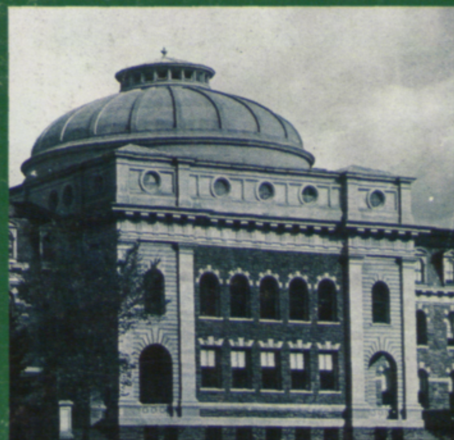
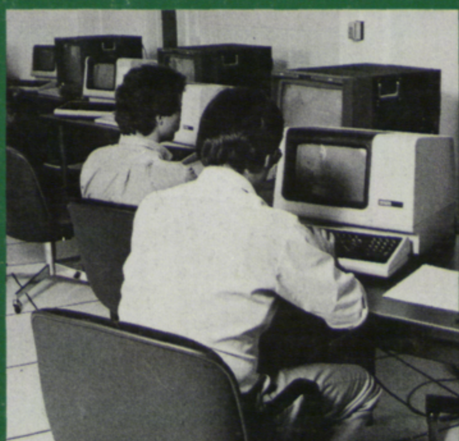
ENGINEERING

CORNELL QUARTERLY





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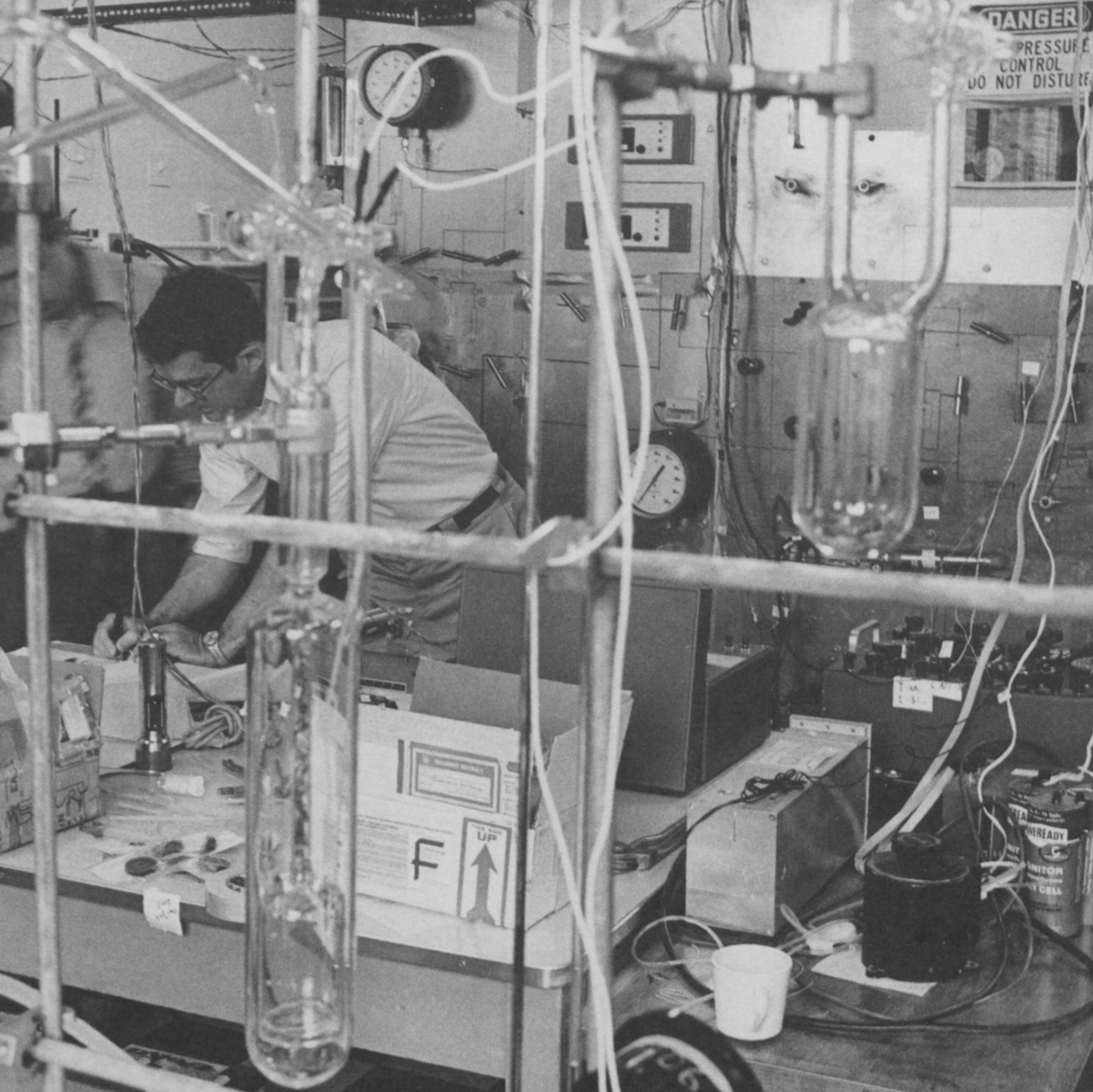
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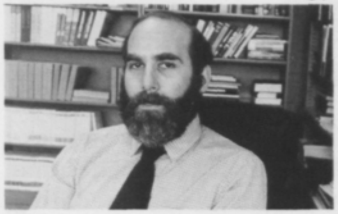

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Opposite: Research is an important part of engineering at Cornell. The new dean, William B. Streett, has conducted an active research program in chemical engineering since he came to the College in 1978.

Cover illustrations, clockwise from noon: an early machine shop for engineering students at Cornell; the central dome section of Sibley Hall, built for mechanical engineering on what is now the Arts and Sciences campus; students using computers—a sign of the times; Snee Hall for geological sciences, a new building designed for current needs.

TO THE YEAR 2000 AND BEYOND
A Comprehensive Plan for Engineering at Cornell

Now is the time for a bold new plan for the engineering campus. This is the conclusion reached by Dean William B. Streett and a faculty advisory committee who are drawing up recommendations for long-range development at the College.

If their visions materialize, the engineering quadrangle will have a completely new look, with the present buildings incorporated into an expanded and interconnected architectural assembly. Besides accommodating specific current and future needs, the design will facilitate communication among departments and greatly improve the esthetic quality of the engineering complex.

Heady-sounding ideas such as these are rapidly taking shape now that the committee is beginning to consult with a leading architectural firm about how to adapt the present engineering plant to meet present and anticipated needs. For a while the idea took hold that there must be a major new building, plus extensive renovations of the older ones. The new building would house the University's new "supercomputer" facility—the Center for Theory and Simulation in Science and Engineering—and also provide additional space for academic units, such as Electrical Engineering, that have serious problems of overcrowding. Later, however, it was recognized that a more useful and practical approach would be to plan an overall, integrated complex with the capacity to expand physically as future needs arise. Early this summer the architectural firm of Bohm-NBBJ of Columbus, Ohio, was selected to do a feasibility study and develop a master plan, a project that is expected to be completed by early next year.

THE THEORY CENTER: A WELCOME CHALLENGE

A major impetus for early completion of the College study is the necessity to house the new Theory Center, as it is commonly called; the center's offices are expected to be located on the engineering campus. The interdisciplinary facility is directed by Nobel Laureate Kenneth G. Wilson of the physics department, who spearheaded the effort to establish it, and the deputy director is Ravindra N. Sudan, a member of the electrical engineering faculty.

The Theory Center is a major addition to the University research facilities and programs, serving Cornell investigators and also providing a national supercomputing resource. Last February the National Science Foundation selected Cornell as the host institution for one of four new National Advanced Computing Centers and awarded a grant of $21.8 million. This NSF funding is augmented by industrial contributions, including a powerful new IBM computer valued at more than $30 million. The center is expected to increase the capacity of Cornell's hardware computing system by a factor of 10,000, and other huge increases are expected in software productivity and communication power and capability. A special feature will be a world-class facility for three-dimensional computer graphics based on a program directed by Donald P. Greenberg, professor in architecture and engineering.

The vast computing capacity will open up powerful new approaches to problems that cannot be solved ana-

Figure 1

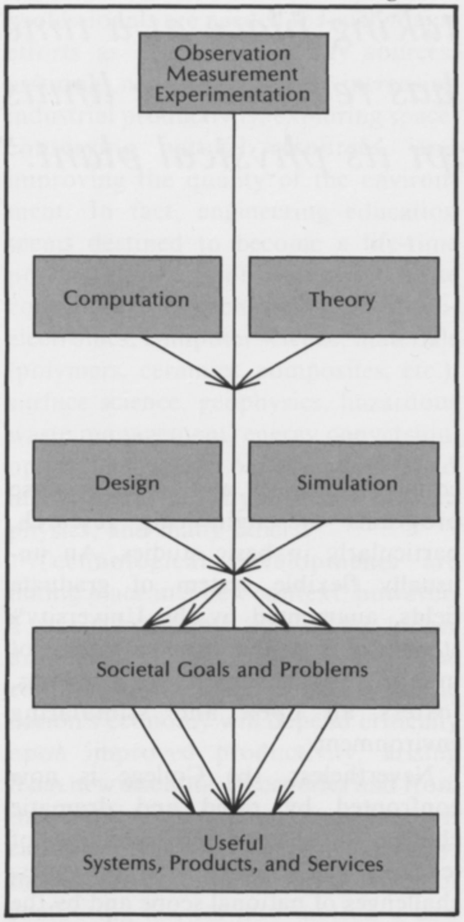
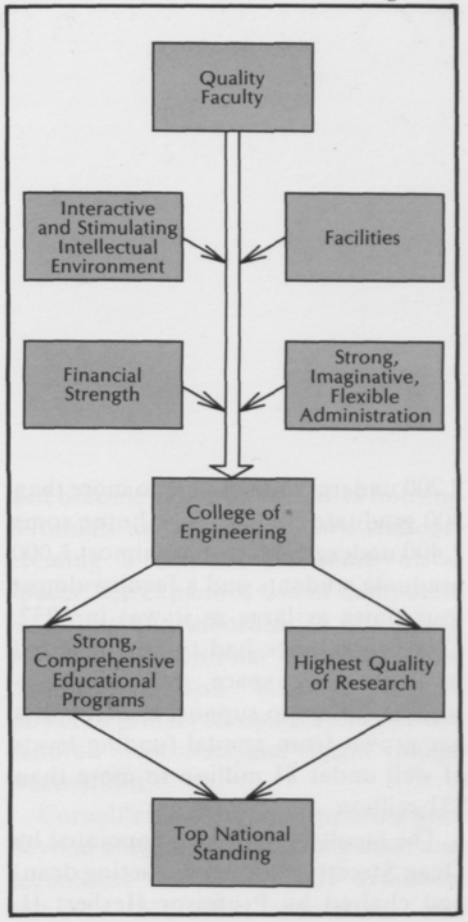


Figure 1. Engineering and society. Using an engineering approach to long-range planning, the faculty committee diagrammed its view of relationships among professional activities and societal goals and problems.

Figure 2. Factors affecting the quality and reputation of the College. A faculty of high quality is seen by the planning committee as the chief requirement for excellence. The greatest need is perceived in the area of facilities improvement.

Figure 2



lytically, for supercomputers facilitate techniques broadly classified as computer simulation (a method useful in laboratory instruction as well as in research). Mathematical equations that describe the behavior of complex physical, chemical, biological, and economic systems will be able to be solved numerically through massive expenditures of computing power, at speeds 100 to 10,000 times faster than can be attained now. Such "number-crunching" problems occur in many areas, including atomic and molecular modeling of matter, robotics, thermodynamics, fusion energy, manufacturing systems, astrophysics, aerodynamics, structural analysis and design, electric power transmission, and biotechnology.

Of course, advances in computing speed and power must be accompanied by parallel developments in theoretical, experimental, and computational research. Cornell is particularly well suited to fostering this kind of development because of its highly effective interdisciplinary centers and programs: the Theory Center functions in concert with experimental facilities such as the Materials Science Center, the Cornell High Energy Synchrotron Source, and the National Research and Resource Facility for Submicron Structures (commonly called the National Submicron Facility). Cornell will have an exceptional opportunity to assume world leadership in supercomputing-dependent research.

DISCERNING AND MEETING THE FACILITIES PROBLEM

Beyond the necessity to provide for special new programs is the ongoing problem of accommodating modern engineering education and research in buildings designed for a different era. Crisis looms despite, or perhaps because of, the flourishing research program and solid educational reputation of the College.

The basic problem is that most of the engineering buildings, designed in the late 1930s and built between the late 1940s and early 1960s, were obsolete almost from the beginning. Planned primarily for undergraduate instruction, they had few provisions for graduate research programs. Buildings intended to accommodate between 2,100 and

"These changes are taking place at a time when the College has reached the limits of its ability to adapt its physical plant."

2,200 undergraduates and no more than 300 graduate students now house some 2,400 undergraduates plus almost 1,000 graduate students and a faculty almost four times as large as it was in 1937. Classrooms have had to be converted to laboratory space and graduate-student offices to support research that has grown from annual funding levels of well under $1 million to more than $31 million.

The faculty committee, appointed by Dean Streett (while he was acting dean) and chaired by Professor Herbert H. Johnson, has issued a preliminary report, "The College of Engineering: A Plan for the Future," which is partially summarized here. The committee's outlook is broad, encompassing general considerations of engineering in the future and engineering at Cornell, as well as detailed analysis of the facilities problems. Included is a consideration of the College's history, particularly as it bears on the development of the physical plant and the "lessons of the past." The recommendations in the report will serve as a starting point for the architectural feasibility study.

THE CHANGING CONTEXT OF ENGINEERING EDUCATION

In the nineteenth and early twentieth centuries engineering education was strongly practice-oriented, providing training in machine shops, foundries, and construction and testing laboratories, and it was mostly at the undergraduate level. This pattern began to change during World War II with the rise of engineering science and the development of new products and technologies. The government responded to new educational needs by establishing a system of public support for university research and graduate education that has transformed science and engineering in the United States.

At Cornell the College of Engineering experienced unprecedented growth in research and graduate enrollment without sacrificing the size or excellence of the undergraduate program, and it has become one of the strongest engineering colleges in the nation's comprehensive research universities. An excellent faculty offers an impressive array of undergraduate and graduate programs, and maintains one of the country's largest and most diverse programs of engineering research, particularly in basic studies. An unusually flexible system of graduate fields, augmented by the University's strong and innovative assembly of interdisciplinary centers and programs, fosters an open and stimulating environment.

Nevertheless, the College is now confronted by rapid and dramatic changes in the tools and techniques of teaching and research, driven by new challenges of national scope and by the ongoing revolution in computing and information processing. These changes are taking place at a time when the College has reached the limits of its ability to adapt its physical plant. The committee warns that unless facilities problems are addressed, the College will be unable to attract and hold the distinguished faculty that is the source of its vitality and strength.

The new challenges referred to in the committee report arise from national needs that require technological advances in every area of science and engineering. Appropriately educated professionals are needed for such major efforts as developing energy sources, assuring national defense, increasing industrial productivity, exploring space, conserving natural resources, and improving the quality of the environment. In fact, engineering education seems destined to become a life-time process. New opportunities will arise continually in such fields as microelectronics, computer science, materials (polymers, ceramics, composites, etc.), surface science, geophysics, hazardous waste management, energy conversion, optical technology, biotechnology, fluid mechanics, aerodynamics, plasma physics, and many others.

Technological developments are taking place in a new context, however: a world economy that is no longer dominated by the United States. The continued growth and prosperity of the nation's economy will depend critically upon improved productivity, arising from new scientific discoveries and from the creative development and application of computer-based technology. Indeed, the phenomenal development of computing has set into motion a new industrial revolution based on the coding and processing of information for the design and production of goods using machines controlled by computers.

The key to enhanced productivity and the strengthening of the United States as a force in world markets is computer-aided design and manufacturing (CAD/CAM), employing interactive computer graphics. Furthermore, the technical superiority of American products will depend on new means for incorporating microcomputers and computer-controlled systems into commercial products.

MEETING THE MANDATE FOR COMPUTING CAPABILITY

The future success and prestige of universities, and in particular engineering colleges, will be strongly influenced by how wisely and well they integrate and use new computer technology. The second half of this decade will see the continued acquisition and use of mini- and microcomputers and the growth of local, university-wide, and national communication networks, and the results will improve the quality of engineering education and the productivity of engineering faculties. Spectacular advances in computing hardware will continue, and although the necessary software will be developed more slowly, it will be the focus of major research efforts.

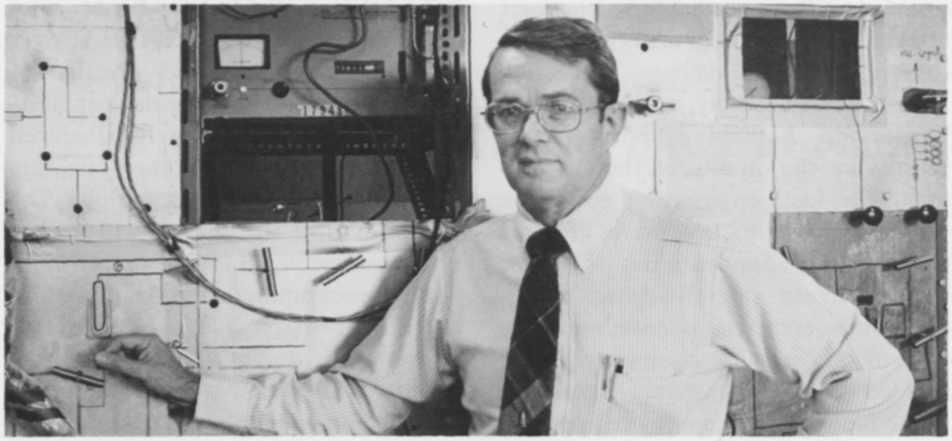
In the College today there are at least eighteen super-minicomputers and a comparable number of minicomputers operated by departments and research laboratories. In addition, there are now about forty powerful individual work stations and two hundred or more microcomputers, and more are being added almost daily. The College has installed an ethernet linking all major buildings as a first step toward a College-wide network that will provide electronic mail, easier access to specialized equipment (array processors, laser printers, etc.) and eventual access to library automation systems and other data banks. Planning is already underway for installing fiber-optic cables as the next step toward higher-speed networks that will create a new "nerve system" for the College.

This development will require extensive renovation of existing buildings. Faculty and graduate-student offices will become office-laboratories housing terminals and powerful work stations, creating a demand for more office space. The expanded use of computers in offices and laboratories will create substantial additional demand for air conditioning and "filtered" electric power to protect computers from power failures, brownouts, and violent voltage fluctuations.

Cornell's initiative in computing goes beyond keeping up with equipment and techniques that are already available, however. Excellent theoretical and experimental research programs contribute significantly to the development of the science and application of computing. An example of Cornell's leadership is the conception and establishment of the Theory Center, which will dramatically advance the power of the computer.

ASSESSING THE COLLEGE'S UNDERGRADUATE PROGRAM

Cornell's undergraduate academic program in engineering, one of the oldest and most distinguished in the nation, is adapted to meet changing educational



Dean William B. Streett was acting dean of the College when he initiated the long-range planning effort by a faculty committee. A preliminary report has been prepared.

needs. The curriculum includes a common core of course work in mathematics, chemical and physical sciences, computer programming, and introductory engineering, followed by specialized study in one of nine major fields. Every student takes elective courses in the humanities and social sciences, and special options address individual interests.

