unlocking our Future Toward a new National Science Policy” and it is a concise, coherent and comprehensive road map about the policy Congress intends for support of science and direction of science will go in the future. But another reason why he's an especially appropriate member of this symposium is he went to the same graduate school and studied the same field as Dale Corson, nuclear physicist from Berkeley. He has an especially important place in my heart because he's a physics professor. Before being elected to Congress as a representative of Michigan’s third district, he was a physics professor and once a department chairman in Calvin College in Michigan. Vern Ehlers, welcome very much to the symposium. We’re looking very much forward to your comments and the title of the presentation is, “Science, Policy and Politics”. Thank you, Vern.

**Vernon J. Ehlers:** Thank you very much. It is indeed a pleasure to be here and particularly to honor Professor Corson. We not only share the same university, we have many of the same interests but I especially want to commend him for the excellent textbook he wrote. As an undergraduate I struggled with electricity and magnetism, suffering from both a poor textbook and a poor professor. I managed to get an A in spite of that but I felt I never really learned it. Then I took a graduate course and had the same experience and then finally I had to teach. At that time, the textbook came out and for the first time I really understood electricity and magnetism and I have to thank Professor Corson for that. The best thing I can say about the book, it’s the first time I’ve experienced a case where a book became, in my mind, a classic the first year it was used. It has, for a long time since then, served as a classic. I’m also pleased and honored to share the podium with Professor Brademas. I’ve heard so much about him. Our paths haven’t crossed before and I haven’t met him but it’s certainly an honor to be here. It’s the first time in my experience that I’ve been a part of two members of Congress, occupying the same platform, at the same symposium when it was not devoted to a political discussion. Maybe the organizers of this are trying to send you a subtle political message. I noticed they carefully selected a democrat and a republican. I also serve on the Education and Workforce Committee rather than the Education and Labor Committee.

Having said those introductory comments, I also wanted to thank you for inviting me to be here. This is only my second time at Cornell as was described to me yesterday, you are proud to be centrally isolated and in a sense, that’s appropriate. When I received my PhD after four years of intense work with no breaks, my wife and I decided to travel by car to Quebec where I was giving a paper on the results of my work. One of our stops was here and we explored the canyons or gorges. It is a beautiful location or as my daughter reminded me yesterday, I was supposed to tell you, this is a “gorges” location. She’s an academic and apparently she heard that from a Cornell graduate. Having said that, let me return to my preferred role as professor and jump down from the stage, use transparencies and so forth and pretend that I’m still in the classroom.
I was asked to talk about science, policy and politics but before I get into that I want to just discuss briefly one of the reasons I’ve tackled this vigorously. First of all, one of the reasons I got into politics from an academic career – it’s an unlikely profession for a physicist. I did not realize it until I was elected but I’m the first research physicist ever elected to Congress of the United States. The only thing remarkable about that is that it’s a real indictment of the physics community that none of us have ever been elected to Congress before. But that shows the reason I became involved and felt that we needed to redo the nation’s science policy.

If you look at what’s happened to the federal budget, and I’ve just split it into three large areas: the entitlements (and that includes social security, medicare, Medicaid, welfare, and student loan programs) were roughly only a quarter of the budget in 1962. Interest on the debt approximately ten percent. All the rest was discretionary defense. Discretionary defense - that is the money that Congress can’t allocate. The rest is automatic once Congress has passed a bill, established a program, all those who qualify will receive that particular stipend. In 1820, notice how the entitlements have grown as well as the interest on the national debt. 1998: entitlements now 53% of the total budget; interest on the debt 17%. That totals 70% and that leaves only 30% for discretionary defense of which defense is one half. I certainly agree with Congressman Brademas’ comments about the need to define what our defense posture should be. We are currently spending approximately $1K per capita for defense and we have not clearly defined our purpose, our agenda, the need for defense since the end of the Cold War. Now that relates to my discussion about why I got into science policy and I’m also going to apply this to two areas of interest that I was asked to address and one which is of particular interest to me. One is math science education, the K-12 regime and secondly, how this relates to the future of the research university.

So let’s talk for a few moments about the report I prepared on a new national science policy. Now this particular report took a considerable amount of work but if you are familiar with Congress, and Congressman Brademas is, you would recognize that we do not give ourselves any more resources than we give anyone else. In fact, typically less. If I had to arrange for a National Academy on this, it would have cost considerably more. I did this study with two science fellows who were provided through the AAAS program and working part time in addition to my Congressional duties which roughly consume 80 hours a week, so I didn’t have too much time to spare on this: we did our best with the time we had. It took twelve months to do it, working part time with two staff members, but above all else you have to recognize that this was written for the Congress. There has been a little criticism as I suspected; this is nothing new, that it was shallow and so forth. I don’t think that’s quite true but aside from that I had to educate the Congress about where we are and where we should go, and that we were writing a primer in a sense.

Now the reason for this is that the U.S. has been particularly poor on establishing a science policy. In fact, for most of the early history of this country, it didn’t have a specific science policy other than to establish things that were needed for defense such as the naval research observatory and things of that sort. But there’s one major area in which the national government invested money in
research — and a research university is an example of that — through the land-grant system. Our country invested in research in agriculture, much more so than anything else during the first 150 years of its existence and I might say with considerable success. I’ve always been envious as a scientist, viewing the incredible research program that has been developed in the agricultural sciences and the means to get it to the people, the Cooperative Extension Program.

In my state, when Michigan State discovers something in the laboratory one year, the farmers are using it in the fields the next year. Most everything else done in scientific research has a lifetime of anywhere from ten to twenty years before it reaches the public use. I think we have to model after the Cooperative Extension Program. After that 150 year period, we had World War II in which we had science and its relationship with the federal government changed dramatically. It’s amazing to the scientists of today that there is so little contact between the federal government and the scientific community that in order to make the federal government aware of the possibility of nuclear fission and nuclear weapons we had to get the famous scientist, Albert Einstein, to write a personal letter to Franklin Roosevelt telling him about this possibility. That led to endless cooperation, including radar in which President Corson spent some time working in the war as well as the Manhattan project.

At the end of World War II President Roosevelt asked Vannevar Bush, favorite point man in science during the war, what we should do next and he developed what became the nation’s science policy and this came through this book, “The Endless Frontier” — excellent piece of work but nothing has been done since then. What has changed is the end of the post-war. We have reached what George Brown, former chairman of the science committee, used to say, a period in which we do not have a science policy, we have a budget policy for science and that’s what I’ve tried to change. We have a major change taking place here and we simply have to begin thinking seriously about what we should be doing and how we should be doing it.

The vision statement I prepared is simple, straightforward, although I must say I’m surprised it survived the work, study of the committee and so forth, but I simply said that the United States must maintain and improve its preeminent position in science and technology in order to advance human understanding of the universe and all it contains. That’s always been the objective of scientific research and, furthermore, to improve the lives, health and freedoms of all peoples. That sounds rather idealistic and in fact it is, but I’m convinced that it is a possibility. I’m not one of those, incidentally, who thinks science can solve all problems, particularly social problems, but I think science, technology and engineering have the ability to improve the standard of life of developing nations to introduce political stability and from that you have improved lives, health and freedoms for all peoples.

In the course of this, early on, I developed four theses, which I would like to outline just very briefly to you. First of all, that our science policy is outdated. I think I’ve already shown that. Secondly, that the American public does not understand science or its practice. I and any other scientists or engineers here could give you multiple examples of that. One of my favorites is, and I’ll use examples from my field of the physical sciences, is that if you ask the American public today “how long does it take the earth to orbit the sun?” Only fifty percent of them can answer that definition of a year as better known logical models for several thousand years but only half the American public can tell you that.

Let’s take a look at something a little more esoteric. I want to show you a brief video, interviewing Harvard graduates on the day of their graduations. Some of you may have already seen this. I’ll only show you two minutes of this. If we can have the video please and the question is, “What is the season”.
Video: “... which produces warmer weather and when it’s gets farther away it produces colder weather and hence the seasons. “How hot it is or how cold it is at any given year has to do with the closeness of the earth to the sun during the seasonal periods. The earth goes around the sun and it gets hotter when we get closer to the sun and colder when we get farther away from the sun.

Voice Over: These graduates, like many of us, think of the orbit as a highly exaggerated ellipse even though the earth’s is very nearly circular with distance producing virtually no effect on the seasons. We carry with us the strong, incorrect belief that changing distance is responsible for the seasons.

Student: I took physics, Planetary Motion, Relativity and Electromagnetism ...

Student: I never really had a scientific background whatsoever and I got through school without having it and I’ve gotten far without having it.

Student: I had quite a bit of science in high school, yeah. Physics first year and two years of chemistry.

Interviewer: Regardless of their science education, 21 of the 23 randomly selected students, faculty and alumni of Harvard University revealed misconceptions when asked to explain either the seasons or the phases of the moon.

Student: When it’s further way from the sun, then it gets colder.

Faculty: The air interferes with the reflection of the sun against the moon.

I like the faculty member’s explanation the best – the results of the reflection from the moon. At any rate, for those of you who might not know, the distance from the sun has very, very little, if any effect. In fact in the northern hemisphere, we are closer to the sun in the winter and farther way during the summer. This is something that everyone presumably has been taught in high school and certainly at a college level course. 90% of these students had it wrong. Furthermore, this test has been repeated on other campuses with identical results – 90% say it has to do with the distance. One survey had an interesting follow up question after they gave that answer and that was to say, “well, what about Australia?” And then they were all totally stumped because they knew that when we have our winter, Australia has their summer and therefore their answer is wrong.

The point of this is to simply say that the American public does not understand science or its practice. I’ve just given you aspects of the knowledge of science which is even more important than their lack of understanding the practice of science — and that’s really something we have to change. Since I have a large number of members of the humanities here, let me add something additional. President Rawlings gave a superb speech about the importance of the humanities and I’ve always supported the knowledge of the humanities. That’s partly why I went to teach at a liberal arts college. I believe that it’s extremely important but I also regard the sciences as part of a liberal arts education. It always amused me that it seemed to be one sided.

A good example of that is, sitting over coffee one day where an English professor was expounding at great length of the inferiority of the writing of the student papers he was seeing and particularly the lack of precision of language and words and so forth. A bit later he commented that his wife was not well that day. He thought she had a fever but he might have said that he had a fever because even a corpse has a temperature. I’m not sure what impact I had but this has become a bit of a personal vendetta with me for years when attending parties. Individuals ask me, “what do you do?” and I would say that I am a physicist. The answers generally were either “oh,” and then a few pleasantries and they’d walk away or they say “I can’t understand all those numbers and math and everything. I just gave that up long ago.” I accepted that for a number of years and then I began to think “that’s really silly. We can’t stand for this.” Suppose it were reversed and I had asked them “what do you do?” and the person said, “Well I teach English” and I’d say, “oh all those letters and words and so forth. I could never get that. I gave up reading long ago.”

Now what educated person in our society would profess to such ignorance of the humanities? Publicly? But yet, I find individuals constantly in public professing their total ignorance of science, as if that’s alright. It isn’t alright. We have to be well educated in all fields not just the humanities. End of sermon.

Third thesis: scientists are politically clueless. I have experimental verification for that, but this is actually a quote from Science magazine which wrote an article, The title was, “The Scientifically Illiterate and the Politically Clueless”. It’s just another version of the two cultures argument of C. P. Snow in the 1950s. It really is true and is something that has to be corrected.

What does our nation need and this is what the report starts to address: better math, science, engineering, technology, education. It needs a new coherent, concise, comprehensive science policy which is something I tried to produce. We need socially and politically responsible, politically aware scientists and I’ll say a little bit more about what those mean in a few minutes.

The report’s recommendation just in Fulbright categories (I’ll go in just a few more details on that), is basically a statement that federal government must continue a strong support of basic research simply because no one else is going to do it. The private sector’s role is to fund some basic research but mostly applied research. I’m building a bridge between the two, the bridge that I call crossing the Valley of Death. If we have time, we’ll talk about that as well.
I believe it's important to increase the integration of science and decision making through the regulatory and the judicial systems. We have to have a regulatory system in which knowledge of science infuses the whole process, rather than some regulator making a decision about what has to be regulated and then, at the end, going to scientists and saying, "now, what number must we plug in again here". Similarly, in the judicial system scientists are currently being pulled into the adversarial system that has been established through the centuries and the courts. That is very likely not the optimum way to bring scientific information into the court system but in a more advisory role to the jury and the judge.

Finally, I think it's important to improve our system of education from pre-school to grad school. I'm primarily working on improving math, science and education in K-12 and we'll talk about that a bit later. Just to amplify each of these very briefly and I won't take time to discuss this in detail but I believe support for basic research must be stable and substantial, certainly better than it's been in the past in both regards. That implies long-term budgeting which is very difficult to do in the Congress.

I believe it's important to support interdisciplinary research. That is most likely to be the most important research in the future. It's important to maintain a balanced research portfolio. At the moment we have immense increases going to the National Institutes of Health but other areas of science are holding steady or in some cases declining and that is likely going to lead to a great imbalance. I believe we have to be certain to fund more innovator risk-taking projects. The more we bureaucratize the United States, the less likely you are to find the grant makers willing to take risks on projects that may not pay off.

Second: the private sector has a role both in basic and applied research and building bridges in between. I think it's important to encourage young start-up companies through various legislative means. Make R & D tax credits permanent. Streamline regulations, pursue and develop partnerships. Now a moment ago, I talked about the Valley of Death. What basically is supposed to happen is that basic research is supposed to develop new ideas, new theories and that these ideas should dribble down and form the basis for applied research and eventually product development, but we have a Valley of Death developing between the two which slows down the process. I think it's important to bridge the gap or to encourage the entrepreneurs over here who often fill the Valley of Death by taking their ideas when they find no one is willing to market for them and they in fact get involved and do the marketing themselves. This, as it applies to research university, I've tried to, incidentally, in the report some people believe that I am adhering to the old idea of the linear approach, as some people call it, where you have basic research and through a linear process goes into applied research and so forth. It's simply not true. It's far more complex then that. Don Stokes has done some good research, as has Gerry Holton of Harvard and if you would like to talk to me about it that afterwards, I'd be happy to discuss that briefly but there simply is not time in this arena. It's far more complex than just relationships which Vannevar Bush outlines. But to Illustrate part of the complexity, if you were really trying to get rid of the Valley of Death, I believe you have to encourage through legislation and other means, administrative means at universities and so forth. Partnerships to tackle particular problems and I've indicated on this chart. Some of the parties involved in potential partnerships, and notice I have drawn lines, interconnecting all of them. The only one I have not connected is from state governments to foreign governments. There is no line there, because it's unlikely to have foreign governments directly interacting with state governments, although since drawing this chart, a few months ago, I have discovered a few examples but they are rare. The point is simply when people talk about the federal role in project development in applied research, they seem to think it should be federal government giving grants to industry to perform research that is a model. I do not think it is the best model. The best involved would certainly involve partnership between government and the private sector, but also with state governments, particularly through universities. State governments, after all, are far better at developing programs to help develop local and state industries, and they do a much better job than the federal government who tends to have difficulty with all the state situations. Furthermore, the universities are the seats of knowledge and of research in most cases, and they certainly should be involved in helping this. Some of this is going on in very tentative stages, but it has not been systematized and I hope that by thinking through some of these things, we can develop better means of encouraging partnerships. This will involve federal legislation certainly, but it also involves a change of attitude at many universities, and also the cooperation of state governments. Federal facilities, the national laboratories, treasurers of research, and again, I think they can be more heavily involved in many of these areas, certainly. They may be involved with universities, can we extend beyond that.

Foreign governments -- I am not convinced that there should be any more international research facilities that are not fully cooperatively international science and funded in international way. The death of the SSC (Superconducting, Super Collider) if nothing else should convince us that we are not likely to go forward with any of these in the future without full international cooperation and international funding.

On the third point of improving our educational system, I have been operating in two-year cycles in the Congress simply because the Congress operates in a two-year cycle. My first two-year project given to me by Newt Gingrich was to computerize the House. I was astounded when I got there and discovered that it was easier to send an e-mail to Russia than to send it 20 feet down the hall to a colleague. When I mentioned this to Newt, he was fully aware of it and as someone deeply interested in science and technology, he urged me to take the lead and once we got the majority he put me in charge. We now have a fully computerized House. Everything was on the net. You can access virtually every House document over the net if you wish. You can watch the sessions on TV on C-SPAN. If you have a question about what's being discussed, you can go to your computer, look up the bill, the language itself, you can then formulate your opinion, if you have one, and send it off to your member of Congress, by letter or e-mail on the Internet, all within the space of half an hour. Anyone who believes, as some people say, the Congress is not in touch with the people simply doesn't know what's going on. We are more in touch with the people than we ever have been in the history of our nation.
So, my first project was that. My second two-year project was the science policy study. Newt again because of his interest in science, and Newt did not get a fair treatment by either the media or others. He is a complex person as you well know from reading about some of his current difficulties, he was one of the few people I met in the political arena, who had vision and was concerned about where our nation was going to be in 30 years from now. He is also very concerned about science and engineering.

The third one which I’m engaged with now, (which Newt started and which is strongly supported by the current speaker, Jim Sensenbrenner of the Science Committee, who is just a very fine person and a good chairman), is to improve math, science education in the United States. The question is, why should we do this? What is the problem? Aren’t we already doing so well as a nation in terms of science? We are if you look at our scientific research capability compared to the rest of the world, but part of the cause is that we have more resources than any other country. Secondly, the best scientists from other countries also come here because we have the most resources, and that has sustained it, not because of our excellence in education, particularly K-12.

I’m often asked why should we do that. And I define three purposes, which I find important: first, the traditional one. We should have a good K-12 math, science, education system, just so we can produce the scientists and engineers that we need. Many people think we have too many already, in fact, we have a shortage and we have a special visa program to allow educated technology, science, engineering specialists into this country, almost 100,000 of them per year, come because we cannot meet the demand from our own nation. Or just look at the graduate programs and other universities – over half of the students come from other countries simply because we do not have enough students able to compete successfully. So we have to do better than that. And that’s still our best area.

In other places – workplace readiness. I have been convinced for a long time that within 20 years you will not be able to get meaningful employment in the private sector without an adequate knowledge of mathematics and science. I can give you endless examples, but even if you just look at my congressional office, as I have told my staff, if you worked in this office 20 years ago and you went into a deep Rip Van Winkle sleep, and woke this morning and came to work, you would not know what to do. Literally. They could not operate telephones. They could not operate a copier. They certainly could not operate the computer, etc. More and more we’re going to find this in every workplace, and not all computers are going to be like McDonald’s, where you have little pictures that you punch. You will be expected to have much better knowledge than that. So workplace readiness, I think, is very important. After talking to John Chambers, a few weeks ago, the current CEO and founder of Cisco Systems, which he has built in only 14 years to a corporation that is now currently the size or valuation of General Motors. After a conversation with him, I became convinced that my estimate was wrong. It’ll be 10 years that you will not be able to get a decent job without the knowledge of math and science.

And finally: better voters and consumers. Better citizens and better consumers. By that, I mean, you’ll be able to make better judgments within the political arena, both in terms of issues and who you vote for. Secondly, better consumers: you’ll be able to better judge the claims that are made for products, particularly health products, by having a better understanding of them. The principles, I think are important, is to teach by doing science, not by teaching about science. Probably the biggest mistake we make today is that our instruction is about science, not doing science, not really understanding what science is. That gets back to my comments about understanding science, as it’s practiced. That means teaching science as a mode inquiry, not just a collection of facts, theories, results and that is the key. Science uses a different mode of inquiry than one might use in the humanities or various other fields of study. It’s different in it’s very nature, and it is important that students understand that already, at the elementary and high school level, if they are to learn to think in a way that scientists think, if they are to perform their jobs in science in society as they are to be performed. There several aspects to that. I think it is very important that we improve our curriculum. We have some very very good curricula there, but the majority are not very good. I believe a good curriculum for elementary school science, and certainly for secondary school science is something that is object centered, experiment oriented, but yet concept based and too often we find the curricula split. They emphasize either the experimental approach, inquiry-based approach or they emphasize the concept based approach. I believe both are essential and only the really good programs combine those two aspects.

Finally: teachers. Teachers are much reviled today, criticized for not knowing math or science, not understanding how to teach it. And in a sense, that is true, but it is not fair to blame them. When we have schools of education in universities, which do not prepare them to teach properly, do not teach math and science, to not give them the bare knowledge they need to understand it. I think it’s important to review teacher training and teacher training requirements. It’s also important to recruit and train great teachers. That’s easier said than done. 50 years ago there was a ready supply of teachers. Most female members of the population had little choice. Teachers, nurses, secretaries - so you had an ample supply. Now, there is largely equal opportunity, and many are choosing other fields, and we are losing some of our best teachers. In the meantime, we have not changed our culture to indicate that we need more males in the classroom so that we have true equality there. I recall this particular part we have to find, we have to train and we have to keep good teachers, because retention is also a major problem. We have to also assist current teachers by professional development programs, and that’s where the federal government could certainly play a role. We already have to improve that and I believe we may have to look at higher salaries for mathematics and science teachers. After all, we live in a market economy, and if they can earn twice as much money elsewhere, as we know they can, then you have to recognize that factor or, you are always going to have inadequate teachers. You can also, I recognize, make an argument for higher salaries for all teachers, and I would also support them, but there will always be a differential of some sort.
Finally, it's very important that we improve our research efforts on teaching of science. There are some good work going on at the National Institutes of Health and various other universities. There's also a lot of poor work going on in many locations, and we certainly have to improve there. So, I believe it's important that we address those problems.

Now, just a few closing thoughts – the report and the comments are a very broad brush view and I hope they are the beginning of a process. This is not intended to be a final verdict on the direction our country has to go, but to stimulate discussion, stimulate thought particularly in the Congress and is certainly stimulated thought discussion outside the Congress is beginning to develop within the Congress. As an example, the funding for science continues to be a major problem in the Congress, it just is not regarded with high priority. I skipped over one important reason for that. If you have a science policy, funding policy, that is based on the fact that we need to do scientific research in order to defeat our enemies militarily, and the Cold War suddenly ends, you have lost the rationale for your research program. I don't believe we should have ever used that rationale in the 1st place, but having used it we're immediately hurt once the Cold War ends. I have tried to educate my colleagues that if they want to think in terms of international competition as a reason for science, we have a better reason now than we did when we had the Cold War because the competition is economic, not military, and it is much more severe competition that we've ever faced militarily. If we wish to maintain a rising economy, we must continue our research efforts, not just in science and engineering, mathematics, technology, and of course the humanities, which all play an important part too. Future directions – success require the participation, contribution of entire scientific community. That also means a relationship to the questions you are asking here, the research university, it is not enough just to do scientific and engineering research. Simply not true. You have to place this in the total context, and the purpose of the university. You also have to relate it into the nation's needs and programs and above all you have to relating to the political system. I would love to have more physicists in the Congress. We now have a second by the way. Rush Holt from Princeton University has joined me about five years after I got there, pretending I was an economist. I did a quick calculation. If you have a doubling time of five years, that means in the year 2038, the entire Congress will consist of physicists, which might seem good to me, but I'm not sure it would be good for society. We certainly need greater participation, and I hope also that the scientific community will become much more active politically, and into addressing social issues, for example math and science education – one of the best things you can do, and incidentally that's how I got started in the math and science education 30 years ago, is to simply visit the neighboring school and say
I'm a scientist. I love science and really enjoy doing it. I just talked to students about why science is fun, and why I like it. Can I just let them see what a scientist looks like, what a scientist does and talk to them about it, or perhaps give them a tour of the laboratories? I think every scientist should be doing in terms of approaching the neighboring schools and try to develop some interest. I was interested in it but I never thought I could be a scientist and I didn't know what they did. I didn't know what they were, and I think getting out in the community and doing things of that sort, we can meet our social obligations, as well as our research.

If you want to read the report, it is out in paperback now. It's not quite a best seller, but if you want a copy free, just write my office and I will send you one. Sharon Haines and Laura Rodrigues were two science fellows who worked on this. They also had another staff member who helped Mike Champness and his name was omitted for some reason.

The challenge I leave you with is that you certainly have to redefine the role of the university. In this new emerging global society, but you also have to redefine the role of the research university in terms of what is happening in scientific research, and how it relates to other things going on in the world and that’s where the humanities become extremely important it’s very important, I believe, for the university to help with this matter, educating the public about math, science and technology, but also very important, but also educate them about the limits of science, math and technology. There’s certain major questions in our life, which science does not address. Obviously, those can be addressed by poets, philosophers and theologians – all of these are extremely important areas of life in society. And I think we’ve come to depend too much – “oh, the scientists will take care of that problem.” It is also very important, I believe, for the scientific community and the research community to become more politically astute and to communicate better to the Congress and with its citizens, and on that score I commend President Rawlings. He is one of the few university presidents of this country, who is coming to my office and said that he would like to talk to me about some of these issues. That’s what’s needed. I hope more presidents and more faculty members throughout this land will take the opportunity to do the same thing. I thank you for the opportunity to be here, I wish you a wonderful symposium. I am sorry I have to leave early this afternoon to get back to Washington, but I went through the program and it looks remarkably good and I wish I could stay.

Thank you very much.

John Brademas, Michael Voiland, and Vernon Ehlers, M.C.
Graduate Education in Research Universities: A Look to the Future

Charlotte V. Kuh
Executive Director, Office of Scientific and Engineering Personnel, National Research Council

Note: If you are reading this from a digital file (rather than printed book), click here to listen to an audio recording of the December 1999 delivery of this lecture.

Charlotte V. Kuh: I’m delighted to be here at Cornell. Since I have been asked to give this talk, I have discovered more and more Cornell connections that I didn’t know I have. This is a wonderful place and what I have been finding out is, that is in part a wonderful place because of Dale Corson and I’m really honored to be here. Hunter Rawlings gave half of my talk, so perhaps we can have some discussion. I do understand the repetition is an acceptable rhetorical device and so I am going to use it. I’m going to be talking about doctoral education in research universities, getting to the people part where you heard something about the resource part this morning.

I did some homework for this meeting. Less than five years ago, a symposium was held here in honor of Frank Rhodes, another Cornell leader in American higher education and the title of the volume that came out of it was “The American University: National Treasure or Endangered Species”. I see Ron Ehrenberg there blushing. In preparation for this talk, I look back at that volume and reread what had been written about many of the topics we were addressing today and since Hunter repeated the more original part of this talk, given what had been said then, we will do repetition. In any case, that exercise in hindsight, convinced me of the danger of dichotomies. National treasures or endangered species. It turns out our universities remain national treasures. Yet as in most dynamic systems, parts remain endangered, while other parts thrive. Research universities are resilient institutions. They continue doing what they have always done in the face of enormous changes in the world around them. Change does happen and they have the flexibility to meet it. I think the cause of endangerment, at that time, was pressure on the federal funding of university research. We have passed through the shoals and research funding is again growing, assisted by a federal budget surplus, although as you saw today, not as a share of the federal budget. That was something that was hard to imagine back then, yet many of the issues raised remain.

They are not caused by a dip in research funding. They are intrinsic to the changes in the American economy and the role that the research universities play within it. Here are some of the things, going back to that volume, that the contributors five years ago took note of. Harold Shapiro discussed the enduring value of a liberation education for undergraduates. That certainly remains, and you
heard about it from President Rawlings. Marianne Fox discussed how much more rapidly the world of work for people with graduate education is changing than in the past and how important it is for graduate education to be flexible to respond to that change. We still haven’t solved that one and I will discuss that further today.

Bill Bowen discussed diversity, noting the improving educational attainment of blacks which had not been matched by economic gains and urged research universities to continue to work to create ways to aid minorities in achieving meaningful equality in American society. I’m not going to talk too much about that question, but, as we are well aware, that one hasn’t gone away either. Those issues didn’t disappear over a five-year period and a few more have arisen which I’m going to talk about today.

The first is the amazingly rapid spread of information technology, and that’s really going to be the core of my discussion. The other thing is the restructuring of the provision of medical care. I note these two because the transformation of the provision of medical care happened very rapidly and as a result of cost pressures. It illustrates how rapidly seemingly enduring institutions can change. The spread of information technology points to a vehicle that may hasten similar fundamental change in the provision of higher education, both in the US and worldwide.

Having noted that the range of new things to say is somewhat limited, I would like to use this opportunity to try to look ahead a bit. My husband likes to tell a story about vision and I think I will tell it to you before I present a vision.

This is a story about two rabbinical students. One a disciple of the Rabbi of Prague and the other a disciple of the Rabbi of Vienna, who met in an inn one night and were bragging about their respective mentors. The Viennese disciple told stories of his Rabbi’s erudition. The student of the Rabbi of Prague, “but my rabbi is gifted with the ability to see amazingly long distances. One day he came to Vienna and was praying when he stopped suddenly and hit his forehead. “Oh no!” he said, “My synagogue in Prague, it’s burning down!” and he rushed out and returned to Prague immediately. “So”, said the Viennese disciple, “Did it burn down?” “Oh no, it was fine, but what vision!” That said, let me present you a vision.

What I’m going to do today is first discuss how information technology is changing the way higher education is provided and the effect that it having on the higher education industry as a whole. You may not often think about it that way, but we are all participating in an industry. Maybe as an economist, I think of it more as an industry than perhaps others here do.

Second, I wanted to discuss what that means for what we need to teach our graduate students. Third, I want to end with some issues that vision raises about doctoral education. First I want to say, and you heard it from Vern Ehlers this morning, that it seems very unlikely that federal funding or even state funding will be the engine of growth for research universities in the future that it has been in the past fifty years. Rather change is more likely to come in the production process of education, and that change in production is likely to be enabled by ubiquitous information technology. Let me start with the evolution of the US higher education systems in an information technology enabled environment. IT, information technology, is just a technology. What really matters is how it is used and in its uses, seems to me to be a potentially transformative technology. Changing the process of research and education, not just the delivery of it and we will hear more about that this afternoon as well. I am not going to discuss the transformative effect it has had on the disciplines, but let me note, four big changes. In biology, without IT, we would be nowhere near as close as we are to sequencing the human genome. In physics we would not be rethinking everything, from the age of the universe to the forces between subatomic particles. In history, we wouldn’t be able to construct new theories of the relation between climate and settlement. In classical language, in important texts, formerly limited to special collections and the glosses on them would not be available to scholars online and to anyone else with an interest in studying classics. None of this would be possible without the power of networked computing. Of course, this is old news at Cornell which has pioneering high-volume, high-speed computing. The widest use of information technology is as a medium of communication within the university and throughout the community of scholars, it is used for discussion, for collaboration, and for the communication and exchange of data. Research universities are also increasingly involved in the communication of knowledge beyond resident students via distance education, and you heard a little about that this morning. Distance education which I’m going to define as the provision of education to non-residential students is not new. In some form or another it has been around for a long time – in print through extension and correspondence courses, via television, through courses on tape and later through two-way television and now through the internet. It has always been a blessing to the place-bound and to students who wish to combine education and employment. In the research university, distance education has not been a core concern. Recently, alternative providers like Walden University, The Open University which by the way isn’t just in England, it’s here in the United States as well, in cooperation with a university in Florida, I believe, and the University of Phoenix have been established and have been enrolling thousands of students, actually tens of thousands of students nationwide. These institutions typically provide online instruction, combined with face to face sessions, at places that are convenient to students who are fully employed. Originally aimed at the extension continuing education market, these offerings are now being extended to professional degrees, master degrees, associates degree and technical certification. These institutions have already received accreditation from the same bodies that accredit ordinary institutions of higher education. It may sound overly competitive to say this but they are on our turf. Research universities are now entering that market and you heard a little bit about that is morning, either through consortia or R1.edu and are more entrepreneurial faculty, and you’ve are already heard about Arthur Miller this morning, are supplying instruction to online providers arguing that teaching online falls under university regulations that permit consulting or encourage authorship of instructional materials.
The essential of economics in distance learning can be described as follows: there are high costs of infrastructure and course production, but low cost of dissemination. In other industries, like telecommunications, this sort of cost structure has led to the emergence of a small number of producers who sell a commodity to large markets at low cost. Research universities have the advantages of brand names that are associated with high quality. The question arises, how well can they compete with specialists institutions that provide only distance learning with consultants who may even be drawn from the faculty of the research university?

The specialist institutions don’t have to cover the cost of plant. They don’t have to pay to shovel the walk way. They don’t have to cover the cost of laboratories or dorms. They can thrive by offering low prices for credit hours and can woo away price-sensitive students. A possible evolution is that low-cost providers may eventually dominate the market or it may be that specialist institutions will not be the only players. We may see the emergence of hybrid of institutions. Nonresidential universities that provide face time and lab time at widespread learning centers may develop. We already see this with the development of satellite campuses at many public universities and I’m not just talking about the Cornell Medical Center, that’s a satellite campus. There are other places that combine satellite education and satellite centers with distance education.

The certification that they provide bears the name of the flagship institution and so you have an Indiana degree or maybe even Cornell degree. At present, it is unlikely that students with an interest in science or engineering, majors that require hands-on work in laboratories, will be attracted by these providers. As course developers get better though, at putting together virtual laboratories or as experiments that can be carried out at distant sites, which they can now, that’s very true of very expensive research equipment at present, science and engineering may no longer be immune.

Charlotte Kuh and Norman R. Scott, former Cornell vice-president for research.