Over the past decade, the number of applications for admission has increased steadily to about 4,600 a year for approximately 600 places in the freshman class. Average SAT scores of freshmen enrolled over the past five years are 695 (mathematical) and 580 (verbal); the combined average is the highest in the University. In the near future it is planned to augment the highly selective freshman admissions with high-quality transfer students. Women now account for about 23 percent and minorities for about 19 percent of the total undergraduate enrollment of approximately 2,400.

The number of B.S. degrees awarded has increased from about 325 a year in the early 1960s to an average of 558 annually over the past five years, mainly as a result of decreased attrition. Among private institutions of higher education, Cornell's total of 2,790 undergraduate engineering degrees awarded over the past five years was exceeded only by that of M.I.T.

The emergence of Cornell as a major center for graduate study and research in engineering has been a mixed blessing for the undergraduate program. On the one hand, undergraduate education has been enriched and diversified by the increase in faculty quality, and the visibility of the research program has attracted many outstanding students. On the other hand, intense competition for facilities has forced undesirable reductions in undergraduate laboratory instruction and has led to the conversion of many classrooms into research laboratories and graduate-student offices. The extensive renovation and building program proposed by the College will correct this situation; laboratory-based instruction will remain an essential ingredient of undergraduate education.

In addition to more space, the renovations must provide additional kinds of facilities. The trend toward the use of computers for data acquisition and analysis and control of experiments will continue, as will the use of simulation to study physical phenomena and engineering systems that are too expensive, too time-consuming, or too hazardous to explore in real life. Therefore, new teaching laboratories must be established for microcomputer instruction, and students must be given easy access to terminals that are connected to computer networks and local printers. Properly equipped lecture halls will be needed to project computer-screen images and to provide micros for classrooms so that "hands on" participation can occur during lectures.

THE RISING IMPORTANCE OF THE GRADUATE PROGRAM

At the graduate level, enrollments have increased over the past decade from 600 to almost 1,000; they now account for 40 percent of the endowed Graduate School enrollment. Over the past five years, Cornell has awarded more graduate engineering degrees than any

Johnson

The chairman of the planning committee was Herbert H. Johnson, professor of materials science and engineering and director of the Materials Science Center.

Continuing members of the committee, which will act in an advisory capacity, are Richard L. Dick, Civil and Environmental Engineering; Juris Hartmanis, Computer Science; John A. Nation, Electrical Engineering; George L. Nemhauser, Operations Research and Industrial Engineering; Wolfgang H. Sachse, Theoretical and Applied Mechanics; Associate Dean Kenneth E. Torrance, Mechanical and Aerospace Engineering; and Gilbert F. Rankin, director of administrative operations and facilities.

of the other private institutions except Stanford and M.I.T. Over the next few years, graduate enrollment in engineering fields is expected to rise to 1,200 or 1,300, including 200 in Master of Engineering programs (the current level). This will bring the ratio of undergraduate to graduate students to about 2, and the ratio of graduate students to faculty members to 5 or 6 (considered the optimal level).

The increase in graduate enrollment, it is expected, will result from a continuing growth in research funding, from the addition of young faculty members with strong research interests, and from the further development of innovative interdisciplinary programs. For example, a strengthening of the ties between the College of Engineering and the Johnson Graduate School of Management at Cornell will be established in areas such as manufacturing systems engineering and management. The overall goal is to raise the graduate engineering program from its already high standing, as reflected in national surveys, to a position among the top three institutions in the country.

LOOKING AHEAD TO THE 21ST CENTURY

One of Streett's highest priorities as dean is to oversee the completion and implementation of the plans for expanding and renovating the engineering facilities. His first public statement after moving from the position of acting dean to that of dean concerned these plans. "The existing buildings, apart from Knight Laboratory and Snee Hall, were simply not designed to accommodate the large programs of graduate education and research in engineering that have grown up at Cornell since 1960," he said.

In making their recommendations, the dean and the faculty committee have been aware of lessons learned from past experience. They point out that the College faced similar problems of obsolete and inadequate facilities in the early years of this century, some thirty years after its founding. Through the wisdom and foresight of Andrew D. White, Cornell's first president, and the leadership of engineering leaders such as Estévan A. Fuertes and Robert H. Thurston, Cornell engineering had reached a position of preeminence and influence rarely, if ever, equalled in the history of American higher education, but the failure of the College and the University to modernize the technical facilities at a time of national expansion in engineering education led to a long period of decline. Enrollments fell over a twenty-five-year period from more than 1,700 in 1910 to fewer than 800. The report of the planning committee emphasizes that "this must not happen again."

The stage is now set, the College planners believe, for a new golden era of engineering, growing out of the need for improved industrial productivity and economic competitiveness and based on the revolution in computing and information processing. With imaginative planning, they contend, Cornell engineering will continue to provide national leadership as the country enters the new era of technological challenge and opportunity.

BUILDING FOR ENGINEERING AT CORNELL

by Kermit C. Parsons

If it hadn't been for the economic crash of 1929, Cornell's engineering buildings would be grand Gothic Revival edifices, complete with towers, dominating the northern side of the present Arts Quad. Instead, a whole new engineering campus, with buildings of modern design, took shape during the austere post-Depression period.

This dramatic switch in design concept and location was a major turning point in the architectural history of the College of Engineering, but it hasn't been the only one. Over the nearly 120 years since Cornell University was founded, there have been many changes in the physical facilities for engineering, and because they reflect the remarkable evolution of the discipline, as well as of the University, they make an interesting story.

STEP-WISE EVOLUTION OF THE ENGINEERING CAMPUS

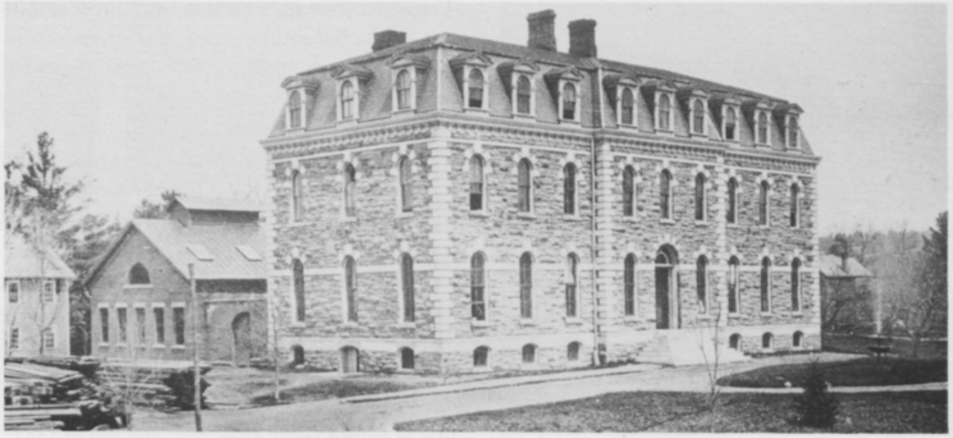
Up until the past few years, when the first new buildings in almost two decades appeared on the engineering campus, planning and construction of the physical plant for engineering at Cornell had evolved in three phases. The first, from 1866 to 1912, consisted of the establishment and extension of buildings at the north end of Cornell's early campus. The second, from 1912 to 1940, was a less productive period during which the University tried unsuccessfully to rebuild the engineering facilities in the same area. The third phase encompassed the development of the present campus to the south, along Cascadilla Gorge.

During the first phase, the engineering facilities were housed in Sibley, Franklin (recently renamed Olive Tjaden), Lincoln, and Rand Halls, and in a large collection of shops, foundries, and other temporary structures nearby.

First came the building later called West Sibley Hall, the fourth of the stone halls erected on the original campus. It was the gift of Hiram Sibley, Rochester business associate of Ezra Cornell and friend of Andrew Dickson White, the University's first president. Designed by Archimedes N. Russell, West Sibley initially had three bays and a central entrance (now the west entrance of the present Sibley Hall).

This first engineering building was on the north side of a planned 1,000-foot-square quadrangle, the heart of the overall campus plan of 1866. For more than fifty years, expansion of the engineering facility was well served by this plan, for it provided sufficient room, between the back of West Sibley and Fall Creek Gorge, for a number of smaller teaching and laboratory buildings of wood and masonry. (One of the first of these "temporary" buildings can be seen furtively peeking from behind the corner of West Sibley in the photograph on the facing page). West Sibley and its adjacent buildings housed the College of the Mechanic Arts (which was subsequently named for Hiram Sibley and ultimately evolved through several more name changes to the present Sibley School of Mechanical and Aerospace Engineering), and also the School of Engineering, which offered the program in civil engineering as part of the College of Mathematics and Engineering.

In the late 1870s and early 1880s the pioneering work of Professor William A. Anthony in electrical engineering



Left: The first engineering building was the initial section of Sibley Hall, home of the College of the Mechanic Arts. This photograph from the 1870s shows the original three bays of West Sibley. There were also temporary buildings (such as the one in the photograph) behind West Sibley.

Below: A photograph of the campus in 1871 shows, from the left, Morrill, McGraw, and White Halls along the west side of the quadrangle, and Sibley on the north. A wooden structure (at far right), situated west of the present site of Goldwin Smith Hall, accommodated civil engineering and architecture.

education generated heightened interest in the new field, and the University trustees decided to invest some of the money from the sale of western lands in a new building that would accommodate both the physical sciences and electrical engineering. It was designed by the professor of architecture, Charles Babcock, who was a protégé of Richard Upjohn and the architect for many of Cornell's most distinguished early Gothic-Revival buildings. Franklin Hall, as it was named in honor of "the nation's first electrical engineer," was completed in 1882 and became the home of the nation's first electrical engineering department.

At about the same time, West Sibley Hall was extended to the east. Then in 1887 Professor Babcock (with some protest because the chairman of the Board of Trustees, Henry W. Sage, thought that the architecture professor should design buildings as part of his duties) designed Lincoln Hall, Cornell's first permanent building for what was then the College of Civil Engineering and its Department of Architecture.

Engineering was growing so rapidly, however, that it required peripheral laboratory and shop buildings. Accordingly, the University provided a new building for chemistry: Morse Hall, designed by Charles F. Osborn, a new member of the architecture faculty, and built in 1888 on the site of the present Herbert F. Johnson Museum of Art. Morse Hall, a very large brick structure, was generally regarded as ungainly. President White thought that the site should have been kept open "in deference to the wishes of Ezra Cornell."

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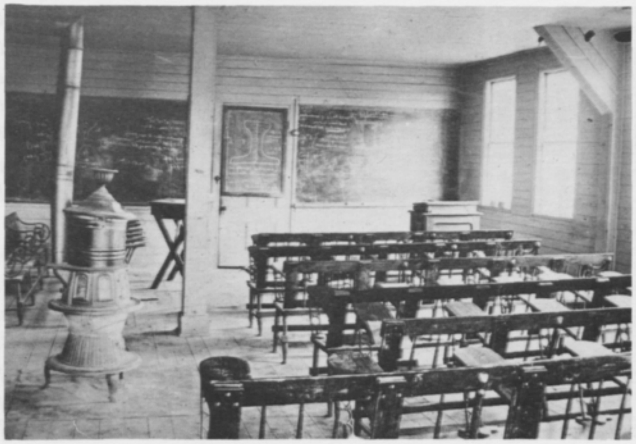

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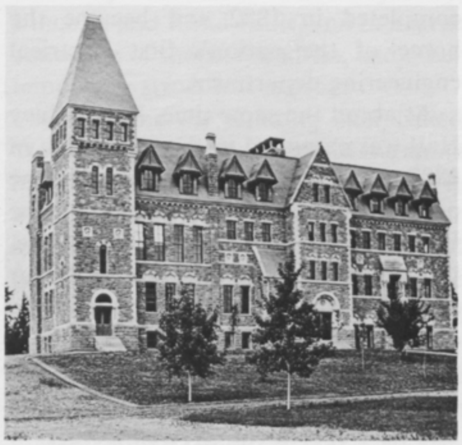

1. Classrooms such as this were provided in the first civil engineering and architecture building, a temporary wooden structure opposite McGraw Hall.

2. The temporary building is shown at right, with West Sibley in the background.

3. By the time this photograph was taken, the grounds around the wooden classroom building had been smoothed enough for softball.

4. Franklin Hall (renamed Olive Tjaden Hall one hundred years later) was erected in 1881. Originally it was used for instruction in the physical sciences and the new discipline of electrical engineering.

5. Space for Sibley College was enlarged, first in 1882 by the addition of two bays on the east side of West Sibley (the building at left), and then by the building of East Sibley Hall in 1894. The photograph also shows some of the smaller structures built as temporary laboratories and shops. The monitor of the foundry is seen above the roofs at center.

6. The only one of the auxiliary engineering structures that still stands was built as a foundry, across the road from Sibley. It is now the sculpture studio.

7. This photograph of the foundry dates from about 1910.

8. Lincoln Hall was built in 1888 to provide a facility for civil engineering and architecture. It replaced the early wooden structure to its southwest.

9. Morse Hall, built for the chemistry department in 1888, was on the site of the present Herbert F. Johnson Museum of Art. It was demolished in 1954.

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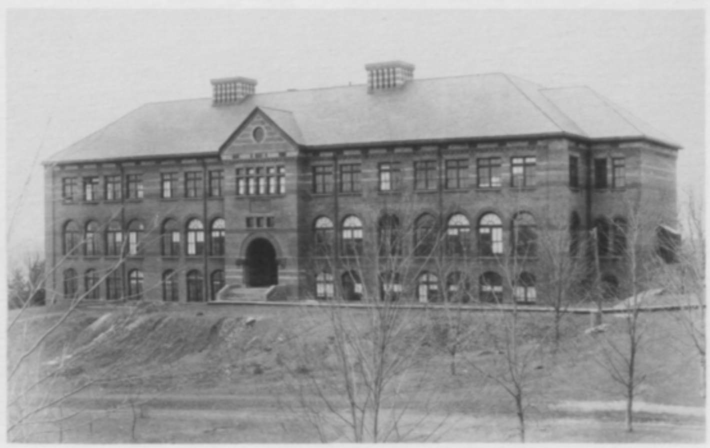

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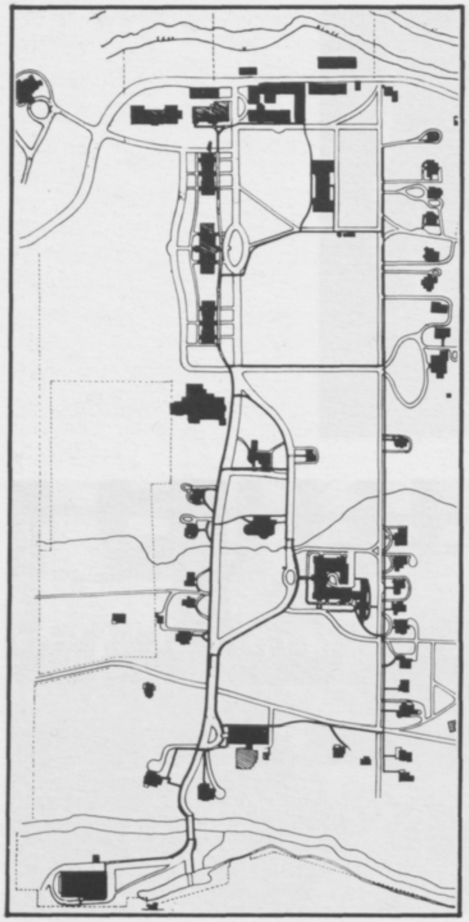

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1. The campus map ca. 1891 shows the location of the engineering buildings on the quadrangle to the north. Toward the center on the northern side is West Sibley Hall and the adjacent auxiliary buildings. To the west of Sibley is Franklin (now Olive Tjaden) Hall, and beyond that Morse, the chemistry building (later demolished). The newly built Lincoln Hall faces the three original buildings (Morrill, McGraw, and White), which are lined up on the west side of the quadrangle. Buildings still extant are the library (Uris), Sage Chapel, Barnes Hall, and Sage College (now the Sage Graduate Center). To the south, on the site of the present engineering quadrangle, stood an armory and gymnasium. Across the gorge is Cascadilla Hall. The various small buildings along East and Central Avenues are faculty houses.

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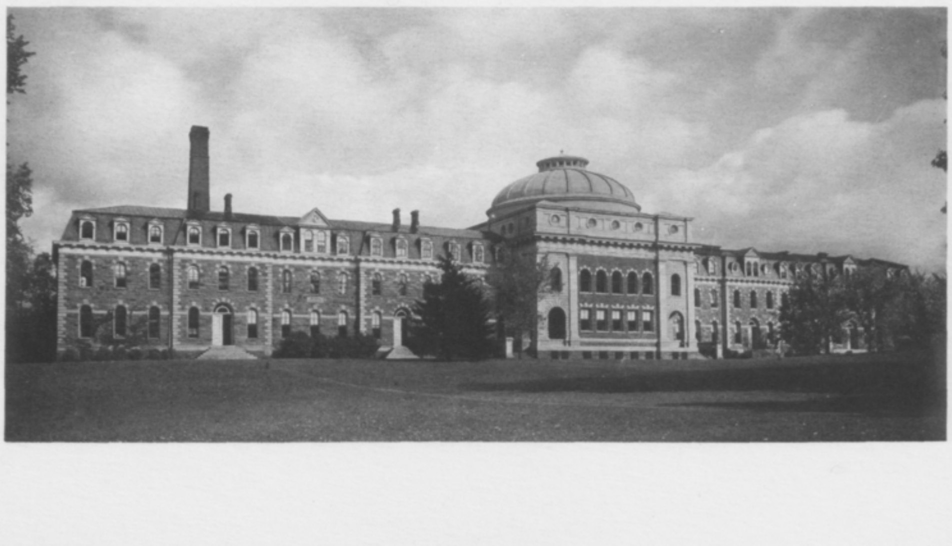

2. The academic halls around the turn of the century were (from bottom left) Morrill, McGraw, White, Franklin (now Olive Tjaden), Sibley (before the dome was added), Lincoln, and the Dairy Building (later the first part of Goldwin Smith; only a corner appears in this photo).

3. With the addition of the dome, Sibley Hall was completed in 1902.

Details of Sibley and Lincoln Halls have lent character over the years to the campus area that is now the Arts and Sciences Quadrangle: (4) a Lincoln Hall entrance; (5) a Sibley Hall window; and (6) a Sibley Hall dormer.

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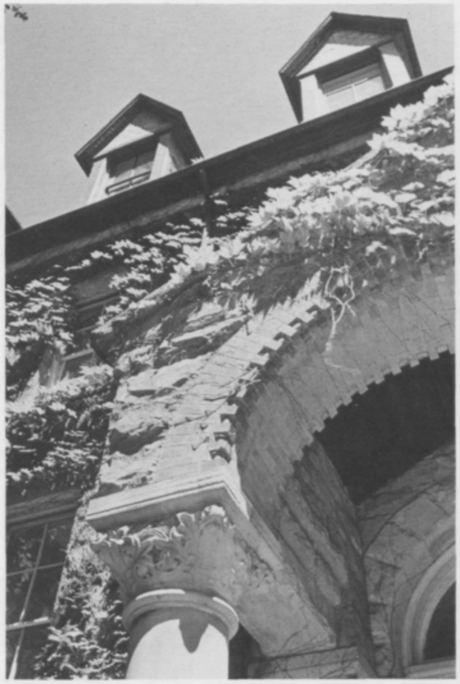

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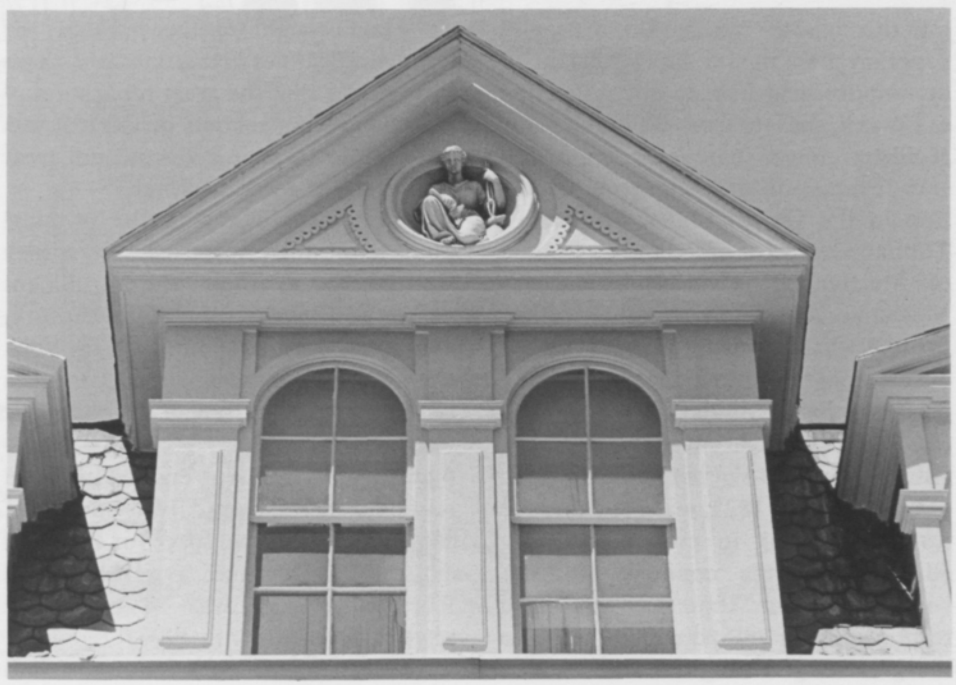

(The ill-fated building was partially destroyed by fire in 1916, rebuilt, ravaged by fire again, and finally demolished in 1954 after a long period of temporary use by the College of Architecture and its Department of Art.) Nevertheless, the construction of Morse Hall did allow more room for civil engineering, and the situation was further improved shortly after the turn of the century when the Department of Architecture became a college and moved out of Lincoln Hall.

The Cornell campus as it was in about 1891 is represented in the map on the facing page. The engineering buildings are in the relatively crowded area to the north. Expansion continued, however. East Sibley Hall—a gift of Hiram W. Sibley, son of the original donor—was added in 1894. Designed by Osborn, East Sibley very nearly cloned its predecessor (it did have minor differences in the roof line, was deeper, and was better built). Then in 1902 Sibley Hall was completed with the addition of monumental Sibley Dome between the east and west buildings. The dome, also funded by Hiram W. Sibley, was occupied by Sibley College administrative offices and a great auditorium. (Currently it houses the offices of the dean of the College of Architecture, Art, and Planning, and part of the Fine Arts Library.)

During the period from 1868 to 1902, when engineering schools were develop-

Left: The hydraulics laboratory in Fall Creek Gorge on Beebe Lake near the bridge was completed in 1902. It has not been used since 1959.

Opposite: A general plan for the Cornell campus was developed in 1902 by the architects Carrère and Hastings during the administration of President Jacob Gould Shurman, but it was never executed. Proposed buildings (hatched, first stage; dotted, second stage) would have invaded the open space of the northern quadrangle and Libe Slope. At the south end of the campus, only the armory and faculty houses occupied the area that is now the engineering campus.

ing throughout the nation, Cornell's program grew in size and influence. In his unpublished history of engineering at Cornell, the late Dean Solomon Cady Hollister noted that according to an early evaluation of engineering education in the United States, Robert H. Thurston, director of the Sibley College of Mechanical Engineering and the Mechanic Arts, as it was then called, probably had a greater influence on the development of mechanical engineering curricula and methods of teaching than any other American educator. Likewise, Estévan Antonio Fuertes, who had been at Cornell since 1873, was probably the foremost leader in civil engineering education in the country. Hollister commented that "these men had been responsible for moulding Cornell into the great engineering school it was.... They had brought together probably the strongest faculties in this country. There is no doubt that the great reputation of the engineering schools of Cornell was due to the farseeing vision and great leadership of these two men."

Enrollments rose and the physical plant continued to grow. At Sibley College, for example, the enrollment passed 600 by the turn of the century, and by 1905 it exceeded 1,000. By 1902, when Sibley Dome and the hydraulics laboratory at the foot of Triphammer Falls were completed, Cornell's investment in buildings for engineering had reached the magnificent sum of $300,000. Additional space for electrical engineering became available when Rockefeller Hall was built for the physics department in 1906.

The deaths of both Thurston and Fuertes in 1903 marked a turning point, however. Although Cornell's reputation in engineering remained high for some time, and enrollment continued to climb—reaching a peak of more than 1,700 in 1910—a decline set in. Many of the professors accepted positions as senior faculty members and deans of engineering schools at other institutions, including Wisconsin, M.I.T., and particularly Stanford. The building program slackened. When Eugene E. Haskell became dean of Sibley College in 1906, he made an effort to accommodate the growth in enrollment with new physical facilities, but the only building actually constructed was Rand Hall, completed in 1912. Funding for that project was provided by a $60,000 gift from Mrs. Florence Rand Lang, whose brother had been a student in Sibley College.

Thus ended the first great period in Cornell engineering, a period of growth and rising reputation, accompanied by the development of a physical plant that was, for the most part, appropriate and adequate for its teaching programs.

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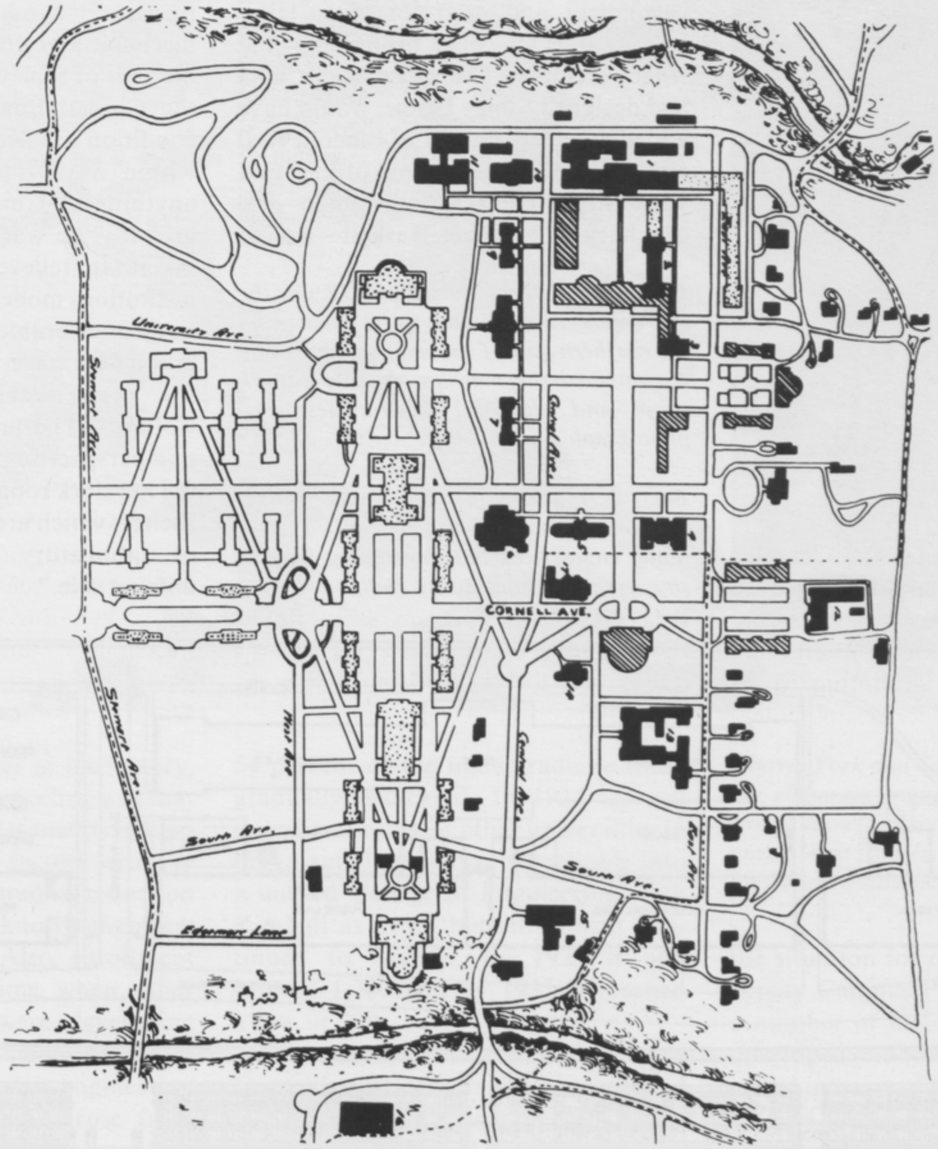
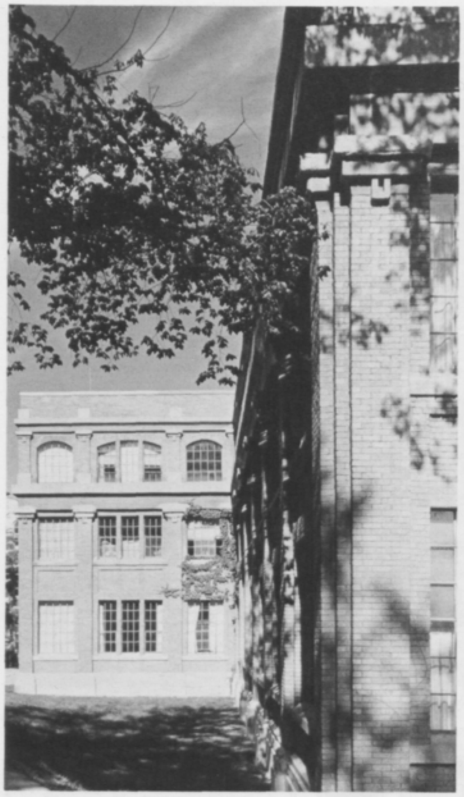
CORNELL'S NEW CAMPUS.



Reproduction of the plans adopted by the Board of Trustees for the location of proposed buildings. The buildings numbered in the drawing are as follows: 1. Sibley College. 2. Lincoln Hall. 3. Dairy Building. 4. Stimson Hall. 5 Boardman Hall. 6. Library. 7. Morrill Hall. 8. McGraw Hall. 9. White Hall. 10. Franklin Hall. 11. Morse Hall. 12. Veterinary College. 13. Sage College. 14. Barnes Hall. 15. Armory, Gymnasium. 16. Cascadilla Building. 17 Sage Chapel.



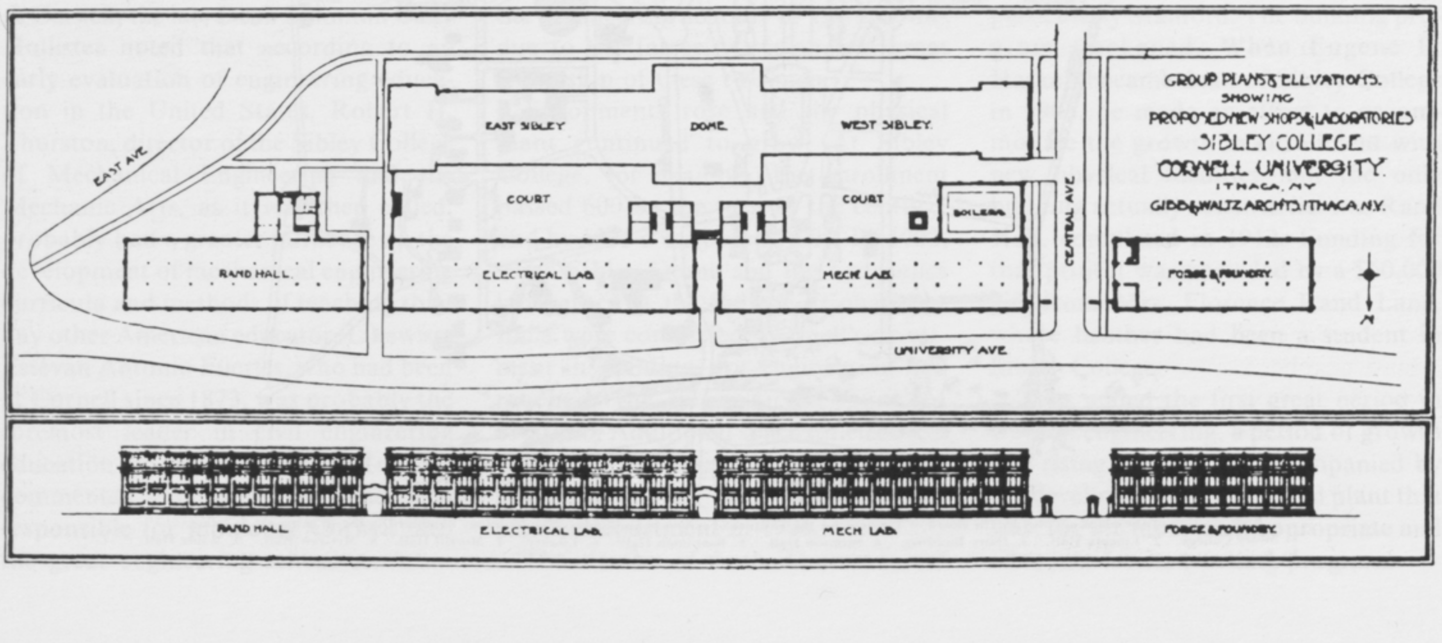
THE SECOND PHASE: A PERIOD OF DECLINE

During the second phase of the history of engineering facilities at Cornell, the College struggled in vain to adapt its northern campus site to rapid growth in enrollment and need for more laboratory space. One plan, proposed by the Ithaca architects Gibbs and Waltz, who had designed Sibley Dome, would have added wings to the east of Lincoln Hall and pavillions at either end of East and West Sibley Halls. Another plan—the one backed by Dean Haskell—was to demolish the old workshops and construct a row of buildings north of the Sibley group: Rand Hall was the first—and last—to be built on that plan.

Left: Rand Hall, completed in 1912, was the last engineering building to be situated on the northern part of the campus. Originally it contained the machine shop, a pattern shop, and electrical laboratories. The photograph is ca. 1920.

Below: A plan by Gibbs and Waltz, architects, would have provided for additional engineering buildings along University Avenue behind Sibley Hall.

The seriousness of the engineers' space problem was pointed out in 1912 by Dexter Kimball, a professor of the mechanic arts who was serving as acting director of Sibley College, in a report to the Cornell Board of Trustees. "This condition will become extremely critical within a very few years in spite of anything that may be done to restrict growth," he warned, "unless steps are taken...to relieve the situation. Other institutions modelled after [Cornell] and to a considerable extent manned by its graduates, have much better facilities for their work than has Sibley College....The impressions of a visitor or a perspective patron upon inspecting the low dark rooms and other makeshift shelters which are dignified by the name of laboratory must inevitably be unfavorable."



As noted by Hollister in his history, another indication of a decline was that "during this period replacements in kind were not made on the faculty with the result that there was a gradual reduction in the number of well-known engineers on the Cornell staff." Also, enrollment was dropping at a time when other engineering schools were developing and competition was increasing. From 1909 to 1935 the total engineering enrollment in the country rose from 13,000 to 70,000, but enrollment in engineering at Cornell, which had been 54 percent of the undergraduate total, gradually decreased. In 1921 Cornell joined a number of other universities in organizing its engineering schools into a unified College of Engineering, with Kimball as dean, but enrollment continued to decline. By 1925 it was around 1,200 and by 1935 it reached a low of 789.

When Livingston Farrand became Cornell's president in 1921, he initiated an ambitious program of campus development that changed the overall design of the University but did not improve the situation for engineering. The University Campus Plan Commission and a number of major architectural firms developed elaborate plans which resulted in some of Cornell's most beautiful and useful buildings. The elegance and spaciousness of the designs of this period are exemplified in Willard

Above: York and Sawyer's 1925 plan shows the elaborate engineering buildings which would have replaced most of the existing ones. West Sibley, dwarfed by the new buildings, would have been retained.

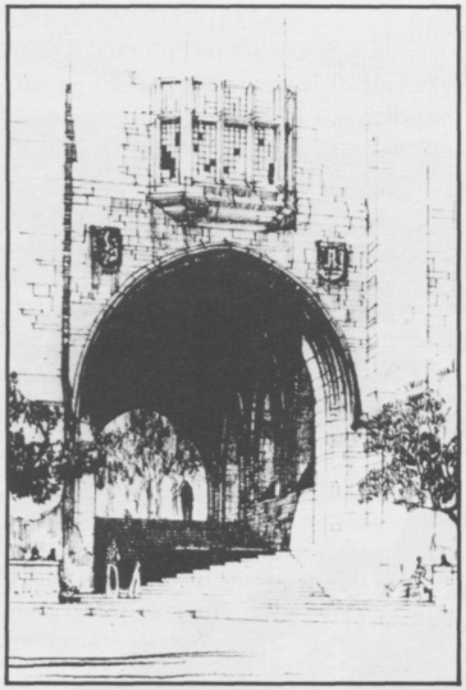
Massive Gothic-Revival engineering buildings on the northern part of the campus were included in the 1925 York and Sawyer plan, which was dropped because of the national economic crisis.

1. The large scale of the proposed buildings is suggested by this sketch of the tower proposed for the electrical engineering facility, and the archway beneath it. The civil engineering building would have been larger than Lincoln Hall, which would have been demolished.

2. A building proposed to span University Avenue (at left) would have extended into Fall Creek Gorge.

3. The design for the bridge over the gorge included a covered walkway under the roadway.

1



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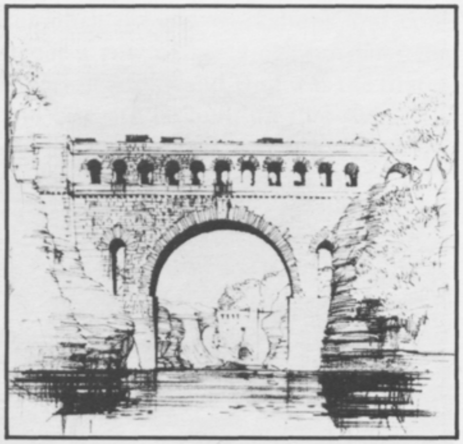
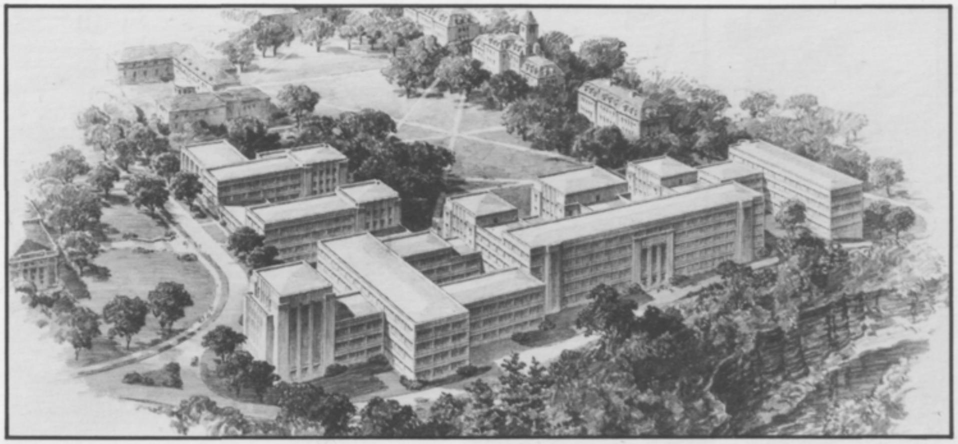


2

Straight Hall, the student union; the War Memorial men's residential group at the foot of "Libe Slope;" Balch Hall for Women; and Myron Taylor Hall for the Law School.