Now let me ask you to think like an University administrator or economist, painful as that may be. What kind of course are these entrance schools that are entering, what kinds of courses are they going to find most attractive to offer? The answer is high-volume
courses like Economics One, Introduction to Computer Science, Beginning Accounting, Introduction to English Literature, and Introductory Psych, etc. These courses are profit makers for traditional institutions, too. Cyber schools can offer them to more students at a lower price to the extent that credits are transferable and that’s really not the case now, a lower-cost alternative may lead the traditional institutions that do not have a prestige degree to offer with lower enrollments and/or high-cost courses.

So there is cost pressure from market erosion as well as what we’ve been facing for a while which is resistance to higher tuition. Research universities are quite lucky in this kind of a scenario. They have endowments. They have research funding and they have licensing income as alternative sources of revenue. Universities that lack these alternatives may well go out of business. In this vision, the success of the research university will depend critically on an entrepreneurial faculty that focuses on research that is most likely, or appears most likely to yield a market return. This is my vision alone. We’re living much of this vision now. The real vision as Clark Kerr’s, almost 40 years ago and Max Weber, who didn’t show up in my search. Clark Kerr said in his Godkin lectures in 1963, the University and segments of industry are becoming more like. As the university becomes tied into the world of work, the professor, at least in the natural and some of the social sciences, takes on characteristics of an entrepreneur. Industry with its scientists and technicians learn an uncomfortable bit about academic freedom and the handling of intellectual personnel. The two worlds are merging physically and psychologically.

Does this vision of the future have anything to do with graduate education and research universities? I would argue that it does. The new academia may be largely on line and today’s graduate students will be its faculty. The research universities will continue to exist but they will employ a diminishing share of new PhDs as faculty and those who are so employed will be chosen in part on the basis of demonstrated, in part, on entrepreneurial ability. Cornell should do well in this environment, since it has from the start combined the useful and the humane Art and Sciences.

Now let me talk about education of PhDs in the digital University. If you accept this vision of the new higher education and I get to it, frankly I have to say that I don’t like it, but it’s there. We need to educate our graduate students to deal with it. I think this education has three elements. The first is flexibility of expectations for graduate students for what they will become. This is not a new point. The COSEUP report, reshaping the graduate education of students, scientists and engineers made it, as did Marianne Fox at the Rhodes symposium. These days in almost all fields fewer than half of the PhDs end up in academic jobs. All doctoral students need to know what else is out there and have opportunities to experience that kind of work without having to keep it a secret from their advisor.

Second thing: teaching and learning in a digital environment. The teachers in my digital scenario do two things: one, they prepare web courses that speak to students who are not in the room with them. This requires attention to a new pedagogy. How are you a model of thinking and learning when people can turn off their computers? Second, the second task is to coach students at learning centers, lecturing. Yellowing lecture notes won’t work. It needs to be efficient, customized instruction. The third element of education has to do with academic work in the new research university. The value is grants-personship and license oriented research. Who is going to pay for the humanistic or the arcane and neglected field? Fields that may actually without the intention, perhaps yield higher returns than the ones where the return can be seen.

Now let me return briefly to the economics of research universities. To an economist, the research university is the nest of cross subsidies, for example high volume, lower division courses subsidize small upper division courses. It used to be that surpluses from the medical school subsidized arts and sciences. That may still be the case for other professional schools. Overhead and indirect costs from federal funding of research may pay for libraries that may be used by faculty who are not so amply funded, etc. Although each of us is certain that somebody else is receiving more than his/her share of subsidy, university departments and centers do not operate purely as profit centers and probably never will. Doctoral education in arts and sciences however has a long tradition of subsidy. In arts and sciences many doctoral students who finish in a reasonable period of time can expect to be fully funded while they are in graduate school. The growth of cyber competition makes it more difficult to sustain such subsidies. It may be argued that because graduate students provide teaching and research assistants at below market rates, the size of the subsidy of doctoral education is overestimated by tuition plus stipend. We’re getting this benefit because we are not paying a regular faculty member to teach that course. However, the traditional justification has been the PhDs are foregoing lucrative, nonacademic jobs in order to undertake a long period of research training for academic positions that will be comparatively lowly paid. PhD training stands out as free graduate education compared to costly professional school or Masters level training which is paid for largely by the students themselves.

The point of this discussion of cross subsidy is to suggest that there may be pressure to have students pay a larger share of doctoral education. If that occurs, a number of new pressures emerge. First the benefits of costs of doctoral education may need to be spelled out more clearly. As in professional schools, tuition may need to be justified by results. This is already the model for Masters Programs. Enrollments even in prestigious departments may become more sensitive to the job market for graduates.

The sciences are different. They are reliant on government funding for research but are vulnerable to changes in federal government funding priorities. As is increasingly the case now, university researchers are likely to be driven into the arms of industry – and they may be welcoming arms. This is not necessarily a bad thing, but business operates to make profits. Business partners need to be very patient indeed to encourage curiosity-driven research that may not improve the bottom line for the foreseeable future.
Now let’s look specifically at what the changing employment market means for graduate education and training. First where are our doctoral students going? It has been noted in the past five years that in the sciences an increasing share of PhDs go to industry and to more training in the form of postdocs. In all fields, for those entering academic employment there has been a growth in non-tenure-track appointments. In the sciences they are called research faculty and some are very eminent and many may be in this room. But if their research funding goes away so does their position. That’s good for the university, it gives it flexibility. But it’s not clear how people feel about a career that is subject to forces as Congressman Ehlers pointed out, that it may be beyond their control. In the humanities these non-tenure-track faculty are called adjunct or part-time faculty. They are positions that may be mutually convenient to following spouses and university employers, but positions that carry no career advancement and are increasingly resulting in disaffected army of the underemployed.

What is appropriate graduate education for this changing employment picture? Let me briefly describe the new competencies. First, education for teaching – in addition to intensive training in research which we do now there would be preparation for teaching in an asynchronous learning environment. We need to know more about how pedagogy should change. How can media be combined to make teaching more effective to keep people from changing sites? How does a professor project to an unseen audience? What is the best way to provide feedback for students who may send e-mails any hour of the day or night? How does the graduate student become an effective coach and learning center designed to help students learn material developed and presented by others. The Council of graduate schools has for a number of years sponsored a program called “Preparing Future Faculty” in which it is explicitly recognized. These research university trained PhD’s may find themselves teaching in non-research university environments, small colleges, community colleges. This could be extended to include asynchronous instruction.

Second, education and research - the principal investigator based model where the PI initiated and directed-research is only one model of how research is produced. Not only do teams conduct research in industry but interdisciplinary research in universities is conducted by teams of investigators in which each researcher brings a special expertise to the research question at hand but is required to communicate effectively with other investigators who may come from quite different disciplinary backgrounds.

In the IT enabled world, teams can easily be international as well. How do we educate graduate students to carry out this kind of research, especially when many of us have come to it late in life, if at all. Third: education in service. One of the promises of the wired world is availability of learning to audiences who have previously been excluded due to distance from campus, either earlier inadequate education or expense. The land-grant model of extension service that links the university to practitioners is worth considering in light of the new technology. K-12 school teachers, for example, can become more involved in the world of ideas and research at much lower costs than ever before. We need to think of ways of extending arts and sciences scholarship just as the land grant universities have always shared agricultural knowledge. Our doctoral students are probably more adept than we are in understanding how best to do that. To encourage that work, however, requires the faculty to value that sort of outreach activity.

Finally education in partnership: the research university, as many authors have reminded us, has never been an ivory tower but management of relationships with patrons. Industry and government needs to be an explicit part of the curriculum for doctoral students who will be negotiating these relationships and may be negotiating them from either side. Non-university partners expect a return on their investments. Universities expect to be allowed free range to do what they do best, investigator-initiated research. Proprietary information may be critical to obtaining profit from the implementation of research, not falling into Ehler’s “Valley of Death”. Openness and publication are key to scholarly communication and the growth of ideas. Universities themselves may be conflicted as owners of patents. Professors may be principals in start-up companies or may possess proprietary information from their membership on boards of scientific advisors. Such issues are part and parcel of the new environment our PhDs will face. They need to be addressed explicitly in doctoral education.

To conclude, we have looked at the pervasive effect information technology that it is having on higher education. In some ways that it may or should affect graduate education. A number of issues raised above have been around for a while but the maturing of the information age increases their salience. I would argue that research universities need to rethink doctoral education as information technology reshapes our education. In the past decade we have seen an increased realization of the varied kinds employment our doctoral students encounter and many graduate schools have instituted career colloquia, cooperative programs to prepare future faculty and growing relationships with industry. On the other hand many of these actions have been piecemeal, undertaken by some departments but not others. We still hear from graduate students that they cannot tell their advisor that they would like to pursue a nonacademic job. We see increased unionization efforts among our graduate students, another symptom that students feel the need to readjust what they perceive to be an unfair balance of power.

Into this uneasy world, comes a transformative technology. Research universities have been happy to embrace it, as it transforms research and scholarly communication, but have not really addressed the question of how it will transform their own industry and the workforce that industry will need. The vision I presented is really speculation to that end.

So, instead of conclusions, I want to leave you with questions. First, given my guesses or your own, is there a need to shape the future or do we just let it happen? I thought of four issues. There are plenty more. The first: declining enrollments in traditional graduate education. We see that already. Is this an adjustment to an imbalance or will there be serious shortages? Who will be the next generation of faculty? How do we get them to be who we want?
The second issue is, is there a need for increased evaluation of the use of information technology in teaching and research. Everybody is doing it very much on their own. Do we want to take a look at it overall? What criteria would we need to do this?

Third issue: Will research universities grow further? Who will pay for it if they do? How will they remain as unique as they are as they do seek to grow? That is true for almost all organizations.

Fourth: how do we preserve the values of scholarship and inquiry-based research in a world that is increasingly linked to the private sector. It is not bad, it's just there.

The second question relates precisely to graduate education for higher education in a digital environment. Do we need to rethink existing models beyond the change that has already occurring? Three issues: if we recognize explicitly that our doctoral students will conduct research and teaching in a variety of settings, is the PhD required for all of these? People now use the PhD for virtually anything. Second issue: what's special about the PhD? Somebody I talked to from an industrial employer, said they like to hire PhDs because they have shown that they can finish something. A PhD provides a certification of conduct of independent and original research. Are there alternatives, less expensive ways, of demonstrating the ability to conceive and complete a piece of research? Third issue: what would an alternative model look like? The possibility would be masters degrees combined with continuing education where going back and forth to the university and to training is a much more frequent occurrence. You don't just leave and then get a letter from the development office. You come back and learn things and I actually know from my friends, that Cornell does some of this and the alums who do it, like it a lot. How could such an alternative for training teaching faculty become more respected and I think it could.

I know we've run out of time and we won't have questions now, but I look forward to your discussions tomorrow and continued speculation on these issues. Thank you.
Introduction by Walter LaFeber: Thank you, Dr. Kuh. Our next speaker is the Chancellor of Vanderbilt University, Joe B. Wyatt. His background is in the program. There is one thing I want to add, that is not in the program, however, and that is that since he has been Chancellor at Vanderbilt, he’s had an extraordinary commitment to teaching. He has developed a teaching program in which the Vanderbilt faculty are involved, that is one of the more original and productive and successful teaching programs that I know about in higher education. Moreover, something I did not know about Chancellor Wyatt, until recently, he is a licensed pilot and one of the associations he belongs to is called the Experimental Aircraft Association. Now, among other the things the Experimental Aircraft Association does is not only fly what must be extraordinarily interesting airplanes, also what this Association is doing is with a large grant from the Lilly foundation is teaching principles of engineering, science and mathematics to grade and junior high school students by essentially engaging their interest in aircraft and especially in experimental aircraft. In other words, Chancellor Wyatt, who has been an extraordinarily distinguished speaker for the research universities over last generation in the United States, has also been extremely concerned to make sure that the results of the research university that these results are transmitted to many levels of American education, from junior grade school, high school, on up through college and graduate education. For that particular reason, it is an honor to invite Chancellor Joe Wyatt to speak on the topic “The Government-University-Industry Research Nexus”. Chancellor Wyatt.

Joe B. Wyatt: Thank you very much Walter for that provocative introduction. I’m afraid I don’t have time to explain it fully, but of course as you know about pilots, they’d be happy to talk about flying at any time in the halls or elsewhere.

We do at Vanderbilt, as you do with Cornell, treasure teaching. We treasure learning. We have a number of programs to honor and improve undergraduate teaching at Vanderbilt. One of those is a series that I started about a dozen years ago it’s the Chancellor Lec-
tured Series on Teaching. We invite people who are distinguished teachers at undergraduate institutions and graduate institutions as well around the United States to come to Vanderbilt talk about how they teach. One of the early people that we discovered and invited to Vanderbilt to talk to us about teaching was Walter LeFeber. As you probably know, he is a master of teaching large collections, of engaging, holding, and teaching large collections of people and we were privileged to have him in our presence.

Let me explain further that my connection here with Dale Corson is that I am his successor’s successor, as the chairman of the government, university, industry research Roundtable. This is an organization that, as the name implies, joins leadership from the university sector, the industrial sector and the government sector, relating to research issues. It meets under the auspices of the National Academy of Sciences with the enthusiastic participation of the presidents of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. I might say that this is a very interesting organization. I will say a word or two about it, but I want to take a bit of time to sort of connect the questions that Charlotte raised in some of the issues that were raised by speakers earlier this morning.

It is a pleasure to talk about the future of research universities. Most university presidents are mired in the present with issues that come up, that cannot be delegated and that must be decided. Some of them relate to the future and some do not. One would conclude that part of life at a university deals with the past, rather than the future, except for its students. As a person who spent a career in the computer field, now it’s coming to light that the computer field is influencing everything. Of course, those of us in computer science have known that all along, it’s just a matter of when, not whether. I might make this observation: that we at universities are particularly adept at creating change, at discovering new knowledge that causes change, and teaching others to change. But I must also say that we are loathe to change ourselves. It was once said that if your great-great-grandparents came back to visit, where might they feel most comfortable, where things have changed the least? The answer was “any college school classroom looks pretty much the same”. Now we want to maintain what we value in what we have held for the past. We must engage the future, because we are now exposed to more and more forces outside of our own control. This issue is one, that I believe, going to engage this presidential election, perhaps more than we might even think now. I’ll make that prediction here. We’ll see how it plays out, but I think education, change, the global economy, you heard described this morning will become very, very active issues as the campaign progresses.

I want to use a quotation from a former presidential candidate, and I quote, “neither a wise man nor a brave man, he said, lies down on the tracks of history to wait for the train of the future to run over him.” That candidate was Dwight Eisenhower. He spoke those words during the presidential campaign some 47 years ago; but if anything the advice is more appropriate today. We have to look forward and we need to act on what we see. Otherwise, we do indeed run the risk of getting literally run over by the express train of global change stimulated by information technology and other forces.

I have been asked to address this nexus between these three sectors – something that’s very comfortable to me. My early career in working my way through college, I made $50 an hour and not $30 an hour. I worked at a grocery store, and it paid more than grading math papers, and that’s how I made my decision. When I got into legitimate work in the computer field I went into the private sector, because actually at that time (this was in the middle 1950s), that’s where the more interesting work was being done. I was sent off to MIT in the late 1950s, as one of five people from around the United States to help get out of the laboratory. One of the items that Frank Press showed us on slide this morning, and that’s a computer-controlled machines. There’s some research going on there. We have had the job of getting that out and making these machines actually work. At least my own experience in this university industry connection goes back that far, not very heavily recognized then but very much a connection.

I have since been involved equally in the private sector as well as the universities and so the notion of the differences don’t come through to me nearly as clearly as the similarities and the growing dependence. Now this Government University Research Industry Roundtable, as conceived by Dale and perpetuated by others, serves as an advisory, actually I should say in the capacity of enlightenment on public policy. We do not give specific advice to government agencies that’s because where prohibited by law from doing so since we have government representatives with us at the table. It is an organization that treats its choices of subjects carefully. There are many questions. Many we do not cover. I think today I would like to illustrate with an example or two, and talk about why I think this is an important entity still and is one of Dale’s more important contributions to the value of science research as it relates to our civilized society.

I think it’s very easy to make the case for strong communication and coordination between these sectors. I think that, just to give you an illustration of the membership of this group, they won’t allow more than two university presidents in this group of 30. They’re smart people. We have scientists. We have entrepreneurs, that ranges from Nobel prize laureates, and Dean Kamen, who was a college dropout from Worcester Polytechnic Institute. Kamen is a billionaire. I think he has 200 patents at last count, mostly in medical devices, but more recently, you may have seen on some of the national news broadcasts, a new wheelchair that Dean invented that can stand. It actually has gyros installed in it to allow full vertical and horizontal mobility by those who use wheelchairs. The man is truly a genius. We have all types of individuals there. I would put in the middle, of course vice presidents of research from several major corporations.

We have a number of issues that we consider important, and let me just touch on just a few of the linkages. Just last week, the Association of University Technology Managers an organization, called ATUM found at least 280,030 and $4 billion in economic activ-
It is directly attributable to university-based research — directly attributable. Indirect attributions, you saw from the Press slide, go well beyond that. In fact, the long-standing policy that created this national science research system recognized the importance of these intersections and established national laboratories and some of them are allowed by virtue of the tax laws, some are enabled by appropriations to special parts of the government, the Department of Energy, for example. The spectrum of these facilities is full and complete. This approach, this business of full spectrum of research activity, ranging from universities to industrial laboratories to government laboratories, then to industry is one of the recognized great strengths of the country. You heard some data on it this morning. Let me just give you another quote or two. David Gergen, in the *US News and Report* recently said that “Washington needs to wake up. Just as the patrons of the Renaissance Italy supported artists, statesmen today should support scientists and engineers”. Alan Bromley, writing in the *Washington Post*, Alan was a former president’s adviser, said and I quote, “America is on a roll. We are balancing the federal budget. We’re reforming welfare and making retirements secure. Sound like a breakthrough in fiscal management? Not exactly. Our awesome economic success can be directly traced to our past investments in science.” George Mellowin, writing in the *Wall Street Journal*, and I quote him, “all this new science just didn’t happen. It had to be incubated. If the United States that hatches inventions can look forward with optimism to the 21st century.” All this attention is very nice, but in today’s world if he stopped long enough to pat yourself on the back, you risk missing the next half dozen other developments. So in keeping with the theme that the future of research universities in looking forward and taking action, I want to suggest three key areas where new thinking and approaches may be needed.

There are examples of areas that will require substantial attention if we want to continue strengthening partnerships among research universities, the federal government, and private industries and if we hope to sustain the advances that are driving our global economy. The first is, for lack of a better term, interconnectedness. This mindnumbing term, and others like it works like multidisciplinary, interdisciplinary, crosscutting all reflect the reality that much of today’s best research is happening at the intersection of disciplines. Today’s science and technology don’t fit in neat little boxes that reflect long-standing organizational charts, whether they’re used by campus administrators, federal bureaucrats or corporate CEOs.

Last June, at the Government Research Roundtable held its first ever quarterly meeting outside the nation’s capital. We did so deliberately, we wanted to get outside the Beltway to look at the degree, and there is much evidence that its very substantial, to which research universities do serve as catalysts for regional high-tech development and innovation, and so we chose a relatively new stronghold of this phenomenon. The meeting was hosted by the University of California at San Diego, a location that is exploding as a result of this interconnection between universities and industry. It is especially exploding in the area of biomedical and information technology areas. It is sort of an incubator for wireless communication, in the communications area. In fact this whole phenomenon has occurred in about the last dozen years, so it is much younger, much newer and happening much more rapidly than Route 128, Silicon Valley, Research Triangle Park, and some of the other illustrations.

One of the buzzwords at this meeting was bioinformatics or as one UCSD researcher called it, silico-biology. It represents a merger, borne of necessity as Charlotte mentioned earlier, between information technology and the biomedical world, and undoubtedly is spawning a new breed of highly skilled researchers to meet the demand of a burgeoning industry. We at Vanderbilt established a department of Bioinformatics about 10 years ago, in the medical school, actually. Although it’s University wide area, and in fact it is indeed burgeoning. As these secrets, as they say in the human genome that Charlotte mentioned are unlocked, literally mountains of data are coming out that are only meaningful when they can be organized, connected and made available by means of information technology. This is revolutionizing biology and its teaching, even in the earliest years. This is not a small job – neither the research end or the education end or at the application end. It is a job for biologists with solid grounding in information technology and related fields. No computer wizard alone, no biologists alone can accomplish this. It takes teams, these interdisciplinary teams. This is relatively common knowledge in a whole host of disciplines, but it is one that is causing a number of frictions and tensions in academia. Interconnectedness also reflects the fact that many exciting biomedical technological breakthroughs are built on the underpinnings of the basic research accomplished by the physical sciences. Hal Varmus, who is a regular member of our group, and
until recently the director of the National Institutes of Health, summed up the relationships in the following way, and I quote, “most of the revolutionary changes that have occurred in biology and medicine are rooted in new method. Those in turn are usually rooted in fundamental discoveries in many different fields. Some of these are so obvious that we lose sight of them, like the role of nuclear physics and producing the radioisotope, essential for most modern medical science. Physics has also supplied the ingredients fundamental to many common clinical practices: x-rays, CAT scans, fiber-optic viewing, laser surgery, echocardiography and fetal sonograms. Material science is helping with new joints, heart valves and other tissue mimetics. These are but a few of many examples of the dependence of biomedical sciences on a wide range of disciplines – physics, chemistry, engineering, and many allied fields. These examples underscore the need to sustain the strength of science across the full spectrum. And I would point out the distance sometimes is rather large. I believe nuclear magnetic resonance was discovered in 1946, mid 1940s, but until the large scale high-speed computer came along to enable that technology we could not do MR imaging, as we do today, so many of the gaps in basic discovery in actual use are more than a trivial number of years.

What needs to be done, in order to accelerate this? I think there are two or three that I would like to leave with you. Universities need to encourage, recognize and reward faculty members who want to work in these promising new areas. Their careers shouldn’t suffer. They should not be penalized in promotion renewal and tenure, in other words, for stepping outside the traditional confines of their departments to work in these new intersections with other departments or schools. I might say in the 18 years that I’ve been chancellor at Vanderbilt, we have changed the appointments for renewals at Vanderbilt two times: major undertaking. Major committees took three or four years each time to try to move closer to these objectives. This is not easy work, but it is, I believe, essential work.

Meanwhile, second, policy-makers in Congress and in the White House need to provide stable research funding for all scientific disciplines. This by extension means smoothing out the uneven, stop and go patterns of funding for the various agencies that provide grants for university-based research. Patterns often based more on political considerations in the current popularity, and some types of research done without awareness of how the various disciplines interact. You heard a good deal about that this morning. It is a recognized problem. Getting to the solution of a problem is something that we hope to address a GUIRR and this certainly going to take enlightened work from members of the Congress, like Congressman Ehlers and Sen. Frist who has not been mentioned yet, but who is on the Senate side helping a good deal with science policy.

Biomedical research has enjoyed substantial and well deserved budget increases over the last couple of years. That was described also. But other disciplines haven’t fared nearly so well. A recent report sponsored by the National Research Council, according to that report has found in recent years, federal support for such research areas as physics, mechanical engineering, electrical engineering, and the geological sciences has actually dropped substantially. That needs to be corrected.

The second major area I want to touch on is our education system itself. It’s a large topic but I want to touch briefly a couple of aspects germane to our discussion today. First, the quality of American education is a great concern not only to those of us in academia and to all levels of government with responsibilities in this area but also to the leaders of our high-tech industries. They need skilled workers to handle the complex demands of the workplace, fueled by the rapid advancement of technical knowledge, and some high-tech industries and some locations; it’s a near-term problem and it is being addressed with temporary fixes that allow them to make do. Raising immigration quotas, you heard the numbers this morning. Hundreds of thousands are coming in because we cannot supply the workforce necessary from our own educational system. The high-tech CEOs know that it’s a bigger, more dangerous problem in the long run than in the short. They worry that this country’s educational system will not be able to meet their future demands for skilled workers. It’s a bottom-line issue for them. It’s the pipeline issue for them. Many of them know it’s a problem that begins in the K-12 classroom. In fact, the solutions they have, in addition to raising the immigration quotas, which is a very political issue in this country, is simply to locate their facilities outside this country, which is not necessarily in the best interest of the United States.

When one looks at the traditional composition of this country’s science, technology and professionals, and then considers the nation’s demographic trends, it’s easy to conclude you can’t get there from here. Something has to change. The talent pool has to be expanded to include fast growing segments of our population who previously have not been well represented in these fields. At our meeting in San Diego we learned that many of the high tech companies there are so aware of this problem, educational haves and have-nots, that they are working diligently with the educational community to do something about it and in fact have created a high-tech high school, a new tuition free, public charter school aimed at the diverse group of middle school students interested in math and science who are from impoverished backgrounds who otherwise would not get access to high quality education.

This links students with industry mentors. This is financed by industry. This sits on the campus of University of California at San Diego. That is a manifestation of the level of interest and concern that these companies and their university counterparts have to this K-12 issue. In addition, more than 150 organizations in that area, including biomedical firms, and high-technology companies, along with government and university programs have become involved in the San Diego Science Alliance. It’s designed to identify and meet the needs of K-12 science teachers who seek to encourage students to seek to consider science careers. This program draws heavily on business resources and features free, eight week seminars for science teachers, including site visits to technology oriented companies, and a telephone hot line that connects teachers with volunteer scientists and engineers. This includes volunteer scientists and engineers at the University as well as at the industrial companies.
While on the subject of educating American youth, I want to interject here a note about the critical role played by our schools of education, the institutions that create the teachers, train the teachers, who prepare children for the fast changing world. This is an issue of great personal concern, to me not only because Vanderbilt has one of the better education schools in the nation but also, because I have long believed that those in education also accept the job of teaching the teachers have a special responsibility to do the job well. Let me just say I went to Vanderbilt University as Chancellor in 1982. Vanderbilt had merged with a bankrupt school of education, Peabody, two years prior. It had gone under financially. One of the issues that I faced was what to do about that school. In evaluating it, it turned out to have one of the best reputations for teacher education in the world, but it was not able to sustain itself financially. I can say today that that school is a school of Vanderbilt just as Arts and Science. It has a dean. It is in the black. It is going well. It is very, very much a leader in the kinds of changes that I think we need to see. Let me just mention, that six weeks ago, The American Council on Education released the report of a task force that undertook a yearlong evaluation of the way teachers are taught on US campuses. I was a very interested and involved member of that task force and I must tell you the picture is not favorable. It found that the quality of schooling in America is inadequate for today’s needs, and that strengthening teacher education is the key element in improving the United States schools.

Of particular interest to this audience, the report came down hard on the employment of unqualified teachers, which is especially prevalent in mathematics and science. We found that more than half, and that’s kind, it’s probably closer to 70 to 80% in most places, of United States students in grades 7-12 were taught by unqualified math and science teachers. That won’t do. As one might expect the figures are even higher for those impoverished inner-city areas and rural areas. This report charges college presidents to step in and do something about it as a personal issue for the chief executive officer.

Here are some of the recommendations. Ensure that the teacher education programs have the resources to educate future teachers in the use of technology in teaching mathematics and science, particularly. Otherwise, technology will fail to meet its educational promise, if we neglect to equip teachers with the skills they need to understand and use it. We now know that it does involve different ways of teaching and the people have to learn to do that.

Second: require that the education faculty and courses be coordinated with arts and sciences faculty and courses. Let me say that at Vanderbilt, we got a governor in years past to get legislation changed so that in order to be certified for secondary teaching in the state of Tennessee, a person has to have both an education major and major in one of the 17 arts and sciences disciplines, truly a double major in order to teach at the secondary level. A number of other states have done that. That is the kind of thing we think involvement by both arts and sciences faculty and education faculty need.

Third: we need to make a greater investment in educational research, which lags well behind research in all the other national priorities: defense, health, agriculture and energy but there is one other ingredient and that is the only professional schools that teachers have are education schools and yet the research that education schools do is unread, not understandable by practicing teachers. Education research is almost totally disconnected from the practice. We would not allow patent medicine. We couldn’t. We won’t allow it in law. We won’t allow it in business. We must correct that connection in education research, and the practice of teaching.

The real bottom line is that colleges and universities with education schools, should either make a commitment to do the job well and fulfill that commitment or get out of the business. They are doing more harm than good. The report put the onus squarely on the college and universities presidents. It emerged last week. I am hopeful that it will have some impact, and I am hoping I will have something to do with that impact.

Talk of national interest leads me to the third and final area I want to address and that is federal policy as it affects the overall climate for university research in the United States. I strongly believe that it has been and will continue to be in this country’s best interest to make basic research one of its highest priorities. Ideally it would be mentioned in the same breath with the national issues of education, which is a political issue, if there ever was one, Social Security, same thing, and Medicare. We need to have research in that group of things that are highest priority for this nation, and it could be done. It could be done with some leadership that we can develop if we work hard and work with the members of Congress and the administration that will help us do it. It’s the only way it’ll happen.

As I noted earlier, the United States has developed a unique system for conducting it’s scientific and engineering research. It relies extensively on a large and diverse array of research universities, laboratories, both public and private. The success of that system relies partly on the size and shape of annual appropriations, by those agencies that fund research grants, but just as importantly, the success is based on national policies that foster an environment for a robust activity in research that is in direct policies that have a profound effect other than just appropriations. Let me mention a couple.

A conservative fiscal policy that has helped us reduce the federal deficit, stabilize the monetary policy that has led to low inflation, trend toward economic deregulation, trade liberalization. All of those things – support for and our protection for intellectual prop-
erty, The Bayh-Dole the Act of 1980, that revolutionized the transition of new ideas and new knowledge into industrial applications have all had an effect. These are indirect public policy issues that have had a profound effect on our research environment. Now it's reasonable and important to ask whether our national policies could create some change in the first part of the new millennium. I think that we can see some indication of progress, but some of danger in the last Congress. About three weeks ago, the Congress finally completed its work on the first fiscal year 2000 budget, almost two months into the new fiscal year. You heard it about it this morning, midnight appropriations bill and the like.

One of the issues that I personally, with few other college and university presidents, have lobbied on for 25 years is making the research and development tax credit a permanent part of the tax code. It has been a part of the tax code, renewed every three years or so, which is good. I don't want them to stop doing that, but the problem with it is that industry, unless they can write down the investment in these three years or five years or whatever, feel at risk if they make a large investment and depend on that write down. So they can make small ones and some that score. We have been through all that issues of abuse. We've been through all that issue of corporate welfare. It is neither. It is progressive and progress and you have heard, and I was pleased to hear Congressman Ehlers this morning that he supported this measure. We almost got it done, but we can get it done again. They now have only extended it for five years. So I would encourage all of you as members of the University community, just as I encourage my corporate colleagues to get involved in this issue politically. It was the genius of Dale Corson and his colleagues to establish the Government Research Roundtable, to have a venue in which these matters could be discussed. I believe we have made good progress. I believe there is much left to do. We hope that we can continue to make progress in what is indeed an interconnected world. Thank you very much.

Charles Walcott (dean of the University Faculty, 2003–2008) and Wyatt.

Corson with Martha and John Hsu.

Edwin and Miriam Salpeter greet Dale.
Introduction by Walter LaFeber: It is a privilege to introduce Dr. Fred Plum, who is a University Professor at the Weill Cornell Medical School in New York City. Dr. Plum has written a succinct, very elegant statement that actually replaces his biography in the program. I would just mention as background that Dr. Plum graduated from Dartmouth College and received his M.D. degree at Cornell Medical Center. He was the president of the American Neurological Association, and won the prestigious Jacoby Award of that association. It is an honor and a privilege to introduce to you Dr. Fred Plum who will speak on the topic of "Medical Neuroscience in the 21st-century".

Fred Plum: I beg for forgiveness, because at least half of what I was going to talk about is what the president of this extraordinary university was talking about this morning, which is to say, the ethics and the targetry of what we're living through at the present time and its relationship with the humanities. It's a privilege to be here this afternoon.

During the next 30 or 40 minutes, I will touch on four points, each of a different in nature. My first point hails Dale Corson, a friend and an inspirer. My second compresses into about eight minutes – a sketch of the astonishing scientific findings that have evolved during the past 50 years in understanding the human brain’s health, illnesses, behavior and its relation to the present health care. My third effort will focus on which current, devastating neurological problems particularly challenge neuroscience to remedy or conquer. Finally, I shall present to you some considerations of future social, ethical questions that may arise when well intended, high-tech medicine rescues the body but cannot save the overwhelmingly damaged or chronically unconscious brain.

Fifty years ago, believe it or not, as a resident at the New York hospital, I had the somewhat fearsome responsibility of being at the center of a poliomyelitis epidemic putting young adolescents, old adolescents, and young grown-ups into iron lungs. They were, for all the world, like the boiler that sits outside the house in a long cradle and fills up with water, except under these circumstances, these tin cans, as they were sometimes called instead of iron lungs, had essentially bellows at the end, which evacuated the compression within the can and the child or the adult breathed by negative pressure around the body which drew air from the atmosphere. All that was gone. All that was gone in six short years because of the invention of a vaccine. This has essentially been the way medical science, in a whole variety of ways, has gone since that time. Work was proceeding in the fundamental domains of anatomy, chemistry, physiology, microbiology, mathematics, even physics. Neurology and psychiatry usually dealt with the basic sciences only under specific circumstances and, indeed, in many instances and despite of the rapidly growing understanding of the nervous systems of the 50's and early 60's, even the basic sciences retained separate systems of intelligence, perception of immediate and past memories, psychology, psychiatry, sleep/wake systems, chemistry, mathematics, pharmacology, pain physiology, tension – all viewed their scientific engagements as isolated, indispensable events. A very few scientific leaders, however, realized that these hitherto independent pursuits had to be part of a whole, since that was the way the brain worked. This was the integrated unit. This was the integrated machine of every animal that has more than two cells.