As part of this process, the architectural firm of York and Sawyer was commissioned to prepare detailed designs for College of Engineering buildings on the north campus. In scale and style these plans, presented in 1925, resembled those for the other buildings. The central tower of the electrical engineering building would have been grander than the Law School tower.

This plan provided for an enrollment of up to 2,000 students in the Schools of Civil, Mechanical, and Electrical Engineering in a physical plant with almost 700,000 square feet of floor space. The idea was to demolish Franklin (later Olive Tjaden) Hall, Lincoln Hall, the various laboratory and shop buildings behind Sibley and Franklin, and indeed, all of the Sibley group except for West Sibley Hall. The School of Civil Engineering was to be housed in a new building that would have been larger than Lincoln in height and



Left: This plan, the last drawn up for new engineering facilities on the north campus, was prepared in 1938 as a recasting of the Shreve, Lamb, and Harmon plan.

overall plan area. The Schools of Electrical and Mechanical Engineering were to be housed in an enormous building that would incorporate Rand and West Sibley Halls, extending from East Avenue to the present site of the Johnson Museum of Art, where it would have a semicircular ending. Massive Gothic-Revival masonry would have embraced West Sibley (which would have served as the College's administrative center) and totally enclosed and covered Rand. This huge building would have matched the equally large massing of York and Sawyer's proposed addition to Uris Library, west of the present building; between them was to be a great terrace spreading across the western facades of White, McGraw, and Morrill Halls. The building was to have a series of penetrating arches designed to allow pedestrians to move north from the quadrangle through to a relocated University Avenue. A further extension of this massive building was proposed north of the relocated University Avenue. And a bridge over the gorge was to have a covered arcade for pedestrians.

A model, superimposed on a photograph, shows how the south campus engineering site would have looked according to the Shreve, Lamb, and Harmon plan (ca. 1940). The proposed buildings are for mechanical engineering (foreground), electrical engineering (upper right, on the site of Sage College), and chemical engineering (middle left). East Avenue is on the right.

All of this, as we well know, was not to be. A campaign to raise funds for the engineering buildings did not get underway before the crisis of 1929, and was abandoned.

Other attempts to rebuild for engineering were made in the late 1920s and the 1930s. For example, a revised, scaled-down plan was prepared by York and Sawyer in 1928. Later Dean Kimball retained the New York architectural firm of Shreve, Lamb, and Harmon to prepare a new revision, but it failed to materialize before Kimball retired in 1936. The new dean, Herman Diederichs, assigned Hollister, who had become his associate dean, the task of reviewing the needs of the College. When Diederichs died the following year and Hollister succeeded him, the Shreve, Lamb, and Harmon plan was revived. This plan, completed early in 1938 and approved by the Committee on Buildings of the Board of Trustees, called for a new set of modifications of the north campus. West Sibley Hall was to be retained, along with all the other existing buildings of the College, but many useful buildings were to be

demolished and new facilities for chemical engineering were to be added. The group would have encroached fifty feet on the open space in the quadrangle. This plan, simpler and less expensive than the one proposed by York and Sawyer, but also larger, had even less chance of realization, given the national economic situation.

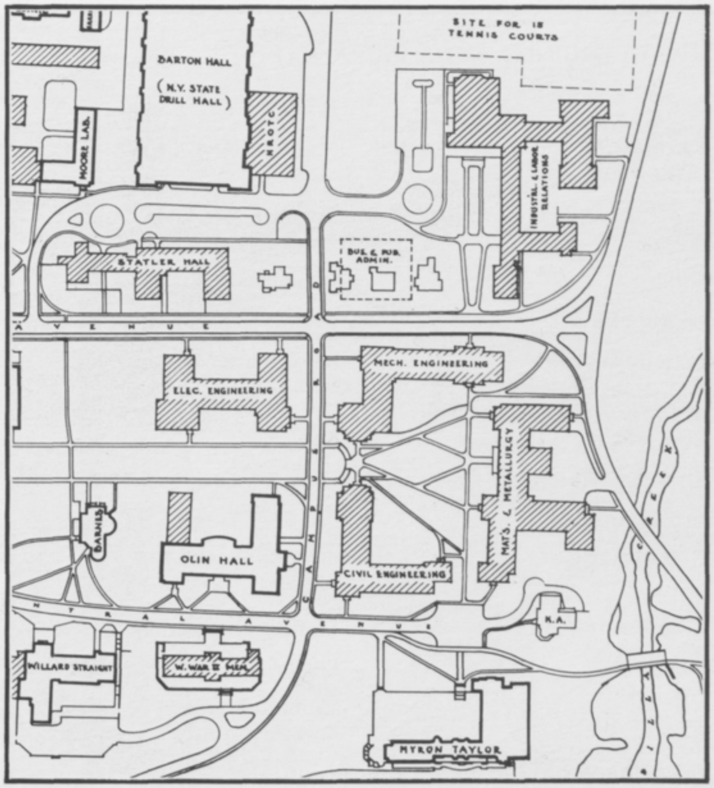
In retrospect it seems clear that all these plans were bound to fail. As every good engineer must know, a large part of solving any problem is asking the right question—or asking a question in a way that it can be answered. The question that had been posed since 1912 was: How can the College rebuild its facilities on the north side of the campus? Before a solution could be found, the question had to be changed.

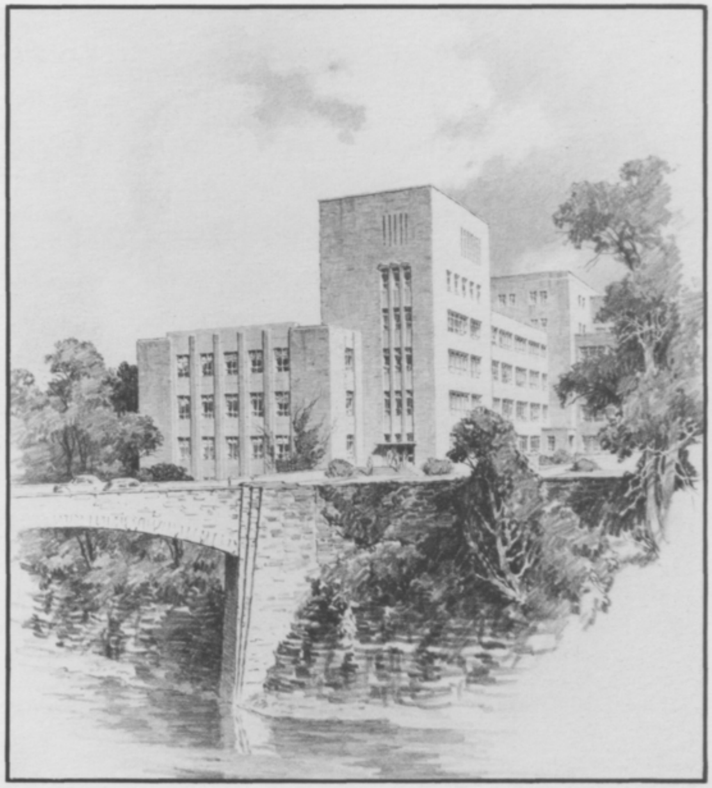
AN ENTIRE NEW CAMPUS FOR ENGINEERING

When Hollister began his twenty-two year tenure as dean, enrollment at the College was at a low level—865 students plus 144 who were double-registered in Arts and Sciences and in Engineering—

This 1936 aerial photograph of the main Cornell campus shows how the site of the present engineering quadrangle looked before construction began on the new buildings. The only building on the area at that time was an armory and gymnasium.

and faculty salaries and morale were correspondingly low. These problems were bound up with the problem of inadequate facilities, so a major priority of the new dean was to provide better buildings. When it became clear that building on the north campus was not





Above: A 1948 plan showing the proposed new engineering campus. Sage Hall would have been demolished to make room for the electrical engineering building.

Right: The metallurgy building proposed by Shreve, Lamb, and Harmon in the 1940s would have bordered Cascadilla Gorge; a new bridge would have been built across the gorge. The location of the proposed bridge, east of the one leading to Collegetown, can be seen in the 1948 map at left.

feasible, Hollister worked with Gilmore Clarke, dean of the College of Architecture and chairman of Cornell's Architectural Advisory Board, to formulate a new question: Where should the College of Engineering build its facilities? Clarke proposed to make a new start in the more open southern part of the campus, and Hollister embraced the idea enthusiastically.

Various plans for this area had called for extensive reorganization and the construction of a number of academic buildings. In 1922 a beginning was made when the Law School moved from Boardman Hall to the newly built Myron Taylor Hall along the edge of Cascadilla Gorge. Now Clarke proposed an entirely different group of buildings—an engineering complex—for this general site. Hollister and the University trustees approved: in a time of austerity, when funds were difficult to raise, the move to the more adaptable site on the south campus seemed eminently wise. Shreve, Lamb, and Harmon drew plans for the new engineering campus, to be located on the area between Barnes Hall and Cascadilla Creek, and between Central Avenue and Hoy Field. The new plan not only provided ample space for the College of Engineering, but made available room needed for long-term expansion of the College of Arts and Sciences and the College of Architecture, Art, and Planning. In addition, as we can now appreciate, the move provided possibilities for the College of Engineering to grow beyond the initially planned complex of buildings.

The first of the new engineering

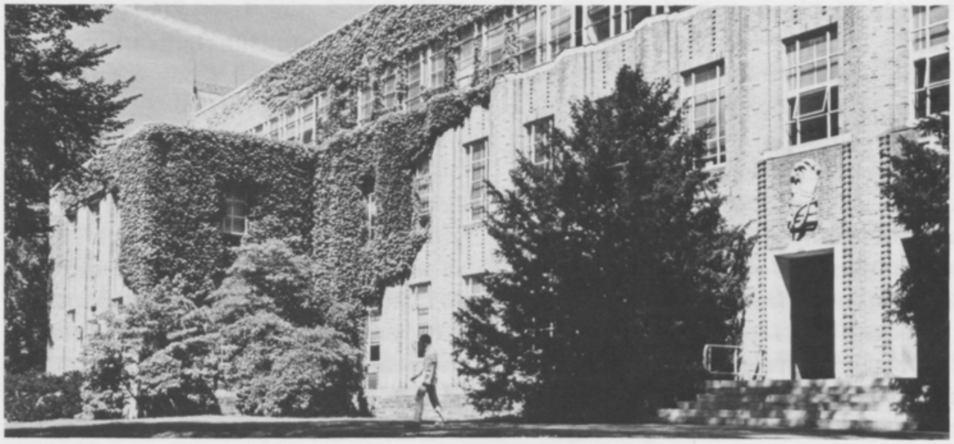
BUILDINGS ON OR NEAR THE JOSEPH N. PEW, JR. ENGINEERING QUADRANGLE

	Name	*Completed*	*Current Occupants*	*Principal Donors*
1.	Olin Hall of Chemical Engineering	1942	Chemical Engineering; Admissions and Undergraduate Affairs	Franklin W. Olin '86
2. 3.	Kimball Hall and Thurston Hall	1953	Mechanical Engineering; COMEPP; Theoretical and Applied Mechanics	Engineering Development Fund
4.	Phillips Hall	1955	Electrical Engineering	Ellis L. Phillips '95
5.	Carpenter Hall	1957	Administration; Engineering Library	Walter S. Carpenter, Jr. '10
6.	Upson Hall	1958	Computer Science; Mechanical and Aerospace Engineering; Operations Research and Industrial Engineering; Laboratory of Plasma Studies	Maxwell M. Upson '99
7.	Grumman Hall	1958	Mechanical and Aerospace Engineering	Leroy R. Grumman '16
8.	Hollister Hall	1959	Civil and Environmental Engineering	Spencer T. Olin '21
9.	Ward Laboratory of Nuclear Engineering*	1961	Nuclear Science and Engineering	J. Carlton Ward, Jr. '14
10.	Bard Hall	1963	Materials Science and Engineering	Francis N. Bard '04
11.	Knight Laboratory	1981	National Submicron Facility	Lester B. Knight, Jr. '29
12.	Snee Hall	1984	Geological Sciences	William E. Snee '24 and Katherine Snee

** Originally the Nuclear Reactor Laboratory, built with support from the Atomic Energy Commission, the National Science Foundation, and the Cornell Aeronautical Laboratory. J. Carlton Ward, Jr. contributed to the original design and establishment of the building and subsequently provided funding for improvements.*

In the recent aerial photograph on the opposite page the numbers in color identify the engineering buildings.

buildings, built during the presidency of Edmund Ezra Day, was Olin Hall of Chemical Engineering to house the recently organized School of Chemical Engineering. Funded by a gift from an alumnus, John M. Olin, and designed on an ample scale by Shreve, Lamb, and Harmon, it was completed in mid-1942 in time to serve as one of the main



Right: Olin Hall of Chemical Engineering, built in 1942, was the first of the engineering group on the south campus.

instructional spaces for the Navy program at Cornell during World War II.

After the war, the first new construction on the campus was a University administration building (named for President Day after he resigned in 1949). This was soon followed by a number of other new buildings, including Anabel Taylor Hall, an interfaith center; Teagle Hall, a sports building; and Clara Dickson Hall, a women's dormitory. Construction of the engineering buildings on the new south campus did not resume until 1950, when ground was broken for the attached Kimball and Thurston Halls, also designed by Shreve, Lamb, and Harmon.

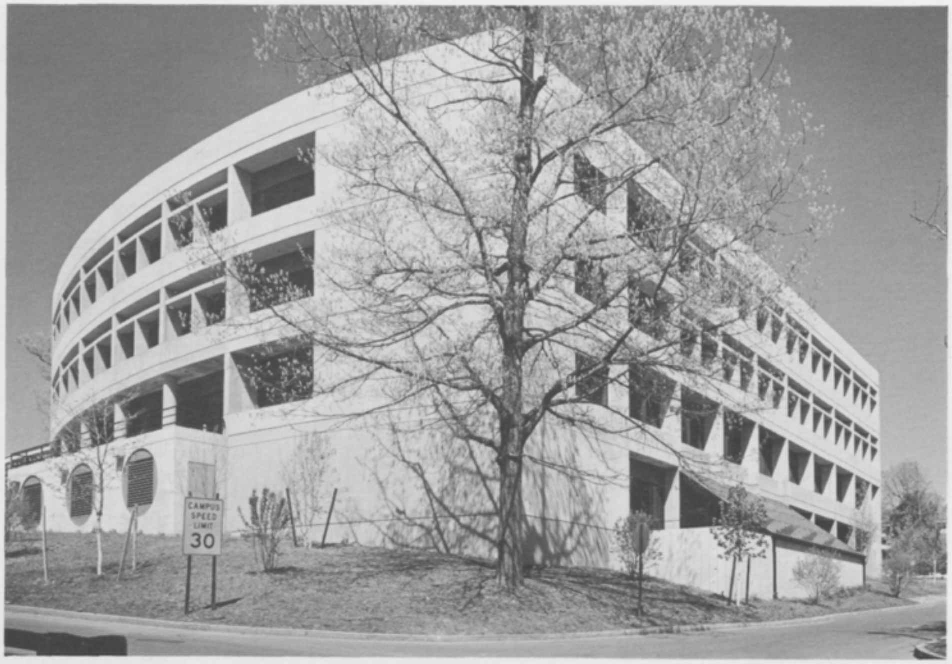
During the 1950s, Dean Hollister was very active in the campaign to secure additional building funds, and he was very successful. Alumni were the major donors, and many of the buildings bear their names (see the table on page 22). With one exception (the Ward Laboratory of Nuclear Engineering, built with the Vitro Engineering Company as architect-engineers), these buildings were all designed by the architectural firm of Perkins and Will. The last of them (Bard Hall) was completed in 1963. The completed campus (subsequently named the Joseph N. Pew, Jr. Engineering Quadrangle) was essentially as it had been planned in 1940, except for changes that preserved Sage College (now Sage Graduate Center) and shifted the extension of East Avenue farther to the east to accommodate some of the new engineering buildings.

Unfortunately, the quality of the campus building suffered considerably during this time. In 1950 the University

The most recent addition to the engineering campus is Snee Hall, home of the Department of Geological Sciences.

The view in the upper photograph is from College Avenue; the building follows the curve of the roadway as it goes from the Collegetown bridge onto the Cornell campus. Features of the building include a central atrium and a solarium (at ground level on the right in the photograph) used as a reading room.

The view below is around the corner; College Avenue is to the right.

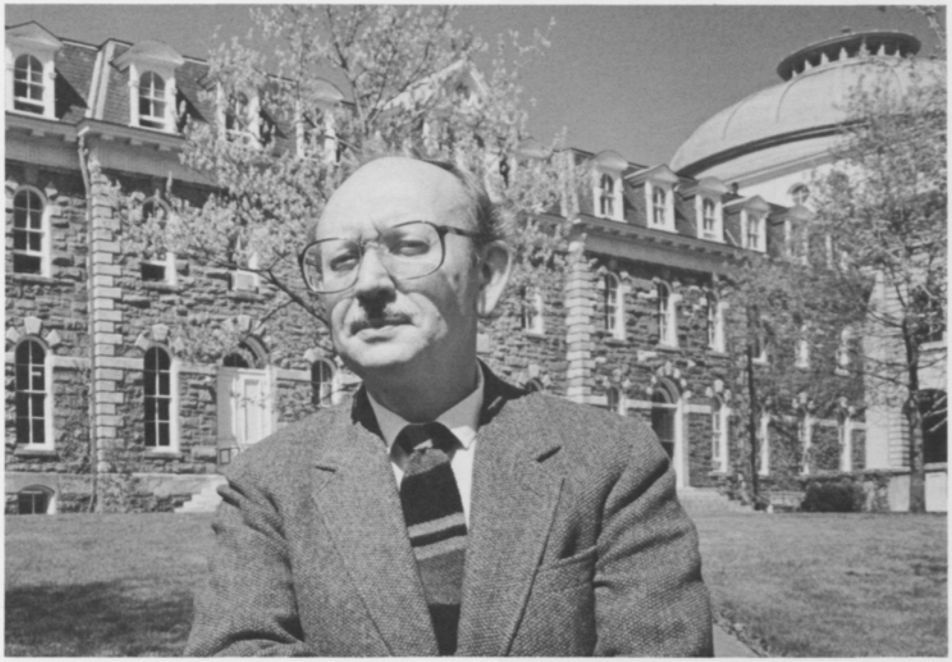


trustees decided, as stated in the official minutes of the Board, that "engineering rather than architectural construction" would be advisable for the much-needed men's dormitories; consequently, cost-cutting became the policy for all new construction, as well as for remodeling and maintenance. The University, which was in an expansion mode, was spending more money on faculty and less on facilities. Most of the present physical plant of the College of Engineering was built under this policy, which was in effect until the mid-1960s.

ENTERING THE FOURTH ERA OF DEVELOPMENT

After the facilities planned and funded under the leadership of Dean Hollister had been completed, no major new buildings for engineering were added for some eighteen years. The College concentrated on curricular changes and an extensive development of research capabilities that brought Cornell into the forefront of engineering education in this country.

Then, in 1981, Knight Laboratory was built to house the National Re-



search and Resource Facility for Submicron Structures, which had been established at Cornell in 1977. The building was especially designed to meet the exacting needs of submicron research—needs that include "clean-room" laboratories and a vibration-free structure. Funds were provided by Lester B. Knight, Jr., for whom the building has been named, and the architectural design was by Lester B. Knight and Associates. The most recent addition has been Snee Hall for the geological sciences, situated between Hollister Hall and Cascadilla Gorge. Named for the late William E. Snee '24, it was funded with gifts from Snee and his wife, Katherine, the Joseph N. Pew, Jr. Trust, and other friends of Cornell. It was designed by Perkins and Will (the Washington office, with Mario Schick as architect). Knight Laboratory and Snee Hall, with their special design features, represent a turn from the policy of austerity in construction.

Now extensive planning is underway for additional construction on the engineering campus. The College appears to have entered the fourth era of planning for change in programs and facilities, those two mutually dependent and supportive aspects of a modern engineering institution. Indications are that this time the keynote may be innovative architecture to serve ambitious new programs.

Kermit C. Parsons is professor of city and regional planning at Cornell. One of his special interests is the architectural history of the University; he is the author of The Cornell Campus: A History of Its Planning and Development, *published in 1968 by Cornell University Press.*

He received the degree of Bachelor of Architecture at Miami University in Oxford, Ohio, in 1951, and the Master of Regional Planning at Cornell in 1953. He joined the Cornell faculty in 1957 after four years as a staff member of the Cleveland City Planning Commission. At the University he has served as chairman of the Department of City and Regional Planning and as dean of the College of Architecture, Art, and Planning. This summer he was appointed director of the Cornell-in-Washington Program.

He has conducted research on urban planning and development sponsored by various federal and state agencies and private foundations, and has served as a consultant to local, state, national, and international organizations. These include a number of communities in Ohio and New York State; the Ford Foundation; the United States Department of State (the AID program); Mid-Hudson Patterns for Progress; the Philippine government; and the World Bank. He has been a visiting professor at the University of Puerto Rico, Western Reserve University, the University of Washington, and Harvard University.

He is a member of several professional societies in the fields of architecture and planning and has served as president of the Society for College and University Planning. He is a registered architect in Ohio.

THE RISE OF RESEARCH

Fifty Years of Change in Cornell's Engineering Program

by Julian C. Smith

Fifty years ago Cornell's College of Engineering was a very different place. It was a lot smaller, with about 850 students and eighty-one faculty members. The administration consisted of the dean and the directors of the three schools—in civil, mechanical, and electrical engineering. The College was still in a twenty-five-year period of falling enrollments and decline in reputation. Most different of all was the attitude toward research: the College was overwhelmingly a teaching institution, with emphasis on training young men for careers in the rough-and-ready world of professional engineering practice. (Young women in those days became nurses and teachers and secretaries—and housewives—but not engineers.)

Today there are about 240 faculty members in twelve schools and departments and some 2,400 undergraduates—almost one-fourth of them women—plus close to 1,000 graduate students. Administration has grown. Cornell once again has a prestigious engineering college, with both undergraduate and graduate applications increasing every year in numbers and quality. And research is big business; it is the principal activity of many of the faculty members, and an important activity of nearly all of them.

The change in the perceived mission of the College of Engineering from teaching to an integrated teaching-and-research function makes a fascinating story.

DEAN KIMBALL'S TEACHING FACULTY: 1934–35

In 1935 professors were concerned with preparing students for professional careers. True, they built on a foundation of mathematics and physics, and at Cornell this preparation was generally very good; but the "engineering" part of the curriculum was devoted to practical matters—the design, construction, and maintenance of structures, highways, and machinery, and the operation and administration of factories and electric-power systems. (Chemical engineering and agricultural engineering were both offered in 1935, but not in the College of Engineering.) The material taught was largely empirical. To most practical engineers, the attitude toward scientists was admiration from a distance, or disdain, or something in between; certainly many on the engineering faculty felt that science had little relevance to their interests ("Real engineers don't do research"). Although professors did write books and articles, these were mainly on topics of applied engineering; and actually, a faculty member could have a successful university career without publishing anything. He didn't have to worry about tenure—the tenure system didn't begin at Cornell until some time after 1938.

He didn't need an advanced degree, either. Doctorates were especially rare in engineering faculties. At Cornell, of the eighty-one active professors, assistant professors, and instructors (there were no associate professors), only six had doctorates. Over half the faculty had only an "Engineer" degree—C.E., E.E., or M.E. Twenty-two had master's degrees, but all but three of them were "Master of Engineering" professional degrees rather than research degrees. Five had baccalaureate degrees and two professors and two instructors had no college degree at all.

Table I. ENGINEERING GRADUATE FIELDS

1934–35	1984–85
Aeronautical Engineering	Aerospace Engineering
Agricultural Engineering	Agricultural Engineering
Automotive Engineering	Applied Mathematics
Electrical Engineering	Applied Physics
Experimental Mechanical Engineering	Chemical Engineering
Highway Engineering	Civil and Environmental Engineering
Hydraulics and Hydraulic Engineering (in C.E. and M.E.)	Computer Science
Industrial Chemistry	Electrical Engineering
Industrial Engineering	Geological Sciences
Machine Design	Materials Science and Engineering
Materials of Engineering (in C.E., E.E., and M.E.)	Mechanical Engineering
Mechanic Arts	Nuclear Science and Engineering
Mechanics (in C.E. and M.E.)	Operations Research
Railroad Engineering (in C.E. and E.E.)	Theoretical and Applied Mechanics
Sanitary Engineering	Water Resources*
Structural Engineering	
Topographic and Geodetic Engineering	

**Minor field only*

All the professors and assistant professors were also members of the Engineering Division of the Graduate School. The advanced degrees offered were M.E.E., M.M.E., M.S. in Engineering, and Ph.D. Every candidate for a graduate degree had to present a thesis, but original research (at least for the master's degree) was not required. According to the pamphlet "Graduate Study in Engineering," the thesis could be "(a) an analytical or interpretative discussion of results already in existence; (b) a design or construction or both, of sufficient importance and originality to demonstrate thoroughly a knowledge of the principles involved and of their applications; (c) a dissertation based upon his original investigation, analytical or experimental." The student had a long list of topics to choose from, even within any one graduate field, and the numbers of fields (Table I) and departmental laboratories (Table II) are impressive. The actual number of graduate students was small, however: fifty-four in 1934–35 and thirty-three in 1935–36. More than half of these were in civil engineering; in electrical engineering there were only three graduate students during one of those years and only one during the other year. Since most graduate students were working toward a professional degree, the number of Ph.D. candidates was tiny.

With so little research in progress and so little incentive to publish, it is not surprising that faculty publications were few. The president's report for 1933–34 lists some 750 publications by faculty members of the University. Most of these authors were from the College of Agriculture or the Medical School, and most of their papers and books could be called research publications. Contributions from the College of Engineering totalled twenty-two, including six books and monographs, one handbook, and thirteen articles; of these, perhaps six would qualify as research publications. The others dealt with curricular matters and musings about the nature and future of the engineering profession.

Table II.
FACILITIES IN 1935

Civil Engineering
Cement and Concrete Laboratory
Testing Laboratory
Mechanics Laboratory
Laboratory of Applied Elasticity
Highway Laboratory
Hydraulic Laboratory
Sanitary Laboratory
Fuertes Astronomical Observatory

Mechanical Engineering
Materials Testing Laboratory
Photo-Elastic Laboratory
Steam Laboratory
Gas Engine Laboratory
Hydraulic Laboratory
Oil Testing Laboratory
Refrigeration Laboratory
Cement Laboratory
Fuel Testing Laboratory
Belt Testing Laboratory
Foundry

Electrical Engineering
Electrical Machinery Laboratories
Standardizing Laboratory
Electrical Communications Laboratory

Right: An attitude of support for faculty research activity was introduced by S. C. Hollister, who was dean of the College of Engineering from 1937 to 1959.

Trevor R. Cuykendall of Physics and Fred H. Rhodes of Chemistry, both of whom later joined the engineering faculty, published seven research papers that year.

In 1934 an engineering professor could expect little monetary support for research. There was the income from the Harold I. Bell Research Fund and the McMullen Research Scholarships. But the Bell fund was only $5,000, the income from which was restricted to research in hydraulic engineering; and the McMullen scholarship money was used that year for faculty salaries "to prevent a greater salary reduction."

By the following year the situation had improved somewhat. An alumnus, Herman W. Westinghouse, had left $500,000 to the College to "promote science in engineering," and in 1935–36 the income from this bequest provided not only additional money for faculty salaries, but $6,000 for research—an enormous allocation by previous standards—and $1,000 for publications. The publication fund permitted three bulletins to be issued; they contained a total of four research articles, reprinted from the student-run periodicals *Civil Engineering* and *Sibley Journal of Mechanical Engineering*. (These journals were combined to form the *Cornell Engineer* in 1935–36.)

Industrially subsidized or "cooperative" research was a subject of much debate. Dean Kimball's report to the president is revealing: "...the college has always engaged in work of this kind under somewhat strict supervision and it has been believed by many members of the faculty that such work should be strictly guarded as it sometimes has a tendency to lower the teaching efficiency of the teacher who engages in such outside activities. Experience with cooperative work or in fact any outside consulting work on the part of a professor indicates that these objections have been well founded. Yet a number of institutions in this country have engaged in cooperative research with apparent success."

Dean Kimball and the three directors (S. C. Hollister in civil engineering, Herman Diederichs in mechanical engineering, and Paul M. Lincoln in electrical engineering) were to study the problem and report on it; Hollister, "who has had considerable experience in cooperative research," was expected to be the most helpful. But in those days industrially sponsored research consisted mainly of routine tests of materials and equipment—breaking concrete samples, for instance, or testing drive belts for machinery. Probably none of it would be considered "research" today. In any event, professors who engaged in it were suspect; it might lower their teaching efficiency.

POST-DEPRESSION AND WAR YEARS: 1936–1945

In 1936 Dean Kimball retired. Diederichs succeeded him, but became ill in February 1937 and died the following August. Hollister, who had been appointed associate dean in 1936, took over the deanship in October 1937. Things began to change.

In an unpublished history of the College, Hollister said flatly, "There was virtually no research going on in the College of Engineering [in 1937] except what the writer had got underway in the School of Civil Engineering." This consisted of research on welded joints sponsored by the American Welding Society and on light-gage structural members for the American Iron and Steel Institute. Also, because of the disastrous floods in the Southern Tier counties of New York in 1936, the Army Corps of Engineers supported research at Cornell in hydraulics and soil-testing. These projects were the beginning of sponsored research in the College.

The new dean was clearly in favor of research, by at least some of his professors. In his history, which was written in 1950, he commented that every faculty member should be "of an inquisitive mind and more or less in contact with the front line of knowledge in his field." This means, he said, that "we must expect him to participate in outside professional society work, in some consulting of a high order, or in some research. He is not only permitted but urged to do this sort of thing." The teaching load, moreover, was to be adjusted to make such a duty possible. Quite a change in attitude from 1935!

In 1936–37 Hollister reported the establishment of ten $1,000 McMullen Research Scholarships to support graduate students and permit them "to divide their time equally between research and graduate study." In the same year the engineering budget included $17,225—income from the Westinghouse fund—for research. Apparently, it was used chiefly to buy equipment in this and subsequent years, but there is no specific mention of the Westinghouse fund in the dean's later annual reports to the president.

Despite the scarcity of resources, the new dean had large ideas for changes in the College. Some of these came to fruition before 1941: The High Voltage Laboratory for electrical engineering research was established on Mitchell Street at some distance southeast of the engineering quadrangle. Chemical Engineering became part of the College, with its own new building, Olin Hall. And research activity began to increase.

The advent of war interrupted the trend and essentially stopped what research was in progress. Accelerated teaching programs, especially the Navy V-12 program, took precedence. For three years the College was on a three-term basis; one session followed another without interruption, and all courses were taught every term. Many professors left to enter the armed services or to become staff members of the proliferating government agencies in Washington. A few did do research—at secret facilities remote from Cornell. The faculty members remaining on campus had to teach enormous numbers of students, day in and day out, with Christmas as the only holiday in the entire year. Any notion of doing research on top of all that was clearly beyond reason.

The administration, however, was making long-range plans that would lead to significant changes not only in the research program of the College, but in the attitudes toward research.

CHANGES IN THE POSTWAR YEARS: 1946–1959

World War II greatly changed the general attitude toward research. Morris Bishop commented in his *History of Cornell* (published by the Cornell University Press in 1961) that "what had been the peculiar passion of unworldly professors became a necessity in international and industrial warfare...." Even some of the worldly engineering professors came to share this opinion, and glimpse the promise of new and distant horizons.

Another change was signalled by the opening of the Graduate School of Aeronautical Engineering in 1946. Here for the first time was a unit of the College not concerned with undergraduate teaching. The value of research wasn't questioned: the purpose of the school *was* research and preparation for research. But it was remote from the rest of the engineering college—for many years it was housed in a temporary wooden building at the airport—and its immediate impact on most of the engineering faculty was small.

More significant and controversial was the acquisition from the Curtiss-Wright Corporation of what became the Cornell Aeronautical Laboratory (CAL). This research facility was at the Buffalo airport, 150 miles from Ithaca. The gift was engineered by Dean Hollister, approved under great time pressure by the executive committee of the University Board of Trustees, and confirmed when $750,000 of working capital was raised from eight airplane manufacturers. The proposal was never voted on by the full Board of Trustees, which very possibly might not have approved it; faculty sentiment, both in and outside of engineering, was certainly against it.

In assuming the direction of a large research institution far from the campus, the University accepted a new principle, which was, as Morris Bishop expressed it in his history, that "research divorced from education is part of the business of a university." Also involved

"...sponsored research was well established during the 1950s ... [and the decade] was notable too in the opening up of new areas of teaching and research."

was a principle regarding secret or "classified" research. Cornell had already established a firm policy that no classified research was to be done on the campus, and that there must be open publication of all research results. Much of the research at CAL was secret and unpublishable, however. Valuable as the facility was to the new Graduate School of Aeronautical Engineering—and there was much useful interchange of ideas and personnel—there remained a persistent undercurrent of feeling that classified research was really not a proper thing for Cornell to be doing. As we shall see, matters came to a head in the late 1960s.

By 1948 government-sponsored research projects were becoming fairly common. A vice-president for research was appointed. Annual research expenditures for the University rose six-fold to $12 million. A number of engineering projects were started; by 1952 some $750,000 a year was being spent on the engineering research. One project—on emergency solidification of soils, directed by Kent Hough in Civil Engineering and me in Chemical Engineering—received a lot of unwarranted publicity in the early 1950s. (Our process received the ultimate accolade: it was mentioned in the comic strip *Steve Canyon*.) But this research was acceptable only as a spare-time activity; Director Fred H. ("Dusty") Rhodes once said, "Smith—how about more teaching and less soils work?"

In the 1950s the emphasis at the College of Engineering was still on undergraduate teaching. Those were the days of the five-year undergraduate programs. Buildings appearing on the new engineering campus were designed primarily for teaching, not research. A program in metallurgical engineering was developed by Rhodes; like the rest of Chemical Engineering, it was strongly oriented toward practice and applications. Still, sponsored research was well established during the 1950s, with almost constant annual expenditures of $700,000 to $800,000. Of this funding, 90 percent came from government agencies; the rest was mostly from industry. These would be small sums today, but must have seemed enormous to professors who had been here in the 1930s.

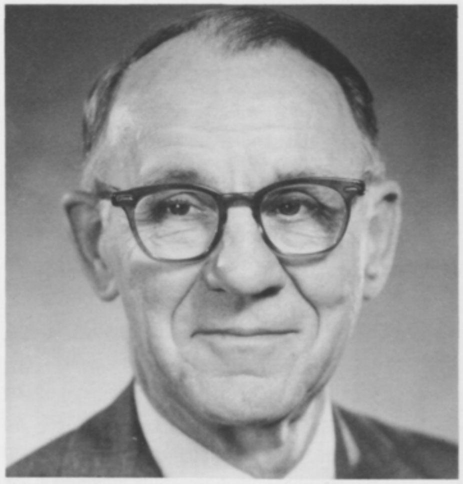
The decade of the 1950s was notable too in the opening up of new areas of teaching and research. In 1955, for example, Robert K. Finn was appointed to begin a program in biochemical engineering. Space research began also. The Center for Radiophysics was formed, mainly by people in Electrical Engineering, and this ultimately became a very large undertaking. In late 1957 the Russians launched the first man-made satellites, Sputniks I and II, and this had far-reaching effects on research and education in science and engineering in the United States. Years of complacency about America's technological leadership vanished overnight. Colleges and universities began frantic soul-searching about curricula and research, especially about ways to get more science into engineering. (The failure of the Vanguard programs was called "an engineering failure"; the successful Pioneer IV moon shot, in March 1958, was "a scientific triumph".) But major changes in engineering at Cornell did not come until the end of the decade, with the advent of a new scientifically oriented dean.

A PERIOD OF NEW EMPHASIS: 1960–1970

In July 1959, when Hollister's long period of leadership ended, Dale R. Corson, chairman of the physics department, was appointed dean of engineering. This was a break with tradition; it would have been unthinkable, before World War II, to choose a physicist to head the engineering college. But the space program wasn't the only successful example of applied physics: transistors were beginning to revolutionize computing equipment and electronics generally, and nuclear power was showing great promise. Over half the engineering faculty members now had doctor's degrees (see Figure 1*a*) and interest in research was growing fast. Things were ripe for change.

Very quickly the new dean promoted the expansion of the Center for Radiophysics and Space Research. Interest in that field by College faculty members led to the conception, planning, and building (in 1963) of the 1,000-foot radar-radio facility at Arecibo, Puerto Rico. Corson also proposed to the Advanced Research Projects Administration (ARPA) the establishment of the Materials Science Center, a multimillion-dollar interdisciplinary facility. It was funded and began operation in 1963.

Seizing still another opportunity, Corson in 1960 made a proposal to the Ford Foundation outlining needs of the College of Engineering and requesting several million dollars to meet them. His proposal reflected a greatly increased emphasis on research by engineering professors and graduate students. The new research was to be fundamental rather than empirical, and



Left: Rapid expansion of the College's research program proceeded during the administration of Dale R. Corson, who was dean from 1959 to 1963.

Left below: The unique radar-radio telescope facility at Arecibo, Puerto Rico, was conceived and planned at Cornell and built in 1963.

Below: Another innovation was the establishment of Cornell's Materials Science Center, a federally funded interdisciplinary research facility.