Just think of it! Without a brain, from what direction would we have come? What pseudopod do I pull in? I'm not sure the little monster knows what he's doing, but nevertheless that was the organized expression of all those chemicals in that very low level of sea life. It was
not until the circumscribed efforts were understood that an integrating organ to make the creature live and thrive was needed. That integrator in many cold species was the nervous system, and until the middle of the 1960’s clinical and fundamental neurological science traveled the different paths that I explained up above. The only exclusion that one can possibly make is that of clinical neurophysiology, which in fact managed to learn more from humans, once one knew about the axon. Then systems neuroscience became related to a clinical disorder in neurophysiology. Nevertheless, many important biochemical discoveries gave little immediate attention to their possible place in health care or disease, and very few psychiatrists realized that schizophrenia and manic depressive illnesses reflected cell molecular systems gone awry, and not the result of an unfortunate exposure to a non-loving mother.

With the above march of science two inevitable revelations made their appearance. One was the realization of the necessary synthesis of incorporating previously specific independent compartments of human neurobiology. The other was the need to encourage leaders of specific biological disciplines to exploit the principle of integrative neuroscience by subjects, discussions and mutual explanations of their own scientific areas to one another.

We had an example of this, this morning. We had two Congressmen, one a Democrat and one a Republican and they’re still arguing with each other on a one-on-one basis about some of the important issues that we talk about today. We’re wonderful as individuals; we are sometimes wonderful as scientists; but we’ll be damned if we can become politicians. [laughs] It’s very sad because it’s so obvious.

In 1966, Frank Schmidt, F.O. Schmidt, senior professor of MIT and supported entirely by his institution, grasped the point and initiated a small all-star interdisciplinary discussion group labeled “The Neuroscience Program”. The program was quartered in one of the more separate Boston parks in order to give it isolation from the everyday, come and go of the students, and it’s goal was to attempt a coherent field of research activities relevant to a broad scientific understanding of the nervous system, especially the brain and mind of man. The field was called Neuroscience. The impact on scientific neurology was staggering. The original 36 and subsequent members, which rotated three dozen on a steady six-year interval, included both American and foreign leaders in top bioscience. Indeed the term itself indicated the cohesion of top level biochemists, pharmacologists, anatomists, physicists, physiologists - more than I can count on the next quarter of a page.

From the very beginning, however, the program established biennial retreats which took people from these different disciplines and parked them in high Colorado, not high enough to be delirious because they weren’t all 25 years of age, but nevertheless high enough to keep away from invasions and even from people who wanted to drive by and talk to them. Twenty-five years later, this was still continuing, and the last society of neuroscience essentially described after this initiative was pleased to indicate that we had 25,000 young men and women at the annual meeting It gets harder and harder to get an auditorium that can handle both them and the placards that go up with every graduate student across the United States.

As the 70’s and 80’s advanced, more and more attention continued to be directed to cell molecular biology, specifically to the influence of genes on human health, particularly on aging human health. This was obviously directed both to the brain and to other functional body systems, but nevertheless with infectious disease gone, with proper nourishment by and large settled, with avoidance of war, thank goodness, then meticulous public health, genetic-linked illnesses rapidly increased and, in many instances, been specifically identified. Indeed, just a week ago, I looked at a list of the particular, specific genes related to specific neurological disorders, and it’s already in the neighborhood of upwards of 175 that can even get commercial testing in potentially genetic illnesses. Only a few of these disorders have yet been successfully treated, but already several have started to meet their goal.

Behavioral studies of monozygotic and dizygotic twins imply that a great deal of previously thought unique minor activities in such persons may develop due to genetic influences. A group of geneticists at the University of Minnesota have identified with exactitude the behavior of twins separated from each other at a very early age – where they put their toolboxes, how many trees they planted in the back yard. Did they paint the house white or did they paint it grey or blue? Astonishing representations of what aesthetics had in that particular family.

On the other hand, it’s been more and more difficult, as you probably know, to solve how one might change one’s mind’s loss in the face of genetic disability. In just a moment, I’ll put up a few slides, which represent advances in the last eight years.

I didn’t feel so bad about the CAT scan coming 10 years after the mathematicians got in there. Imagine what it was like! Imagine what is was like to have to make a diagnosis on somebody with a cryptic brain tumor when the only thing you knew about this 35-year-old, or 37 or 38-year-old, the only thing you know was that he or she had had a seizure which might have been focal and may have been a guide. An elderly person, that is to say- now that I’m standing in front of you- anybody over the age of about 60 comes to you with a headache not previously expressed and we did not paid very much attention to it. Except one night, at 2 AM his wife could not wake him. There was no CAT scan to tell that he had a subdural hematoma, which should be drained. We made a lot of mistakes. The initial strong train in this area was by Marcus Reiko, actually one of our former residents at St. Louis, who was able to identify relatively primitive and simple neuropsychological paradigms in which the brain carrying out metabolism could be identified in the proper geography. Newer machines have been more dynamic. The possibility of using a PET scan instead of a molecule that takes about 40 minutes to decide where all the ions are landed because of the consumption of glucose so that one could do a short scan on Oxygen 15, enabled one to take a series of looks at how the thing develops and how it disappears. Most recently, the invention and development of magnetic resonance imaging has been able to bring really remarkable understandings to the way
we think at least about simple problems, and to some degree how we change the brain’s function in fear, in placation, in anticipa-
tion, in intention, and in attention. You have my attention. I have my intention to look at your head. My frontal lobe picks this up. My
MRI can exactly pick up the frame of whether that’s a new face or an old face, whether that is danger or whether that is presumably
friendship. We are that far along understanding certainly of the normal functioning brain. We are not that far along, even by MRI
scanning, of getting a strong handle on manic-depressive illness or schizophrenia. They are clearly genetic in their development,
not clear in the specific genetics which are associated with the diseases because there are families in which no horizontal bipolar
disorder appears, yet the family as a whole, over three generations are far above the average that one might expect.

And so it goes. As an illustration of the progress, I will show the slides now please. (Slide 1) What I’m showing you is a diagram that
was posted in 1982, actually at a 1979 hearing of the Society of Neuroscience, and at that time approximately 11% of the population
were over the age of 60. Beyond that, one sees a rise at that time that was predicted at the year 2000 to have turned down on the
activity and almost a straight rise to the next 40 years of the third millennium.

(Slide 2) In 1992 the Dana foundation called 32 people, headed by Jim Watson, the discoverer of the double helix at Cold Spring Harbor to
identify what drugs or what learnings would be most important with respect to ten (10) major illnesses. Familial, Alzheimer’s, Huntington’s dis-
ease, the identification of genes responsible for manic depressive illness, the development of new medications, and therapeutic strategies for
strokes and other forms of brain injury and the asterisks I’m coming back to show you one or two of the specific things which have changed – the development less strong of new drugs for multiple sclerosis and the other illnesses that you
read there, except for Parkinson’s disease, which only recently has been shown to be responding to a major improvement from stimulation within
the brain. The identification of new peripheral nerve and spinal cord injury has been a little dis-
appointing but it’s been more promising in the last year or so.

(Slide 3) As I mentioned earlier, the severe psychiatric illnesses have not yet been satisfied except by the kind of pharmacology, which may bring a form of stable behavior to the suffering individual. Agents that can block cocaine and other substances have
not been introduced yet into clinical practices. New treatments for pain and so forth are predominantly constructed rather than
discovered at the present time. Many genes have been identified in problems of deafness and vision and the elucidation of memory as the element of consciousness.

(Slide 4) The Alzheimer problem looks like it begins to be controllable, or it may be. Four genes are identified within patients with
Alzheimer’s disease. One, number 19, has the relationship of the amyloid protein which has been, ever since World War I, a known pathological accumulation of fat in the area of untreated infections or degenerations. The actual genes of all four of these have been
identified, but the most important, recent observation is that the enzyme which normally clips what Alzheimer disease with chromo-
some 19 has, is essentially the rather stiff fatty patches of amyloid which is thought to extract specific materials from surrounding
cells in the cerebral cortex. The abnormality was that a long protein which relates to the construction of amyloid was not snipped as
it is in normals, which therefore could not replace the amyloid – that is to say the smoking gun – that was causing the disease.

Obviously that is extremely important since that is the most frequent of the group. Huntington’s disease has about 50,000 people
presently in the United States. To give an idea of the frequency of the libido of the ancestors, the whole trait goes back to the early
part of the 19th century or the late 18th century - to two people who landed on the shores of this country.

(Slide 5) In stroke and trauma, not much has happened. For stroke treatment as most of you may know the onset of an acute rela-
tively severe stroke can be dissolved and washed away if one can dissolve the clot within six hours of onset. More importantly, for
the prevention of stroke, treatment of hypertension, the treatment of atherosclerotic heart disease and arrhythmia defibrillation, stop smoking, don’t get fat. If you did get fat, take it off and be thin and treat hypercholesterolemia.

(Slide 6) Now, Learning and Memory. We have several kinds of memory. One is my volitional memory in muscle and movement. One
is enough memory to remember the telephone number and go over to call it up. It takes something in the neighborhood of 16 to
20 seconds, one in which that immediate memory is put back into long-term memory where one can retrieve it for a very long time.
One is no memory at all – that is delirium and delirium is unconscious. It’s nothing but wakeful unconsciousness because it’s the loss of
memory of the self.
Tragically, the better the technical improvements the less time and financial support has gone to the acting physicians and surgeons. For almost all physicians living in the metropolitan areas, the reimbursement for time spent on first evaluation or follow-up of a patient can barely reach enough time to talk with the patient about how he feels. How is her mood? What’s going on with your friends? Has anything serious happened? Only the doctor and the priest, and for most people not even the priest, are able, in an hour if they have an hour, to learn almost every personal thing with the patient that he or she is contacting. This is wiped out by the insurance companies, by the demand to take tests that are so expensive that there is no money left for the doctor’s fees and are unnecessary, but we all do it because are so afraid that somebody will charge us with mischief. Even if they’re wrong, the financial loss is staggering for any individual doctor in many instances, for any institutions.

Physicians have learned that they go broke unless they pass their patients through their offices turntable style, 12 hours a day. Most practitioners even in New York, even on the socially best side of New York who are interns who, even if they practiced internal medicine without a lot of gadgets and tests and so forth, simply couldn’t make a living. Certainly they couldn’t make a living to send their children to school unless they worked a good 12 hours a day, six days a week.

Surgeons and others who deal with expensive technological equipment or laboratories have a modestly better position, but continual political pressures are gradually biting into their take-homes as well. Teaching hospitals, at least in metropolitan areas, face three potential catastrophes. One consists of reduced payments for in-hospital care of pre-insured patients. Another reflects an ever-increasing number of indigent patients who can pay nothing, yet we cannot keep them from our doors. What would we be if we couldn’t be the good Samaritans?

A second pressure is that the University or other level hospitals must have 24 hours at a time to keep active the finest, heavy and expensive equipment to manage patients requiring acute care. This is the truth of every hospital, at least in the metropolitan area that has an ambulance service and that has a 24-hour a day intensive care reception. All three and federal aid to the metropolitan larger teaching hospitals has steadily been attacked.

It’s hard for me to say this without a catch in the throat. The federal government has cut drastically paying the salaries of residents in training in the finest hospitals of the United States, expecting the hospital somewhere to go out and get the money off their rich clientele, I suppose. Two other factors enter into this. On the other side we have people who sit in, while I don’t like to say this, but people who sit in executive offices for 40 hours a week have put in bills that interns and the residents can’t work more than 70 hours a week. Hells bells! I work more than 70 hours a week, and I have for 55 years. I liked it! It was a privilege. You probably think I’m demented, but I don’t think I am.

The other thought, again an invitation for malpractice is that families fear that if every test possible must be performed to guard against whatever their family member may be suffering. Even if it’s a hangnail. Continuous pressure from local governments attempts to reduce working hours without increased funding to fill up the gap. Tax increase? Not on your life! Where are you going to get the money? Tell me. I’ll go take my shovel and dig it.

Many doctors no longer have enough time to play doctor and reassure their patients whose only confidence exists in that doctor. The A+ candidates who choose medical school look forward mostly to prepare themselves for careers that have both clinical medicine and industrial finance of research, and neither clinical trials nor the capacity of their MD/PhD program are a very smart lot. They are just the top of the skin.

On the other hand, one sees not just applicants from overseas but one sees internships and residencies throughout the country being packed by persons who can’t speak the English language. How they can speak to the English soul? I don’t know. I just don’t know, but I weep for it, because this is the change in American medicine. You’ve put instruments in front of us. You’ve put the future in front of us, and we have tried to maintain the future in front of us; but I’m afraid that the best hospitals in the nation are going to go broke. I don’t know how they are going to get out of it.

I think we have to think of the social problem, what is sometimes called ethics. I am more concerned than you are that we throw away at least two years of a child’s life before the child starts to be given specific schooling. Before, a three-year-old just sits and looks at a television screen, that three-year-old is losing geometry. I think that’s one of the reasons that mathematics is so hard to people. It’s because they never had this wonderful thing of putting the block in the block’s hole and the ball and the “0” hole – because they never had toys like that. They don’t have the social status to have somebody in the home with them all the time or to have schools built for them that are something else than essentially non-intellectual kindergartens.

I’m sorry to say that there is a conflict between how long one supports unconscious persons at the end of their lives and what’s been put into the educational system of the country. Sooner or later you’re going to have to face this. I’m going to have to face it for myself.
and I really have. Sooner or later, this is the wrong way for the money track to go. It isn't the wrong way to go if you're possessed of your mind or right down to the very last wisp of it, but it is a problem.

We are not doing enough about the degradation of the planet. It doesn't take the doorman at the apartment house that I live in a New York to say, “doc, something's wrong with this world. It's too hot down here. This is December and the temperature was 68° today.” I am told that the ice at the South Pole has, over recent years lost an ice pack, which is the size of the state of Texas in acreage on its top.

We are wild with putting out – I don’t call them cars – those jeeps they have the growth factor put into them, and you get about five or six miles to the gallon and a good deal of destruction capacity to their drivers and to other cars. This should be wiped out. This should be wiped off. We can have cars that can easily handle 35 to 40 miles a gallon; and if we really put our energy to it, we can have electrical cars which get at least some of their energy from moving water. We don't have to have gasoline in everything.

Manifest destiny depends on a good education, proper nutrition and must begin at very early childhood.
Introduction by Walter LaFeber: Thank you Dr. Plum. After a presentation like that especially, that I regret that we will not have questions and answers. We’ll have to defer that until tomorrow.

The final speaker for this afternoon I have a particular personal pleasure in introducing to you because I have known Don Greenberg for a very long time. We have two mentors in common. One is Marie Underhill Noll who was a benefactor and a Councillor of this University for nearly 50 years. Other than being a great friend of Cornell’s, Marie, who died a year ago, was also a nationally acclaimed teacher at Manhasset High School in Long Island. Marie liked to brag that she had many, many successful students out in a number of fields, but her favorite was Don Greenberg. Of all the men and women she taught over many, many years at Manhasset, she put Don at the top of the list and I think one reason for that was that, was that Don was uncommonly intelligent, and obviously committed but, I think to pick up one of the phrases Hunter Rawlings used this morning, Don ‘was thinking otherwise’ a long time before he knew anything about Carl Becker. One of Don’s great gifts is that he does not go along the usual path and that’s a good thing because in the 1960s Don became very interested in a field called computer graphics. In those days, computer graphics, somebody said at lunch today, it was kind of like a hula-hoop – looks very interesting but it didn’t seem to have much of a future. It took a considerable amount of attention and commitment on the part of Cornell to give Don the resources and encouragement he needed to become one of the really great pioneers in the development of computer graphics in the world and the person who did that was Dale Corson as I’m sure Don has told many of you on a number of different occasions. It was Dale Corson essentially who put together the resources and the institutional commitment and made possible much of what Don has done not only at Cornell but around the world in the development of this fabulous field of computer graphics. So it’s a particular pleasure to introduce the true pioneers of this new computer information revolution, Don Greenberg of Cornell University.

Don Greenberg: Thank you very much, Walter. I’m not sure I can meet some of your comments. It’s tough being the last lecturer of a long day and instead of giving the concluding lecture I think all give a summary because so many of the things have already been said. But I’m really not going to have a multimedia show here today. I’m trying to talk very seriously about the implications of what’s happening in the electronic age with respect to what’s happening in the universities. In trying not to offend anybody but perhaps taking the path that many people don’t take, I decided to write a letter.

Dear Dale – what a pleasure it is to be here today at this wonderful celebration in your honor. You know how grateful I am to you but the rest of the audience may not know the role that you played. Many years ago during the volatile 1960s this wide-eyed bushytailed adventurous faculty member got turned on by computer graphics. But
no one wanted to be involved. No department was receptive. Architecture thought it was too technical. Engineering thought it would be useless to draw pretty pictures with the machine. Computer science, just getting started, and was not interested and you encouraged me to persevere, to write a proposal to the NSF and if funded you and Provost Don Cooke committed to establish a center, the Program of Computer Graphics. You even provided matching funds in very difficult economic times.

Little did I know how that decision would change my life, but more importantly how that decision has provided opportunities for thousands of Cornellians and hundreds of graduate students, ones who have taught computer graphics at MIT, Carnegie Mellon, Princeton, Harvard, Stanford, Washington, and Cal Tech just to name a few – ones who have won Hollywood Oscars and ones who have become Microsoft millionaires. Graphics is now commonplace – the only user-interface on most computer systems. Fortunately today the teaching of the subject is now institutionalized at Cornell and I might add in a variety of forms in many departments. Your foresight was impeccable and I am forever thankful. But I'm now concerned about our future in the information age, about the abilities of research universities to play a leadership role, about the structure and flexibility of our institutions. The time it takes to respond and the real difficulties with interdisciplinary education.

(slide 1) To put things in “perspective”, no pun intended from the graphics professor, let’s first examine the rate of progress in the computer industry. May I have the first slide of the day? This is the only equation you got during the day and this is one which describes Moore’s law. Moore’s law originally stated that chip density, the number of transistors per unit area on a chip, would double each year. This was later modified to a doubling every 18 months. Basically if you work through the numbers, in 15 years, we get 1000 times the processing power.

(slide 2) And with increasing chip density comes increasing processor speed, compounding the increase in processing power. At this rate, by 2010, our microprocessor, roughly the complexity of today’s Pentium III, (slide 3) will cost four dollars to manufacture and a gigabyte of memory will be $10. Amazing isn’t it? And there are doubters. People who have been skeptical of this continued rate of change for more than two decades, but Moore’s law has held true. The National Semiconductor Research Association, the group which sets the technology roadmap, just for the $150 billion chip industry to be competitive, just two weeks ago stated that this growth will continue for at least 15 more years. Yes, there will be some technical hurdles, perhaps as soon as five years from now, but there are many alternative paths even though at this stage the technology is pressing the molecular and atomic limits. At this growth rate memory chips of (the year) 2014 will have 64 billion transistors and microprocessors will run at 3.6 GHz. Understanding Moore’s law, it’s hard to understand all of these numbers but let me try with two illustrations.

(slide 4) This one is just the plot showing the growth in transistor density, or processing power if you wish, in the next 18 months and what’s significant is that red area is equal in size to the blue area, which means that in the next 18 months we will have as much computer power generated and produced as existed in the entire previous history of the computing industry.

(slide 5) Perhaps this is even more relevant to the honoree who was so interested in photography – this is one of Edgerton’s slides and I use this in my introductory course in Disruptive Technology in the business school, basically one that says on a standard desktop 500 MHz Pentium III, how many instructions can be computed in the time it takes this bullet to go through the Apple. Today, it’s 50,000 and tomorrow, in 2014, it is going to be 50 million instructions in that amount of time. What will we do with all of this power when already most of us only use a very small fraction of the power available on our desktop. E-mail, word processing, Excel spreadsheets, and surfing the web don’t come close. The cost of processing, memory and storage will be insignificant and it will be cheaper to replace the components that the fix them. The major challenge for Intel and AMD and others is not in the manufacturing of better and faster chips, although they have to continue this trend, but in creating new markets which demand this processing glut.

(slide 6) It’s not the numbers which are important! The famous Dutch computer sciences Dykstra once said, “A baby crawls at 1 mph, a person runs at 10 miles an hour. The car drives 100 mph, the plane flies 1000 mph. Each of these rates represents an order of magnitude, (10X), increase from one to the next, but it’s not so much that they increase by a power of 10, but the change in the world which is visible because of the change. Bandwidth is increasing at an even faster rates, now doubling every eight months. Witness the amount of fiber being laid around the globe and the subsequent reduction in long-distance phone charges. On an abstract level communication will exist from any place to anyplace, and it will be video and text in addition to voice. In the words of the New Zealand actress Anna Pacquin in her telecom advertisement, “There is no more there. There is only here.” The Internet already provides an infinite encyclopedia, a global library at your fingertips and in a commercial sense it is an disintermediation, reducing the friction between the buyer and seller, the consumer and the manufacturer. In this mostly unregulated environment and I have to emphasize the word “unregulated” since it rarely occurs without government intervention, without bureaucracy, without ownership of turf, the problems will not be technical. Of course we will always want more bandwidth but we will always have access to information although it may be difficult to separate the wheat from the chaff. The Dewey decimal system will have been supplanted by the search engines Ask Jeeves, Lycos, Excite, Yahoo, and others. Our new problems are not ones of technology, they are ones of privacy, protection of intellectual property, authenticity and veracity of information. A photograph may no longer be valid evidence in a courtroom.

(slide 7) Let us look at this nonexistent theater, modeled and rendered by a Cornell undergraduate architecture student, (it) never existed, and was done by somebody who didn’t know how to use the machine. If we look a little bit closer we can note Pavarotti’s replacement. (slide 8) Rehearsing on stage in his younger years although there are members of your family who, despite all of your versatility, Dale, claim that this is an impossibility.
Moore’s Law

“Chip density doubles every 18 months.”

Processing Power (P) in 15 years:

\[ P = P_{\text{today}} \left(2\right)^{\frac{15 \text{ years}}{18 \text{ months}}} = P_t \left(2\right)^{1.5} \]

\[ = P_t \left(2\right)^{10} = 1000 P_t \]

Increased processor speed 1995-2012

Understanding Moore’s Law

How many instructions are completed in a 2 Ghz PC in the time it takes for the bullet to pierce the apple?

Apple diameter = 3.36”
Bullet velocity = 2800ft/sec

* National Semiconductor Association

* Photograph by Harold Edgerton
On a more serious note, how should this electronic environment change the modus operandi of the research universities of the 21st-century. I don’t pretend to have any answers, but I wish to make some observations and compare University behavior to industry behavior and let us look at several examples and note the differences.

The first example which I take, which was written up in Microprocessor Report a couple of months ago, relates to strategy. How industry decides what to produce. In the early stages of a design process with linear growth rates, it’s relatively easy to predict the demand, the cost, and even the required performance. The automotive industry can determine the required miles per gallon five years out. Utilities can estimate power demands five years out, and school systems can anticipate student enrollments well in advance. But how will leading-edge microprocessor digital or electronic products plan? Executives, designers, engineers meet to determine performance, estimate costs and they design and schedule the testing, the implementation and production.

In the computer industry today the design cycles through production last between 24 and 36 months. Inputs to the decision are the current competitive state of the industry, estimated consumer performance demands, associated with relevant other components – monitor resolution, bandwidth, etc. and Moore’s law. We have to be above Moore’s law. In theory, engineers work 36 months as shown on this timescale to build a microprocessor that lies above Moore’s Law’s curve. Note in theory there is no difference between theory and practice. In practice there is! Competition might do better. Project completion time might slip so they set the goal way above the curve and everybody’s enthusiastic and optimistic. Can the engineers meet the performance specifications? Generally not. When considering the implementation details, the compromise decision, a cost component, and perhaps missing technologies, we get the inevitable emergence of the “gap”.

The “gap” is not a clothing store, it is the difference between the PowerPoint performance, what executives tell each other, and their customers, and the actual performance. When the “gap” is too large there is turmoil in the project. Schedules slip, performance goals are renegotiated and we have to stretch out the development time, performance expectations are lowered, the schedule is lengthened and this may happen two or three times.

But once it appears that the target will be the below Moore’s law, morale problems occur. Finger-pointing, competitive and proud engineers leave, etc. What are the business management issues and problems associated with this? First the executives are the last to know. They are tracking the PowerPoint performance. Can you kill the project? It’s probably too late. Why? There’s been a marketing blitz - reputations, possible revenue loss. There is need for their development platforms for future designs so they can’t stop it.

Problem number two: in today’s industry because of the rapidly increasing rates the product development time is greater than the product’s shelf-life time. The latter is a function of competitive performance, market demand, or need to operate at the high end of the performance level because that is the high margin end of the market. When throughput time is less than the shelf life time there is a need to pipeline – that is, run several production cycles in parallel.

It’s not unusual in the computer industry to have three or four designs going simultaneously and note, here we go - the cycle starts again. The key to success is correctly setting the goals for performance objectives, the perfect execution and perhaps most important, crisp and fast decision-making.

Here is where I have some concerns. Universities are and should be democratic institutions. Many recommendations are made by committees and decisions are made in the spirit of compromise. However, what I personally most admire about Silicon Valley is that the culture is not risk adverse. Failure is not a stigma. Decisions by compromise inherently lower project goals.

In academia, we may end up with our project but we end up with changing our project goal because of compromise. Perhaps even worse is the duration of the decision-making with committee reports, department, college, university and trustee approval, the decision-making time may even exceed the implementation time, no less than the shelf life time.

In an exponentially changing world, this is a disaster and we will always be followers. Is this our educational destiny? Or perhaps can we provide more authority to a president or a provost without having the backlash of the faculty? David Packard, of Hewlett Packard, had an adage, “ready, fire, aim”. Maybe, just maybe, the major impact of Moore’s Law is not the computer power but the compression of time. Regulatory structures – rule of law is the foundation of our country and our prosperity but in the computer industry we have found that over specification of rules and standards just doesn’t work. The Internet is the best example of this mostly unregulated environment.

In the beginning there are only two were rules. Anyone could say anything. And nothing was official. Basically no rules and
except for establishing open standards, that same philosophy holds true today. As soon as rules were made to try to overly specify or overly constrain the system, difficulties arose. Of course we should not allow pornography on the web, or provide a safe harbor for terrorists or drug cartels. Content will never be completely separate from the service. Dismemberment of AT&T into the regional Bell operating systems also separated service from content. I am not advocating monopolistic power. Both AT&T and Microsoft were guilty of monopolistic practices. But today we are attempting to rebuild the dismantled telephone system, to merge the long distance carriers with the local exchange suppliers and AOL is extremely successful in providing both service and content. Look at the Glass-Steagall Act - finally revoked. Now Citigroup can offer one-stop shopping and one company can provide insurance, banking and stock brokerage. The trend is toward aggregation, not disaggregation toward systems and integration. In contrast, universities have been moving in the other direction. In the 1970s and the 1980s the trend was to put individual colleges on their own bottom. Since college faculty are vying for their own share of the university budget, out of college electives have been diminished. Look at the recent decisions of our own arts and sciences college faculty, restricting the allowable number of out of college electives. In the past, computer graphics was not even co-listed as a college engineering course. Until it was recognized, because of the change in the budget structure, that the architecture college was receiving financial returns for thousands of credit hours taken by computer science and electrical engineering students. Curricula are primarily set by individual departments with rubberstamp approval by college and university faculty. To paraphrase President Kennedy, “it is not time for us to ask what the university can do for us, but what we can do for the university.” Should we not be relaxing our requirements, encouraging cross-pollination and providing more freedom to students to set their own curriculum. Forget about who gets the credit for the credit hours. Just as the computer industry is moving from components to systems, so should we allow the integration of different disciplines.

Next point is the influence and importance of the consumer. I have already documented the well known trajectories of the computer industry. Suffice it to repeat that with the exponential decrease cost there is a commoditization of the computer software, hardware industry. With the ubiquity of computing, and the emergence of the appliance age, computers will be more noticeable by their absence than by their presence. Just look at the technology adoption cycle as described by Geoffrey Moore in his book, “Crossing the Chasm”.

*slide 9* We are now in the “early majority stage”. The importance of this diagram is not the growth rates which obviously increases with the start, levels out and then diminishes with time. Nor is it the increasing numbers of users as we proceed from the innovator and laboratory curiosity stage to the “late majority stage”. The important fact is that it is no longer computer scientists and electrical engineers who are the majority using the system, but the common folk - from grade school to retirement, across all income brackets and all occupations. As the commoditization continues, the major contribution, I hope, is made by the user - the creativity of the web designer, the imagination of the animator, the concepts of the architect, the ingenuity of the engineer, the diagnostic skills of the doctor and the intellect of the author. The technology is there, is necessary, but no longer dominant and perhaps not even visible.

But the technology is changing - and changing at very rapid rates. As previously stated, the changes will open up new vistas, new ideas and new opportunities. It is incumbent upon a first rate research university to teach, at least in the science and technology areas but probably all areas of the university, not what is, but what will be - to educate our students, not for today, which is what community colleges can do, but for the future. As hockey star Wayne Gretzky stated, "his achievements occurred not because of his skating skill but because of his innate ability to skate toward where the puck will be." In this scenario, it is necessary to know the future, one which is based on technological change, but also one which serves a constituency that is not a homogeneous body and certainly not one predominantly composed of the proverbial geeks and nerds. Who should teach our future students? It is my belief that it must be faculty who are skilled in computer technology, ones pushing the state-of-the-art, ones who are creating the future but also ones who are motivated by the needs of the consumer and interact with the diverse disciplines of the University. In this sense computer science must address a much broader computer community than the past. I applaud the president and the provost for establishing the new faculty of computer and information sciences at this great university. This will be a necessary ingredient for maintaining our leadership position in the information age which leads me to my last analogy.

Virtual universities and real boundaries: and here I have three major points. The first is the definition of the Cornell experience and its duration. In the world of e-commerce, successful entities have repeat customers. Service providers do almost anything to keep their subscribers. Their major goal is to reduce the churn rate, the number of users who leave as the cost of replacement is exceedingly high. In fact most of these Dotcom companies spend an excessive amount of money on advertising to attract or maintain
Technology Adoption Life Cycle

Panoramic projection system
customers. The more customers, the more eyeballs. The more eyeballs, the greater the advertising revenues and the greater the advertising revenues the higher the stock price. It is insanity! It is said that the ultimate successful e-company is one which sells one-dollar bills for $.85 and makes its profit from advertising. 

I'm not suggesting that this should be a goal of an Ivy League university, but we should strive to retain our customers and provide a lifetime education for all the students who spend much on tuition during four or five years here in Ithaca. In a rapidly changing world, it is difficult to stay up to date, more so now in the computer age than any other time in history. Couple this with the fact that the average longevity with a single employer is rapidly declining. In Silicon Valley the churn rate is so high, new hires average about nine months. With all these changes, why not offer a lifetime education. The Internet will allow us this capability and has the added benefit for the development officers in this room of keeping our alumni very actively involved.

Which brings me to my second point - distance learning. Perhaps now I can talk about distance learning in a different way than other people talk about it. The Internet can eliminate the physical boundaries of our classrooms. The classroom of the future can be virtual. Whether we are in the same physical location or not, we can place the lecture or lecturers as well as the entire class in the same virtual space, so that seen from any place in looks the same.

(slide 10) This doesn't really show this but this starts to give you an idea of the virtual space we already have in our laboratory in Rhodes Hall. There is great concern about losing the classroom experience, the ambience of our learning environment, but we can maintain most of this technologically today. Certainly with increasing bandwidth we will be able to do so in the future. Characteristics we must maintain are the eye to eye contact between faculty and students, the ability for everybody to witness any and all exchanges and the full and natural manner for interaction, a participatory as contrasted to passive experience. We can do most of this now and at the program of computer graphics we've been giving joint seminars with five universities participating simultaneously with two video windows plus separate channels for text slides and simulations and computer control at each site and we have been doing this since 1992. Yet we can hope for much more! Rather than duplicate the blackboard, we can now share the whiteboards with multiple users. We can bring the laboratory to the class rather than the other way around and if the laboratory doesn't exist, we can simulate the behavior. If we had a video projector here and more time I would show you some of this on video, but I don't have that luxury right now so please excuse the non-multimedia presentation.

But imagine how science teaching in the K-12 level could be improved if we brought the San Francisco Exploratorium to every inner-city grade school free of charge. We already have the concept of universal service for the telephone system in the United States. Why shouldn't we provide universal broadband service for every kindergarten, for every high school and every university in this country. There is a considerable amount of negativism about distance learning. It's too passive, like watching TV! It cost too much! How do we maintain our campus experience? It takes too long to prepare the lecture material. What is the reward system? Why not talk about how we may better provide our information delivery. What we could do with this new technology if we took advantage of what it will be, instead of worrying about cost for tuition or other difficulties. With all the awesome computer power and available bandwidth we will ultimately be able to provide an excellent conduit for the delivery of lecture material. Should we do this? I believe the answer is yes! Yes! Yes! And Yes! Unlike the strategy with respect to setting goals and exponentially changing world we need to start now. No! Yesterday! The early bird gets the worm. We need to be a leader not a follower. Maybe Ezra Cornell's adage of "I would found an institution where any person can find instruction in any study" is no longer able to be supported alone but if we have a critical mass of expertise in one area we can partner with a sister institution in another. If we wait, well we shouldn't wait! It is well known that one of Cornell's greatest strengths is its beautiful Ithaca campus and its exquisite rural surroundings. It's also well known that one of Cornell's greatest weaknesses is its beautiful Ithaca campuses and exquisite rural surroundings. As previously stated this morning "centrally isolated". Why study law or business or computer science or architecture in such a rural setting away from the action? But if we can bring the expertise of the financial community of New York City, London and Tokyo, the policy experience of Washington and the technology strategy experience of San Francisco to the Johnson school we can improve our business education. Interaction with the vitality and entrepreneurship of Silicon Valley would only be beneficial to engineering. Working collaboratively on real projects with our friends in urban areas would make our architectural education much more relevant and diverse. The Internet of tomorrow makes all this possible. Are we not moving too slowly?

And last – the problems associated with interdisciplinary studies. Maybe this subject is most dear to my heart. "Interdisciplinary" a very frequently used term which in reality is accompanied by many unseen obstacles. Yet the most exciting research areas of tomorrow are those that exist at the fringes - something also previously stated today. In no man's land, at the boundaries between discipline. Why do we have such difficulties in creating truly interdisciplinary disciplinary activities? I have personally witnessed the frustration of hundreds of Cornell undergraduates, if not thousands, who wants to take interdisciplinary paths. Maybe it's because I am a maverick but more probably because the field of computer graphics is truly interdisciplinary. Students come to me who want computer graphics in theater design. They want education in electronics art. They want computer aided architectural design. They want to learn about machine animation in the film industries. They need computer graphics and molecular modeling. Computer graphics and protein synthesis. Astrophysics and graphic simulations. Finite element analysis with graphical input and output and all are areas which are interdependent disciplines with specific knowledge and computer science knowledge.

Admittedly at Cornell we are fortunate to have some actual excellent options today. The College scholars program in the arts and sciences college, and the engineering college program in engineering and of course the graduate school all provide excellent op-
tions. These options are not well publicized to the undergraduates and are not yet mainstream. The Internet has been a commercial success because it dis-intermediates. It reduces the friction between buyers and sellers and in so doing eliminates the middleman. Because of its open standards anyone or any company can participate. In the future, as more intelligence is added to the network, solutions will simultaneously be broader and deeper. In a sense the remarkable part of the Internet is that it has broken down the barriers surrounding the individual activities. How can universities of the next millennium learn from this? The Internet forces collaboration yet joint appointments are exceedingly difficult to achieve, particularly before tenure promotion. The Internet provides for flexible options, but students are constrained by excessive requirements. The reward system is biased by the inherent loyalties to individual units as contrasted to the University. Jack Welch of GE rewards his executives, not just for their division performance, but for what they do for other divisions. What would happen in the University of tomorrow if there were no departments or no colleges and all faculty were part of one University, grouped only by like intellectual pursuits. Now that would be truly interdisciplinary! Maybe this is what Ezra Cornell really meant when he said, “any person could find any instruction in any study”.

Dale, I have high hopes that Cornell can address these challenges of the electronic age and maintain its leadership position among the great research universities of the next century and I repeat, I am forever grateful that because of your support for interdisciplinary activities, I have had this wonderful experience. I feel like I am the surfer who has caught the once in a lifetime wave, except mine has never stopped. Congratulations and thank you again.
Thoughts On The American University
At The Dawn Of The Third Millennium

by Frank H. T. Rhodes
President Emeritus
Cornell University

I am happy to have this opportunity to pay tribute to Dale Corson for the extraordinary leadership he has provided for Cornell, and to all sectors of higher education, over so many years. The health of higher education today rests squarely on the efforts of those who have loved learning, advanced its borders, and defended it well. And in each of those activities Dale Corson has made a notable contribution as teacher, as scholar, and as advocate for all that is best in the life of learning. Father Theodore Hesburgh, president emeritus of Notre Dame, once remarked that the greatest service a president can provide to his university is the example of his own life. Cornell stands permanently indebted to Dale Corson for the outstanding example of his own life. Dale, I salute you, congratulate you, and thank you.

The end of the century, and even more the end of the millennium, is a time when we are showered with lists: the ten most wealthy people, the ten most influential individuals, the ten best songs, the ten most decisive battles, the ten most significant inventions, the ten most popular movies, the ten best books, or even the ten worst books. All of us, I suppose, could suggest candidates for each of these. But I want to suggest a strong candidate for the list of the ten most significant inventions of the millennium. I believe, by any reasonable standard, the university should be at, or near, the top of any such list.

Why is the university the most significant creation of the second millennium? After all, other social institutions have been more inclusive in their membership: the nation state and the city, for example. Other communities have been more homogeneous and exercised more direct influence upon their members: the Communist party, for example. Other inventions have produced more immediate impact: the internal combustion engine and antibiotics, for example. And still other means of learning and communication have reached a larger audience more directly and less expensively: printing, broadcasting, and the Internet, for example.

But the university, while it is an institution, a community, a cradle of invention, a means of learning, and a source of communication, combines and compounds the influence of each of these in uniquely powerful fashion. From modest beginnings, over nine hundred years ago, it has become the quiet but decisive catalyst in modern society, promoting neither political action nor government policy, but providing the knowledge and data on which both are developed; manufacturing no products, but creating the science and technology on which those products depend; producing no newspapers, magazines, or TV programs, but training their publishers, writers, and producers; informing public understanding, cultivating public taste and contributing to the nation's well being as it nurtures and trains each new generation of architects, artists, business leaders, engineers, farmers, lawyers, physicians, poets, scientists, social workers, and teachers – as well as a steady succession of advocates, dreamers, doers, dropouts, parents, politicians, preachers, prophets, social reformers, visionaries, and volunteers – who leaven, nudge, and shape the course of public life. No longer an ivory tower, the university, while it strives to retain its independence and impartiality, runs demonstrations of agricultural projects in the desert, grapples with the social problems of the inner city, develops alternative energy sources, provides the most
sophisticated health care, monitors natural hazards, shelters and informs the debate on every vexing issue of public life, provides most of the basic scientific and biomedical research on which our future well-being depends and, in the United States, educates half the rising population directly and all the rest of us indirectly. Cherishing the independence and autonomy society has granted, the university has, for nine long centuries, been a place of "full and fair enquiry, bringing wisdom to bear in human affairs," as John Masefield once described it.

The university as we know it is the product of the second millennium. It is one of the few institutions that spans almost the whole of the millennium itself. The University of Bologna was founded in the 11th century; others followed soon afterwards. Although many universities are of much more recent origin, the university, as an institution, is a creation of the early years of the second millennium. The university is one of the most distinctive institutions of the second millennium, with a nature, membership, responsibility, and autonomy that make it unique.

It is also, as Clark Kerr has reminded us, one of the most durable institutions of the millennium: "About eight-five institutions in the Western World established by 1520 still exist in recognizable forms, with similar functions and with unbroken histories, including the Catholic church, the Parliaments of the Isle of Man, of Iceland, and of Great Britain, several Swiss cantons, and seventy universities. Kings that rule, feudal lords with vassals, and guilds with monopolies are all gone. These seventy universities, however, are still in the same locations with some of the same buildings, with professors and students doing much the same things, and with governance carried on in much the same way."

Growing secularization of the universities in the 19th century saw not only changes in financing and governance, but also change in mission. The curriculum was expanded and professionalized. In the United States, the Morrill Act of 1862 gave great impetus to this movement, while research and public service were increasingly seen as the responsibilities of the university.

Until the 19th century, the universities had little impact upon the professions, modest impact upon their surrounding societies, and made little contribution to the general corpus of knowledge and invention. But in a mere century, all that has been transformed.

- Universities have become the essential gateway to and foundation of every major profession. They have expanded and improved training in what were once non-professional occupations, from interior design, library science, and business, to nutrition, agriculture, and journalism.

- Universities have become the primary agents for basic research in this country and they are having a growing impact upon applied research, in everything from medicine and bioengineering, to computer science and communications.

- Universities have had a huge impact upon their regions, from Route 128 in Massachusetts, to the Research Triangle of North Carolina, to Silicon Valley. Employment, economic development, and almost every area of public life have been influenced by this growing impact.

- Universities have become major agents of social mobility, growing in their own inclusiveness, and providing the means for economic advancement for many previously denied access to traditional careers and opportunities.

1 The medical school at Salerno, founded in the 9th century, remained a medical school, rather than developing into a university. The University of Paris was founded between 1150 and 1170, and Oxford by the end of the 12th century.

• Universities have become significant providers of social services, beginning with model schools, but now embracing such things as tertiary care hospitals, health networks, legal services, technology parks, engineering research centers, and athletic and other entertainment.

In this major accretion of tasks and this huge expansion of role, the university of 2000 bears only the most general resemblance to the university of 1900. The contemporary university has grown not only in size and number, but also in inclusiveness of knowledge, in variety, in complexity, in quality, in the inclusiveness of its membership, and in its intellectual, professional, and social role. Paradoxically, in spite of these major changes in responsibility, membership, and complexity, the university has shown almost no change in its organization, management, and governance and only modest change in its teaching style. Indeed, the responses it has made to changing social needs have been only in part planned and only in part idealistic. In part, they have also been opportunistic, sometimes reluctant and sometimes absentminded.

Some of the changes I have described above – the function of preparation for professional careers, activity in basic research, role in social mobility – are true of the universities in many parts of the world. In other respects, however, the American research university is a distinctive institution, whose 19th century history is one of gradual divergence from its European sister institutions.

The rise of the American research university reflects a pattern not seen elsewhere on anything approaching the same scale. In Europe, for example, at the close of the nineteenth century, a handful of universities – Berlin, Cambridge, L’Ecole Polytechnique, Göttingen, Heidelberg, Oxford, and the Sorbonne among them – represented the standard towards which all other universities aspired. A listing of the world’s top ten universities – had there been one in those days – would have included, at most, only one or two American institutions. A century later, such a list might have included two-thirds or more universities from the United States.

What were the distinctive factors that produced this transformation? Perhaps there were seven or eight particular characteristics.

• First, institutional mission has played a significant role. Whether developed out of older colonial colleges – Columbia, Harvard, Princeton, Yale – or created by nineteenth century benefactors – Chicago, Cornell, Duke, Hopkins, Stanford, Vanderbilt – or established by states in response to public needs – California, Illinois, Michigan, North Carolina, Virginia, Wisconsin – all American research universities embraced a mission of research, undergraduate, graduate, and professional education, and many, especially the state universities, consciously adopted a wider role of public outreach and extension. This mixture of functions produces tensions – research versus teaching being a frequent complaint – but it also produces benefits of cross-fertilization and professional cooperation. The performing arts exist alongside law and medicine. Philosophy and public health share a common home with economics and environmental engineering. All disciplines and all students are swept up in the atmosphere of inquiry and discovery that pervades the campus. All this has been developed around the core of a college of arts and sciences, a legacy of both the colonial college and the need to educate large numbers of undergraduates, coming from a variety of pre-college backgrounds. This widespread membership of the undergraduate student body, representing a rapidly growing proportion of the traditional college-age group, distinguished the American university from its more selective and elite European counterpart until the last few decades.

• Second, the sponsorship of American research universities is distinctive. There is no one sponsor, no overseeing ministry, no national plan or government regulation. Decentralized, feistily independent, uncoordinated, pluralistic, American universities have been opportunistic, adaptive, creative, and responsive to new opportunities. The pattern of state control and centralized funding, so typical of most European universities, is here replaced by fifty states, each with distinctive goals and needs, and scores of independent institutions, each with its own goals and traditions. While internally American universities – whether public or private – tended to assume a broadly similar functional organization, their independence from central government planning and control gave them a vigor that proved more elusive in the regulated European institutions, where faculty members are often civil servants and where central government control extends not only to management of institutional enrollment and programs, but also to regulation, budgeting, and evaluation of individual academic departments. It is ironic that, whereas the older universities in Europe – including the great civic universities of the nineteenth and earlier twentieth century – were privately founded by religious orders, individuals, cities, and other communities, they were later effectively nationalized into a national system of higher education, rigidly planned, budgeted, and controlled by a central ministry. Even in those countries, such as Germany and Switzerland, where local states — lands — supported universities, they did so within the context of a well-defined national plan.

In contrast, the great state universities of the United States have tended to become more diversified over time, with each state supporting a distinctive range and style of institutions, many of which have gained a substantial degree of autonomy. Unlike the planned “command” educational systems of Europe and elsewhere, the unplanned, opportunistic, pluralistic “system” of the United States has proved adaptable, flexible, and remarkably successful.

• Third, the governance of American universities has been distinctive. The typical board of the colonial college, made up of independent “gentry,” developed into the lay board of trustees of the private university, whose independence became a model for the generally less independent, politically appointed, or elected board of regents of the public universities. The latter boards, though of variable quality, have tended to have far more authority and autonomy than the typical boards of universities in other lands. Because the boards of American institutions had a major role in justifying, obtaining, and providing funding for their individual universities – as opposed to dispensing what was provided from a remote central government ministry – their identification with the aspirations and success of their universities was immediate and strong. This has led to a degree of inter-institutional competition
unknown elsewhere—a competition which, though it has its liabilities, has been a force for good. In this, the great private universities— the Ivy League, Stanford, Chicago, Cal Tech, MIT, and others— have been pacesetters not only for the independents, but also for most of the public. It is not that private universities were unknown in other nations, but rather that their limited number and particular role (often specialized professional—as in France, the U.K., Germany, and Sweden, for example—or serving particular religious, or ethnic communities, or devoted to expanded undergraduate education—as in Japan, Brazil and Venezuela, for example) have made them much less influential.

• Fourth, the leadership of American higher education has had a strong influence on its development. Though many would argue that there has been a decline in the influence of presidential leadership since the giants of the late nineteenth and earlier twentieth centuries, still the power of the American university president, however exercised, has typically been substantially greater than that of his or her counterpart rector, vice chancellor, principal, or president elsewhere. Imaginatively exercised, supported by a strong faculty and a committed board, presidents have shaped and nurtured their institutions to a remarkable degree. Andrew Dickson White at Cornell, Charles Eliot at Harvard, Daniel Coit Gillman at Johns Hopkins, David Starr Jordan at Stanford, and many others, seized the responsibility entrusted to them and led their universities to greatness.

• Fifth, the American university remains an organizational enigma, whose loosely coupled structure and collegially-based organization defy the established canons of management. But the very flexibility of the internal organization of the American university has nurtured its entrepreneurial spirit. The basic unit of organization—the department—is not, as in some other countries, the domain of a single professor, presiding over it, sometimes with a heavy hand, for an indefinite and often prolonged period, but an alliance of more or less equal colleagues, democratic in spirit, if not always in fact. The elected chair, the first among equals, serves for a specified term—often three or five years—renewable by agreement. This system, while it has imperfections—lack of continuity and lack of strong leadership—has major benefits in its lack of rigidity and in the entrepreneurial opportunities it provides for all its members.

So, too, does the academic career ladder, where a full professorship can be the career aspiration of most faculty members of a department. The incentive to continued striving provided by this structure contrasts sharply with the more restricted career opportunities of the traditional academic hierarchy in other countries.

While the department chair in the American university has been relatively weaker than his or her opposite number in other countries, the office of dean has typically been relatively stronger, representing a substantial level of administrative and financial independence and academic responsibility. This, too, has fostered a sense of entrepreneurial initiative and scholarly creativity. Behind much of the success of the American university lies the steady leadership and vision of generations of deans who have nudge the aspirations and nurtured the creativity of their colleagues.

• Sixth, the size of most American research universities has been a positive factor in allowing a critical mass of faculty in those areas, especially the sciences and science-based professions, where scale and teamwork are critical to success in research. While less important in the arts or humanities, the larger size of the science-based faculty allows a degree of specialization and cooperation which have major benefits in research. This does not mean, of course, that a physics department of 60 faculty members is necessarily superior to one of 30, but there are few eminent small departments.

• Seventh, the pattern of federal support for research has been critical to the success of the American research university. A variety of federal agencies—the National Institutes of Health, the National Science Foundation, the Department of Defense, the Department of Agriculture, the Department of Commerce, among them—have offered financial support at growing levels, aimed at varying national needs, from national defense to health care, from environmental conservation and agricultural productivity to regional economic development. Almost all this support has been based on proposals designed by the professor-investigator, rather than being contract work designed by the sponsoring agency, and it has been awarded on the basis of the merit of the proposals submitted, with awards screened and largely determined by independent panels of expert peers. This pattern, first established by Vannevar Bush more than half a century ago, has returned an incalculable dividend on the nation’s investment in research.

In other nations, much of this type of research would have been performed in national institutes or academies having little linkage to universities.

• Eighth, none of this would have been possible without an unabashed competitive spirit and entrepreneurial attitude within the university. The great private universities with their long traditions of strong alumni financial support, the openness to industrial and state partnerships pioneered by the leading land-grant universities, and the existence of charitable foundations willing to share in the research enterprise in everything from multimillion-dollar telescope systems to inner-city poverty and drug abuse, have represented an extraordinary degree of support and opportunity for the American university.

These factors, taken collectively, have shaped the history of the American university over the last century. It would be rash, of course, to suppose that any one factor has been decisive—quite different patterns of organization and oversight, for example, have been used by the various states in their support of the great flagship public universities—but collectively, these features have defined the characteristics of the most successful universities. Unplanned, opportunistic, well-governed, well-led, as conservative in some respects as it has been entrepreneurial in others, the research university is one of the great success stories of America’s 20th century history.
So how does the American research university stand at the gateway to the 21st century? Is the model that we have developed adequate for the challenges of the years ahead? Of course, we cannot know, any more than an audience gathered to discuss the same topic in 1899 could have foreseen the staggering changes that were to lie ahead during the years of the 20th century. In 1900, for example, only 4% of the college-age population were enrolled in college. At the close of the 20th century, the figure is about 43%. In 1900, relatively few women, and almost no members of underrepresented minority, ethnic, and low-income groups, attended college. Today the campus has been transformed by the participation of all these groups, and society is the richer for it. In 1900, the universities were storehouses of knowledge, but by and large, they made only a modest contribution to the growth in knowledge itself. All that has changed, as America's universities are the dynamo that drives the knowledge explosion. Nowhere is that more clearly seen than in the remarkable growth of science and technology with all the benefits that provides, from medicine to communications.

In 1900, America's universities were only loosely associated with preparation for the professions. Medicine existed largely outside the universities, and law was a recent arrival on most campuses. Now the universities are the unique pathway, not only to the older professions, but also to a host of new professions developed from knowledge the universities have created. In 1900, the economic impact of the universities was very localized, arising chiefly from the demand for accommodation and services by the academic population. Since then, universities have become economic catalysts, not only to their immediate communities, but in a wider region. A Bank of Boston report, for example, noted that MIT faculty and graduates have created no fewer than 4,000 high-tech companies that provide 1.1 million jobs. These companies have annual global sales of over $232 billion. If they and their profits were regarded as a national economy, they would rank 23rd in the world.

All those changes, each remarkable in its impact, have taken place in the space of a century within institutions that must have looked, at the turn of the 19th century, as stable and secure in their ways as do our universities today. In fact, the optimism of American higher education is well illustrated by the 1997 annual report from the American Council on Education, whose president, Dr. Stanley Ikenberry, introduced the report with the comment, “American higher education is at the top of its game.”

The shorter-term changes to which universities must respond are already clear, though their particular impact is far from clear.

The first change involves knowledge itself, the commodity around which every university exists. Knowledge is the new economic currency, the new national capital. Every nation's well-being has depended in the past on its natural resources—its mineral deposits, topography, climate, population, communications, and so forth. These will still be important, but the most important element will be knowledge.

Now, knowledge is not like other natural resources. It is undepleted by its use. It multiplies, even as it is shared and applied. Even as it is challenged and tested and questioned, it is refined and increased. But knowledge is not a resource we simply stumble upon. It is not something we pluck out of the air. Knowledge is created. It is coaxed into existence by thoughtful, creative people. It is not a free good. It comes only to the prepared mind. And that is why colleges and universities are crucial in the new economically competitive world.

So far, so good. But four more trends impinge upon that. And the first is information technology. How do we measure the effect of information technology? It is a major new opportunity for our institutions because it provides completely new access and new approaches in the dissemination and application of knowledge. Yet it is also a major new threat because having created it, we have been slow to employ and modify it.

Information technology will transform the traditional pattern of learning because the old pattern pursued knowledge and a degree as the goal. The new pattern seeks competencies and skills as things to be transmitted. The old pattern was site-based—one campus, one place. The new pattern is unconstrained—Any person, any study, any time, any place. The old pattern was a standardized curriculum, with limited choice. The new pattern is an individualized program with unlimited choice.

The old pattern involved a fixed calendar. The new pattern is infinitely flexible. The old pattern was faculty-centered, faculty-presented. The new pattern is student-centered, student-discovered. The old pattern was cost-intensive. The new pattern is cost-effective. The old pattern involved purchasing the whole package, a four-year degree. The new pattern involves cherry picking, on time, as needed, as required, disarticulated.

The effect of all this? We still don't know. But we need to take the initiative, rather than drift, by indecision, into a future not of our own making.

There is another trend that may be even more disturbing for some institutions: Our monopoly of higher education is about to end. We are about to become a deregulated industry, with all the turmoil that has produced for other industries. As long as learning depended on a fixed base and fixed resources, and as long as it depended on libraries, labs, lecture rooms, and professors who were the resident authorities, we had a monopoly. We are self-accrediting, and we have done a good job, on the whole. But we also are self-credentialling in terms of those we graduate. This is about to change.

The University of Phoenix is also accredited to award degrees. It is one of five for-profit institutions quoted on the NASDAQ. Last year, it enrolled 60,000 students, and its profits—its profits—were $33 million in 1997. Its price-to-earnings ratio is 50, which makes it a glamour stock. And there are others.

The group of for-profit universities is dwarfed, however, by distance education. Eleven different nations have distance-learning universities with more than 100,000 students. In Turkey, for example, Anadolu University has 530,000 students, and the cost of instruction for those students is one-tenth of the cost of instruction at conventional universities. And lest we immediately aver that the quality of those programs is inferior, a recent student ranked Britain’s Open University—which has 157,000 students and operates at 50 percent of the cost of traditional campuses—tenth out of 77 traditional universities in the quality of its programs.

And in all this, our own colleges and universities are rushing to join Cyber League, rather than Ivy League, schools. From 1993 to 1997, the number of cyber schools grew from 93 to 762. And students enrolled now total around a million, compared with 15 million in traditional higher education.

On these trends will be imposed another, which is a continuing change in the demography of both the national population and the population enrolled in higher education. The number of students is expected to grow from about 15 million today to at least 16.1 million in 2005. The largest growth is expected to be in the Southeast and in the western states, and there will also be relatively strong growth among older students. An increasing number of entering students will probably require some degree of remedial assistance in order to succeed. And the relative number of students involved as full-time, residential, traditional-aged students will probably decline as off-campus learning and part-time enrollment become more popular.

The final change is one that concerns funding of higher education and is closely related to the question of the end of the monopoly long enjoyed by universities. As public funding for higher education continues to decline as a share of overall public expenditures, creative new partnerships will be required to finance the costs of higher education. Partnerships, strategic alliances, takeovers and mergers are likely to disturb the tranquil world of higher education.

Viewing these challenges, several thoughtful observers of higher education conclude that there are speedbumps in the road ahead, arguing that the success story of the late 1990s is about to come to a sharp and unhappy conclusion.

- Peter Drucker, a respected observer and dean of management leaders, has observed: “Thirty years from now the big university campuses will be relics. Universities won’t survive. It’s as large a change as when we got the first printed book.”

- And the voices from within, closer to the business of higher education, contain equally bleak predictions. Eli Noam, professor of economics and finance at Columbia University, in a recent paper in Science entitled “Electronics and the Dim Future of the University,” argues that the new wave of electronic development will do to the universities what the development of printing did to medieval cathedrals; it will remove from them the monopoly they had on the dissemination of information. And he asks, “Have we reached the end of the line for a model that goes back to Nineveh, more than 2,500 years ago?”

- Or listen to the late Bill Readings, associate professor of comparative literature at the University of Montreal, in a book published two years ago by Harvard University Press: “We have to recognize that the university is a ruined institution, while thinking what it means to dwell in those ruins without romantic nostalgia.”

So at the close of the millennium, we find two contrasting view of the future of the research university. One view, held by knowledgeable observers, argues that the university has never been stronger, that it is “at the top of its game,” and that its prospects are bright. The other view, held by equally informed observers, is that wrenching changes are about to take place. Which of these two views represents reality? Only time will tell, but I believe that the success of the university in the coming years will depend to a large extent on how it deals with six pressing issues that now confront it. Curiously enough, these issues involve some of the very factors that have made the university so remarkably effective in the 20th century. The paradox of this situation is that qualities that had been a source of institutional strength may, under the changed conditions of the 21st century, become a liability unless we take thoughtful steps to address them. Let me illustrate what I mean by addressing what I see as six of the most pressing issues.

1. **Mission, role, and function of the university**. I have argued above that the mission that universities inherited at the dawn of the 20th century has played a significant role in their success. But the pattern of the 20th-century development of many universities, both old and new, has been a trend towards increasing uniformity. I have elsewhere referred to this as the Harvardization of the campus, by which I mean that universities, beginning from strikingly different origins and originally serving very different purposes, have uncritically accepted the notion that the pathway to success lay in emulating the leading universities of the nation, partly in the comprehensive range of programs offered and partly in the insistence that the award of the doctoral degree in every field was essential to be worthy of the designation of university. In contrast to this, I believe that success in the 21st century will go to those institutions that define their particular mission in more distinctive and direct ways than has been the case in the past. Many in higher education are cynical of mission and value statements, perhaps justifiably, for many read as bland and self-serving. But that

skepticism may also reflect an uneasiness in attempting to pin down the precise purpose and function of an individual institution, as opposed to the more generic role of the university. Yet with every industrialized country now seeking to expand its educational programs, it becomes less and less credible for individual institutions simply to offer generic identities. In the future, the institutions that prosper will be those which have embraced a more specific role and a more restricted niche.

To talk in specific terms about role and function of a university is to make a statement of priorities. Just as no institution can possibly teach all languages and all literatures, so no institution, even the most wealthy, can now offer programs of the highest quality in every major area of learning. It is this very selectivity and differentiation, however, against which many academics rebel. Perhaps the most urgent and the most difficult task of both board members and rector/presidents is to identify, in appropriately refined terms, the mission, role, and functions of their institutions. This will involve a responsible blend of vision and hard-headed realism, as well as patient negotiation and difficult choices, but only by making choices in this way can universities continue as strong and vigorous institutions, capable of seizing new opportunities, developing promising areas, and effectively serving their communities.

2. The residential campus. The typical pattern of the 20th-century development of colleges and universities has been the growth—explosive in the last three decades—of the fixed-base campus. It is already clear, however, that trends now in place will make learning beyond the bounds of the campus (off-campus learning) a far more important feature of all aspects of education than it has been in the past. The walls of the campus are becoming increasingly porous, and much of the instruction provided on the campus will take place at a distance. This raises in direct form the question of the future role of the residential campus in the overall pattern of higher education.

No discussion of the residential experience as a method of learning can ignore the burgeoning fact of information technology upon every aspect of life. Yet strangely, the process of learning remains only marginally influenced by the extraordinary power of information technology, perhaps because those who are our students enjoy much greater skills and imaginative capacities than those who are their teachers.

Given the explosive growth of knowledge, to which the universities have themselves made substantial contributions, and our increasing dependence on it, we have to ask whether the existing traditional patterns of learning are adequate for the needs of the changing world. Not only is knowledge itself increasing at an ever-expanding rate, but new methods of learning and new means of delivery are themselves undergoing rapid development. In contrast to this, the leading universities still employ what is essentially a medieval residential system in which youthful students are instructed by tutors and lecturers in a broad range of subjects judged to be appropriate for a baccalaureate degree.

This traditional structure has been supplemented over the years by other means of study, including, especially, postgraduate and professional schools, internships, and other similar programs, part-time, sandwich and extra-mural arrangements, continuing professional education, both formal and informal, and most recently, a major expansion in distance learning.

Unexamined among the burgeoning numbers who still participate in traditional educational schemes is the question of whether or not the format, contents, and nature of a baccalaureate degree, and especially of a traditional residential experience, remain appropriate to the needs of the new millennium. In some countries, such as the U.K., for example, there has been implicit recognition that they do not; degrees which formerly required three years of full-time student attendance, now typically require four. Such change, though significant, is scarcely radical, and it remains easier to continue the present pattern and style than it is to challenge and modify it.

Yet our net investment in the traditional campus-based residential baccalaureate experience is enormous, and is made even more so in the United States by the professional requirement that those aspiring to practice in fields such as medicine and law should receive virtually no professional instruction in those areas until they have completed a nonprofessional, though frequently pre-medical, or pre-legal, baccalaureate degree

What is surprising here is the lack of any debate, either professional, national, or institutional, as to whether these ancient arrangements continue to serve society well. Nor is it clear who should address that question, for it may be argued that the universities themselves are ill-equipped to provide an impartial review and recommendation. Yet few are as well equipped as universities to address these issues, even if the ultimate decisions do not rest in their hands. With increasing demands from the higher education community for a greater investment in plant, equipment, and capital needs, such a review seems both timely and important.

At another level, other questions remain unaddressed. In spite of the volume of research produced by the university, little attention has been paid to the cognitive process and to the effectiveness of various teaching methods. Nor is there any serious study of the value added to the educational experience by its residential component, together with the large and costly range of services typically associated with it. A critic might argue that unless universities can demonstrate significant value-added to the educational experience from the residential style, one should examine other alternative arrangements.

Even to raise these questions will be seen by some as an unfriendly act, but universities, if they are to prosper, need to address these issues themselves and to lead both the debate which they would generate and the reforms which may arise from such reviews.
3. Information technology. Research universities are awash with information technology. Some would claim that they invented it. Certainly, they have made major contributions to its development. They use it on a massive scale, not only in the mundane world of purchasing and record-keeping, but also in research and scholarship of all kinds. Furthermore, it has revolutionized practice in fields as different as medicine, law, and architecture, as well as being the basis for huge improvements in information storage and retrieval systems.

How universities collectively and individually respond to the challenges and opportunities of information technology will do much to shape the future. This technology has the capacity, even in its present form, to provide vast increases in access, to provide improved quality, to create new partnerships, to reduce costs, and thus to increase the capacity of the university to serve its several audiences. The world’s cyber universities are growing rapidly, and some appear impressively effective.

I believe no institution is immune to either the competitive effects or the educational benefits of information technology. How it will be used will vary from institution to institution, and in that variety will lie the seeds for future success. It is doubtful if any institution can go it alone as far as the development of off-site learning is concerned. But, just as books have expanded the capacity of a leading author to reach a wider audience, so in time must well-crafted video lectures by the world’s leading authorities displace the one-time performances on local campuses, with those who had formerly served a lecturers now serving as coaches, mentors, and guides to the new learning experience. This will threaten both traditional university practices and also, perhaps, the role of the professor, but it may represent one way of making a significant reduction in costs, while at the same time allowing improvement in quality. Many questions will be involved if such a practice develops. How, for example, will questions of intellectual property be resolved? Who should produce teaching materials? Should we follow the practice of book publishing with independent publishers contracting with the professor, or will the contract be with the university, which will then invite particular members of its faculty to contribute, or will both systems exist side-by-side? What about questions of copyright and royalties? How will credit be determined? What kinds of business partnerships and alliances will this involve? To what extent will institutional autonomy and academic freedom be influenced by any such arrangements? These and related questions are now pressing and deserve serious attention.

4. Patterns and limits of outreach. Since their earliest days, America’s universities have accepted responsibility for a measure of public outreach. Nowhere is this more fully developed than in the Land-Grant universities, whose record of success in this area has been extraordinary and whose influence continues to be of major significance in regional economic development and societal well-being. As the importance and impact of knowledge increases, more and more demands are made upon both the expertise and the purser of universities – public and private – to address issues of community concern. These requests range from research and professional service, to investment in community development. Increasingly, universities are seen not only as agents of economic growth, but as sources of community renewal. What is unaddressed in these increasing demands is the larger question of coincidence between such outreach and the core responsibilities and obligations of the universities to its own members. Ideally, each would complement the other, but in practice, the total costs of outreach are rarely recovered by those providing support, and frequently the university covers part of these ventures out of its own resources. Where universities choose to do this, there is clearly no problem, but the difficult question involves the extent to which the university facilities, faculty, student time, and administrative attention can satisfy the needs and demands of the local community. It would be particularly helpful to have a thoughtful review of the guidelines and benchmarks which representative institutions have developed in this important activity.

A related area concerns partnerships, for increasingly such outreach and public service involves partnerships with government agencies, corporations, foundations, and private individuals, some of which require new protocols and procedures if they are to be successful. These partnerships may range from cooperation in field tests of new crops or clinical tests of new pharmaceutical products, to public health programs, community services, or environmental projects.