Figure 1a

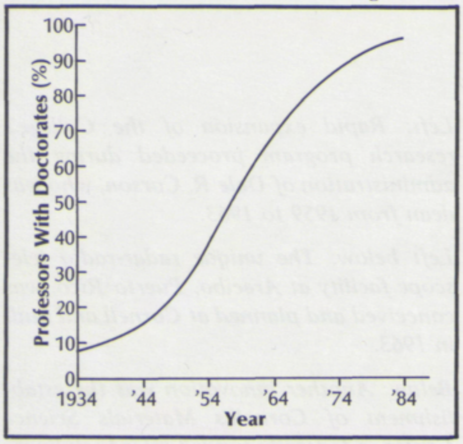


Figure 1b

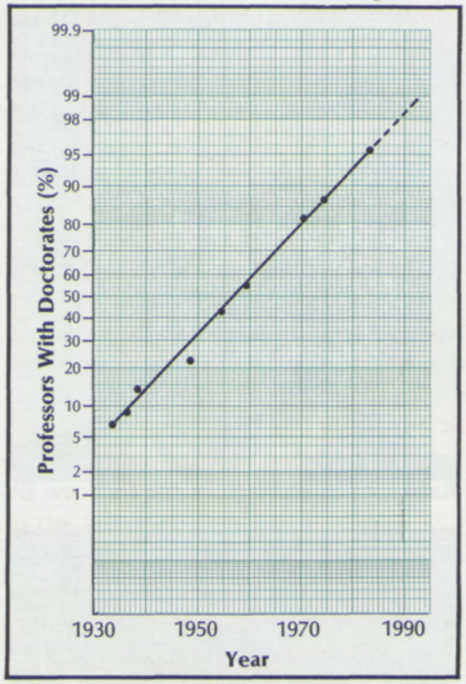


Figure 1. The rise over the past fifty years in the percentage of Cornell engineering professors with doctorates—a reflection of the rise in importance of research. An intriguing feature of the graph (a) *is that it plots as a straight line on probability paper* (b).

Figure 2

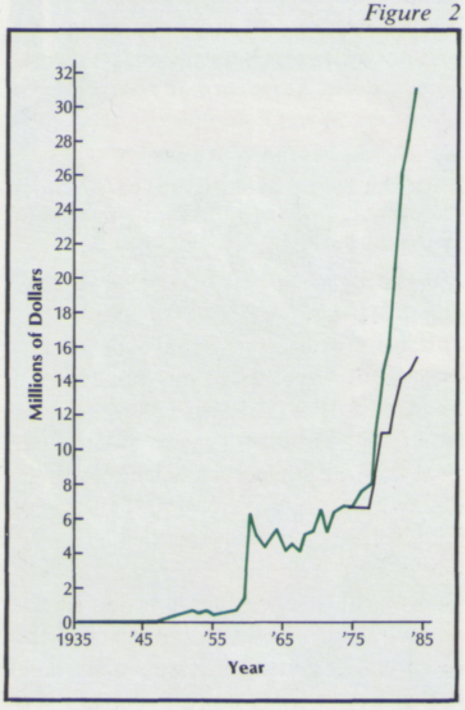


Figure 2. Research expenditures in engineering at Cornell. The ending of each fiscal year is plotted. The line in black shows an adjustment for inflation. The amounts include funds spent through special laboratories and centers.

much of it was to be interdisciplinary, involving joint efforts by professors in various branches of engineering and science. Although the emphasis would be on "difficult and novel problems," the research would also be "professional" in nature, with attention paid to ultimate, practical applications. A \$4.1-million grant was awarded in 1961.

Partly because of the Ford Foundation grant and partly because of the funding of the Arecibo project and the Materials Science Center, the research budget of the College jumped in two years from \$700,000 (in 1958) to over \$6 million (in 1960). It fell back a little in the middle 1960s, and then began to rise once again (see Figure 2).

The pace and urgency of research had clearly quickened, and engineering instruction had to change too. In some areas new technologies seemed to develop overnight. The term "obsolete engineer" began to appear, as did "engineering science"—a somewhat ambiguous term that had great currency in the early 1960s. No one agreed on exactly what it was; it was apparently compounded of about equal parts of mathematics and physics, with a dash or two of engineering practice. (Chemistry, in this context, was not a science.) But regardless of the rhetoric, a sounder scientific basis for engineering was obviously needed: research efforts cut deeply across traditional lines, and all over the United States engineering deans were thinking about reorganizing their colleges along research lines and dissolving the old-style departments of civil engineering, mechanical engineering, and so forth. A few institutions even did this. At Cornell a study by Lloyd Smith of Engineering Physics recommended the reorganization of the College into more or less separate research units and teaching units.

In 1963 Corson became provost of the University and Andrew Schultz, Jr., of Industrial Engineering and Operations Research, became the engineering dean. One of Schultz's early actions was to commission a full-scale review of College organization by a faculty committee under my chairmanship. The review led to the "Smith II report," which recommended the formation of twelve research departments headed by chairmen who would have most of the financial authority, and a number of subsidiary schools whose chief concern would be curricula and the granting of degrees. This report stirred up a lot of acrimonious debate, but except for some changes in Mechanical Engineering, the recommendations were not followed. Simultaneously, the Engineering Policy Committee made a study of the curriculum and proposed an end to the five-year undergraduate program. This recommendation *was* adopted, not without bitter words by a divided faculty, in April 1964.

These developments contributed to the unsettling ferment of those times. To a professor hired ten or fifteen years earlier, who just wanted to go about his teaching and modest research, these changes—especially the threat of reorganization—may have seemed like the end of his world. More than one professor sought employment elsewhere.

By this time the building program was completed and all branches of the College of Engineering had moved south. The last building, Bard Hall, housed the new Department of Materials Science and Engineering. But even the newer buildings were designed primarily for undergraduate teaching, not research.

After 1965 the turmoil in the engineering faculty abated, but student turmoil began in connection with the Vietnam War. Every spring brought disruptions. During one academic year, final examinations were optional (most engineering students took them). Faculty members at the College remember mostly street blockades, night watches for fire bombs in the buildings, and, toward the end of that period, the occupation of Carpenter Hall. As to research, the focus of the student activists was primarily on the secret military work at the Cornell Aeronautical Laboratory; and indeed, after several years of discussion and some difficulty in finding a buyer, Cornell did finally give up its interest in the facility. It was not considered a great loss, for the laboratory had little direct influence on the growth and effectiveness of research underway on the Ithaca campus.

A PERIOD OF PROGRAM CONSOLIDATION: 1971-1985

By 1971 research was considered to be at the heart of the program in nearly all the departments and schools of the College. Annual research expenditures had risen to over $6 million. All but two of the new faculty members hired after 1960 had doctor's degrees; by 1971 80 percent of the engineering faculty had doctorates. It became almost impossible for an assistant professor to get tenure without having developed a significant research program.

In the following fifteen years, under Deans Edmund T. Cranch and Thomas E. Everhart, there were many changes, but they were largely evolutionary, not the wrenching changes of the 1960s. Computers became increasingly important in all branches of engineering and science and in 1965, with the help of a Sloan Foundation grant, Computer Science was formed as an intercollege department, a part of the College of Engineering but with strong ties to the College of Arts and Sciences. In 1971 Geological Sciences, invigorated by the new concept of plate tectonics and the research it generated, was also converted to an intercollege department primarily in Engineering; it was moved to a location on the Engineering Quadrangle.

Research centers and programs proliferated (see Table III). The organizational pattern has become much like that recommended in the Smith II report, only turned upside down: much research is now done in interdisciplinary centers and programs, each with its own director and drawing on faculty from within the College or outside; teaching, undergraduate degrees, and curricula (as well as considerable research) are the concerns of the schools and departments. The funds for interdisciplinary centers or programs are administered by those units, so that although the amounts may be large—several of these centers have substantial industrial support, as well as federal funding—there is only indirect impact on the overall operating budgets of the schools and departments.

Overall growth in research expenditures from 1964-65 to 1974-75 was slow and irregular, averaging just over 5 percent per year (see Figure 2). In 1975-76 government support began to

Table III. ENGINEERING AND ENGINEERING-RELATED CENTERS AND PROGRAMS, 1984–85

Biotechnology Institute
Center for Applied Mathematics
Center for Environmental Research
Center for International Studies
Center for Radiophysics and Space Research
Center for Theory and Simulation in Science and Engineering
Cornell High-Energy Synchrotron Source (CHESS)
Cornell Manufacturing Engineering and Productivity Program (COMEPP)
Cornell Program in Power Systems Engineering
Institute for the Study of the Continents (INSTOC)
Laboratory of Plasma Studies (LPS)
Materials Science Center (MSC)
National Astronomy and Ionosphere Center
National Research and Resource Facility for Submicron Structures (NRRFSS)
Program of Computer Graphics
Program on Science, Technology, and Society
SRC Program on Microscience and Technology
Ward Laboratory of Nuclear Engineering

Industrial Affiliates Programs
Consortium for the Cornell Injection Molding Program (CIMP)
Cornell Materials Science Industrial Affiliates Program (MSIA)
Cornell Program for the Study of the Continents (COPSTOC)
Cornell Program on Submicrometer Structures (PROSUS)
Industrial Affiliates Program in Computer Science

"... the way to promote research is to hire people who want to do it, and to give them the necessary support."

increase; the faculty established large flourishing research programs, and dollar expenditures for the next ten-year period increased by 15 percent annually. Even discounting for inflation, the average increase was over 10 percent per year.

The change to a research emphasis came late in Chemical Engineering. Despite the pioneering research in biochemical engineering begun in 1955 and a major study of sea-water desalting started in 1967, the focus of the school through the 1960s was on continued excellence in undergraduate education. Research expenditures were under \$100,000 per year. The often-painful change began in 1971 with the hiring of four new research-minded professors; it continued in the late 1970s with the appointment of seven additional faculty members, all with strong research programs. Research expenditures by the school rose by a factor of fifteen over a ten-year period, and there was much involvement in interdisciplinary studies.

A CHANGING FACULTY FOR CHANGING TIMES

History, especially in a changing environment, is a poor basis for predicting the future. Figure 2 is a good example: Who would have predicted, in the 1930s, annual research expenditures of \$700,000 in the 1950s? Who could have foreseen the spurt around 1960 or the

Figure 3

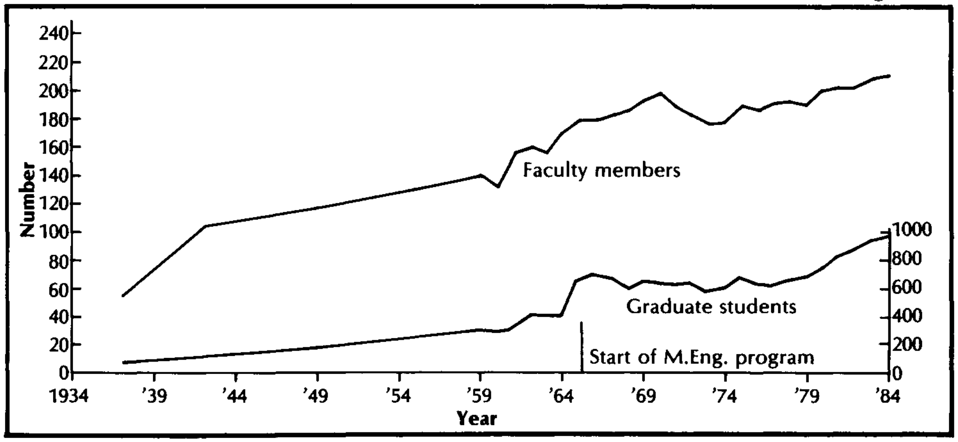


Figure 3. Growth in the numbers of engineering faculty members (excluding instructors and agricultural engineering professors) and graduate students at the College of Engineering. Figures for the fall term of each year are plotted.

The ratio of graduate students to professors is now close to the level considered optimal for a research program. However, since about a fifth of the students are in the M.Eng. program, which is oriented toward design rather than research, many departments wish to admit more M.S. and Ph.D. degree candidates.

The professional M.Eng. program, which began in 1965 as indicated, was developed after the five-year baccalaureate program was cut back to four years.

explosive growth beginning in 1975? Sharp changes are the result of somewhat delayed but rapid response to new conditions—to forces that gather, almost unnoticed, during a lengthy incubation period, waiting for the propitious moment.

Outstanding research is done by creative research-minded people, and the growth in research at the College reflects, more than anything else, a change in the nature and attitudes of the faculty. As Deans Hollister, Corson, Schultz, Cranch, and Everhart all knew, the way to promote research is to hire people who want to do it, and to give them the necessary support. Under Hollister, faculty members with doctorates were hired in rising proportions, and by the end of his tenure half the faculty had training in doctoral research. The trend continued under the later deans, who made sure to appoint directors and department heads who were themselves in favor of promoting research. Now, of course, the change is almost complete. The probability plot of Figure 1*b* is a surprisingly good straight line; it extrapolates to a value corresponding to less than one person without a doctorate (in a faculty of 250) in the year 2000. All but perhaps one of the present eleven professors who don't have doctorates will, indeed, have retired by then. Unless there is a change in policy—as, for example, a decision to hire people from industry who don't have doctorates to teach design or laboratory courses—the twenty-first century should see a completely "doctored" engineering faculty.

Trends in research funding are harder to predict; how the Figure 2 graph will continue depends on many factors, often beyond our control. Funding will depend on the numbers of faculty and graduate students (see Figure 3 for these statistics over the past fifty years); on the nature of their research and the vigor and success of their funding efforts; and on external forces such as government policies and industrial attitudes toward sponsored research. As shown in Figure 2, funding levels increased stepwise until 1975, when growth became steady and continuous. Perhaps this trend of the past ten years merely reflects a slower step change to a new plateau at $40 to $50 million per year; perhaps growth will continue indefinitely. (It seems unlikely that funding will decrease.) The short-range picture is very bright, in view of the favorable attitude of NSF toward engineering, the College's concerted effort to hire outstanding faculty researchers, and the recent funding of additional Cornell centers and interdisciplinary

programs—the Biotechnology Institute, the SRC Program on Microscience and Technology, and the Center for Theory and Simulation in Science and Engineering—which involve much participation by researchers from Engineering.

Engineering research has changed not only in magnitude, but in nature. It is no longer empirical, like most of the research of forty years ago: it seeks fundamental understanding through mathematical modeling, studies of molecular, atomic, and subatomic behavior, and investigation into the nature of design and information transfer. It deals with increasingly complex systems, both large and small. Experimental conditions of temperature and pressure are at almost incredible levels. And the amount of data processed by even a small non-supercomputer would boggle the mind of a researcher of 1935. The list of graduate engineering fields (Table I) hardly conveys a sense of the richness and complexity of today's engineering research.

Dean Kimball and his faculty would find little familiar in today's College of Engineering, with its new campus, large number of graduate students, and enormous research budget. The attitude toward research would strike many of those earlier Cornellians as foreign to their concept of practical engineering. One thing that remains the same, however, is a concern for undergraduate teaching. Today nearly all the professors teach undergraduate courses in addition to doing their esoteric research. Despite the increase in graduate study, undergraduates constitute some 70 percent of Cornell's engineering students, far more than at most comparable institutions.

The Cornell College of Engineering also remains dedicated to education, at all levels, for professional practice, but it has enlarged its province to encompass the advancement of research and has become a world-renowned research institution in an exciting period of growth. The changes begun in 1935 have yielded impressive results, and we can anticipate that by 2001 Cornell engineering research will reach a level of activity and significance undreamed of when the first small program was introduced fifty years ago.

Julian C. Smith, professor of chemical engineering, has been at Cornell as student and faculty member for most of the fifty-year period he writes about in this article. After receiving the Cornell degrees of B.Chem. in 1941 and Chem.E. (with distinction) in 1942, he worked for four years at E. I. duPont de Nemours and Company as a chemical engineer and group head, and then returned to the University as an assistant professor.

During his tenure here he has served as director of continuing education, and as associate director and then director (from 1975 to 1983) of the School of Chemical Engineering. He has also been a visiting professor at the University of Edinburgh in Scotland and at the Universidad de Oriente in Puerto la Cruz, Venezuela, as a UNESCO consultant. Several years ago, in connection with Cornell's Program on Science, Technology, and Society, he visited Nigeria and Colombia for the U.S. Department of State.

A specialist in mixing, solids handling, and phase equilibria, Smith has served as a consultant to many government agencies and firms, including duPont and Rockwell International. With Rockwell, for example, he has worked on the management of radioactive wastes. He is a licensed professional engineer in New York State.

Smith is a coauthor of Unit Operations of Chemical Engineering, *published by McGraw-Hill; the fourth edition (written with W. L. McCabe and P. Harriott) appeared this year. The book has sold more than a quarter-million copies around the world. He has also published many professional papers and contributed to reference books. He holds two patents.*

Smith is a fellow of the American Institute of Chemical Engineers and a member of the American Chemical Society. He is also a member of several honorary societies.

COMMENTARY

Is the Fear of Pollutants Overemphasized in Our Society?

by Neil Orloff

In Zaire, the people of the Lele tribe most fear three risks: being struck by lightning, contracting bronchitis, and barrenness. Of course, these are not the only risks facing the tribe. The people are also susceptible to the usual run of diseases common in the tropics, such as fever, gastroenteritis, tuberculosis, leprosy, ulcers, and pneumonia. But they fear lightning, bronchitis, and barrenness more.

In the United States, one of our greatest fears is of toxic chemicals. Scientific evidence points to much greater risks of mortality —from automobile accidents, smoking, sunbathing, motorcycling, coal mining, and mountain climbing, to list just a few. Yet concern over these risks is small compared with the concern over exposure to chemicals.

As most anthropologists will tell us, the explanation for these apparent inconsistencies is simple. People do not focus on a particular set of risks simply in order to safeguard health and safety. The choice also reflects their view of moral and immoral conduct. Dangers are exaggerated or minimized according to the social acceptability of the underlying activities.

To be sure, there are real risks associated with toxic substances. Asbestos, benzene, lead, PCBs, formaldehyde, and other widely used chemicals threaten the health of many individuals. But the fear aroused by exposure to extremely low levels of chemicals in the environment far exceeds what available scientific evidence will justify.

THREE REASONS FOR PUBLIC REACTIONS

What, then, does support the widespread concern? Three grounds suggest themselves.

First, the focus on chemicals provides a simple and plausible explanation for dreaded diseases such as cancer and birth defects. It provides a ready answer—other than pure chance—for their occurrence. Moreover, this explanation exonerates the victims from responsibility for their personal decisions about life-style that contribute to the outcome—matters such as the foods they eat, the amount of alcohol they drink, and the extent to which they smoke. The link to chemicals frees individuals from blame by reducing the multiple factors involved in contracting these diseases to a single, unavoidable event.

Second, the focus on the risks of chemicals helps maintain people's image of the sanctity of nature. Many individuals are upset by the recent discovery in the environment of low levels of thousands of chemicals because this conflicts with their notion of the purity of the natural environment. It destroys their idealistic view of our air and water. The ubiquity of toxic substances demands either a new, less benign conception of nature, or an all-out attack against the "unnatural" risks posed by these substances in the environment.

Third, the focus on chemicals provides an outlet for a variety of anti-business attitudes, particularly our society's strong resentment of the power and perceived indifference of large corporations. In a number of highly

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A version of this commentary appeared in the Wall Street Journal *of December 3, 1984.*

"The mistake here is clear: Officials have failed to consider the cultural factors underlying people's fear of chemicals."

publicized cases, chemicals are known to have caused substantial harm. In several cases, the harm has been aggravated by corporate misconduct, such as concealment of known risks. By latching onto these cases and then generalizing to a much larger number of other instances, the public has devised a powerful weapon with which to attack the general business community.

Viewing the fear of chemicals as grounded in this complex set of social needs, rather than simply in a concern for health, helps to explain some of the major failures in resolving environmental controversies.

GAPS IN THE INFORMATION SCIENCE CAN PROVIDE

The Environmental Protection Agency, the Occupational Safety and Health Administration, and many companies have sought to latch onto scientific evidence to defend their proposals on the necessary degree of control of toxic substances. Yet science cannot provide sufficient certainty to dispel people's beliefs—and probably will not be able to do so for many decades.