The issues involved in these partnerships involve far more than the financial arrangements by which they are supported. They also involve questions of ethical norms and values, institutional autonomy and accountability, and the interests of both the public and the students, especially graduate students, who may be active participants in the programs.

Here again there is little to guide individual institutions as the number of these partnerships proliferates. A task force identifying best practices and dealing with codes of practice would be of substantial value.

5. Organization, governance, leadership, and management. The pattern of university organization has remained essentially unchanged for the last century. But during that period, the university has experienced explosive growth in numbers, size, and complexity, and the significance and impact of its work has multiplied.

Governance and management need to be reviewed on at least four distinct levels:

- The department. Does the traditional unit of university organization – the department – still represent the most appropriate organizational unit? Departments arose in the late 19th and early 20th centuries to represent the disciplines for which they were named. These disciplines, in turn, reflected the division of the curriculum. We need to ask whether intellectually, pedagogically, and administratively, the division of a university into departments – the traditional focus of tenure decisions, curricular design and student supervision – still seems appropriate.
Intellectually, much has changed since the turn of the century. What were pursued then, largely as pure disciplines, are still so pursued, though in most cases the disciplines have become more professionalized and, in some cases, practical application has influenced their development. But increasingly, intellectual interests span a variety of disciplines. Cultural, linguistic, sociological, political, historical, and other studies within the humanities and social sciences are less and less frequently confined to a single discipline. Increasingly, such studies have become multidisciplinary in their approach and sometimes in their authorship. Nor do the problems of society come in neat disciplinary packages. The traditional disciplines are therefore not wholly appropriate in terms of intellectual categories. Furthermore, they sometimes tend to weaken interest in interdisciplinary and multidisciplinary approaches, particularly when appointments and tenure are held only in traditional departments.

The transitory nature of disciplines is reflected in changes which have taken place in disciplines, and thus in departments themselves. Disciplines that were once apparently well-established – geography, for example – are now less widely recognized and less highly regarded, and geography departments have been closed in many universities. Other disciplines are now fragmented into a host of sub-fields and specialties, which may enjoy little common discourse. The typical discipline of “English” is such an example. Within the sciences, new disciplines have developed and evolved, including such things as biochemistry, computer science, neuroscience, and others. The emergence of new disciplines is often cumulative, rather than substitutionary. Thus, geophysics does not obviate the need to continue to teach both geology and physics, its parent disciplines.

If one asks whether pedagogically the department still “makes sense,” the answer is far from clear. Departments were established when the curriculum was relatively fixed, involving a dozen or so disciplinary courses. The departments at that time had very strong influence, not only upon the development of the curriculum, but also in their responsibility for its implementation and representation. Furthermore, they provided nurture and evaluation to students, who found in them a congenial home. The influence of departments in both these areas is now much less significant than it once was. Courses have proliferated. Department offerings have fragmented. Interdisciplinary courses abound. The oversight of the curriculum is in limbo.

Administratively, the department has been the foundation of the organization of the university, but, as the disciplines have developed, some departments have shrunk in size, being now represented by only three or four faculty members, while others – such as English and psychology – may number 100 or more faculty members in some of the larger universities. Added to this, the once strong role of department head has now been replaced by department chair, and the individual appointed to this position often has little influence upon the imaginative development of the department or the creation of constructive linkages with other departments.

Taking these three aspects of the life of a typical department — its intellectual contribution, its pedagogic contribution, and its administrative contribution — it is tempting to say that there must be a better method of coordination and management within the university. Unfortunately, that is far from clear. Though it is easy to suggest that the smallest departments should be merged into larger units, it is not clear that any alternative method is superior to the departmental organization we now have, even with all its admitted imperfections. The question may well become how do we take an imperfect organization – the department – and improve it? I believe that the two essential steps in bringing about improvement are to strengthen the leadership of the departmental chair and to provide periodic internal review, supplemented by external review, as appropriate, of the life and work of the department. In this way, the benefits of the department could be retained, and some of its present limitations could be improved upon.

• The college or school. Universities, since their earliest days, have been created on the basis of the college or school, known in many European universities as the faculty. The characteristic feature of this grouping is that it represents a collection of departments united by broadly common intellectual interests and methods. One finds typically, therefore, a college of engineering or a school of medicine or a faculty of law. A traditional college is headed by a dean who, in the better universities, has substantial administrative and financial responsibility. In most cases, the dean is assisted by a small administrative staff and an appropriate advisory council. Perhaps the greatest variation in this traditional pattern of organization is found within the humanities, arts, social sciences, and sciences. When I was dean at the University of Michigan, I presided over a college whose title was Literature, Science and the Arts; this was a mammoth grouping of some 50 departments, museums, colleges and institutes that, at the time, accounted for some 20,000 students. In many North American universities, this association still continues, with the arts, the social sciences, and the sciences all unified under a single administrative leadership. In Europe, on the other hand, as well as in some North American universities, the three major divisions have been separated as individual colleges. In still other cases, particular groups of subjects — the earth sciences or the biological sciences — for example, have been established as separate schools or faculties. The reason for the separation of what had once been combined extensive colleges is the unceasing intellectual growth in some areas, not least in the sciences. In universities where separation has taken place, it is argued that there is now little in common between, say, the sciences and the humanities. In those where an association is still continued within a single college, it is argued that the demands of liberal education favor the retention of the older association. There is no simple solution to this enigma, but the academic style, curricular direction, size, and administrative complexity of the university will determine the most appropriate organization.
In general, collegiate structure is still remarkably effective, both intellectually and administratively, not least where there is a strong dean with a well-developed sense of intellectual purpose and direction. I believe it has proved effective largely because the colleges still define common intellectual interests and therefore are able to appeal to common standards and norms. Colleges have prospered when their deans have been willing to exercise authority in a way that current department chairs have generally not. What is needed here is for the deans to require of their chairpersons the same kind of financial responsibility and initiative that they themselves display.

Perhaps the other reason for the success of this division within the university is the fact that deans are generally carefully selected and well supported, occupying their positions for a significant period and regarding their appointment to these positions as a significant career move.

Could the present collegiate system be improved? Certainly it could benefit from better strategic planning, from better cross-college linkages, with appropriate incentives for partnerships in the attainment of university-wide goals, and from the advice of a standing visiting committee from outside the college itself. None of these improvements would be revolutionary, but they would take what is now one of the strongest aspects of university organization and make it even better.

- The president. The president, rector, chancellor, or vice chancellor occupies an ancient office, the power of which varies greatly from country to country and even from institution to institution. In general, presidents, chancellors, and vice chancellors in North America enjoy more autonomy than those in other parts of the world, in part, perhaps, because, unlike those in many industrialized countries, their universities are not wholly dependent upon the state for both financial support and direction. The presence of large numbers of independent universities in the United States makes the role of the president distinct.

I have recently written at some length on the art of the presidency, and there is also available a recently published report on renewing the academic presidency. That report urges the delegation of more substantial authority to the president and I believe that if universities are to prosper in the new millennium, that will prove desirable.

- The Board of trustees, board of regents, or board of overseers. In contrast to all the organizational categories and responsibilities described above, the board exercises a governance function, rather than one of management. In essence, it exists to provide public accountability, public oversight and public support for the institution. It may be of several types. Some boards are statewide in their authority, overseeing the work of as many as fifty different institutions within a state, representing many levels of individual responsibility and intellectual and professional concern. Other boards have responsibility for only a single university. In public colleges and universities, board members may be appointed by the governor or, in a few cases, elected in statewide elections. In private universities they are invariably self-appointed, often including substantial representation from the alumni association.

In general, the concept of board governance and responsibility has proved remarkably resilient and successful. Given the public responsibility of the universities and its growth beyond that of providing higher education, the function of the board is likely to grow more, rather than less, critical in the years ahead. This is not to say, however, that the system has been without its problems. Boards of public institutions have, on occasion, become politicized and intrusive. The boards of some private institutions are so preoccupied by the fund-raising that they have become largely symbolic rather than being actively involved in governance. In practice, much of the work of the large boards characteristic of private institutions is done through board committees. Perhaps the two greatest hazards of any board are the dangers of too much engagement, on the one hand, leading to intrusive micro-management, especially in athletics and in the medical school, and, on the other, of disengagement from the major issues, where board meetings become show-and-tell events in which senior university administrators present a fairly cut-and-dried agenda, leaving little room for inquiry or guidance on the part of the board. This places a heavy responsibility on the board chairman and the president to work together to insure the maximum effectiveness of the board. Creatively used, the board provides an effective system, not only for assuring public accountability and responsibility of the university, but also in serving as a bulwark against both internal usurpation of authority, and public intrusion or control. The delicate balance among institutional autonomy, personal freedom and responsibility, and public support and oversight, is one that exists in a constant state of dynamic equilibrium. A wise board will recognize the delicacy of that equilibrium and will nurture the vitality of the various forces that contribute to it.

6. The place of institutional values. The sixth and final challenge to all universities seems to me to be the most difficult. It is to retain the bedrock values on which the university was founded in an age when the institution itself is becoming corporatized, where the notion of individual instruction has given way to distance learning, and where so much of the work of the university lies beyond the walls of the conventional campus. The university as an institution has always been committed to the conviction that teaching is a moral vocation, that scholarship is a public trust, that public service is a societal obligation, and that an independent and open community is the essential means to both learning and discovery. That community is now more fragmented than ever before, and although there are many loyal and able faculty members who regard information as a means whose end is knowledge and knowl-

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edge as a means whose purpose is understanding, they are not characteristic of all those who serve within our universities. In too many cases, knowledge is depersonalized, scholarship is self-referential, and tolerance is confined largely to current orthodoxy. What is lost in this is the fact that we can have true community only to the extent that we are willing to cherish the importance of the individual, and especially the individual student. The community, for all its methodological power, is after all made up of individuals.

More than a century ago, John Henry Newman offered the antidote to the depersonalized university. “The university,” he declared, “is not a foundry, or a mint, or a treadmill . . . but an alma mater, knowing her children one-by-one.” One-by-one, person-by-person, student-by-student: that is the basis for educational success. It is also the basis of a free society, and the secret of a great university. Universities will remain great only to the extent they are great student universities, as well as great centers for individual learning, discovery, and outreach.

This list of topics leaves unaddressed several of great importance, among them future financial support for universities and the future of the academic profession. But without broad agreement on the future role of higher education, there can be no agreement on sources of financial support. It is the debate on role, and the related discussions of scale and scope, which should drive the discussion of methods, means, and finance. That is a public discussion that deserves urgent attention, and it is the responsibility of the universities to ensure its place on the public agenda.

Universities are one of the glories of the past millennium, one of the treasures of human vision and creativity. Arising from human-kind’s highest aspirations, they have made a unique and growing contribution to enlarging human understanding and advancing the human condition. In the world of the new millennium where population continues to outstrip resources, where natural disaster compounds human mismanagement, where ancient animosities fuel new hatred and terror, where hunger, poverty, and misuse still blight the lives of one quarter of our fellows, the challenge to universities will now be greater still. Their products – experience shared, considered and analyzed, knowledge created, refined and applied, and skills perfected, focused, and humanely used – are the essential, but frail, tools by which we fashion our collective future well-being. These skills are not given. Each must be cultivated. None is free-standing. Each requires community. None is self-sustaining. Each depends on support.

It is these three vital commodities – shared experience, demonstrable knowledge, and humanely used skills – which are the business of the university: at once both its means and its products. Our successors in the new millennium will look back on a planet and a people whose condition will largely reflect how responsibly, intelligently, and humanely we, the members of the universities, have cultivated them today.
I. Tuition Keeps Rising at Selective Private Institutions

Over thirty years ago, William Bowen (1967) studied data from a set of selective private institutions and concluded that their tuition levels had been rising, on average, by 2 to 3 percent more annually than the rate of inflation ever since the turn of the 20th century. He attributed this partially to the increased specialization of knowledge and the growth of new fields of study. But first and foremost, this occurred because the nature of the educational process did not permit academia to share in the productivity gains that were leading to the growth of earnings in the rest of society. Put simply, the number of students the average faculty member educates each year at these institutions had not changed because low student/faculty ratios were thought to be essential to high-quality education. Hence, to avoid a decline in the relative earnings of faculty, which might make it difficult to retain existing faculty members and attract new ones, tuition had to be increased by more than inflation to provide revenue for salary increases. Inasmuch as real incomes of families were increasing during the period, due to real wage growth and increased female labor-force participation, tuition had not risen relative to median family income during most of the period.

In recent years, tuition has similarly continued to increase by more than inflation. However, during the 1980s, real income growth in the United States stagnated. As a result, tuition growing by more than inflation meant that tuition as a share of family income was increasing. Figure 1 illustrates this point for Cornell University, but the story is the same for the average selective private institution in the nation. Between 1966-67 and 79-80, tuition remained roughly 26 to 28 percent of median family income. By 1992-93 this ratio had risen to 49 percent. During the mid-1990s, median family income began to grow again in real terms, and the ratio stabilized at this now higher level. However, the damage had been done.

The concern that college costs were taking a greater share of the typical family’s income was magnified by the rapid run-up in endowments that took place during the booming stock market of the 1990s. Families wondered why the selective institutions even had to raise tuition at all.

I am going to claim in this paper that there are a number of forces, in addition to the ones that Bowen discussed, that continue to put upward pressure on tuition. These include the aspirations of academic institutions, our “winner take all” society, the shared system of governance that exists in academic institutions; recent federal government policies; the role of external actors such as alumni, local government, the environmental movement, and historic preservationists; periodicals that rank academic institutions; and how universities are organized for budgetary purposes and how they select and reward their deans.

After briefly discussing each of these forces, I will present some results from a survey I recently conducted of large research universities to obtain information on how they organize themselves for budgetary purposes. Finally, I will conclude with some thoughts on the steps that academic institutions themselves must take if they want to hold down their costs.

II. Selective Academic Institutions are Similar to Cookie Monsters

The objective of selective academic institutions is to be the very best that they can in every aspect of their activities. They are like cookie monsters. They aggressively seek out all the resources that they can find, and put them to use funding things that they think...
will make them better. They want better facilities, better faculty, improved research support, improved instructional technology, and better students. All of these things take more money. While they could aggressively try to increase their efficiency, reduce costs, and get better by substitution rather than by increasing expenditures, they don’t do this for a number of reasons that I will shortly mention. Rather, they adopt the attitude that as long as large lines of high-quality applicants are flocking to their doors and accepting their offers of admissions, there is no reason for them to moderate their tuition increases.

III. The “Winner Take All” Society

And flock to our doors they do. As Bob Frank and Phil Cook (1995) and Carolyn Hoxby (1997) have pointed out, the fraction of our nation’s top students, as measured by test scores, that choose to enroll in the selective private institutions has increased substantially over time. Certainly, the development of need-blind admissions and need-based financial aid played a role, as did reductions in transportation and communication costs, in causing this increased concentration of top students.

More recently, the increased income inequality in the United States has caused students and their families to increasingly want to (in Bob Frank’s terms) “buy the best”. My own research with Dominick Brewer and Eric Eide suggests that they are wise to do so, because the economic return to attending a selective private institution rather than another academic institution is large, and there is evidence that it has increased in recent years. Each of the selective institutions wants to remain in the subset of schools that students find attractive. So each winds up in what many have called an “arms race of spending” to make itself look better than its competitors. This spending is not restricted to the academic parts of institutions. Institutions also compete with athletic facilities (including fitness centers), new residence halls, and improved dining facilities. For example, Duke has a freshman campus, so Cornell had better have one also. The institutions’ quest to be the best pertains to graduate education and research as well. It is easier to remain at or near the top nationwide in a field than it is to strengthen a weak field and achieve a high level of distinction. As a result, at Cornell we swallow as the costs of conducting research in the physical sciences and engineering rise rapidly (I will return to the point below) and continue to heavily devote our resources to these fields in which the University historically has excelled. Pity the poor economist

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whose models tell him that to minimize costs, one should substitute away from things that have become relatively more expensive. Pity the poor university that finds that to maintain its historic excellence, it has to skimp in other areas and continue to raise tuition at rates that exceed inflation.

### IV. Shared Governance

Why selective private institutions fail to seriously consider the option of reducing their costs, rather than raising tuition, to find the revenue to enhance their operations derives to a large extent from how they are governed. Their system of shared governance among trustees, administrators, and faculty almost guarantees that they will be slow to react to cost pressures. Trustees are often successful business people, who know how to cut costs and meet budget constraints. However, if the president of a university, such as Cornell, tells them that it needs to spend money for new initiatives in genomics, advanced materials, and information sciences to maintain the strength of the university and keep it at the forefront of science and engineering, they are likely to swallow hard and go along with him. If the president similarly says that the university needs funds to enhance the living and learning environment in order to attract students, the trustees similarly will likely agree. There is, however, an important distinction between trustees of private and public universities.

Some background data will help to make this clear. In 1978-79, the average full professor at a public doctorate-granting university earned about 91% of what his or her counterpart at private doctorate-granting universities earned. This ratio fell steadily during the 1980s and early 1990s until it stabilized at about 78 to 80%. This fall in public universities’ relative salaries made it difficult for them to hire and retain top faculty, and invariably led to some decline in these institutions’ academic quality. Similarly, between 1988 and 1994, state appropriations to public higher education per full-time student fell in real terms by about 10%. While tuition increases made up for part of this decline, in real terms, spending per student fell at many state institutions. During the same time period, real expenditures per student were relentlessly increasing at the selective private institutions. Hence, the disparity between the quality of the two types of institutions grew. Do these data suggest that trustees of public institutions care less about the quality of their institutions than do trustees of private institutions? In most case the answer is “no” although there are some states, such as New York, in which some people have serious questions about the trustees’ goals.

However, unlike private university trustees, public university trustees often do not have final control over the tuition levels that their institutions charge, or their state appropriations. The political process often makes these decisions. In some states, such as in New York, public university trustees do have control over tuition. However, if the governor lets them know that he wants tuition held constant, it would be foolhardy for the trustees not to accede to his wishes. To do so would leave them vulnerable to the risk of losing their positions. They would also face the possibility that the political process might penalize them by reducing their state appropriation by the amount of the increase in revenue that they gained by increasing tuition. So budgets in public institutions have been cut in spite of their trustees’ concern. Faced with tight budgets due to pressures to reduce state income taxes and the need for more funds for health care, welfare, and the criminal justice system, administrators at the publics make hard decisions and take the steps necessary to balance their budgets. They can always blame the cuts that they must make on state government.

In contrast, if administrators at private institutions were to recommend budget cutbacks, all blame would be assigned to them. They would be widely accused by the faculty of not making a strong enough case to the trustees for the need for higher tuition to maintain institutional quality. Rather than risk losing the support of the faculty, the typical president and provost will often swallow hard and recommend raising tuition by more than they otherwise would prefer in order to provide some budget relief. After all, administrative terms are not that long, and once an administrator loses the support of the faculty, in most cases it is difficult for that administrator to effectively lead the institution.

Why is the support of the faculty so important? Under the system of shared governance in place at these institutions, the faculty rules supreme on academic matters. The faculty also feels that it should play a major role in all other decisions at the university. To achieve faculty support for projects is often expensive, in terms of both time and dollars. At Cornell, for example, the estimated cost of a major new advanced-materials research facility has risen from $40 million to $55 million because of modifications that needed to be made to win faculty support for the siting of the building. These modifications — to improve the college’s environment and six improved classrooms — had nothing to do with the underlying academic program for which the building was being constructed.

See Ehrenberg (1999a).
V. Federal Government Policies

In recent years the federal government has contributed to the cost pressure on selective private institutions in at least three ways. First, the Consent decree between the Ivy League institutions and the Justice Department in the early 1990s now prevents these institutions from discussing the financial need of individual commonly accepted applicants before financial aid offers are made. While these institutions can, and have, agreed to base financial aid only on financial need, each is now free to determine “need” as it sees fit. This has led to increased use of the practice that has become known as “dialing for dollars” at many selective privates, as accepted applicants submit financial-aid offers from elsewhere to an institution in an attempt to improve their packages. Put simply, it is likely that the Consent decree has led to enhanced financial competition for students and improved financial-aid packages. Money for enhanced financial-aid programs comes from increased annual giving, increased payout from endowments, increased endowments for financial aid, and increased tuition. The richest institutions may have been able to finance their improved programs out of an increased payout from their endowments. However, for most selective private institutions, increased financial aid has required at least some additional recycled tuition revenue. Absent the ability to easily cut expenses elsewhere in the budget, the implication is that tuition has had to increase by more than would otherwise be the case.

Second, the value of the maximum Basic Educational Opportunity Grant (BEOG) has not kept up with inflation. Viewed in constant 1997 dollars, the maximum actual BEOG grant rose from $1,500 at the program’s inception to over $4,000 in 1975. Since that date, it has declined considerably. After falling to under $2,500 in the mid-1990s, it rebounded to $2,700 in 1997. This failure of BEOG levels to keep up with inflation, let alone tuition, required the private institutions to dig deeper into their pockets for financial-aid funds, and increasingly, financial aid has become an institutional responsibility, putting more pressure on tuition.

Finally, the cost of doing research has skyrocketed at the selective private universities in recent years as the federal government has put pressure on private research universities to reduce their indirect cost rates. Between FY1990 and FY1997, the mean indirect cost rate at the 39 largest private research universities fell from 62% to 56%. In addition, federal agencies began to put more pressure on all institutions to provide more matching funds in grant applications. At the same time that direct cost funding levels were often being reduced for large center grants, matching fund expectations were growing. Indeed, Cornell has found numerous times that to win a renewal of a major center grant at the same, or a smaller, level of funding, usually requires the institution to ante up more in matching funds. Funds to make up for the loss of indirect costs revenues and the increased matching cost commitments came from the general operating budgets of the institutions, and this too put more pressure on their tuition levels.

VI. External Actors

Alumni, local government, the environmental movement, and alumni who are historic preservationists are vital to selective institutions in a number of ways. They contribute funds, help to recruit students, provide internship and postgraduate employment opportunities for students, and support the institution politically. They also have strong preferences about what should be valued and, by strongly communicating these preferences and threatening to withhold contributions, they discourage institutions from cutting almost anything. Similarly, they occasionally provide gifts that academic institutions don't really want because they would add to, rather than reduce, the institutions' costs. It is a rare president who refuses such gifts. Academic institutions also face cost pressures from local governments and interest groups, such as environmentalists and historic preservationists. The institutions are always adding new facilities and renovating old ones. Obtaining required construction permits from local governments requires complex discussions and negotiations, and ultimately, these may lead to the institutions having to make increased financial payments to local governments to compensate them for tax-exempt status.

A recent story in the Chronicle of Higher Education discussed how much Harvard is increasing its payments to the city of Boston to enable it to develop properties that it owns in the city. Pressure from environmentalists and historic preservationists may slow down academic institutions’ projects and increase their costs by much more than similar pressure would increase the costs of for-profit firms undertaking similar projects. Unlike business firms, most academic institutions do not have the option of packing up and moving to a new location.

Also, since they are either public bodies or nonprofits that receive favorable treatment under tax laws, they are expected to make decisions that are in the public interest. For example, Cornell’s plans to build a new incinerator to dispose of toxic wastes from veterinary medicine research have been delayed for more than four years as the institution tries to assuage environmentalists’ concerns. Similarly, Yale recently announced that it was abandoning its plans to demolish several antiquated buildings that comprised its divinity school because it believed that the cost (in time and money) of fighting the battle in the courts would prove prohibitive.

VII. Published Rankings of Academic Institutions

When published rankings of academic institutions, such as those conducted by U.S. News & World Report, influence potential students' perceptions of the underlying quality of the institutions, no matter how much institutions criticize the rankings, they have reason to fear that the rankings may influence students' decisions. A recent study that I conducted with James Monks shows that this fear is justified. Using data from 30 selective private colleges and universities over an 11-year period, Monks and I found that
changes in an institution's ranking do influence its admissions outcomes and its financial-aid bill. When an institution's ranking improves, this leads to an increase in applicants, a reduction in the fraction of applicants that the institution accepts, an increase in its yield of accepted applicants, an increase in its freshman class's test scores, and a decrease in the amount of financial aid that it must offer to enroll the class. As a result, institutions have an incentive to take actions that will positively influence their ranking. To the extent that the rankings are partially based upon how much an institution spends educating each student, no administrator in his or her right mind would take actions to reduce the institution's educational expenditures unless he or she was forced to by the trustees.

You can imagine how members of the Cornell Trustees' finance committee reacted when I told them once (when they were pressing us to behave more like a business and reduce costs) that for us to take action to unilaterally reduce our costs would result in a worsening in Cornell's position in the USNWR rankings. Cornell's rank rose from fourteenth among national universities in the fall 1997 USNWR ranking to sixth in the fall 1998 ranking. Not surprisingly, there was an increase in applicants for its fall 1999 freshman class, it admitted a smaller fraction of these applicants, its yield rose, and its entering classes' test scores rose. Sadly for Cornell, its rank fell back to eleventh in the fall of 1999, primarily because USNWR changed the formula that it used to compute the rankings. It was my sad task to inform our president and provost that while I was happy that they were basking in the glory of how well the Cornell freshman class looked this year, our research suggested that Cornell would be lucky if it did as well next year.

VIII. How Universities Organize Themselves

The final factors that influence universities' inability to hold down their costs is how the institutions are organized for budgetary purposes and how they select and reward their deans. Ehrenberg (1999a, 1999b) discusses these issues in detail. I summarize some of the key points below and present some new evidence on how universities actually are organized for budgetary purposes. During the spring and summer of 1999 I conducted a survey of the resource-allocation methodologies that are used at research and doctorate universities. More than 200 of the approximately 220 institutions in the sample responded to the survey. While I would like to believe that they did so because they recognized my name, more likely it was because of Monks and Ehrenberg (1999). William Bowen, the president of the Andrew W. Mellon Foundation, provided me with a cover letter to encourage their participation.

Simplifying greatly, I list four broad types of research allocation methodologies or systems of budgetary arrangements that universities use:

Central Control: Under such a system, all revenue, with the possible exception of some external gifts and the direct costs on external research grants, flows directly to the central administration. The central administration covers it central costs and then allocates some portion of the remaining revenues back to the individual colleges.

Tubs: Each college is treated as a “tub” on its own bottom. It keeps all of its tuition and other sources of revenue that it generates. It remits funds to the central administration only to cover its allocated share of the central costs. Each college is responsible for all the direct and indirect costs that it incurs, including facilities, maintenance, and operating costs.

Tubs with a Franchise Fee: Each college is treated as a tub on its own bottom, but it remits more than its allocated share of central costs to the central administration. The extra amount that the college remits is based upon its revenues or its expenditures. This “franchise fee” is then allocated back to the various colleges at the discretion of the central administration and/or through some priority-setting process.

Activity Driven: Under this type of approach, each college remits to the center a share of its total expenditures. The share it remits may differ depending upon whether the expenditures are for teaching, sponsored research, or other programs (for example, executive education). No explicit allocation of central costs to different units is made. The center uses the money it receives to cover central costs and then reallocates any excess funds back to the colleges, as in the third methodology. The benefits that a pure responsibility center management type model (model 2 above) provides, including the incentives that are present for the units to manage their own resources prudently and to generate revenues, are well known. However, in Ehrenberg (1999a, 1999b), and much more extensively in Ehrenberg (forthcoming), I argue that an unwanted side effect of the approach is that it reduces the incentive for individual colleges to collaborate and to take actions that are in the best interests of the institution as a whole. Put another way, what makes economic sense for a unit does not necessarily help to reduce duplication and hold costs down for the university as a whole. So to the first thing that I wanted to know in my survey is how many institutions utilize “pure” responsibility center management (RCM) models. I asked respondents to ignore the medical colleges in their responses (for reasons that those institutions with
medical colleges surely understand). The survey responses indicate that central control is by far the most prevalent form of ten
organizations, with 63% of the privates and 92% of the publics being organized this way. Only 22 of the universities were organized
as tubs, and this form of organization was most prevalent in private research institutions.

Of course, how universities are formally organized is not necessarily a good indication of how they actually behave. One provost
whom I visited at a best-unnamed major public research-I university told me that while all tuition revenue came directly to his office,
not the colleges, he had never thought about doing anything other than giving each unit back the tuition revenue that it gener-
ated. A second provost to whom I spoke to at a public research-I institution told me that while he had the authority to reallocate
tuition revenues across the colleges, it caused him too much aggravation to do so. To see if these attitudes were more widespread,
the survey also asked those universities that had answered that the center fully controlled the allocation of revenues whether in
practice their incremental allocations deviated substantially from proportionality. In almost half of these institutions, in both the
public and private sectors, the answer was no. While this may reflect satisfaction by the central administration with the way things
are going at each of these institutions, it also may reflect that the colleges are de facto being treated as tubs. Asking institutions
which budget model best fits them may drastically oversimplify things, and the survey also included a set of questions about
specific types of income to probe matters further. For example, answers to the question “Is the allocation of tuition revenue from
on-campus degree programs under the control of the central administration of your university?” were similar to the answers about
central control. However, revenues from non-degree programs (continuing education or executive education) or degree programs
off-campus (including distance learning programs) were less likely to be under the control of the central administration. Who “owns”
the endowment and who bears the cost of raising new funds are also important dimensions of institutional control. The individual
colleges at one private research university that I visited last year keep all of their tuition revenue. At first glance, this institution
appears to be organized as a set of tubs. However, the university as a whole has a large endowment which is “owned” primarily by
the central administration. As a result, the provost is able to heavily influence the behavior of the units through his control of the
allocation of endowment spending.

The survey responses indicate that it is much more likely in public than in private institutions that at least part of the costs of develop-
ment activities are borne explicitly by the colleges. It is also more likely that this occurs in research-I rather than other institutions.
The percentage of endowment spending that is under the control of the central administration varied widely across institutions.
However, on balance, there appears to be more central control over endowment at the private than at the public institutions. A final
important factor that determines whether an institution can behave in an efficient matter and function as a whole is how deans are
appointed and evaluated. At many institutions, committees of primarily faculty from the college conduct a search for a dean and
then provide the president or provost with an unranked list of the leading candidates. However, the discussion that accompanies
that list makes clear who the first-choice candidate really is, and typically that candidate is selected. Once in office, among the dean’s
primary responsibilities, especially in the universities that operate as tubs, are fund-raising and external relations (with alumni,
constituents of the college, state policy makers). If a dean is successful on these dimensions and retains the support of the faculty,
it is difficult for a provost or president to penalize the dean (including, in the extreme case, removing him or her from the position)
for failing to cooperate in university-wide initiatives. Deans thus have very little incentive to cooperate in activities that they do not
perceive as being in the best interest of their colleges. The limited power of central administrators to influence deans’ behavior be-
came clear to me when in recent years the presidents of Columbia and Georgetown tried, respectively, to remove and not reappoint
a dean. In both cases, pressure from alumni and key trustees (including the threat of withholding funds) caused the presidents to
publicly rescind their decisions. One wonders if the two presidents had failed to follow what is perhaps the most important advice
that a president can be given: never make a major decision on campus that will eventually rise to the level of the trustees without
first obtaining key trustees’ support for the decision.

IX. What Selective Private Institutions Can Do to Help Control Costs

Selective private colleges and universities have been raising their tuition levels, on average, by 2 to 3 percent more than the rate of
inflation for at least a century. To achieve in the future some moderation in the real rate of tuition increases will require actions from
federal and state government and the institutions themselves. Many of these are discussed in my book (Ehrenberg, forthcoming). I
conclude by briefly mentioning some of the implications of my discussion for institutional policies.

First, as my discussion of the differences between public and private institutions indicated, the trustees of the latter are key actors in
efforts to control costs. If efforts to moderate tuition increases are to come, they must be led by the trustees. Without strong direc-
tives from the trustees, it is difficult for presidents and provosts to advocate such policies.

Second, the selective universities should organize themselves for budgetary purposes in a way that gives the central administration
some control over resources and some levers to influence the behavior of college deans. If academic institutions are serious about
improving the efficiency of their operations and controlling costs, pure tub models are not the way to go. What is in the best interest
of an individual unit is not necessarily in the best interest of the university as a whole. Central control over resources removes many
of the incentives that units have to raise revenues and hold down their own costs. Hence, variants of the “tubs with franchise fees”
or activity driven models are the preferred alternatives.

Third, college deans at universities must be held responsible for the well-being of the institution as a whole, not just their individual
colleges. This should be an explicit part of their job responsibilities. Faculty and alumni connected to their colleges should be educated to understand that this is an important part of deans’ jobs. Serious performance evaluations of deans need to be held annually to reinforce this point.

Fourth, trustees and key alumni need to be educated so that they too understand that what is best for “their” college is not necessarily what is best for the institution as a whole, and that they too need to think of the latter. This is a hard sell, but something that central administrators can profitably devote time to doing.

Fifth, institutions need to conduct regular serious evaluations of all aspects of their academic and nonacademic activities to decide whether efficiencies can be achieved in any activity or whether it makes sense for the institution to stop doing any activity completely. Put another way, the institutions need to get themselves into the mindset of growing by substitution, not by expansion. Faculty legitimately gripe at having to participate in mindless program reviews that get filed away and that have no impact, so these evaluations must be substantive. There is a tradeoff between accountability and collegiality, and serious program reviews may reduce the latter. However, that is a price that the selective institutions may have to pay for trying to be more accountable and holding down their costs.