At present, science can only crudely estimate the effects of a given substance on laboratory animals. The experiments often involve doses that are a million times higher than the levels found in the environment. These doses, while unrepresentative of real-world conditions, are necessary to produce measurable results within a group of five hundred to one thousand test animals. The results are then extrapolated down to the levels actually present in the environment, and further extrapolated from the particular test animals employed in the experiment to humans. These extrapolations involve dozens of different assumptions, to compensate for the lack of more specific data and for our ignorance of the underlying mechanisms causing diseases such as cancer.

This use of predictive models introduces tremendous uncertainties into the process of risk assessment. The National Academy of Sciences recently estimated the number of cases of human bladder cancer likely to result over the next seventy years from continued use of saccharin. Using a variety of different—but plausible—sets of assumptions, it concluded that the number of cases of cancer could range anywhere from 0.22 to 1,144,000.

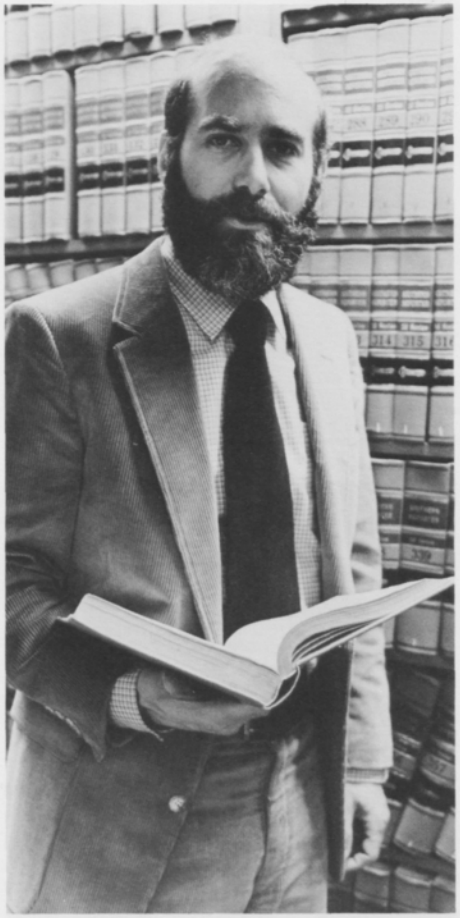
Science can tell us even less about the effects of low-level exposure to several substances. People are not exposed to a single chemical at a time, but to a number of different substances that, as with alcohol and certain drugs, may have synergistic effects. Scientific evidence on these complicated interactions is likely to be dispositive in the long run, but it may be well into the next century before a solid understanding emerges on such issues.

THE FALLACY OF SMALL RISKS

Even if levels of risk were precisely known, however, so that scientists would agree that a chemical dump presented, say, a one-in-a-million risk of cancer to the neighboring community, the current approach to seeking public acceptance of risk would not work. The federal government's risk-management policies are based on the assumption that people will routinely tolerate small risks and only demand protection from large ones. Yet some individuals voluntarily take on large risks, such as mountain climbing and motorcycling. And others run small risks, such as flying in a commercial airplane or allowing their child to ride a bicycle. People obviously measure the acceptability of risk by much more than numbers.

Nonetheless, regulatory agencies and companies have been asking people over the past few years to accept risks from chemicals simply because they are small. And they repeatedly have been rebuffed. In public meetings around the country, officials have been damned when they have tried to placate an angry crowd by noting that the additional risk of cancer would only be "one in a million." The mistake here is clear: Officials have failed to consider the cultural factors underlying people's fear of chemicals.

If the major concern of our society were to save the most lives, we would ban smoking. We also would require smoke detectors in every home and place mobile cardiac emergency units in every community. But where people have a complex set of social needs, including protection of health and safety but not coextensive with it, this approach inevitably would seem inadequate. That may explain why government agencies and companies continue to struggle with the public's concern over trace levels of chemicals that may never harm even one person in a million.



Neil Orloff is director of the Center for Environmental Research at Cornell. A professor of environmental engineering, he is also a lawyer and has had training in business. His teaching is in the area of environmental law and policy, and his research currently focuses on the regulation of toxic substances. An objective of this research is to develop frameworks for government decisions about pollution control in the presence of scientific uncertainty concerning the degree of risk.

Orloff earned the B.S. degree at the Massachusetts Institute of Technology, the M.B.A. at Harvard University, and the J.D. at Columbia University. After receiving his law degree in 1969, he worked for the World Bank on the establishment of development banks in Africa. Subsequently, in the early 1970s, he was a staff member of the Environmental Protection Agency and served on the President's Council on Environmental Quality. He joined the Cornell faculty in 1975 and has been director of the Center for Environmental Research since 1983.

REGISTER

■ The new dean of the Cornell College of Engineering is *William B. Streett*, professor of chemical engineering, who had served as acting dean since June 1984. The appointment as Joseph Silbert Dean of Engineering was effective June 1.

The eighth dean in the history of the College, Streett succeeds Thomas E. Everhart, who resigned last summer to become chancellor of the University of Illinois at Champaign-Urbana.

Streett has been at Cornell since 1978, when he joined the School of Chemical Engineering as a senior research associate. In 1981 he was appointed full professor and also assumed the half-time duties of associate dean.

A statement from President Frank H. T. Rhodes indicated that Streett's appointment came after an extensive nation-wide review. "Bill Streett has performed superbly in the office of acting dean," Rhodes said, "and it is gratifying that he has been selected as the person to continue to lead the College. His breadth of experience and intimate knowledge of the College will stand us in good stead in the future."

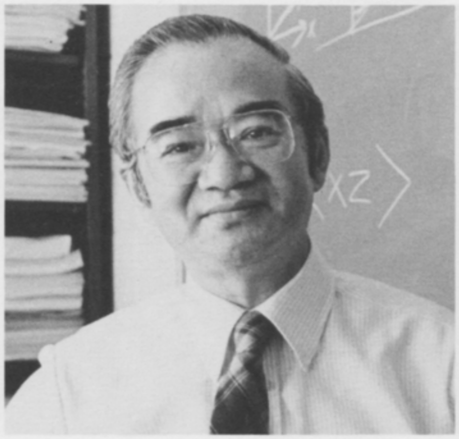
Streett was awarded a B.S. degree and commissioned into the Army upon graduation from the U.S. Military Academy at West Point in 1955. He served on active duty for twenty-three years, including fifteen years on the faculty at West Point. During his military service, he studied mechanical engineering at the University of Michigan, earning the M.S. degree in 1961 and the Ph.D. in 1963.

After teaching astronomy and astronautics at West Point from 1963 to 1965, he spent a year at Oxford University, England, as a NATO postdoctoral research fellow in chemistry. He returned to West Point as associate professor of chemistry and in 1969 became assistant dean for academic research. That same year he founded the Academy's Science Research Laboratory, which he directed until his retirement from the Army with the rank of colonel in 1978.

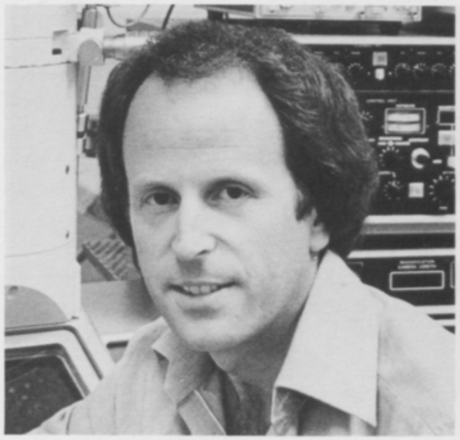
Throughout his career, Streett has conducted an active research program. He has published approximately one hundred papers in the fields of experimental thermodynamics and computer simulation of molecular liquids. An expert on studies of fluids at high pressures, he has developed equipment and techniques for work at pressures up to 10,000 atmospheres. Since he came to Cornell, Streett has been a principal investigator on research projects funded

Pao

Shen



Carter



at more than $2 million; currently he heads four major projects, supported by the National Science Foundation, the Department of Energy, and the Gas Research Institute. His present research group includes a senior research associate and seven graduate students.

Honors he has received include a Guggenheim fellowship that enabled him to return to Oxford in 1974–75 for further research. In 1967 he was awarded the Russell B. Scott Memorial Prize for the best paper presented at the annual Cryogenic Engineering Conference. He has been a invited lecturer at six Gordon Research Conferences. He is a member of Tau Beta Pi, Sigma Xi, the American Institute of Chemical Engineers, the American Chemical Society, and the Royal Society of Chemistry of Great Britain.

Streett and his wife, Jackie, have four grown children, two of them graduates of Cornell.

■ Elected to the National Academy of Engineering this year were *Yih-Hsing Pao,* the Joseph C. Ford Professor of Theoretical and Applied Mechanics, and *Shan-Fu Shen,* the John Edson Sweet Professor of Engineering in the Sibley School of Mechanical and Aerospace Engineering. Academy membership is considered the highest distinction that can be conferred on an engineer.

Pao was chosen "for contributions of basic significance and for stimulating innovative applications in the field of wave propagation in elastic solids." Shen's citation was "for fundamental contributions to aerodynamics and non-Newtonian fluid mechanics." Both were on leave in 1984–85: Pao at the National Taiwan University, and Shen at the Institute of Space and Astronautical Science in Tokyo and at the University of Göttingen in Germany.

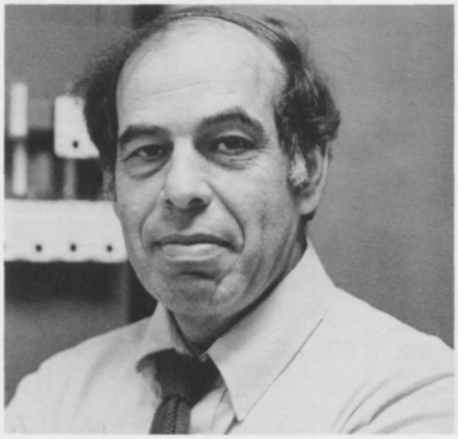
Pao has been a member of the faculty since 1958, and has served as chairman of his department. His degrees are the B.Engr. in civil engineering from National Taiwan University, the M.S. in mechanics from Rensselaer Polytechnic Institute, and the Ph.D. in applied mechanics from Columbia University.

Shen came to Cornell in 1961 after teaching at the University of Maryland for eleven years. He received his undergraduate education at National Central University in China and studied at the Massachusetts Institute of Technology for the Sc.D., awarded in 1949.

■ *Clive B. Carter*, associate professor of materials science and engineering, is one of eight Cornell faculty members awarded Guggenheim fellowships this spring. He plans to spend the coming academic year in England, collaborating with researchers in Cambridge, Bristol, and Oxford on high-resolution studies of phase boundaries in ceramic oxides. He will also spend a month in France, working in Poitiers and Grenoble.

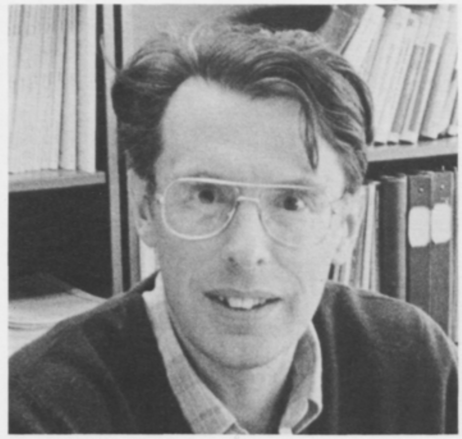
Carter came to Cornell in 1977 as a postdoctoral researcher and joined the faculty two years later. Previously he had earned B.A. and M.A. degrees at Cambridge University, England, and the D.Phil. at Oxford University, and had held a postdoctoral position at Oxford. He is on the editorial board of the *Journal of Electron Microscopy Techniques* and is active in several professional societies.

Batterman



Eastman

Hopcroft



■ Nine faculty members were appointed to chaired professorships in the College of Engineering during the 1984–85 academic year. All are internationally recognized authorities in their fields.

Boris W. Batterman of the School of Applied and Engineering Physics was named the Walter S. Carpenter Jr. Professor of Engineering. A specialist in dynamical x-ray diffraction, he is director of the Cornell High Energy Synchrotron Source (CHESS), a national laboratory for synchrotron radiation research, and was chiefly responsible for its establishment in 1978. He has also served as graduate faculty representative and as director of his school. His honors include fellowship in the American Physical Society and the Alexander von Humboldt Republic of Germany Award for research in Germany during 1983–84. A Ph.D. graduate of the Massachusetts Institute of Technology, Batterman has been on the Cornell faculty since 1965.

Lester F. Eastman has been appointed to the Given Foundation Professorship of Engineering. The holder of three Cornell degrees, he has been a faculty member of the School of Electrical Engineering since he received the doctorate here in 1957. Eastman has been a key figure in the development of teaching and research programs in solid-state devices. He originated the IEEE–Cornell Conference on Microwave Semiconductors, which has been held on campus biennially since 1967, and he has chaired many national and international symposia, conferences, and workshops. He is a fellow of IEEE (the Institute of Electrical and Electronics Engineers).

John E. Hopcroft, a faculty member since 1967, is the Joseph C. Ford Professor of Computer Science. An authority in theoretical computer science, his work has substantially influenced developments in the theory of formal languages and automata, and the theory of algorithms. He is the coauthor of several standard graduate-level textbooks, and is an editor of several professional journals and a monograph series. He serves as a consultant and member of national advisory panels. Hopcroft earned the Ph.D. degree at Stanford University in 1964 and taught at Princeton University before coming to Cornell.

William L. Maxwell, the first Andrew Schultz, Jr. Professor of Industrial Engineering, earned his doctorate at Cornell in 1961 and remained as a member of the faculty. He considers himself the "academic grandson" of Schultz, since his thesis adviser was Richard W. Conway, whose thesis adviser was Schultz. Maxwell, a specialist in scheduling, materials handling, and simulation, is active in the research activities of the Cornell Manufacturing Engineering and Productivity Program (COMEPP). He has been a visiting professor at several universities and a consultant in residence at several industrial firms. At Cornell he has been a recipient of the annual Excellence in Engineering Teaching Award.

George L. Nemhauser of the School of Operations Research and Industrial Engineering has been appointed to the Leon C. Welch Professorship of Engineering. He came to Cornell in 1969 from the Johns Hopkins University, and served as director of his school here from 1977 to 1983. His research is in

Maxwell

Nemhauser

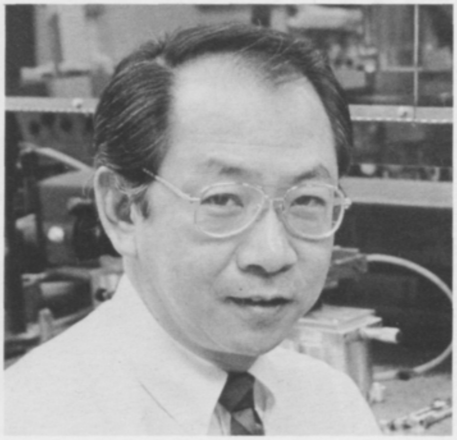
integer and combinatorial optimization, a theoretical discipline with applications in such areas as resource allocation, distribution, scheduling, and reliability. In addition he has been active in professional organizations, serving as president of the Operations Research Society of America and as editor or founding editor of several journals. His Ph.D. is from Northwestern University.

Yih-Hsing Pao, named the Joseph C. Ford Professor of Theoretical and Applied Mechanics, has been a member of that department at Cornell since 1958, when he completed his doctoral studies at Columbia University. He has earned an international reputation in the fields of elastic wave propagation, dynamic elasticity, magnetoelasticity, and, most recently, inverse problems in wave propagation. He has also been active in national and international professional affairs, and at Cornell he recently served a six-year term as chairman of his department. He is a fellow of the American Society of Mechanical Engineers, and this year he was elected to the National Academy of Engineering (see the story on page 41).

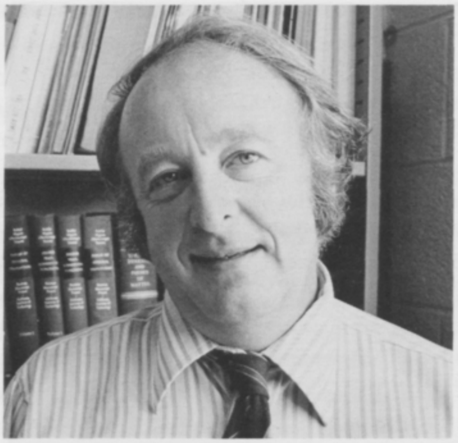
ENDOWED CHAIRS WITH NEW OCCUPANTS

- *The Walter S. Carpenter Jr. Professorship of Engineering* commemorates a Cornell graduate of 1910 who was president and chairman of the board of E. I. du Pont de Nemours & Company. Carpenter Hall, the College of Engineering administration building and library, is also named for him.
- *The John Laporte Given Professorship of Engineering* is in memory of Given, who began his career as a journalist and became head of sales and advertising at the H. J. Heinz Company. The endowment is supplemented by the Ford Foundation Professorship Fund.
- *The Joseph C. Ford Professorship of Computer Science* and the *Joseph C. Ford Professorship of Theoretical and Applied Mechanics* are two of the three chairs in engineering that are named for the late founder and president of the Celon Company. Ford was a 1911 Cornell graduate in mechanical engineering.
- *The Andrew Schultz, Jr. Professorship of Industrial Engineering* honors the Spencer T. Olin Professor of Engineering, emeritus, a specialist in operations research, who served at Cornell as department head and as dean of the College of Engineering. The chair was funded by the contributions of more than three hundred alumni and friends of the College.
- *The Leon C. Welch Professorship of Engineering* (filled for the first time with Professor Nemhauser's appointment) is named for the late vice-president of Standard Oil Company of Indiana, who was a 1906 Cornell graduate in mechanical engineering. The endowment was provided by Welch and his late wife, Edith Packard Welch.
- *The Spencer T. Olin Professorship of Engineering* is named for the former vice president of Olin Industries, Inc., who is a 1921 Cornell graduate in mechanical engineering and an emeritus trustee of the University. The endowment is supplemented by the Ford Foundation fund.
- *The Maxwell M. Upson Professorship of Engineering* is named for the 1899 Cornell graduate in mechanical engineering who became president and chairman of the board of Raymond International, Inc., one of the world's largest construction firms. The endowment is supplemented by the Ford Foundation fund.
- *The Sibley College Professorship of Mechanical Engineering* is named for Hiram Sibley, founder and first president of the Western Union Telegraph Company, whose gifts to Cornell in the early years of the University included funds for Sibley Hall to house the College of the Mechanic Arts (now the Sibley School of Mechanical and Aerospace Engineering). The professorship is one of the oldest at Cornell.

Tang



Turcotte



Wang

Chung L. Tang, a world authority in quantum electronics, solid-state physics, and lasers, was awarded the Spencer T. Olin Professorship of Engineering. He joined the faculty of the School of Electrical Engineering in 1964, after earning the doctorate at Harvard University and working in industry for several years. He is a fellow of the American Physical Society and the IEEE, and his honors also include election as chairman of the 1984 International Quantum Electronics Conference.