Finally, institutions should stress much more heavily the sharing of academic and administrative resources, both across units within a campus and across institutions. The announcement earlier this year that Columbia, Yale, and the New York Public library are building a single repository to house rarely used books of all three institutions is but the tip of the iceberg of things that can be done. More sharing of academic resources by the teaching of specialized courses to students on several campuses simultaneously, through the use of distance learning technologies, is another example. Institutions will have to think very seriously about how they can expand cooperation with their competitors.

Academic institutions are already cooperating on a number of administrative fronts. For example, many are involved in the joint development of information systems for human resources, student services, libraries, development and alumni relations, sponsored programs, and financials. They now need to take the next step and ask if there are ways to share administrative services across campuses to achieve further economies of scale and cost savings. Is it really necessary, for example, for each institution to have its own purchasing department?

References


Financing Cornell in the 21st Century

by Donald F. Holcomb
Professor of Physics, Emeritus
Cornell University

Note: If you are reading this from a digital file (rather than printed book), click here to listen to an audio recording of the December 1999 delivery of this lecture.

Introduction

You might wonder what I, a retired Cornell physicist, am doing here on the platform, in the midst of a collection of experts and university leaders.

There are two reasons: The first is that it's wonderful to be able to participate in this grand testimonial to Dale Corson. When my wife and I came to join the physics department at Cornell in 1954, Dale and Nellie Corson were among the warmest welcomers. Since that time, our interaction has been a wonderful mix of the professional support which he has given to me, as to so many others at this institution, and a continuing family friendship. After living across the road from one another on South Hill for 40 years, on what was sometimes called "Physics Circle," we now find ourselves again living across the green in the Kendal of Ithaca community. Fate must be saying something.

The second reason for my presence is that I was persuaded by our Moderator and Dean of the Cornell Faculty Bob Cooke to act as chair of a task force of Cornell Faculty members of the Board of Trustees, present and former, to look at some long-range aspects of Cornell's financial policies – hence the title, "Financing Cornell in the 21st Century." I've been reasonably close to and interested for some time in the question of how to realize all of our ambitions for Cornell within realistic fiscal constraints. This interest began with my own membership on the Cornell Board of Trustees in the late 1970's and early 1980's.

This Faculty Trustees' task force is still in the early stages of its work. It is important to note that my comments today stem from my own personal judgments, not from concerted work by the task force. The task force expects to have some better-digested ideas to present to the community at the end of this academic year.

Motivation for Establishment of the Task Force

For some decades, the annual cost of education for each student at Cornell and many similar institutions has risen at roughly 2-3% above the rate of rise of many other costs in our society. During some time periods, this rate of rise has been roughly matched by other economic indicators, such as overall productivity in American society or disposable family income per capita. But during other periods (notably the 1980's), the total cost and, more significantly, the fraction of that cost borne by students and their families, galloped well ahead of such indicators, with consequent stress for students, their families, and the society in general.

The private colleges and universities, such as Cornell, have been granted a remarkable financial reprieve by the U.S. economic boom of the late 1990's. Nevertheless, at Cornell a number of signs of future financial stress are visible on the current scene. History says
that the good times will not roll on forever. We need to plan ahead. A long-term financial strategy for Cornell (coming to fruition on a 5-10 year time scale, perhaps) which can prepare for bad economic times as well as good economic times seems essential.

**Relationship to Previous Talk by Professor Ehrenberg**

Some of the themes and judgments highlighted by Ehrenberg will appear again here. You’ll find very little disagreement between him and me as to how the present general inability to control costs has evolved, even though the pathways by which the two of us have arrived at that agreement are rather different. Ehrenberg approaches the subject informed by his profession and his study, backed up by a tour of duty on the other side of the administration/faculty fence. I approach it as an interested and moderately well-informed amateur with a rather different professional background, but perhaps most usefully with 45 years of varied experience in this wonderful institution.

**Structure of the Talk**

Obviously, in 25 or 30 minutes, even if I were both wise and omniscient, I could not address in a useful way very many details of such a huge topic as indicated by the title of my talk. After a few bits of history, I’ll focus on three, loosely connected themes:

**Theme #1.** There is a somewhat loose nature to much of current financial decision-making at Cornell – particularly in the limited attention given to downstream costs of program decisions. I’ll give an example or two as an illustration of this characterization.

**Theme #2.** Cornell’s People and their interactions. The key to sound financial decision-making in an institution as complicated as Cornell ultimately depends upon the actions of People. Thinking of three groups of actors on the scene – central administration, faculty, university trustees – what are the prospects for a major advance directed toward shared responsibility and shared decision-making?

**Theme #3.** Cornell must be itself! While we will inevitably react to outside forces, let’s know when these are driving us, and make some decisions as to which forces are either consistent with our vision or are so irresistible that we must accommodate to them; the others, we should resist.

A few historical trends to set the stage. The first step in trying to look into the future is to examine the past – how did Cornell get where it is today? Are there recent trends whose extrapolation into the future give one worries?

First, some relevant numbers over the past 50 years (1950-2000).
• **Viewfoil #1**: Students, faculty, and total building area (1950-2000).

• **Viewfoil #2**: The rise (1950-1970) and flattening off of federal support of research.

**Viewfoils #3 and #4**: Background changes in U. S. society. These viewfoils show tuition growth over recent decades and changing income distribution in the U. S. We see the post war (1950-1970) rise in productivity, disposable family income, etc., the bad scene of the 1980's (static real family income, high inflation, tuition costs galloping far ahead of CPI or productivity – note this is the period in which the upper part of the U. S. income distribution began to separate), the go-go 1990’s and growth of the Winner-take-all Society. The 1990’s also is the scene for the current phenomenon which has been dubbed the “Arms Race”, carried on most strongly among the private colleges and universities, for attraction of top-notch students.

The flavor of the current Arms Race is beautifully captured by a quote in the *Cornell Chronicle* of November 11, 1999, from the manager of the “The Marketplace,” a new Cornell student dining center: “We tried to create a new atmosphere for freshmen. We know that students coming to Cornell today are not looking for traditional cafeteria fare. Their tastes are more sophisticated. They are used to fine dining and restaurant fare, and we need to be competitive with that.”

Wow!

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**Viewfoil #3**

![Graph showing Undergraduate Tuition – Endowed Ithaca](image)

**Viewfoil #4**

![Graph showing Change in Average U.S. Family Income](image)

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**Viewfoil #5**: Changes in financial aid and financing thereof.

*Comment*: Over the period from 1989 to 1999, inflation-adjusted financial-aid dollars coming directly from Cornell sources (either gifts, return from gifts, or direct budget appropriations) grew at approximately 7% per year, with a total of about $63,000,000 for the current academic year. A good part of this increase has resulted from some remarkably generous and focussed giving by Cornell alumni and others. But suppose this 7% per year rise were to continue for another ten years. Even the recent generous gifts to “endowment” are likely to be swamped by such a demand.

Now, on to the main subject: Financing Cornell in the 21st Century. Worries, generated by inside or outside forces:

*One issue*: Can we distinguish rising costs which genuinely contribute to more effective education from those driven by outside forces or attitudes in U. S. society as a whole not directly related to the fundamental educational enterprise?
An example of an arena in which outside forces mix with an excessively loose internal decision-making structure, particularly with regard to attention to downstream (i.e., later consequences of immediate decisions).

**Viewfoil #6:** The Computer (The Cookie Monster again!)

*Disclaimer:* I’m not trying to play the “Grinch who stole Christmas” against Don Greenberg’s evangelistic picture of the future – I’m focussing on a very limited example to make a point.

All universities, as well as other components of modern American society, seem like sheep walking peacefully to the financial slaughter in the hands of the “software upgrade/hardware upgrade/...” ratchet. It is really not a law of nature that we buy onto every software upgrade.

Let me give one specific, even rather homely, example of the rather special way in which the computer drives costs. The Cornell network has an access interface called “Bear Access.” After operating with it for a period of time, it was decided by the local computer folks that “We can do it still better with another revision” – which led to a 1998 upgrade. This change affected computer users all over the campus in various ways. But so far as I’ve been able to determine, by conversations with knowledgeable people, the basic management questions were never asked– specifically, “What are the downstream costs of making this upgrade? What is the fan-out benefit/cost ratio?” There are two cost implications of every such computer system change: (1) Staff time is eaten up in the process of getting on top of a new system, and (2) Every upgrade occupies more memory and asks for more speed. This often results in running over some threshold in local computer memory or speed – and, whether they like it or not, departments all over campus are forced into one more hardware update.

We see here an example of the peculiar human response to the “computer revolution.” There is something about the dynamic of the computer-driven revolution which causes a suspension of normal budgetary discrimination and, sometimes, even a suspension of judgment. To overly simplify, but not too much, large systems such as universities and the people within them seem to drift inexorably to the conclusion that we must have the latest enhancement, no matter what its cost or whatever other good is pushed aside by the need to replace hardware at frequent intervals or retrain office staff and faculty.

Don’t misunderstand me. I’m not suggesting that we become a coterie of Luddites – only that we gather the information to make sure we know what we’re doing.

*Disclaimer:* No criticism of our new Cornell VP for IT, who has just recently come on board. I wish her good luck in a quest to tame the Cookie Monster.
The inadequate attention to downstream costs inherent in my simple computer example appears in decisions about capital investments and personnel additions. This problem has, of course, been noted many times over the years, but I see in some recent local examples no sign that it is being thoughtfully addressed.

**Now, looking ahead. How can we take charge of our own future?**

Rather than continue to talk about financial specifics, for most of the rest of my time I’m going to center in on **Theme #2: People.**

The key to sound financial decision-making in an institution as complicated as Cornell ultimately depends upon the actions of people. I’ll put forward the thesis that changes in the behavior of People, rather than financial savvy, will ultimately support Cornell’s wise management of its resources in the 21st Century: I’ll be focusing on the concept of Shared Responsibility – Shared Decision-making.

**Viewfoil #7: An important background factor.**

<table>
<thead>
<tr>
<th>Time Scale</th>
<th>Background Factor</th>
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<tbody>
<tr>
<td>3 years</td>
<td>Faculty membership on Faculty Senate Committees</td>
</tr>
<tr>
<td>4 years</td>
<td>Students</td>
</tr>
<tr>
<td>4 - 10 years (or even less)</td>
<td>Second-level administration</td>
</tr>
<tr>
<td>10 years</td>
<td>Upper administration</td>
</tr>
<tr>
<td>10-20 years</td>
<td>University Trustees</td>
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<tr>
<td>15 (?) years</td>
<td>Special academic programs</td>
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<tr>
<td>20 years</td>
<td>Third-level administration</td>
</tr>
<tr>
<td>23 years</td>
<td>Doubling time for cost per student at 3%/year above CPI</td>
</tr>
<tr>
<td>30 years</td>
<td>Faculty</td>
</tr>
<tr>
<td>35 years</td>
<td>Doubling time for cost per student at 2%/year above CPI</td>
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<tr>
<td>50-100 years</td>
<td>Buildings</td>
</tr>
</tbody>
</table>

**“Shared Decision-making?” More importantly, Shared Responsibility.** I’m thinking about Administration – Faculty – Trustees as the interacting entities. In my opinion, here is the key area in which real change is essential. Whether this real change is possible remains to be seen.

First, an assertion: The perspectives of faculty and administration (and trustees, to lesser extent) must change in order that they be part of the solution, not just part of the problem.

Administration, Faculty, and Trustees are currently, to a considerable extent, prisoners of their own perceptions.

**Viewfoil #8: Perception #1:** The faculty sees the administration as responsible for administrative bloat, possessing an edifice complex, sacrificing faculty interests in order to get its strokes from alumni, trustees, large donors; unwilling to use burgeoning “endowment” funds; etc.

**Viewfoil #9: Perception #2:** Administration sees “the faculty” as a whole as an inchoate, self-serving group, protecting its local turf, only partially informed, and likely to lapse into finger-pointing at the drop of a hat.

(My description of these perceptions is obviously a caricature – but there is enough truth in them that they need to be taken importantly into account in design of a new system of Shared Responsibility and Shared Decision-Making.)
Trustees?? Members of our Board of Trustees are dedicated and generous supporters of Cornell. However, they have a perception problem also.

- Their picture of Cornell is, to a considerable degree, that carried away from their undergraduate days, 25 years ago. Cornell has changed a lot, and its needs are, in many areas, quite different.
- The Trustees are drawn, almost universally, from the layer of the American socio-economic structure which has found itself running away from the pack in the U. S. boomtime of the 1990's. The view from the top of the economic heap inevitably colors judgment in various areas of the making of a financial policy for the university.

**So what about Shared Responsibility and Incentives?**

First, a few comments about ways in which I believe faculty members must broaden their perspective in the arena of university financing.

An example of failure on the part of faculty members to escape their innate perceptions and, thus, fail to share responsibility is their attitude about buildings. Contrary to one of the assertions in the cartoon which represents a very common faculty perception (“Administrators have an edifice complex”), most academic buildings are built in response to faculty needs, demands, etc., not to independent administrative initiative.

Another central issue: Are mechanisms in place to phase out programs which no longer contribute in an effective way to the University’s 21st century goals?

**An underlying principle:** “Faculty have tenure, but programs and building space assignment do not.”

Ultimately, the faculty must make it possible to move in new directions by substitution rather than by accretion.

There are some similarities here to the situation described in a famous 1968 piece by the biologist/ecologist Garrett Hardin entitled “The Tragedy of the Commons.” Hardin was speaking of the community area used in times past for grazing domestic animals. Briefly stated, Hardin’s point was that for the individual farmer to add one more grazing cow on the Commons supports that particular farmer’s self interest, but the summation of added cows destroys the Commons.
Message to Cornell: We must modernize by substitution. New programs must not be the equivalent of a few more cows on the Commons.

Yes, it is true that “faculty solidarity” can prevent accomplishment of the admittedly difficult job of deciding when an academic program is no longer sufficiently mainstream to meet the tough test of competing for resources with a new and obviously timely push. Such decisions can be made within a homogeneous entity such as an academic department – but are very hard to accomplish when the push comes from outside the department.

To reach a state in which individual departments or other collective entities can take into full account the needs of the university at large would clearly require both new attitudes and, probably, some new machinery.

Comment: Back to time scales: For effective participation, membership on a faculty committee dealing with financial policies needs a cycle longer than three years.

And whatever machinery is constructed, strong and confident leadership at the College Dean level is clearly essential.

But, you’ll say, are there incentives for such farsighted restraint? (A straightforward example of an incentive for faculty: fix senior faculty salary problem, over the course of a few years, by having faculty joining in the design of a program for "Change by Substitution, not Addition").

Incentives for the top administration to participate wholeheartedly in shared decision-making are not so obvious. Presidents and top-level administrators get their personal satisfactions by doing something new! And their natural time scale (10 years) is such that the accumulating effects of the 2% or 3% effect over that time scale are not catastrophic. It is here, in its interaction with the top administration, that the trustees can be most effective, by insisting on the long-term view of financial policy.

Is this picture of fully engaged planning between central administration and a suitable faculty structure unrealistic? Maybe so. However, if the two sides in Northern Ireland can get a common government going, maybe there’s even hope for my dream!

In conclusion, back to Theme #3: Cornell must be itself!

Don’t try to be like Harvard, Princeton, or CalTech (or anyone else, for that matter).

We need to figure out how to free ourselves from the pernicious effects of such things as the USNWR ratings. Such an effort would clearly require cooperation among institutions.

Examples of special Cornell strengths and characteristics:

- A fundamentally democratic enterprise — the “blue-collar Ivy League school”

- Great strengths
  - An internal balance wheel — the College of Arts & Sciences
  - Many strong fields of science, applied science and technology
  - In this world of communication and global interaction, Cornell has relevant knowledgeability and connections in areas of Feeding the world
  - Land use
  - Water resources
  - Human development
  - International area studies programs
  Many of these strengths lie in the statutory colleges!

- Beautiful campus in this remarkably unspoiled region of upper New York State

Your Choice

Viewfoil #10

Play to strengths, rather than spending time and money trying to fill gaps

Viewfoil #10: Examples of special strengths and characteristics.

- A beautiful campus in the remarkably unspoiled region of upper New York State. It is sometimes uplifting just to walk around this place!

- Cornell is a fundamentally democratic enterprise — the “blue-collar Ivy League school,” with a diverse undergraduate student body (where “diverse” extends far beyond the politically-correct issues of race and color, to diversity in value structures and world views within the student body as a whole).

I am reminded of the old saw which lists the Ivy League schools in the following way: “Harvard, Yale, Dartmouth, Princeton, Brown, Columbia, Penn and, perhaps Cornell.”

Great strengths in:

- The internal balance wheel of the College of Arts & Sciences
- Many fields of science and technology
- The International scene. In this world of global com-
munication and global interaction, concern for impact of the human population on the earth (international issues of population, food, land use, water sources, human aspirations, and technical fixes for certain problems) will be a central issue of the 21st century. Cornell has a remarkable breadth of faculty expertise across this spectrum. **It is important to note that many of these strengths lie in the statutory colleges!**

The financial health of the statutory colleges at Cornell is integral to the overall health of the University. This fact is recognized and is a central concern to the current University administration. But those administrators may need help in the form of really creative thinking on the part of faculty, as well as segments of the population statewide.

Are there realistic ways to move from the present precarious financial situation to one of optimism and strength, in which the key importance of Cornell, statutory AND endowed colleges, to the long-range health of New York State is recognized throughout state and legislature?

In closing: **Cornell is one university.**

*Let’s revel in its diversity and build the financial structure it deserves!*

Don Holcomb and Peter Harriott
The Genomics Revolution: What Role for Cornell?

by Steven D. Tanksley
Liberty Hyde Bailey Professor of Plant Breeding, Cornell University

Introduction by J. Robert Cooke: We will call on Steven D. Tanksley, Liberty Hyde Bailey Professor of Plant Breeding College of Agriculture and Life Sciences and he will share his views on the genomics initiative, which is one of the really bold and strong initiatives that’s being undertaken by this university. Steven.

Steven D. Tanksley: Good morning. Before I talk about Cornell, I would like to talk about something a little broader than that and that has to do with where we are currently in the understanding of life. Now, if you look at all of the exploits that humans have had of human existence and societies, most of it has been driven by interest in themselves and relationship to life and the universe around them. This information has been gathered and collected both through passage through societies, by word of mouth, but also through collection of literature. So if you were to go into one of the libraries on campus, for example, the Mann library and just walk through the stacks you would find a tremendous reservoir of information collected by previous human beings on perhaps any topic you could imagine. This is our legacy. This is the basis on of existence and our society and our understanding of ourselves. There’s another type of information which is even more intrinsic to us in the literature we create and that’s the information that actually prescribes life. That’s the place basic blueprints for life not only of human beings but every other life form on this planet. Now if you look at science, the science of life in biology and ask how has this information been collected, where do we sit today with regard to this information, you quickly realize that we are headed into a revolution of information collection that’s unparalleled in any time in human existence.

Just to give an example, with respect to the human being, you probably cannot escape the public literature on the human genome project, but to put it in nutshell, the goal is to decipher all of the genes that make up a human being, to read out the blueprints of the DNA. There is some 100,000-120,000 of these, and it is these together that are responsible for the individual and the differences between individuals. All of the development of medicine, all of the development of knowledge of life, and so forth has been based upon some pieces of this information, but the information we had has been very limited. Until about 10 years ago, of those hundred thousand bits of information, we had knowledge on only a few hundred. Five years ago, we had...
knowledge on perhaps 10,000. Even though we did not know what all of those did, we had information on them. Within the next year, we will have the complete blueprint of a human being deciphered, the DNA sequence, and within the next five years we will have the gene sequences for probably 100 other organisms. This would be equivalent to going from walking into a library that perhaps had 1000 volumes of books and come back the next week and find out there were 100,000 books, none of which you have read before. This is what we're faced with in biology, and what's behind this is a set of technologies that allowed creation of this information, and the deciphering of the information. What's happening now with these genome projects, and I tell you a little bit about what genomics is, is that we're quickly unraveling blueprints of humans and many other organisms and we're creating a situation where biology is becoming limited not by information, which it was before, but by our ability to manage and understand information. What this is going to create is a change of biological sciences from a more cottage industry of individuals working on their own labs and isolation, to groups of individuals working together in networks within universities and across universities. This is something for which no university is prepared. It's a paradigm that has never existed in biology. It did come into existence in physics, they underwent this revolution, but this is something biologists have not done. The other thing this is going to create is an opportunity for discoveries that will affect every aspect of human existence.

So genomics is a word, you wonder where someone created the word, and probably they were not someone who is not very literate, because it's not a great word to be using, but to give you an idea what is held under this umbrella of genomics, it's really a set of tools, which create possibilities. It in itself is not necessarily a particular discipline, but it's a set of tools that allow a discipline to be accelerated, such things as rapid DNA sequencing, methods for understanding an expression of genes and the functions of genes. Just a few of the predicted outcomes in genomics that affect our lives; the first is to do with health. As I mentioned, until recently, we only had knowledge of 1000 or so genes in the human genome, and only the function of a small fraction of those are known. Yet all of the pharmaceuticals, all of the medical sciences was developed on the bases on that fairly limited bit of information. Imagine going from that to having all the information available. What it creates is the opportunity to go from a medical science, which is based on treating symptoms of diseases to actually treating causes of diseases. Medicine typically deals with symptoms. Symptoms can be categorized and treated with a set of pharmaceuticals and other treatments. Typically, symptoms have different reasons for different individuals, because we're all genetically different and we all have our own life histories. So, currently, there are huge investments in the pharmaceutical industry to utilize genomic information, to create a new wave of pharmaceuticals, which will be based upon the causes of disease and tailored to the individual, such that the effectiveness should increase and the side effects should decrease.

The second has to do with agriculture. Most people, I don't think, realize this and this is probably part of the reason there is such concern about genetics and genetic engineering of plants and animals, but agriculture and its basic sense is not a natural proposition. Humans only began having settled agriculture, some 10,000 years ago. Prior to that, there were no domesticated plants or animals and the process of domestication itself created a very abnormal situation for the earth. That is, we take a few selected species, select them to produce something we want as human beings, but not necessarily beneficial for the plant or animal, and then produce them over a very large acreages throughout the world at the expense of the native fauna and flora. Now I'm not maligning agriculture. We would not exist as a cultured society without it, but this is the underpinning of our existence and the price is fairly high. You can't have escaped the knowledge that a lot of the groundwater pollution and chemicals that wind up in our life cycle come through agriculture usage. Without these chemicals and processes we could not produce food that feeds the world.

But as we gain knowledge of the genomics and genes of plants we have the opportunity to produce plants that can protect themselves naturally, from environmental dangers such as pests or diseases or insects or utilize the natural nutrition in the soils more effectively. We'll soon have a complete sequence of a plant genome. We will finish within six months, and the possibilities for producing plants that have either improved nutritional values or able to produce with less petroleum pesticide input is very likely.

The second has to do with the basis of manufacturing. If you ask, what has really propelled the modern society, a lot of it has to do with petroleum both as an energy source and raw material. A large portion of the things we manufacture comes from petroleum and petroleum, as you may know, is an organic chemical. But it is one for which there is a limited supply, and the cost of extracting it, shipping it and working with it can be high, both environmentally and just in terms of cost itself. But these organic chemicals that are found in the petroleum with which we modify petroleum can all be produced through life forms. In fact, plants have all the building blocks to make any organic chemical used for any manufacturing process; so the long-term source of our manufacturing materials will come from plants which are the only renewable resource that can harvest the sun's energy and not from petroleum. Through this knowledge of the genes of plants we will be in a position to create these plants and microbes as renewable biofactories to produce tailored organic chemicals.

The fourth has to do with meeting the world food needs. Cornell has especially been a university that has been invested globally in agriculture, has a long standing history in international agriculture, and we have great purpose as a university and as individuals to be concerned with the world food supply. You're all familiar with the green revolution which took place in the 1960s, which greatly increased food production and saved many lives and turned a number of cultures around. This was done through two processes. One was genetics through plant breeding, which is a genetic process and the other is through doing that process in conjunction with a greater use of fertilizers and pesticides that would allow production, a much more intensive production.

The next Green revolution will not take place in that way. It will have to take place through genetic modifications, because we can't first afford the petroleum input, nor the environmental cost of that.
The final thing is more difficult to put your arms around, but it’s nonetheless more real. As any society or any time in history that we’ve had fundamental discoveries about things that affect our perception is change our view of life from the discoveries that earth is no longer believed to be the center of the universe. This is a very profound change in how people thought of themselves, as was the Darwinian theory of evolution that we all have some relationship and that life is change. We are about to unravel the blueprints of a large number of organisms and what this does initially, is to make us realize that everything is related. All of us are related to each other, even though we have diversities, and we’re related to every other life form on this planet, instead of sequences coming from genomics that allows us to understand exactly the relationship and exactly how genes have been shared between individuals, between species and through time. It’s very likely, our basic understanding of ourselves and life, where life came from, and perhaps where life is going will change fairly rapidly over the next 20 years.

That was a very long backdrop to what Cornell should be doing, so I’ll try to make this short. Cornell, as a leading research and education institution, has to have an interest in what’s taking place in the life sciences. When a field changes so rapidly and dramatically as life sciences has now, through genomics, it creates both risk and opportunities. The opportunities of course are a huge acceleration in understanding and the by-products of that understanding and to be a place where that can happen. The risk is that we aren’t the place where that happens, and we become spectators in one of the greatest scientific revolutions ever.

We’re not alone in this possibility and risk situation. All universities have the same problem and possibility. All of them will become obsolete to some extent, if they do not change their course and take on a new perspective to life sciences.

I have been acting chair for a group of faculty, which is comprised of representatives from 20 departments and six colleges on campus, which started three years ago began to develop the concepts of how universities like Cornell should proceed in the future with respect to life sciences in light of the genomics revolution. What we propose is a new initiative called the genomics initiative, which would do a number of things.

First to point out why should Cornell be positioned to try to take a leading position in research and education in life sciences and genomics. The first has to do with our breadth. We’re a very broad-based university. We have animal plant and microbe research. We are a land grant institution involving agriculture, and biological sciences program, which is very broad, engineering college, which is very well situated, has developed many new technologies related to other things besides life sciences, and it’s now investing very heavily in life sciences through its nanobiotechnology. We have the college of medicine and the veterinary college. We also have one of the strongest computing facilities in the nation, a very strong computer science department at the Theory Center, which is a supercomputer facility. It would be very difficult to find any other university that had the possibilities of Cornell, in terms of life sciences. What we proposed is an initiative which has six thrusts; three would be based on biological themes: mammalian, which would include animal science, veterinary medicine, medical college – everything related to mammals, because information about sequences relate to everything. If you are interested in humans, you are just as likely to find discoveries working on a mouse or dog. Plant genomics, microbial genomics, two technology platforms – one is computational genomics; the other is technology and innovation, which comes out of engineering, and finally in a re-creation of our teaching program in life sciences to be much broader in a space involving engineering computation in the life sciences.

One aspect of this could also be outreach. As a society undergoes a transition into the post-genomics era, there are a huge number of questions, both philosophical and practical that we have a responsibility to address as a university, so we will have to be engaged in outreach programs. The program that has been proposed now ties together six colleges and two institutions on campus. One is the Boyce Thompson Institute and the other is the ARS Institute, as well as the six colleges I mentioned. This will be a program probably greater than any other in terms of tying together colleges. We are in the process of setting up outreach.
a joint recruitment of faculty, which are above the department level and in some instances, above the college level, so that we are recruiting people that would be much more interactive than they were in the past.

I have to give credit to administration. They have been very proactive about this genomics initiative and life sciences in realizing what's at risk and have changed dramatically and are changing dramatically the structures dealing with how departments and colleges work together to produce something that cannot be produced on a much more provincial level. The challenges we face is that we're not the only institution to realize this huge transition. This is from one of the most recent issues of the Chronicles of Higher Education in August.

There are at least six other institutions of similar size, if not similar possibility to Cornell, making very large investments in this area and Cornell is going to have to make both commitments in terms of its future and its planning, but also in terms of its resources and fund-raising to make this a reality.

Harold Tanner, the chair of the Cornell Board of Trustees attended the Corson Symposium to honor Dale.
Cornell has been characterized as the first American University because of the vision of its founding fathers in the last century with respect to equality of opportunity for persons of both sexes from all economic classes and ethnicities; and because it placed all knowledge, humanistic as well as practical technologies, on an equal, respectable academic footing free from any particular religious or philosophical framework. Dale Corson as well epitomizes these same values of fairness, egalitarianism, and respect for practical truths. So too in the latter part of the 20th century Cornell became the prototype for much of the research framework of the current American university. This framework draws upon the same fundamental egalitarian principles used by Ezra Cornell and Andrew D. White in founding the institution. I speak of the organizational framework which characterizes our large and most successful research centers, which has become the model used by many government agencies for distributing large fractions of their research funding to universities.

The story, as I understand it, begins in the late 50’s with a group of Cornellians including Dale Corson, Robert Sproull, Jim Krumhansl, and especially Henri Sack (who pulled the proposal together in 10 days) who established here one of the first three DARPA-funded Interdisciplinary Labs (IDL) in the country. The Materials Science Center (MSC), now known as the Cornell Center for Materials Research (CCMR), has survived with continuous federal funding for 38 years and has become, in my view, the university and national model for research centers. The unique features of the CCMR are embodied in its charter, approved by the University Faculty and the Board of Trustees. They include the concept of a “member,” the concept of an executive committee elected by the members, and the concept of a director appointed by the Vice President for Research. The central principle of egalitarianism is expressed in the member and elected executive committee concepts: Any member of the Cornell faculty who demonstrates by his/her record research interests that lie within the defined disciplinary scope of the center may become a member when his/her application is approved by the executive committee. The new member thereafter can vote in election of members of the executive committee. The executive committee, representing as it does the interests of the members, allocates the available funding in the center among its members based on the merits of proposals submitted by them. At any given time, many members receive no funding from the center, but the mix of those who are funded changes over time as new ideas emerge, as the materials field changes direction, and as the fields of faculty interest change with time and with the addition of new faculty people. The director, in the role of CEO, holds everything together and negotiates individually with members as funding allocations change. He maintains a collegial and respectful atmosphere in the center. He is appointed for a limited term (usually 3 – 5 years), and his appointment can be renewed – a process which involves a survey of member opinions.

From this organizational structure and philosophy we understand why such centers operate so harmoniously – no qualified person is excluded, no privileged class is created, all members have an equal voice, all can access and benefit from the shared, central experimental facilities which are operated by the center, and as a body they are a powerful force for attracting continued research funding to the University. CCMR funding has for some years been distributed primarily to groups of faculty. The Research Groups of 5 – 10 people are themselves interdisciplinary, and their membership and existence are fluid on the time scale of a funding cycle (3 – 5 years). This ensures that all center members have a pretty good idea of what their colleagues are doing, and can easily collaborate with them. The funding cycles themselves, which involve a national recompetition, ensure that research programs evolve dynamically and remain competitive on the national and international fronts.
The CCMR (formerly MSC) organizational format and philosophy has been the Cornell model over the years as new centers were created: Nanofabrication Facility, Theory Center, Biotechnology Center, Mathematical Sciences Institute, SRC Microscience and Technology. Important elements are shared with centers like the National Astronomy and Ionosphere Center (NAIC) in Arecibo and the Cornell Electron Storage Ring (CESR) in the Wilson Lab., both of which predate CCMR and have become more interdisciplinary over the years than they were at inception. Several of our centers also share an additional organizational feature: a blue-ribbon external advisory body called by various names, such as Policy Board, which in some cases may even have executive authority similar to a Board of Directors.

During the mid- to late 80’s, Cornell enjoyed remarkable success in establishing interdisciplinary research centers. Towards the end of that decade, Cornell was the number one recipient of NSF dollars and the number two U.S. Research University as measured by research expenditures. Perhaps for this reason, the National Science Board used the Cornell approach to centers as its model for a greatly expanded University Research Centers program. The Science Board held two meetings at Cornell, and took testimony from Cornell in at least two of its meetings in Washington. Subsequently, DARPA used the model in several of its University Center programs. Thus it was that the old MSC philosophy came to pervade Cornell and the nation.

A common feature in the establishment of centers at Cornell is that they almost universally originate as bottom-up efforts. The process goes something like this: A group of faculty sees an opportunity, or a need, and begins talking about an organization to facilitate their interaction and attract group support. Before the proposal stage, these discussions expand to include colleagues from other departments to achieve a large critical mass and define the common goals and good that the enterprise will serve. Frequently nowadays, the discussions expand to include colleagues from other universities, government labs, and companies, especially if the group intends to respond to federal funding initiatives for centers with a national scope. As John Silcox pointed out to me at lunch yesterday, interdisciplinary centers are very effective in finding new knowledge, but they also carry an overhead in faculty time and effort that makes such interdisciplinary progress more costly than work done in a single discipline – a fact not often recognized by funding agencies in their expectations of such centers.

To summarize the characteristics of Cornell centers, we can state that:

1) Many are supported by large block grants and use relatively small amounts of university funds.
2) Most are interdisciplinary and involve faculty members from several departments and more than one college.
3) Many provide shared research facilities, which allow many people access to equipment they could not procure if working alone.
4) They foster collaborative research projects involving several investigators.
5) They act as magnets to attract additional resources beyond the block grant.
6) They provide frequent external review and calibration.
7) Their continuity requires constant program evolution and change.
8) They welcome new members with common interests.
9) They play important roles in graduate education.
10) They are effective in all areas of scholarship: humanities, social sciences, and physical sciences.

Some benefits of the center mode of doing research include:

1) Cost-effective provision of expensive equipment or facilities, since investments benefit many people.
2) Cost-effective organizational structures, since usually the number of full-time employees is very small, and these positions can be terminated if the block funds are not renewed. Faculty members are not tenured into centers at Cornell. Center offices usually consist of a few rooms that can easily be adapted to other purposes. Even the central laboratory spaces can usually be used for
other activities. Thus, centers can be terminated gracefully if that is required, without loss of substantial investment, or they can be reincarnated in somewhat different forms. However, if managed with vision and supported by adaptive faculty members, they provide outstanding continuity in the midst of change, as witnessed by the 40- to 50-year lifetimes of some of our large centers.

3) If work is not of stellar quality, an automatic sunset is provided by loss of the block grant.

4) Centers foster mutual respect, a democratic atmosphere, and communication among their members; in short, collegiality.

5) They provide probably the best way to do interdisciplinary research.

6) Because of federal mandates, many of our centers now do an outstanding job of providing educational opportunities for undergraduates, and some are having very effective impact on K-12 education.

7) Centers are also cost-effective in other ways. Some provide capital facilities at no, or greatly reduced, cost. For example, all construction costs of the facilities in Arecibo, Puerto Rico, and in Jicamarca, Peru, are funded by NSF. About half the cost of Clark Hall was paid by the sponsor, as was nearly all of the cost of the Wilson Lab.

The University has done a creditable job of balancing priorities in allocating its funds for physical plants among the physical sciences and other disciplines. Several buildings have been built, in part, because of the needs of center research. These buildings include, for example, Rhodes Hall, Wilson Lab, Knight Lab, and the Biotechnology building. (A number of academic departments are also housed in these buildings.) The construction costs of these buildings total about $75 million. Their annual costs for maintenance and utilities (excluding Wilson Lab, where the utilities are paid by the sponsor) total about $2.7 million, some fraction of which is recovered by the University through the research overhead. In a comparable period, several buildings that might be likened to central facilities have been built for disciplines such as the humanities, the arts, and social sciences. These include the Johnson Museum, the Performing Arts center, the Kroch Library addition, Catherwood Library, and so forth. The Cornell construction costs of these buildings total about $71 million, and their annual operating costs total $2.7 million, none of which is recovered by overhead. These expenditures may also be compared with the $160-million construction and renovation costs projected for North and West campus student housing. It is plain to see that in allocating funds for physical plant renewal, the needs of both scholarship and the undergraduate environment are considered.

These are some of my views on Centers and their impact on collaboration, coordination, competition, collegiality, costs, and continuity at Cornell. I would like to congratulate Dale Corson and his colleagues of the 50’s who with such vision established principles for the successful and collegial conduct of interdisciplinary university research. I firmly believe that, if followed, the principles exemplified in the life of Dale Corson, and embodied in the CCMR charter, can insure the success of current initiatives and those of the next millennium.

Being a religious man, I also express my feeling that these same principles of fairness, respect, egalitarianism, inclusion, cooperation, open communication, and consideration of the common voice, have led to success through past millennia of human endeavor. And to return to the opening remarks of President Rawlings and his challenge relating to enduring principles of moral knowledge, I wonder if perhaps some humanists might endeavor to determine if there are any reasonable grounds for the statement I just made.

Thank you.
**Joseph M. Ballantyne**  
*“Centers: Collaboration, Coordination, Competition, Collegiality, Cost, and Continuity”*

Joseph M. Ballantyne received a Ph.D. from the Massachusetts Institute of Technology in 1964, and then joined the Cornell faculty. He has spent leaves at Stanford University as a National Science Foundation senior fellow, at the IBM Watson Research Laboratories, the University of California at Santa Barbara, the Technical University of Aachen, Germany, and the University of California at San Diego.  

He was instrumental in establishing the National Nanofabrication Facility at Cornell and served as acting director during the first year of operation in 1977. During subsequent years, he facilitated the establishment of five other national centers at Cornell. Ballantyne was director of the School of Electrical Engineering from 1980 until the summer of 1984, and Cornell’s vice president for research and advanced studies from 1984 through 1989. He led the institution to the rank of second in the nation in research expenditures. As a faculty member, he has supervised 31 Ph.D. theses.  

Ballantyne recently served as director of the SRC Center of Excellence for Microscience and Technology at Cornell and the Lester B. Knight Director of the Cornell Nanofabrication Facility. His current research focuses on the MOCVD synthesis of heterostructures in the AlGaInAsPN alloy system, techniques for the heteropitaxy of III-V compounds on silicon, and the design and fabrication of monolithically integrated optoelectronic circuits combining amplifiers, detectors, waveguides, and lasers.

**William G. Bowen**  
*Discussant, Symposium Session III*

William G. Bowen is president of the Andrew W. Mellon Foundation. Bowen was president of Princeton University from 1972 to 1988. He was a member of the Princeton economics faculty from 1958; he was director of graduate studies of the Woodrow Wilson School of Public and International Affairs from 1964 to 1966; and he served as provost from 1967 to 1972.

He serves on numerous boards, including those of American Express, Denison University, JSTOR, Merck & Co., Inc., Teachers Insurance and Annuity Association and College Retirement Equities Fund, and the University Corporation for Advanced Internet Development. He is a member of the American Economic Association, the Council on Foreign Relations, and the Industrial Relations Research Association. Bowen’s recent publications include: *The Shape of the River: Long Term Consequences of Considering Race in College and University Admissions* (co-authored with Derek Bok, 1998) and *Universities and Their Leadership* (edited with Harold T. Shapiro, 1998). [At the last moment, he was unable to attend the Symposium.]

**John Brademas**  
*“The Research University: Some Observations and Admonitions”*

John Brademas, president emeritus of New York University, served as president of the university from 1981 to 1992. During that time, he led the transition of NYU from a regional commuter school to a national and international residential research university.

Brademas served for 22 years (1959-81) as U.S. Representative in Congress from Indiana’s 3rd District, the last four as House Majority Whip. While in Congress, he earned a particular reputation for his leadership in education and the arts.

Brademas serves on the boards of Americans for the Arts, Kos Pharmaceuticals, Inc., Loews Corporation, and Oxford University Press U.S.A. He is a former member of the Board of Overseers of Harvard and of the boards of the Aspen Institute, the New York Stock Exchange, and the Rockefeller Foundation.
He is also chairman of the President’s Committee on the Arts and the Humanities, which in 1997 released *Creative America*, a report on ways of strengthening support, private and public, for these two fields. He is president of the King Juan Carlos I of Spain Center of New York University Foundation. Brademas is a fellow of the American Academy of Arts and Sciences and served on the Council of the Academy. He is a fellow of the National Academy of Education (USA) and a corresponding member of the Academy of Athens. Brademas has been awarded honorary degrees by 51 colleges and universities.

**J. Robert Cooke**  
**Moderator, Symposium Session III**

J. Robert Cooke, and American Society of Agricultural Engineers (ASAE) fellow, is a member of Cornell’s Agricultural and Biological Engineering faculty. His research and teaching in biomechanics focuses upon the study of plants as engineering structures. A co-author of nationally recognized software, he has a continuing interest in the uses of information technology in higher education. In his role as dean of the Cornell University faculty, he co-chaired the planning of this symposium.

**Vernon J. Ehlers, M.C.**  
**“Science, Policy, and Politics”**

Vernon J. Ehlers of Grand Rapids was first elected to the 103rd Congress in December 1993, in a special election representing the 3rd District in Michigan. Ehlers came to Congress following a distinguished tenure of service in teaching, scientific research, and community service. He has served on various boards and commissions and was a member of the Michigan House and Senate. The first research physicist in Congress, Ehlers has been recognized for his strong work ethic and proven leadership skills in his duties on Capitol Hill.

He currently serves as vice-chairman of the Committee on Science, where he has been appointed by House Speaker Newt Gingrich and Science Committee chairman James Sensenbrenner to rewrite the nation’s science policy. He has also introduced legislation that would ban human cloning. Ehlers has served on the Science and Transportation and Infrastructure Committee since his arrival in Washington. He is a member of House Oversight Committee; where he was tasked with revamping the House computer system and moving it into the 21st century.

**Ronald G. Ehrenberg**  
**“Why Can’t Colleges Control Their Costs?”**

Ronald G. Ehrenberg is the Irving M. Ives Professor of Industrial and Labor Relations and Economics at Cornell University. He is director of the Cornell Higher Education Research Institute and co-director of Cornell’s Institute for Labor Market Policies. From July 1, 1995, to June 30, 1998, he served as Cornell’s vice president for academic programs, planning, and budgeting.

Ehrenberg received a B.A. in mathematics from Harpur College (SUNY Binghamton) in 1966 and a Ph.D. in economics from Northwestern University in 1970. A member of the Cornell faculty for 24 years, he has authored or co-authored over 100 papers and books. He is a research associate at the National Bureau of Economic Research. He is president-elect of the Society of Labor Economists.

During the 1998-99 academic year, he wrote *Adam Smith Goes to College*, which deals with why selective private colleges and universities cannot seem to hold down their costs (forthcoming, 2000).

**Donald P. Greenberg**  
**“Virtual Universities: Real Boundaries”**

Donald P. Greenberg is one of the foremost pioneers in the emerging field of computer graphics. Since 1965, he has been researching and teaching in the field of computer graphics; he is primarily concerned with physically-based image synthesis and with ap-
plying graphic techniques to a variety of disciplines. His specialties include color science, parallel processing, and realistic image generation. He teaches computer graphics, computer-aided design, digital photography, and disruptive technology courses. Consistent with the interdisciplinary nature of the field, he is a member of Cornell’s faculty of architecture, faculty of computer science, and the Johnson Graduate School of Management. His application work now focuses on medical imaging, architectural design, perception, digital photography, and real-time photorealistic image generation.

Greenberg was the founding director of the NSF Science and Technology Center for Computer Graphics and Scientific Visualization. He is also the director of the Program of Computer Graphics and former director of the Computer-Aided Design Instructional Facility at Cornell University. He received the ACM Steven Coons Award, the highest honor in the field, for his outstanding creative contributions in computer graphics. He is a member of the National Academy of Engineering.

**Donald F. Holcomb**

*“Financing Cornell in the 21st Century”*

Donald F. Holcomb has been a member of the Cornell faculty since 1954. He served as chair of the Department of Physics in the years 1969-74 and 1982-1986. He became professor of physics emeritus in 1995.

Holcomb’s career ranged over a number of different aspects of a faculty member’s activities. His experimental physics research group centered its activities on studies of the electronic structure of metals, semiconductors, and intermetallic compounds. A persistent interest in improving the quality of teaching and learning in physics, particularly at the introductory level, led to extensive work with the American Association of Physics Teachers, of which he served as president in 1977-78. He received the Oersted Medal of AAPT for “notable contributions to the teaching of physics” in 1996. He is a fellow of the American Physical Society and of the American Association for the Advancement of Science.

Holcomb’s interest in long-range financial planning for Cornell was awakened during his term as a member of the Board of Trustees (1976-81). He served as member and chair of the Faculty Committee on Financial Policies in the early 1990s and as a faculty member of the Provost’s Budget Planning Group in 1993-94.

**Charlotte V. Kuh**

*“Graduate Education in Research Universities: A Look to the Future”*

Charlotte V. Kuh is executive director of the Office of Scientific and Engineering Personnel at the National Research Council. In this capacity, she oversees studies conducted by the NRC concerned with flows of science and engineering talent, graduate education and postdoctoral outcomes, and the assessment of quality of doctoral programs. She is also responsible for two large operational programs that select more than 300 postdoctoral fellows annually for positions in national laboratories and that select recipients for pre- and postdoctoral fellowship programs sponsored by the Ford Foundation and the Howard Hughes Medical Institute.

Prior to coming to the National Research Council in 1995, Kuh spent eight years at the Educational Testing Service, where she was director of the Graduate Record Examinations. During that time, she initiated the first computerization of a national admissions test and a program of research designed to introduce measurement of a broader range of student talents for use in graduate admissions.

Kuh has also served as a manager at AT&T, and she taught for five years at the Harvard Graduate School of Education and at Stanford. She received her B.A., magna cum laude, in economics from Radcliffe and
her Ph.D., also in economics, from Yale.

**Walter LaFeber**  
**Moderator, Symposium Session II**

Walter LaFeber is the Marie Underhill Noll Professor of American History and a Weiss Presidential Teaching Fellow. His publications include *America, Russia, and the Cold War* (8th ed., 1996); and *The Clash: U.S. – Japan Relations Throughout History* (1997). He was a member of the History Department when Provost, then President, Corson enabled the department to double in size and offer new fields.

**Fred Plum**  
**“Medical Neuroscience in the 21st Century”**

Fred Plum, M.D., professor of neuroscience, chaired Cornell's first Department of Neurology and Neuroscience from 1963 to 1998. His clinical observations and experimental studies continue and are mainly devoted to understanding how severe diseases or trauma damage the human brain, and seeking measures that may ameliorate or repair the destruction. Neuroscientific discoveries during the past decade have created astonishing possibilities for directly repairing and, possibly, regenerating defective parts of the injured brain.

**Frank Press**  
**Discussant, Symposium Session I**

Frank Press advises on R&D strategic planning; management and research scenarios for new undertakings in industry and academia; and international research opportunities.

Press was president of the U.S. National Academy of Sciences and chairman of the National Research Council from 1981 to 1993, and science advisor to the President of the United States and director, Office of Science and Technology Policy from 1977 to 1980. Prior to that, he was professor of geophysics at the Massachusetts Institute of Technology and chairman of the Department of Earth and Planetary Sciences. Press has also been professor of geophysics at the California Institute of Technology and director of the Seismological Laboratory. He is a life member of the Corporation of MIT and a board member of the Woods Hole Oceanographic Institution, the Marine Biological Laboratory, and the Monterey Bay Research Institute. He was the Cecil and Ida Green senior fellow at the Carnegie Institution of Washington from 1993 to 1997.

Press has been elected to fellowship in the American Academy of Arts and Sciences, the Royal Astronomical Society, the Royal Society (London), the Russian Academy of Sciences, and the Academie des Sciences (France). He is the recipient of 30 honorary degrees. Among his awards is the Pupin Medal from Columbia University. Press received the Japan Prize from the Emperor in 1993.

**Hunter R. Rawlings III**  
**“The Role of the Humanities in a Research University”**

Hunter R. Rawlings III, a classics scholar, became Cornell University’s tenth president on July 1, 1995. He also holds the faculty rank of professor of classics.

Rawlings received his Ph.D. from Princeton University in 1970, and is a 1966 graduate of Haverford College, with honors in classics. At Princeton, Rawlings was a Woodrow Wilson fellow and National Defense Education Act fellow. Rawlings came to Cornell from the University of Iowa, where he was president and professor of classics from 1988. Prior to that, Rawlings served for four years as vice president for academic affairs and research at the University of Colorado.

Rawlings was elected a member of the American Academy of Arts and Sciences in 1995. He has served
Frank H. T. Rhodes is professor of geological sciences and president emeritus at Cornell University, where he served for 18 years. Before assuming the presidency at Cornell in 1977, Rhodes was vice president for academic affairs at the University of Michigan.

Rhodes is a graduate of the University of Birmingham, England, from which he holds three degrees, a former Fulbright scholar and Fulbright distinguished fellow, a National Science Foundation senior visiting research fellow, and a visiting fellow of Clare Hall, Cambridge and Trinity College, Oxford.

Rhodes holds honorary degrees from more than 30 institutions in the United States and abroad and is a fellow of the American Academy of Arts and Sciences and the American Philosophical Society. He is a recipient of the Bigsby Medal of the Geological Society, the Justin Morrill Award of the National Association of State Universities and Land-Grant Colleges, the higher education leadership award of the Commission of Independent Colleges and Universities, and the Clark Kerr medal of the University of California, Berkeley Faculty Senate. He was the 1999 Jefferson Lecturer at Berkeley.

Rhodes is a former member of the National Science Board, of which he is a former chair, and a former member of the President’s Educational Policy Advisory Committee. He has served as chair of the American Council on Education, the American Association of Universities, and the Carnegie Foundation for the Advancement of Teaching. He has also served as a trustee of the Andrew W. Mellon Foundation.

Rhodes is a principal of the Washington Advisory Group, a member of the board of directors of the General Electric Company, and a member of the Board of Overseers of Koc University, Turkey. He is currently serving as president of the American Philosophical Society.

Robert C. Richardson
Moderator, Symposium Session I

Robert C. Richardson began work at Cornell University in the fall of 1966 in the laboratory of David Lee. Their research goal was to observe the nuclear magnetic phase transition in solid $^3$He that could be predicted from Richardson’s thesis work with Horst Meyer at Duke. In collaboration with Douglas Osheroff, a student who joined the group in 1967, they worked on cooling techniques and NMR instrumentation for studying low-temperature helium liquids and solids. In the fall of 1971, they made the accidental discovery that liquid $^3$He undergoes a pairing transition similar to that of superconductors. The three were awarded the Nobel Prize for the work in 1997.

Richardson is currently the F. R. Newman Professor of Physics and the vice provost for research at Cornell. In his more than 30 years at Cornell he has led an active research program in studies of matter at very low temperatures. In that time, 22 students have earned Ph.D. degrees while working with him. He has been active in teaching introductory physics throughout his time at Cornell. He prepared a series of videotaped lectures for Physics 101 and 102, the course for biology students in 1985. Richardson co-chaired the planning for this symposium.

Steven D. Tanksley
“The Genomics Revolutions: What Role for Cornell?”

Steven D. Tanksley is the Liberty Hyde Bailey Professor of Plant Breeding at Cornell University, where he has been a faculty member since 1985. He received his B.S. in agronomy in 1976 from Colorado State University and his Ph.D. in genetics from the University of California at Davis in 1979.

Tanksley is currently serving as chair of the Cornell Genomics Initiative, a new program to enhance and accelerate biological research and training through an intercollegiate program. The initiative involves most of Cornell’s colleges, both in Ithaca and New York City, and will provide an innovative platform from which scientists and students can explore life processes in a new and highly interactive manner.
Plant breeding depends on the segregation and recombination of genes located in the chromosomes. The Tanksley laboratory is interested in understanding how plant chromosomes are organized and function at the molecular level. The lab is also using molecular biological techniques to develop high-resolution genetic and physical maps of plant chromosomes to be used in gene isolation by chromosome walking procedures.

Joe B. Wyatt
“The Government University-Industry Research Nexus”

Joe B. Wyatt is chancellor of Vanderbilt University in Nashville, Tennessee. Much of his earlier career focused on computer science and systems, beginning at General Dynamics Corporation in 1956; continuing in Symbiotics International, Inc., a company he co-founded in 1965; and then at the University of Houston and Harvard University. In addition to holding faculty positions, he was also associated in various capacities, including president and CEO, with EDUCOM, a consortium of 450 universities that developed computer networks and systems for sharing information and resources. In 1976, he was appointed vice president for administration at Harvard and was named to his present position in 1982.

Wyatt has carried out research on behalf of the National Science Foundation, the Ford Foundation, the Office of Naval Research, and the Eli Lilly Foundation, among others. He is a patentee and consultant in computer system design and computer networking.

He is co-author of the book Financial Planning Models, and the author of numerous papers and articles in fields relating to technology, management, and education. The recipient of a number of awards and honors, he is a fellow of the American Association for the Advancement of Science, and a member of Sigma Xi, Beta Gamma Sigma, and Phi Beta Kappa. Currently he is chairman of the Universities Research Association and the Government-University-Industry Roundtable.

Symposium photo credits: University Photography: Frank DiMeo (Ballantyne, Cooke and Richardson), Russ Hamilton (Ehrenberg, LaFeber), Robert Barker (Rawlings, Rhodes); Charles Harrington (Tanksley), Div. Rare and Manuscript Collections, Carl A. Kroch Library (faculty meeting)
Preface

On December 1, 2004 President Emeritus Dale Corson was inducted as the second member of the new Hall of Fame being created by the Cornell Center for Materials Research in Clark Hall. Corson, who joins the founding director Robert L. Sproull in the Hall of Fame, was instrumental in the creation of the Center. Also present for this event were President Lehman and Presidents Emeriti Hunter Rawlings and Frank Rhodes.

http://ecommons.library.cornell.edu/handle/1813/3761 and a DVD: Corson: Cornell Center for Material Research Luncheon.

The video includes speeches by President Lehman and Vice-Provost for Research Robert C. Richardson, whose Nobel Prize work in low-temperature physics was done at the Center. Professor Neil Ashcroft, former Center director, was moderator for the ceremony.

The transcripts for Ashcroft’s introduction and Corson’s response are included in this book and on this DVD.

Remarks by Neil Ashcroft
Remarks by Neil Ashcroft at Dale Corson’s Induction into the Hall of Fame of the Cornell Center for Materials Research

President Lehman, president’s wife Kathy Okun, President Emeritus Dale Corson, Nellie, the Corson Family, and distinguished colleagues and guests, on behalf of Professor Frank DiSalvo, the director of the Cornell Center of Materials Research, and Dr. Helene Schember, the associate director, I want to welcome you to Clark Hall. And if I may call it that, the Center for Materials and Condensed-Matter Sciences at Cornell University.

We’re actually here to thank Dale Corson for making this so. And over the time that has elapsed since then, for making the effort in the materials and condensed-matter sciences at Cornell a true model for the nation.

Our late colleague James Krumhansel — once, as you may remember, president of the American Physical Society — was fond of two phrases that I think puts it all very well. He used to say, “If it isn’t matter, it doesn’t matter.” But I think even more prophetically, he used to say, “Everything is made from something.” And the something, especially nowadays in the form of modern materials in often of immense complexity, is what today’s recognition of Dale is really all about. For he had the vision and leadership at a true watershed moment for this nation. Dale came to Cornell around 1946 — not long after the publication of that superb document by Vannevar Bush entitled “Science, the Endless Frontier.” And that document was instrumental in establishing the National Science Foundation.

And the National Science Foundation has been absolutely crucial to the research history of Cornell University through the foundation of the Materials Research Lab here, and also through the establishment of major instrumentation projects.

We’re here to thank Dale because at key moments like this it is important to have key people in the right place and at the right time. And Dale’s role in recognizing the likely ongoing impact of the foundation and the other agencies in support of the material sciences and condensed matter sciences has been absolutely immeasurable.

Vannevar Bush said in a word that the government must support basic science because it is eventually useful. And having someone who appreciated that fully and took it at more than face value, right here at home, and forming a model for the nation, is something for which we’ll always be grateful.

So we’re going to hear more about this in a few remarks from Vice Provost Richardson and the President.

And I’ll turn it over now to the Vice Provost for Research, Robert C. Richardson.

Note: This speech and those by Vice Provost Richardson, President Lehman and Dale Corson, as well as additional background on the history of the CCMR are contained on the DVD: Corson: Cornell Center for Materials Research Luncheon and are online at: http://ecommons.library.cornell.edu/handle/1813/3761
Preface

This is Dale Corson’s response when honored as the second member of the Hall of Fame of the Cornell Center for Materials Research on December 1, 2004. The ceremony was attended by the other three living Cornell presidents.

A DVD and online video of this speech can be found at:

http://ecommons.library.cornell.edu/handle/1813/3761/browse-title

Rare group photographs of half of Cornell’s twelve Presidents – sixth through eleventh – are included herein.

Online resources at the Cornell University Library include:

Inaugurating its Presidents

http://rmc.library.cornell.edu/presidents/view_item.php?sec=4&sub=27

Office of the President

http://www.cornell.edu/president/history_bio_corson.cfm

Cornell’s Twelve Presidents

http://rmc.library.cornell.edu/presidents/view_item.php?sec=3&sub=15
President Lehman, Vice Provost Richardson, Professor Ashcroft, ladies and gentlemen.

Let me say at the beginning that Jeff Lehman graduated from Cornell in my final commencement. When he arrived as President I gave him just one piece of advice: “Do not let your picture be taken when you are standing beside Hunter Rawlings.” I was with him a month ago when he completely ignored that advice. You can see that my ideas are not necessarily adopted.

I am honored by what you are doing today and I thank you. I am also embarrassed. What you did for Robert Sproull was just right and you should have stopped while you were ahead. Sproull, with the help of a few others, not I, was responsible for the great features of what is now the Cornell Center for Materials Research.

I will speak briefly about the origins of the MSC, as we called it in earlier days, and then I will relate two or three personal experiences that influenced my thinking about multi-disciplinary programs.

I will begin by pointing out that my work before and during World War II left me widely acquainted with the scientific community in this country. I came from the University of California at Berkeley and it was the center of the nuclear physics world pre-WWII. Everyone came through there, some for short visits, some for longer. Niels Bohr came, Enrico Fermi came, hundreds of others came. I was at least acquainted with most of them.

When war was imminent we moved to MIT and the Radiation Laboratory where I helped develop microwave radar. All the physicists in the world seemed to be there or about to be there. I was working on a piece of the effort that put me in frequent touch with the industrial laboratory world — Bell Labs, GE, Sperry Gyroscope, Westinghouse; and with the US Army Air Corps (the U.S. Air Force was not invented until after the war) in the field and in Headquarters in Washington. After two years at MIT, and with Pearl Harbor a year behind us, we moved to Washington, where I worked in the Air Corps Headquarters in the Maritime Building at 1818 H Street, which has been the official address for the World Bank in more recent times. My office mate was Col. Edwin E. Aldrin, the father of Buzz Aldrin of moon landing fame. I moved to the Pentagon when it opened in January 1943. I was an MIT liaison person with the Air Corps. After a few months I transferred to the War Department (as it was called then) and became a technical advisor to a General who was responsible for new developments relevant to the Air Corps. It was part of my job to stay in close touch with all the laboratories, industrial and academic, whose work related to the Air Corps mission.

Just before the end of the war we moved to Los Alamos, where I was plunged into the midst of another large group of scientists devoted to wartime activities. I stayed there a year, organizing the Sandia engineering Laboratory in Albuquerque, now the largest of the 700 governmental laboratories around the country.

When we came to Cornell in the fall of 1946, after 5 1/2 years of war work, I knew personally a large fraction of the country’s scientists who had been engaged in war work. When those people started coming to Washington to leadership positions in NSF when it was formed, in ONR, and in other funding agencies there was a good chance that I knew them. Those personal relationships opened many doors.

In early 1959, when I was Chairman of Physics, one of my friends (Don Stevens) on the AEC staff called me about an inter-agency group that had been working to develop a government-sponsored materials research program whose home was to be in the DOD in ARPA. Its announcement in the Federal Register was imminent. Stevens told me it would be worth my while to learn about it as soon as possible. I went to Washington almost immediately for a day or two. I went out to Gaithersburg where the AEC had just moved and talked to Stevens and his associates for most of a day. I may have talked to some people I knew in DOD.
When I returned home I went to see T.P. Wright, our Vice President for Research, to tell him what I had learned in Washington. I took Henri Sack, from Engineering Physics and Robert Silsbee from Physics with me. I explained the kind of interdisciplinary program we could submit. He gave me a green light and I asked Henri Sack to take the initiative. A few months later, when Robert Sproull returned from a year’s leave in Europe, I asked him to take the lead and he and Henri developed a proposal to do what we have done so successfully over the past 45 years. I should also include James Krumhansl among those who contributed so much to our initial effort. Jim, incidentally, died a few months ago and Los Alamos is organizing a one-day symposium in his honor for January 12.

I believe my first exposure to a well-developed concept of a multidisciplinary Center came from Mario Einaudi in the Government Department. It must have been in late 1958 or early 1959 when Mario asked me to have dinner with him one evening where he and his colleague Steven Muller explained the Center for International Studies Mario wanted to develop. He sought my support and he received it.

When Tom Gold came in 1959 to take over our one-man Astronomy Department we sought a way to bring some disparate programs in Physics, Astronomy and Electrical Engineering together in some workable way. We created the Center for Radiophysics and Space Research – CRSR. This may have been the first fully operational multidisciplinary Center at Cornell. It was smaller and more manageable than MSC or CIS were going to be. It continues to function today.
I became Dean of Engineering in the summer of 1959 and early on a fifth year Architecture student I knew asked me to be his client for a 5th year design project all architects had to undertake. I asked him to design an engineering research building on Hoy Field. He did a fine job of it except for one thing. Right in the middle of the building there was a long oblong box-like structure I did not understand. He explained that the box was symbolic of the engineering features of the building and they would be the responsibility of engineers and would have nothing to do with the design of the building.

I had a hard time accepting this concept. I thought the engineering design had everything to do with the overall design.

After thinking about this problem for a time I went to both the Civil Engineers and the Architects and proposed that we develop a joint Structural Engineering-Architecture program that would integrate the two fields. I got nowhere. Each side told me that they already had more than they could handle and they had no time to think about anything else. I did not buy that but I learned how ineffective a dean could be sometimes.

Later, Don Greenberg came to me, probably in the 1960s or early 70s when I was in 300 Day Hall, with his proposal for a Computer Graphics program, bridging several disciplines including architecture, where Don was a faculty member after completing his Ph.D. in Structural Engineering. His proposal had been rejected by both Architecture and Civil Engineering. I embraced both Don and his idea. I do not remember how much funding I provided but it matched a significant fraction of the contingent funds he had from elsewhere for the initial effort.

I had another important experience about that time. In 1962 I worked as a Ford Foundation consultant studying some Engineering Education problems. Beginning in the spring, before the semester ended, going through the summer and extending into the fall, I visited 17 universities and spent two or three days at each, studying their engineering programs. The senior Ford official responsible for this effort helped me select the universities, seeking to include some that we believed were probably the best in the country and including some that we thought were the weakest. I went all the way from MIT to Stanford and from Arizona to Minnesota. I looked at the large machines involved with Electrical Engineering power programs. I also looked at one EE department where the largest machine in such a laboratory was 1/15 hp. I looked at the two-story high reactor devices in Chemical Engineering Departments and I looked at other departments where the comparable devices fit on a table top. I talked to one dean who wanted to miniaturize all his engineering laboratory equipment.

I returned from that experience with many new ideas about engineering education and believing that there was a great deal that the profession needed to change.

I undertook to sell a combined sanitary engineering and chemical engineering initiative, believing that we would have a great deal of toxic waste to cope with. I might as well have been trying to sell the Brooklyn bridge. There was no way we were going to put the Cornell seal on a civil engineering graduate unless he had gained competence in structural, sanitary, highway, surveying, and all the other civil sub-fields. I came to believe that our Cornell engineering education, aimed largely at undergraduates, was not going to get the job done in the latter third of the 20th century.

At about this time, in the early 60s probably, I was beginning to get questions from my friends in federal funding agencies about bringing all our academic disciplines to bear on big societal problems. “If you are going to tackle environmental problems why don’t you involve lawyers and economists?” I had much to think about.

There were several other multidisciplinary thrusts along the way – in environmental fields, in water resources, in other critical areas. Generally, where there was adequate funding they succeeded. The others failed and had short lives.

One final multidisciplinary effort during my time. It came just at the end of my tenure as President. NSF sponsored a competition and solicited proposals for a program to further reduce the size of condensed matter electronic devices, to further reduce the scale of complex integrated circuits on a single silicon “chip” the size of a finger nail. I remember discussing with Tom Everhart, when he was Dean, the problems of placing a million transistors on a single chip. Not only did the physical scale have to be reduced but the complex information handling and data transfer problems had to be dealt with. He wanted me to try to recruit someone I knew who could help make all this happen. I tried and failed. I could not find a position for the prospect’s wife. These days you do the million transistor trick before breakfast. Now it’s the hundred million and the billion that are the problem. People have demonstrated “gates” that let through a single electron at a time. The “nano” world is here.
But back to 1977: to respond to the NSF solicitation Joe Ballantyne was selected to put together a proposal. When he had it all together it was staggering to see what we had the capability to do when we brought all our disciplines together. We referred to it as the sub-micron project. A micron is a thousandth of a millimeter or 1/25,000 of an inch. That was about the spacing of circuit elements on the integrated circuit chips of the day.

I committed 750,000 Cornell dollars to match some of the NSF dollars. I was traveling somewhere when some crisis arose that called for more Cornell dollars and Dave Knapp, the Provost, committed another $250,000.

With Joe Ballantyne’s great proposal we won the competition. Our competitors at the end were the University of California at Berkeley and the University of Utah. Tom Everhart organized the Berkeley proposal and when he lost the NSF competition he accepted our offer of the Engineering deanship. If you can’t beat them, join them. He went on from here to be Chancellor of the University of Illinois at Urbana and then President of Cal Tech in Pasadena.

When Robert Barker was Provost here in the mid-80s some of our centers were not running smoothly and he appointed a committee to look at the problem and tell him how to cure the troubles. He asked me to Chair the effort. We wrote a substantial report and identified some of the trouble spots. We tried to write a general report that would deal in a comprehensive way with Center organization and operation. In the summer of 1994 UCLA organized a symposium on “Reinventing the Research University.” Kumar Patel was the Vice Chancellor for Research at UCLA and he was the organizer of the symposium. Kumar was a long-time Bell Labs leader and the inventor of the high power CO2 laser. I was invited to the affair and since I had written the report for Provost Barker I distilled it into a paper on “Interdisciplinary Centers in a University”. It was included as an appendix to the book that constituted the report on the symposium. It discusses some of the problems that can arise in the Center setting.

I thank you for what you have done today but it was unnecessary. The privilege of working with the people who made CCMR happen was enough. Thank you.

Dale Corson

December 1, 2004

Credit: All photos at CCMR Luncheon are by Jon Reis.
A half-century of Cornell presidents (six thru ten) in 1995

The living Cornell presidents (eight thru eleven) gathered to honor Dale Corson in 2004
Preface

“Campus disorders deriving from the Civil Rights issues or the Vietnam War began at Cornell in the spring of 1965 and continued to the spring of 1976. Dale will cover some of the major protests and how they were managed (or mismanaged). He was either Provost or President from 1963 to 1977. He will describe the burden of dealing with building occupations, rallies, threatened violence and marches.”

from Lyceum Presents poster for a lecture by Dale Corson at Kendal at Ithaca on May 31, 2007. Corson was introduced by Marian McPheeters.
Introduction. When Marian asked me to speak, I thought I could talk about the campus unrest in the 60s and 70s in a disinterested, objective manner, but it has not turned out that way. It has become a highly personal statement built around what I saw and what I did during those difficult days. Since I was the de facto crisis manager during much of the six years I was Provost and the de jure manager during the eight years I was President, perhaps it was inevitable that it would be about what I saw and did. I make no claim for having done it right. There are many things I would do differently if I were in a position to do it over (although I would never want to be in that position). I was simply the person who was there, sitting at the same desk doing more or less the same things for 14 years. The chair I sat in became, necessarily, the hot seat.

The national and international context. Student revolts the world over, protests against situations perceived as unjust, are common, but the degree of protest and the extent of the protests reached historic levels in the 1960s and 70s. Each country and each campus had its own protest issues. At Cornell the protests were largely about civil rights and the Vietnam War. All American students were vulnerable then. Black students had lived all their lives against a backdrop of lynchings and Jim Crowism. All students lived under the threatening cloud of the draft. They were being asked to put their lives on the line for a cause they did not support; 58,000 young people paid the ultimate price. In other countries young people were jousting with repressive governments, poverty, and social injustice. They struck out at authority wherever it might be.

The protests were worldwide. We read in the newspapers about French students blockading Paris streets. When my wife Nellie and I went to see the University of Tokyo during a 1968 visit to Japan, we discovered that the university had been closed for months. I traveled frequently to South America in the 60s and I watched the intense protests, particularly at San Marcos University in Lima, Peru, the oldest university in the western hemisphere, and at the University of Buenos Aires in Argentina. I believed that such things could not happen here. Some protests continued longer in other countries than they did here. The biggest trouble of all was the Tiananmen Square massacre in Beijing in 1989, a decade and a half after our campuses became relatively quiet. I knew the Chinese situation well from my advisory role in administering a large World Bank Loan to strengthen Chinese universities. Forty-six students died in the Square that night and hundreds of others in surrounding neighborhoods. In watching a TV program a day or two later, I saw soldiers in the back of a truck open fire on bicyclists and pedestrians on the sidewalk in front of the Beijing Hotel, where I had stayed a few times during the previous seven years.

In December 1964 the Free Speech Movement at the University of California at Berkeley hit American newspapers and news broadcasts. The trigger event at Berkeley was the refusal of the University administration to let students distribute protest literature at a prominent place on the edge of the campus. A student leader named Mario Savio organized a takeover of the University administration building. The students marched in, singing as they went, led by Joan Baez, whose father was a professor of physics at Stanford.

Ed Meese, later Reagan’s attorney general, was the district attorney of Alameda County, and he came on the campus with an army of police who carried the students out of the building, four police officers for each student. It was not a pretty scene.

American protests took many forms. There were rallies, large gatherings of students, often out-of-doors, discussing their issues with public-address systems or bullhorns. There were often marches, usually to a rally somewhere. In Ithaca there were marches downtown to Dewitt Park, near the Presbyterian and Baptist churches, where speakers addressed the assembled crowd. Occupying
the president’s office was a common tactic. Occupying a whole building was sometimes the tactic. Student strikes closed some campuses. Sometimes the events turned violent, and in some cases, fatalities followed. There were four fatalities at one of the traditional black colleges in Spartanburg, South Carolina. There were two at UCLA, two at Stanford, two at the University of Kansas, one at Wisconsin, and there was Kent State, where four people died. Fortunately, there were no fatalities at Cornell.

**The Cornell context.** The first Cornell protest in this era was in March 1965 by a group of students who called themselves “Students for Education.” The last was an occupation of my office in April 1976, eleven years later, by a group of black students protesting the dismissal of a black student employee for failure to perform his duties. What I tell you about today is a sample of what transpired during those eleven troublesome years. There were many, many more protest events.

The Students for Education sought to correct what they saw as deficiencies in Cornell undergraduate education, such as the use of teaching assistants with inadequate command of English. They staged a rally one night in March 1965. I was provost of the University at the time, and the president was James Perkins, who had come to Cornell from the Carnegie Foundation a couple of years earlier. On the morning after the rally, President Perkins came into my office at about eight o’clock, threw the *Cornell Sun*, with its big headlines about the rally, on my desk and said, “This is your problem. I’m going to New York.” By pure coincidence, the rally was the day before the beginning of a big Cornell Centennial celebration in New York City at Lincoln Center. The celebration was a gala affair, including the premier performance of a symphony composed by one of the Cornell music faculty members on a commission from the New York Philharmonic. Other events followed on subsequent days.

So here I was, early on a March morning, with a budding student revolt on my hands and with no experience in, and no qualifications for, managing such a disruption. I was the wrong person at the wrong place at the wrong time. I sat there for perhaps 20 or 30 minutes, asking myself how to proceed. Should I ignore the whole affair and go about my business? Should I get involved to try to learn what the issues were and what might be done about them?

The president of the University of California system was Clark Kerr, a man who was already a leading spokesman for higher education, but he had developed something of a negative reputation by staying away from the campus during the few months since the Free Speech Movement took root. I decided that I had to get involved, so I gave my secretary the names of four or five students, identified by the *Sun* as the leaders in the rally, and told her I wanted them in my office at 10 o’clock. By some miracle, she had every one of them there. I had the dean of students and the dean of faculty with me. The practice of getting to know the protestors was one I followed for the entire eleven years of the troubles.

The first hour of discussion was confrontational. The second hour began to identify issues. The third hour developed an agenda to guide the activity we proposed to initiate.

We pursued that agenda for the remainder of the semester, and at the end of the semester four of the students, two women and two men, invited Nellie and me to dinner one evening at a student apartment in Collegetown, and it was a fine dinner. I have since learned that we surprised them by accepting the invitation.

The young woman who was the chef that evening is now the dean of the Law School and the executive vice-president of George-town University. She served one five-year term as a Cornell trustee. I met one of the men, quite by chance, in Washington once, and learned that he was an official in one of the big political polling organizations.

During the protest years, many people were involved on the University side and many of the policies adopted were the work of many people. During this period, I had the help of Keith Kennedy in some of the events, particularly those having to do with minority students and civil-rights issues. I had learned long before that I would profit by Keith’s help wherever I could get it.

The protest kettle came to a boil, and along the way there was one event that would have been amusing except that in the skirmishing, the head of the Campus Police was fired, not by me, but by someone else with administrative authority. This was the *Trojan Horse* episode. The *Trojan Horse* was a student literary magazine, and in one issue the chief of Campus Police believed a piece of fiction was pornographic and that he had the right and the duty to prevent its circulation on the campus. Without talking to anyone, he ordered his people to seize all the copies they could find. Then the district attorney entered the fray by coming on the campus with the Ithaca police. Students surrounded the police cars so they could not move, and let the air out of the tires. The campus exploded over confiscation of the magazines, and the faculty stormed my office demanding action to restore free speech.

When it was all over, I consulted the local New York State Supreme Court judge, whom I knew, and discussed with him how to deal with such situations. He was quite relaxed about the whole affair, somewhat amused, and believed that a little experience was a good thing for the D.A. I then sought out the D.A. I did not have to tell him that his tactics had not worked. We discussed the campus ethos and the reasons for the emphasis on free speech. He has since told me that those discussions had been a valuable part of his education. Whenever I am at a reception where he is present and where there is a pay-as-you-go bar, he buys me a martini.

The most tragic event during my time in office was a fire, having nothing to do with protests, in an off-campus residential unit, in which nine people died. It was an arson case and its origin in a bottom-floor lounge was easily established. The deaths came from breathing toxic fumes created by burning plastic sofa covers. I did not arrive at the scene until the fire had been extinguished, but the bodies were still scattered in the hallways where people were overcome. One of the victims was a young faculty member who,
with his wife, had house-sat our house one summer while we were away. Another victim was a student from Finland. Before that
day was over, I had talked to the Finnish ambassador twice and to two other Embassy officials once each. Many diplomatic protocols
and international legalities were involved.

One of the heroes of the residential fire was Dr. Henry Humphrey, a fellow Kendal resident, who lived near the building that burned.
He saved the life of a student and was almost overcome himself.

It seemed to be my misfortune for the president to be out of town at times of crisis and I was left to pick up the pieces. That was the
case with the fire. The president was attending a conference in Paris.

**Campus strategy.** By 1968 it was evident that we were going to have ongoing protests, and I made it my business to get to know all
the community police forces. My object was to negotiate an agreement with them, under which we would try to contain whatever
developed with our own campus police, but if events got out of hand, we would call them. They would come on the campus only
if called. I talked to the mayor of Ithaca, the district attorney, the police chiefs of Cayuga Heights and Ithaca, and the sheriff, and
received the assurances I sought,

My birthday is April 5, and some of the unhappiest events clustered around that date. The Residential Club fire was on April 5, 1967.
On April 4, 1968 we had the Economics 103 event. Economics 103 was a course taught by a visiting professor. Some of the black
students alleged that he made racist statements in his lectures, and then occupied the Economics Department office to protest the
statements.

The office had two parts, an outer part, where the secretary had her desk, and an inner office for the department chairman. I went
to the scene, taking the dean of the faculty with me. The outer office was filled with black students and the inner office by three or
four students and the department chairman. There had already been an unfortunate incident. Our campus police carried guns only
on bank runs, when they were transporting money for deposit in the bank. Otherwise, they were unarmed. In this case, they had
been called to the scene just after finishing a bank run. We had sometimes used the tactic of letting protestors leave the scene of
the protest but not allowing reentry. We invoked that tactic here.

The police sought to prevent one of the students from returning to the Economics office, and the student threw the policeman to
the floor. This dislodged the gun and it fell free. That inflamed the whole situation to a high level, just in time for my arrival on the
scene. I never wanted the police to interfere with any discussion I was having with students, and I asked them to retire to a lower
floor of the building. The discussion about racism in teaching economics lasted most of the afternoon without much progress to-
ward clarification of issues.

It is interesting to look at the academic performance of some of the students who were the leaders in raising civil rights issues to
the protest level. There was a widely held view that we were admitting unqualified minority students. The leader of the Economics
103 confrontation was an engineering student, carrying 18 hours of engineering courses, with a B+ or A- average. He was always
in competition for leadership of black students with another student who had been president of his entire freshman class. After
graduating from Cornell, the latter worked his way up the corporate ladder to be president of TIAA-CREF, the organization that man-
ages academic pensions, and then joined the City Bank Group, where he was the third- or fourth-ranking executive in what I believe
is the largest financial institution in the world. The Economics 103 leader left Cornell early in the spring of 1969. He later went to
medical school and became an ophthalmologist. He died from some rare disease.

**The campus scene.** When James Perkins came as president in 1963, the number of black undergraduates was no more than six or
seven. A number representative of the fraction of blacks in the total population would have been perhaps 2,000. President Perkins
looked at this as failure to serve the needs of the country, and decided that we had to have some program to attract able students
such as the Economics 103 leader and the former president of the freshman class, and give them the opportunity for a Cornell
education. Unfortunately, we did not fully realize the great pressure such a small group would experience in the world of white
faces they encountered once here. We committed ourselves to creating a black-studies center where any student, but especially
the minority students, could learn about the black heritage and explore problems in that heritage which needed study. It has long
been called the Africana Study Center.

Throughout this period of the late 60s and early 70s, we were beset by a continuous sequence of confrontations of one kind or an-
other. There were attempts to prevent the military or other governmental services from recruiting. There were attempts to prevent
corporations that did business in South Africa from recruiting. There were attempts to abolish ROTC.

One of our biggest problems was guaranteeing speakers who came to the campus the right to say what they came to say. The first
person who was severely heckled was Averill Harriman, former governor of New York and the person who guided the negotiation
of the nuclear test ban treaty in the early 1970s. Another was Dean Rusk, when he was Secretary of State in the early Vietnam War
days.

A group that did its best to make life complicated for me and others was the SDS, Students for a Democratic Society. This was a
white student organization. The leader of the Cornell chapter was a student who came to Cornell expecting to pursue a military
career as his father had. After a few years as a militant leftist, he turned so far right it was painful. I see him frequently these days, and I exchanged emails with him only about six weeks ago. He teaches in a community college in Los Angeles.

Coming back to April 4, 1968: I went directly from the discussion of alleged racism in teaching economics to the Statler to have dinner with the candidate of choice to be the next dean of the College of Home Economics. When I left that dinner, I learned that Martin Luther King had been assassinated. The next day, April 5, 1968, was a day of turmoil on the campus. I will say little about this sad day. The loss of Martin Luther King was a terrible loss for everyone, regardless of color.

In late 1968, a particularly militant group of black students gained control of the student organization representing them. I believe it was called the Black Liberation Front. They seized an off-campus house where an academic department had its headquarters. The students demanded a place to house the Africana Studies Center we were in the process of creating, and this off-campus building was their choice of a home. They occupied the house, forcing the occupants out, and placed a notice on the door saying that the building was now theirs. It was ironic that I had been working to relocate the people there and make the building available to the Africana Center. The students knew this effort was underway, but they apparently wanted the world to believe they were in charge. Keith Kennedy completed the relocation and the Africana Center moved in.

The black student leader called President Perkins at home, where he was in bed with the flu, to order him to appear in the house at a specified hour. Mrs. Perkins answered the phone and told the student that the president was going nowhere, and furthermore, she told him what she thought of him. She called me immediately to tell me what she had done, and as soon as she freed the line, a very angry black student called to tell me what had happened and ordered me to appear at the designated time. I agreed to go, and an involved faculty member went with me.

At that time, we had a six-foot-five, 230-pound black athlete named Harry Edwards as a student. He had been the organizer of the partially successful black boycott of the Mexico City Olympics some months earlier. He did not generally participate in the negotiations about Africana activities, but he was present at this particular meeting. They placed him between me and the door so I would not try to escape, something I had no intention of doing. In more recent times, Harry Edwards has been a professor of sociology at the University of California at Berkeley and has sometimes appeared as a negotiator in professional athlete labor disputes.

At the meeting in the Africana house, the faculty member and I were seated at a table before perhaps 50 angry students. The campus police were present, but I asked them to stay in the background. The purpose of the meeting was to tell us exactly what we were going to do to create the Africana Center, and how much money they were going to have to operate things themselves. What they proposed was not quite what we had in mind, but we listened. There was little discussion. They told us who was acceptable and who was not for the directorship of the Africana program. In the end, we organized the Center on our terms, with the leader we selected, and with the amount of money we had specified. I believe it opened its doors in the fall of 1969.

During those days, there were black students who came to tell me what was going on and their estimate of how it might play out. The campus police chief also had his informants in the group. At one point, I do not remember exactly when, the Black Liberation Front had a meeting to decide on some radical move that would have been unfortunate from my viewpoint. One of the students told me about the meeting and stated his intent to attend and then report to me what I should be prepared for. The student went to the meeting, was completely turned off by the discussion, and left in disgust before any decision was reached. So my intelligence was about as useful as the intelligence on weapons of mass destruction in Iraq.

A student I was particularly attracted to was the product of the inner city. I came to know him and he came to talk to me sometimes about the issues that concerned the minority students. One time he came for such a discussion and some of his fellow students learned about his visit and gave him a very hard time, presumably for consorting with the enemy. I learned that he was the oldest of what I remember as seven children in a one-parent family. I once wrote a letter to help him get a part-time job downtown. I learned about the issues that concerned the minority students. One time he came for such a discussion and some of his fellow students

The student was eventually selected, and with the amount of money we had specified. I believe it opened its doors in the fall of 1969. On the first day I presided at a lecture on apartheid by a black South African cleric. He was heckled mercilessly by a student I knew. I stopped the lecture, told the student that he was going to let the speaker finish what he had to say or the student was going to be ejected from the room. The speaker was able to finish his talk.

The climax came a couple of days later, when President Perkins was pulled from the podium and the microphone by a black student who had been the cause of growing concern over the previous few months. I had a black secretary, and the student sometimes came to my office and harangued the secretary about what he said I had to do. After the episode with the president, I came to believe that the student was capable of anything. Fortunately, he withdrew from the University before anything more serious developed.

Spring 1969. Tensions grew through the spring of 1969 and reached the climax in mid-April when black students occupied Willard Straight Hall during Parents’ Weekend, ejected the parents occupying the hotel-type rooms, and then, hours later, introduced guns
into the building. I am not going to say much about this episode. I could not relate a true story of events as I knew them without implicating some of the students in despicable behavior and impugning the integrity of some Day Hall staff. I have written some about this event, and those statements are embargoed for another 20 or 25 years.

A Cornell alumnus named Downs, who was an undergraduate in 1969 and is now a faculty member at the University of Wisconsin, wrote a book called Cornell 69 about the whole Willard Straight affair. He did a remarkable job of digging out the factual history of the event, but he drew conclusions I do not agree with. I know more of the motives and intent of the occupation than he discovered.

A number of the participants in the Straight occupation have had distinguished careers and are very able people. The leader of the takeover was the student I mentioned earlier, with a career that led him right to the top of the Citibank organization. Another from that time was the U.S. Attorney for the Eastern District of New York. Another was a partner in a huge law firm. One earned his doctorate in education and has had a distinguished career in educational testing. He has returned to the campus twice in the last couple of years, and I have spent time with him on both occasions. I had lunch with him here at Kendal about six weeks ago. The Vice Provost for Diversity at Cornell and the Director of the Africana Center are organizing a lecture program to bring some of the black alumni back to the campus to talk about their experiences. I believe the program will begin next fall.

Many years ago, I spent an hour or two with the former wife of the Straight occupation leader. The whole takeover had been planned in their living room in the married-student housing area. I asked her, “Why the guns?” She said the black students were being told that there was a conspiracy to round up black people in the North and imprison them in some big holding facility, and they were preparing to resist. I think the immediate motivation for taking the guns into the Straight was a rumor that they were about to be attacked by fraternity members.

On Monday following the Sunday withdrawal of the students from the Straight, the campus was tense almost to the breaking point. I called the supervisor of the state police in Albany to ask if the state police would be available if we needed them. He replied, “Just call me and you will see more state police than you have ever seen in your life and you will see them in 15 minutes.” A large group of deputy sheriffs from neighboring counties was assembled downtown. I never knew how many. I heard 200.

We knew about the guns, incidentally. Perhaps a week or ten days before, we had begun to get reports from gun dealers in this region telling us that Cornell students were buying guns and ammunition. We consulted the state police in Sidney, and a detective, perhaps from the Bureau of Criminal Investigation, came to the campus and told us we had nothing to worry about. Guns were being bought all over the North and were being shipped south.

The turmoil created by the guns and the Willard Straight event led to President Perkins’ resignation and my installation as president. I took over on July 1, 1969, although I was not formally elected president until September. I was never inaugurated. There was an Investiture ceremony at Commencement a year later, a Commencement accompanied by demonstrations and two attempts to take over the microphone. I was introduced by the chairman of the Board of Trustees as the Eighth President of the United States, and that relieved the tension.

President Perkins did not bear the responsibility for the campus disorders all by himself. None of us knew how to deal with the troubles. A whole generation of university presidents was sacrificed on the student protest altar. Cornell, Columbia, Duke, Stanford, Berkeley were examples. At Duke the protesting students occupied the president’s house when he was seriously ill and I believe he was carried out through the crowd of occupying students to a waiting ambulance. At the University of Oregon, an acting president appeared to have died by his own hand on the day following commencement in 1969. The second generation of presidents had the benefit of on-the-job training during the misfortunes of their predecessors.

We never had a student march on our home. One was planned for a Sunday afternoon, but it was a rainy day and the march was cancelled. We always prayed for bad weather in the spring. One year the biggest snow of the winter was on my April 5 birthday. That was a good year.

**Summer 1969.** In the early summer of 1969, after I had taken over the presidential duties, the executive staff held a two-day retreat at the Aurora Inn in Aurora, NY. We attempted to analyze our troubles and specify the steps that would get us headed back toward stability. We established the Cornell Chronicle and a new campus judicial system, and we installed a campus “blue light” telephone system, which enabled anyone to go to the nearest blue light and summon help or ask for an escort back to a dormitory. I met with every college and school faculty in the whole university that summer to discuss our problems and how we might deal with them. We installed a campus Ombudsman Office. We created a judicial advising system for students. We put in motion a plan for a Constituent Assembly to create a University Senate with representatives of students, faculty, staff, and administration to debate, discuss, and help direct the resolution of issues besetting the campus. Some of the most distinguished faculty in the University participated in the Senate. After a few years, people tired of the Senate and we dissolved it.

On April 1, 1970, there was another major campus trouble when the house occupied by the Africana Center burned — another arson case. I never learned the perpetrator. Detective work identified the place where the fire started and the accelerant used, but I never learned more. No one was injured in that fire.
Beginning in the late 60s and extending into the 70s, militant black groups, such as the Black Panthers, were a force in civil rights struggles, and their influence reached into northern university campuses. There was an FBI agent resident in Ithaca and I knew him well. He considered it part of his job to keep me informed. One time Bobby Seale, the Black Panther leader, was participating in some type of rally in New Haven, Connecticut, and police officials believed his next destination was Ithaca. Local police forces and I knew his every move. Fortunately, he had other destinations. I often knew things I thought I should not know and did not want to know. Sometimes, as in the Seale case, the intelligence was useful.

I have said nothing about drugs and alcohol to this point, but they constituted serious problems during those years. I saw bright, attractive, able college students completely destroyed by drugs. One student on drugs walked out of his fraternity house and straight into the Fall Creek gorge to his death. There were times when some students wore boots with a knife thrust into the top of a boot. We feared that such a student, high on drugs, might become involved in some controversy and try to resolve matters with his knife.

For a time, probably in the early 70s, a non-student spent his time sitting in Willard Straight Hall, the student union building. I knew from my FBI informant that the man had a prison record after conviction on a homicide charge. He was often high on drugs, and the longer the situation continued, the more concerned I became. I finally banned him from the campus. This led to severe criticism from some faculty members, who pointed out that a university is one of the most open and accessible institutions in our society and banning a person was intolerable. I stayed with the ban decision, and a few months later the man in question killed another man in Collegetown, over a drug deal.

**Spring 1972.** A disruption that had occasional light moments was occupation of the Engineering College library, in Carpenter Hall, by SDS students in the spring of 1972. I was attending a meeting of university presidents at Northwestern University in Chicago, when Cornell students marched from a big rally in front of Willard Straight Hall down what is now Ho Plaza and up the hill, presumably to protest something on the upper campus. When the march passed Carpenter Hall, the marchers turned into the building and occupied the library before security forces could take any action. The students chained the doors closed and access was only by ground-level windows.

My meeting at Northwestern had just finished a day-and-a-half session and was breaking for lunch when I was called to the telephone to be told about Carpenter Hall. Derek Bok, president of Harvard, was called to the telephone at the same time to learn about a black-student occupation of his office at Harvard. The night before, Nellie and I had gone to Milwaukee for an alumni dinner, and on the evening of the Carpenter Hall occupation we were scheduled for an alumni dinner in Evanston, Illinois. We were staying with a Cornell trustee in Evanston, and I spent the afternoon at his house, on the telephone with my colleagues in Ithaca. The following night we were scheduled to attend an alumni dinner in Tucson, Arizona. Six months earlier, I had accepted an invitation to speak at a dinner honoring the new president of the University of Arizona on the night following the Cornell dinner in Tucson. Our oldest son was a faculty member at Arizona and we were looking forward to a relaxed weekend in Tucson.

By the time of the Evanston dinner, my Ithaca colleagues and I had decided that I would attend the dinner and then return to Ithaca by a charter jet. Nellie would go on to Tucson and meet with the alumni. In the Perkins days, we had signed a contract with a small-jet charter service for some considerable mileage; we used a remaining piece of that mileage for my return to Ithaca. I do not remember what time I arrived in Ithaca, but I do remember almost no sleep that night.

We obtained a court-granted Restraining Order and served it on the occupying students early in the sit-in. We had considered this option in earlier events, but had been reluctant to use it. The students were certain to defy the order, and they would be in contempt of court. The Court was likely to enforce the order using local law-enforcement agencies, which was just what we did not want.

In earlier protests, we had instituted twice-daily radio broadcasts by me, telling the community what was happening on the campus. In this case, we began those broadcasts that day, the second day of the occupation, and I made myself as visible as possible on the campus to make sure people knew I was at home and on the job. In the course of the evening, I spoke to the Tucson alumni over a telephone hookup.

During the evening, the protestors demanded a discussion about Cornell’s complicity in the Vietnam War. The terms for that discussion were negotiated by some of the executive staff, and I agreed to participate.

By the time I entered the building, it was about 2 a.m. A first year law student was an active participant in resolving protest issues that year, and he was much concerned about my personal safety—something I was never worried about. I never felt any personal insecurity in all the eleven protest years. The law student never left my elbow, however.

The discussion by a panel that included University officials and protesting SDS students seemed like a reasonable one to me. I was able to respond in what I thought was a responsible way in spite of almost no sleep for 48 hours. I was treated with respect by the students, and the only verbal abuse I experienced was at the hands of a faculty wife who was in the crowd.

I was back in my office early that morning and I made the morning radio report. I began to think about the speaking commitment in Tucson that evening, and the more I thought about it, the more I was determined to keep it. We arranged a charter jet to Chicago, leaving Ithaca at 11 a.m., a commercial flight to Tucson, and a charter back to Ithaca. I recorded the afternoon broadcast and
left town at 11. I arrived in Tucson about 6 p.m., was met by my family, changed into my black-tie outfit at my son's house, went to
the designated place at the designated time, had dinner, gave my talk, and went to the airport for the charter flight back to Ithaca,
where I arrived around 6 a.m. I was back in my office by 8 o'clock, and no one other than my immediate office staff knew I had been
away.

It was a gorgeous spring Saturday and students were streaming up the hill past Carpenter Hall to attend the day's athletic events, a
Medieval Fair, and other campus activities. The protestors tried to attract the attention of the passing crowds, but to no avail.

There was one noteworthy bit. A well-known Law professor was tired of hearing the harangue over the outdoor public-address
system, so he came along with some wire cutters and cut the wires to the loudspeakers.

By Monday, after five days, everyone was tired of the disruption of campus life, and the protestors declared victory, left the building
and marched up East Avenue past the Administration building. One of the vice presidents, who was always close to any protesting
students, was standing in front of Day Hall as the marchers passed. A young woman who was one of the organizers of the protest
saw her administrative friend, left the march to embrace him and say to him, “I guess we lost that one.” Administrators and protec-
tors alike are human beings.

One of the problems with the injunction process was the difficulty in getting positive identification of the people defying the or-
der. In this case, the campus police equipped themselves with cameras and attempted to photograph the students. The students
smear their camera lenses with peanut butter. About ten students and one faculty member, out of perhaps a hundred people
occupying the library, were identified and served two weeks each in the county jail. The SDS president was brought before the city
judge on some other charge and was also sentenced to two weeks in jail. After the judge pronounced the sentence, the student
replied angrily, “Why don’t you make it a month?” The judge banged his gavel and said, “a month it is.”

There was a much-publicized sit-in at the University of Chicago, where the students occupied a building with the main entrance
apparently the only access point. The students were in the building several days and faculty members entered the building and
identifying everyone. When the students came out, the police apprehended all of them as they left the building and booked them
all on the appropriate charge. Cornell faculty would never participate in the identification process.

Spring 1976. The protest intensity diminished in the mid-70s, although there were still some major disruptions. The final event was
an occupation of my office in April or May 1976 by a group of black students protesting the dismissal of a black student employee
for poor performance of his duties. I went directly from my office to the University lawyers, and we started the restraining order
procedure, a procedure that had been perfected by that time. The local Supreme Court judge was hearing a case in Elmira. I called
him there, he came out of the courtroom to talk to me, told me where he would be at 7 p.m., we delivered the requisite papers to
him, he signed them, and the order was served. The students were being advised by a black law student who told them that they
would be in serious trouble if they defied the order. The sit-in ended shortly after midnight.

Reflection: In all the major protest events, we decided at the beginning of the event how we were going to conduct ourselves. The
executive staff met to define our operating principles: “no outside police, nobody gets hurt, no amnesty for anyone, willingness
to discuss issues but not while building occupations in progress, etc.” I carried that list in my pocket throughout the event and we
discussed it with the campus police. We were always close to the police and they were a fine group of human beings. There were
many nights when I spent part of the night in the police headquarters in Barton Hall.

We always had alternate command posts in various buildings around the campus. Telephones were always in place and operational,
and there was a stock of necessary supplies. In the Willard Straight takeover, the alternate site was the Law School dean's office
and we operated from there, with the president in charge. In the Carpenter Hall occupation, I believe we never used the alternate
site—we stayed right in the president's and provost's offices. In crisis times we reserved a room in the Statler to provide a place for
people to get some sleep, which was often badly needed.

In those protest times in the late 60s and early 70s, there was a group of students who helped resolve issues, sometimes from an elected
position in campus governance or simply because they wanted to be involved. One of the particularly effective ones was the Law student
who played a significant role in the Carpenter Hall occupation. An-
other was an undergraduate named Steven Hadley, now the National Security Advisor in the Bush Administration.

One feature of the protests I never understood was the prevalence of foul language and obscenities. Every protest crowd seemed to have
a coterie of loud-mouthed participants whose mission was to address me by every foul word or phrase I had ever heard and some I had
never heard before. Somehow, it was a badge of membership in the protest culture to outdo the next person in the use of foul language.
We lived on South Hill and I usually drove to work down Hudson and Aurora Streets to Buffalo and then up the hill to the campus. There were almost always students hitchhiking rides up the hill and I often stopped to pick them up. One regular was an SDS leader whom I knew, and I gave him rides several times. We debated the issues of the day in a friendly manner on the way up the hill. One day I picked up a student I did not know but recognized as a participant in some unhappy event the day before. I asked him whether he thought such affairs really promoted the cause, whatever it was. We had a reasonable discussion of the question and it was clear he did not know to whom he was talking. We pulled into my parking place behind the Administration building and he suddenly realized who I was. He said “Je-sus Ch-rist,” got out of the car, slammed the door, and walked away without looking back.

What was the impact of all the protests? Did they change anything? The protests about the Vietnam War and the marches on Washington certainly had an influence on ending the war. I doubt that the university protests added much to the success of the civil rights movement when compared to the work of Martin Luther King and the determination of Rosa Parks and other like-minded people in the South.

On many issues, I was on the side of the students, but I had trouble seeing what occupying my office did to influence American foreign policy in Southeast Asia.

On the other hand, if people do not work to right what they see as injustice when they are young, when they have more idealism and more energy than they will ever have again, God help us when they are old. May 31, 2007

Additional Resources

Audio

An audio recording of the delivery of this speech by Dale Corson, 93, to fellow residents of Kendal at Ithaca is also available as a DVD and is online at http://ecommons.library.cornell.edu/handle/1813/3613.

The audio of the presentation was recorded at Kendal by Don McPheeters; the introduction was by Marian McPheeters. This DVD contains that presentation, including the transcript, “Campus Unrest.”
Preface

George Gull and Dale Corson share an abiding interest in choral music and in photography. George sang in the Glee Club serenade to Dale and Nellie at the Corson Symposium’s Gala Banquet (December 1999), as well as at many other anniversaries and birthdays honoring the Corsons. Dale and George both are accomplished photographers. George contributed this collection of photographs.
Participation in Special Events

Dale participates in various public speaking events – here at the retirement dinner of J. Robert Cooke on December 1, 2005.
70th Wedding Anniversary of Dale and Nellie
Kendal at Ithaca
June 20, 2008 event
The Corson family gathered on June 20, 2008 to celebrate the 70th Wedding Anniversary of June 17th
The Hangovers of Cornell University Glee Club delight Dale and Nellie, as they so famously sing and as they have done many times.

A few friends helped celebrate Dale's birthday.
Dale explains how the sundial works

Dale discusses his birthday present, a precision scale model of his Sundial, with Bill Gordon, the intellect behind the Arecibo (Puerto Rico) Radiotelescope.
The Ithaca contingent of the Corson family gathered on April 5, 2009 to celebrate Dale’s 95th birthday.

Dale and the creators of the precision replica of the Sundial. Ksenia Chumakova designed and built the model; Joseph Thanhauser commissioned the sundial model. (See a description of the outdoor-one in “A Sundial for the Quad.”)