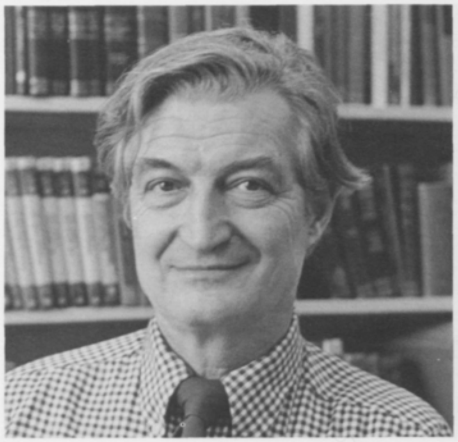
Donald L. Turcotte, chairman of the Department of Geological Sciences, has been named the Maxwell M. Upson Professor of Engineering. He came to Cornell as a member of the aerospace engineering faculty, after working as a research engineer at the Jet Propulsion Laboratory and teaching aeronautics at the U.S. Naval Postgraduate School in California, but his interests turned to geological science through his research activity in geophysics and geomechanics, particularly the study of mantle convection. His work has contributed substantially to the development of plate tectonics and has been recognized in the award of two of the highest honors in geophysics—the Day Medal of the Geological Society of America and the William Smith Lectureship of the Geological Society of London. He holds a master's degree from Cornell, as well as B.S. and Ph.D. degrees from the California Institute of Technology. He is a fellow of the American Geophysical Union and the Geological Society of America, and is active in these and other professional organizations.

Kuo K. Wang, appointed to the Sibley College Professorship of Mechanical Engineering, is on the faculty of what is now the Sibley School of Mechanical and Aerospace Engineering. He began his university education in China, where he earned the B.S.M.E. degree at National Central University in 1947. After working for shipbuilding companies in China and Taiwan, he earned the Ph.D. at the University of Wisconsin and two years later, in 1970, joined the Cornell faculty. His current research is in materials and manufacturing engineering, in particular polymer processing, computer-aided design and manufacturing, numerical control of machinery, friction welding, and metal cutting. At Cornell he took a leading part in forming and directing the Cornell Manufacturing Engineering and Productivity Program, and established an industrial affiliates' program in injection molding. Active nationally and internationally in professional organizations, he is a fellow of the American Society of Mechanical Engineers and the recipient of many national awards.

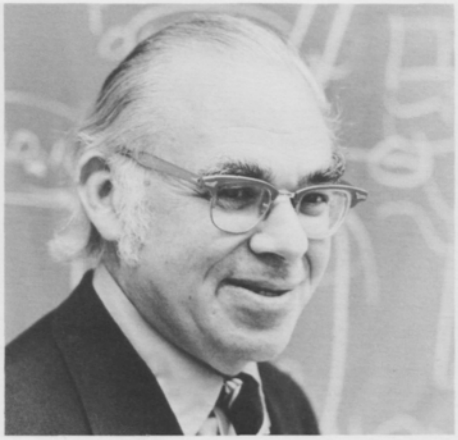
■ Two Alexander von Humboldt fellowships were awarded this spring to College faculty members. The recipients are *Shan Fu Shen,* professor of mechanical and aerospace engineering, whose election to the National Academy of Engineering is noted above, and *Thor N. Rhodin,* professor of applied and engineering physics. They are among more than twenty Cornell professors who have received these prestigious U.S. senior scientist research awards, sponsored by the Federal Republic of Germany since 1972.

Shen has been at the University of Göttingen in West Germany conducting research under the award since mid-

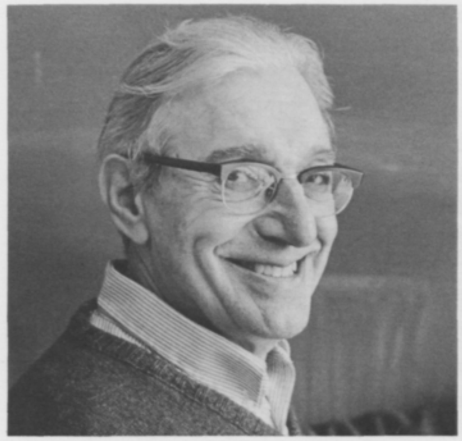
Rhodin



Siegel



Bechhofer



April. He is expected to return to Cornell this summer.

Rhodin will spend part of his sabbatical leave this coming year at the University of Munich in West Germany, and will also work at Cornell and the Brookhaven National Laboratory. A specialist in the electron physics of metals and semiconductors, he will conduct synchrotron radiation studies of surface and bulk electron properties and atomic structure of metals and semiconductors.

Rhodin came to Cornell in 1958 after earning a B.S. degree at Haverford College and a Ph.D. at Princeton University, and working in the engineering research laboratory of E. I. duPont de Nemours and at the Institute for the Study of Metals at the University of Chicago. He has been a National Science Foundation visiting professor at the University of Cambridge; a NATO lecturer at Namur University in Belgium; a visiting professor at the Massachusetts Institute of Technology; and a visitor sponsored by the Japanese Society for the Promotion of Science. He is a fellow of the American Physical Society, a member of the Surface Science Executive Committee of the American Vacuum Society, and an advisory editor of four professional journals on surface and interface sciences.

■ Two professors in the College were honored during the year by the publication of Festschrifts in recognition of their professional contributions. The presentation of Festschrifts, generally collections of papers, is a German academic tradition for honoring senior colleagues on their birthdays.

Benjamin M. Siegel of the School of Applied and Engineering Physics was recognized by having an issue of the international journal *Ultramicroscopy* dedicated to him in honor of his sixty-eighth birthday. The twelve articles in the issue (Vol. 15, No. 3) were contributed by researchers in Japan, the United States, West Germany, France, and Great Britain.

Siegel came to Cornell in 1969 to head the newly established Electron Microscopy Laboratory. In recent years his research has focused on extending the resolution and capabilities of the electron microscope and its applications to molecular biology and materials at atomic resolution. He is a past president of the Electron Microscopy Society of America and received its Distinguished Award in Physical Sciences in 1982. His academic degrees are the B.S. and Ph.D. from the Massachusetts Institute of Technology

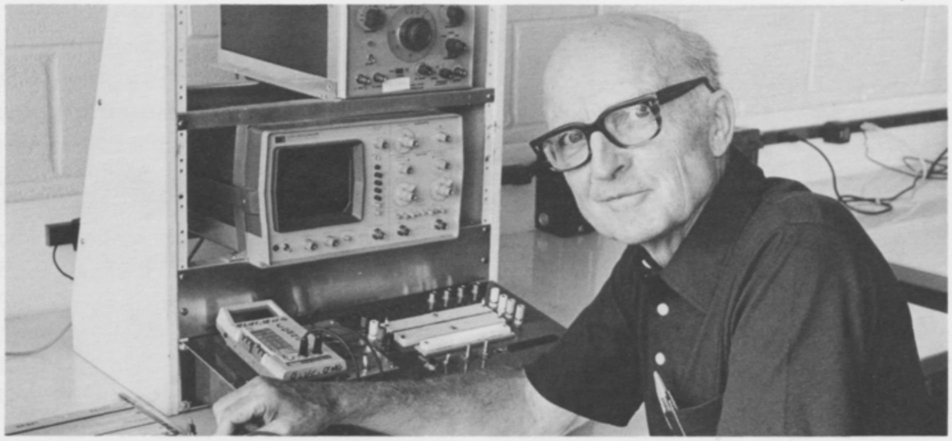
Robert E. Bechhofer of the School of Operations Research and Industrial Engineering was presented with a volume of collected papers, including some by colleagues and former students, at a sixty-fifth birthday dinner held in Philadelphia during the annual meetings of professional societies in the field of statistics.

Bechhofer came to Cornell in 1952 from Columbia University, where he studied for his undergraduate and doctoral degrees. A specialist in ranking and selection procedures, he is a fellow of the American Statistical Association, the Institute of Mathematical Statistics, the Royal Statistical Society, the American Society for Quality Control, and the American Association for the

Advancement of Science, and an elected member of the International Statistical Institute. In 1981 he was the recipient of the first Samuel S. Wilks Award given by the Army Mathematics Steering Committee for contributions to statistical methodologies in army research. At Cornell he served for ten years as director of his school.

■ Two longstanding members of the College faculty, *Nelson H. Bryant* and *Leonard B. Dworsky*, became emeritus professors this summer.

Bryant



Dworsky

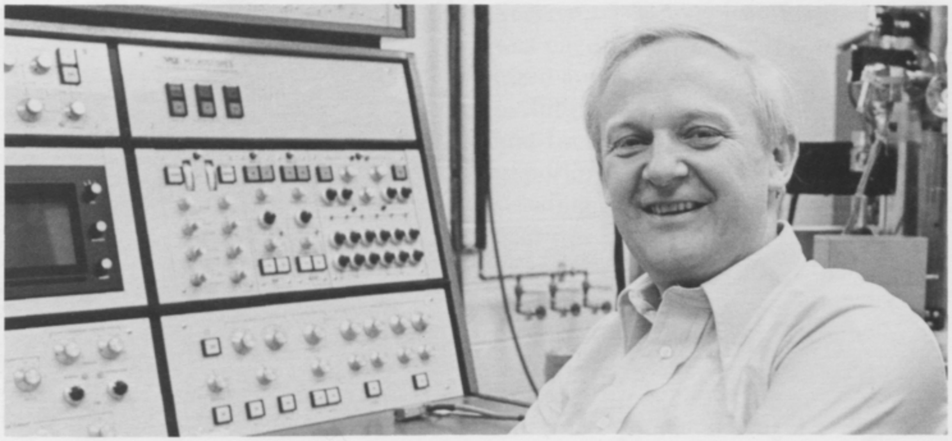
Bryant, who received his education at Cornell and taught at the School of Electrical Engineering for thirty-nine years, is recognized most prominently for his large part in developing instrumentation and courses in the areas of electronic circuit design and digital electronics. Among his publications is a text, *Electrical Engineering: Theory and Practice*, written with his colleague, William H. Erickson. Through the years he has also been active in many areas of electrical engineering practice and research, including fluorescent lamp development, study of radio scattering from turbulent atmosphere, and bioelectronics.

After Bryant received the B.E.E. degree in 1939, he worked for the Westinghouse Electric Company as a lamp engineer, and then served for two years during World War II as an electronics officer in the U.S. Naval Reserve. In 1946 he joined the Cornell faculty as an instructor and worked toward his M.E.E. degree, granted in 1949.

His sabbatical leave activities reflect the range of his research and development interests. The first one, in the 1950s, was spent at the Stanford University Electronics Laboratory, where he used radar techniques in atmospheric studies and designed an antenna array to scan the scattering region. In the early 1960s he worked at the University of Pennsylvania's Johnson Foundation for Medical Research, designing a rapid-scanning spectrophotometer for use in biochemical studies. During the 1970s he spent two leaves at the Powers Manufacturing Company in Elmira, New York, designing electronic circuits, and for twelve years he served as a consultant to that company.

At Cornell he participated in administrative and committee work for the School, the College, and the University. He was particularly active in the M.Eng. (Electrical) degree program as a member of the Graduate Professional Programs Committee and as project adviser to many M.Eng. students.

He has begun working half-time doing circuit design at Ironics, a small new company in Ithaca that produces computers and other equipment for factory automation. He and his wife, Tommie, will maintain their home here.



Silcox

Dworsky, a specialist in water-resource planning, management, and policy, joined the faculty of the School of Civil and Environmental Engineering in 1964 after an extensive career in public service. After receiving the B.S. degree in civil engineering from the University of Michigan in 1936, he worked for five years as an environmental engineer in the Illinois Department of Public Health, and then served in the Army during World War II, attaining the rank of lieutenant colonel. For the following eighteen years, before coming to Cornell, he was a senior administrator of the federal water-pollution control program in the U.S. Public Health Service. During this time, he earned the M.A. degree in public administration at American University and studied natural resources conservation at the University of Michigan. He is a registered professional engineer in Illinois.

At Cornell, in addition to teaching in the Department of Environmental Engineering, Dworsky directed the Water Resources and Marine Sciences Center from 1964 to 1974. Recently he has also been active in public policy studies conducted under the Cornell-in-Washington program. His research has focused on the interaction of science and technology with public policy and management. Specific problems he has worked with include unified river-basin management, water-quality planning, and the management of resources in boundary areas such as the Great Lakes and the United States–Mexico border.

Dworsky has served on the national water and energy policy committees of the American Society of Civil Engineers, and is a diplomate of the American Academy of Environmental Engineers. He has been an environmental consultant to the Rockefeller Foundation; he sat on the Science Advisory Board of the International Joint Commission; and he was an adviser on water resources to President Johnson.

His retirement plans include continued teaching in both Ithaca and Washington, and participation in Great Lakes and United States/Canada/Mexico boundary problems. He and his wife will continue to live in Ithaca and Venice, Florida.

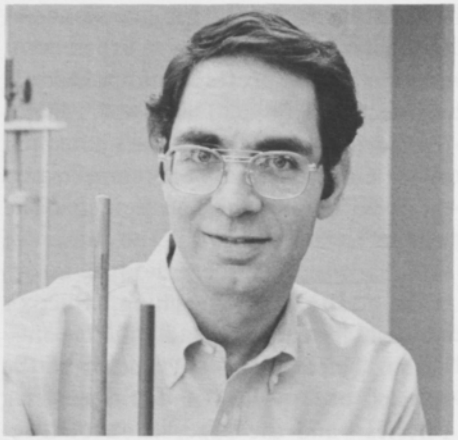
■ This year's Award for Excellence in Engineering Teaching at Cornell went to *John Silcox*, professor of applied and engineering physics. The award, accompanied by a $1,500 prize, is sponsored by the Cornell Society of Engineers and the local chapter of Tau Beta Pi. The winner is selected on the basis of nominations by students.

In addition to teaching, Silcox's activities have included administration—he has twice served as director of the School of Applied and Engineering Physics—and the supervision of a research program of international reputation. A specialist in electron microscopy, spectroscopy, and diffraction, he has focused on the development of instrumentation and techniques to study electronic, chemical, and crystallographic microstructure. Such studies are applicable, for example, to the production of semiconductor thin films for electronic devices.

Silcox came to Cornell in 1961 after receiving the Ph.D. from Cambridge University. At Cornell he is associated with the Materials Science Center and the National Research and Resource Facility for Submicron Structures. He has spent sabbatical leaves as a Guggenheim fellow in France and England; at Bell Laboratories; and at Arizona State University.

He is a fellow of the American Physical Society and past president of the Electron Microscopy Society of America. He has also served on the Solid State Sciences Committee of the National Academy of Sciences/National Research Council. At the present time, he is a member of advisory committees to four national electron microscopy facilities.

Avedisian



Leu

Gilbert

■ Four more Cornell engineering faculty members received Presidential Young Investigator Awards from the National Science Foundation this spring, bringing to fourteen the number from the College who are recipients. This year's award-winners are Assistant Professors *C. Thomas Avedisian* and *Ming C. Leu* of the Sibley School of Mechanical and Aerospace Engineering; *John R. Gilbert* of the Department of Computer Science; and *Robin O. Roundy* of the School of Operations Research and Industrial Engineering.

Introduced just last year, the prestigious awards are given annually to two hundred faculty members throughout the United States. Each award is worth up to $100,000 a year for five years of research in science or engineering: $25,000 a year plus additional funds from NSF to match any industrial grants. The purpose is to help universities attract and retain outstanding young researchers.

Avedisian, a specialist in heat transfer and thermodynamics, emphasizes an experimental approach in his research. He is currently studying various phenomena associated with evaporation and combustion of liquid droplets, and superheating and bubble growth within liquids. He received his undergraduate education at Tufts University, earned a master's degree at the Massachusetts Institute of Technology, and came to Cornell in 1980 after completing his doctoral work at Princeton University. He has also worked at Bell Laboratories in Holmdel, New Jersey. He is a member of Sigma Xi, Tau Beta Pi, the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the Combustion Institute.

Leu's research in the area of mechanical systems is directed mainly to improvements in manufacturing technology; he is interested in robotics, CAD/CAM, and automatic control. Leu joined the Cornell faculty in 1981 after earning the Ph.D. at the University of California at Berkeley. He belongs to Sigma Xi, Tau Beta Pi, Phi Kappa Pi, the American Society of Mechanical Engineers, the American Society of Automotive Engineers, the Society of Manufacturing Engineers, and the American Society for Engineering Education. He is a winner of the 1981 Wood Award, given by the Forest Products Research Society, and the 1985 Teetor Award, given by the American Society of Automotive Engineers.

Gilbert's research is in combinatorial algorithms, especially as applied to numerical problems. In particular, he is interested in sparse matrix problems, which are numerical in nature but require for their solution algorithms that use discrete techniques and data structures. Gilbert holds the B.U.S. degree from the University of New Mexico and the Ph.D. from Stanford University, and joined the Cornell faculty after completing his doctorate in 1981. He is a member of the Association for Computing Machinery, the Society for Industrial and Applied Mathematics, and the Mathematical Association of America.

Roundy, a faculty member here since 1983, investigates lot-sizing, scheduling, and inventory control in complex multistage production and distribution systems. He was graduated magna cum laude from Brigham Young University in 1978, and received the Orson Pratt

Roundy

Ioannou and Chrysostomou

Award for the outstanding mathematics student. After earning the M.A. degree at Brigham Young, he studied at Stanford University for the Ph.D., awarded in 1984. While at Stanford, Roundy was a part-time consultant at Allstate Research and Planning Division in Menlo Park, California. He is a member of the Operations Research Society of America and the Institute of Management Sciences.

■ Professor *Peter Gergely* has been elected to the board of directors of the American Concrete Institute, a professional society with about 18,000 members in the United States and more than one hundred foreign nations. Gergely, who is director of the School of Civil and Environmental Engineering and chairman of the Department of Structural Engineering, is the first Cornell faculty member to sit on the board since Dean S. C. Hollister was president of the ACI in 1932.

■ *John F. Booker*, professor of mechanical and aerospace engineering, was recently named a fellow of the American Society of Mechanical Engineers. He was cited as an "internationally recognized authority on tribology" (the study of lubrication in mechanical systems) and for making "basic and practically important contributions to the understanding of the dynamics of fluid-film bearings and bearing systems." Booker joined the Sibley School faculty in 1961 after completing doctoral work in mechanical engineering at Cornell.

■ *Fred H. Kulhawy,* professor of civil and environmental engineering, has been awarded a Fulbright grant to conduct research at the University of Cambridge, England. A specialist in geotechnical engineering, Kulhawy has received several major professional and research awards and has been a consultant for complex engineering projects on five continents. He has published more than 125 papers in his field.

■ The newly established John E. Perry Undergraduate Prize was awarded this spring to *Chris Chrysostomou,* whose athletic accomplishments are recounted on the following page. The $500 award, which will be given annually, honors a graduating senior in the School of Civil and Environmental Engineering who is chosen for "scholarship, enthusiastic participation in student life, and commitment to the profession of engineering."

The prize is named for John Edwin Perry, who taught civil engineering at Cornell from 1915 to 1953, and was established by a group of Perry's former students, led by Alpheus F. Underhill '30. The donors hope that additional contributions will make it possible to establish another award that will recognize the best teaching assistant in the school.

Chrysostomou's wife, *Maria Nicos Ioannou,* also received a B.S. degree in civil and environmental engineering and won a prize—the coveted solid-gold Fuertes Medal. Established by Professor E. A. Fuertes in 1890, this medal is awarded to the graduate with the highest grade-point average (Ioannou's husband was second in their class). The couple has returned to their native Cyprus for the summer, but will be back on campus in the fall to begin work on Master of Engineering degrees.

■ *Cyndi May,* a senior in chemical engineering, received an award for the best paper presented at this spring's New York State regional conference of student chapters of the American Institute of Chemical Engineers (AIChE). Other chemical engineering seniors honored recently include *Roger Bonnecaze,* who received an American Institute of Chemists Award, and *Michael Snyder,* who was recognized by the Twin Tiers section of the AIChE.

■ Six outstanding engineering seniors and the professors they found most influential were honored this spring at the University's second annual Presidential Scholars Convocation. At a luncheon May 30 Cornell President Frank H. T. Rhodes presented awards to thirty-three seniors who were selected by the deans of the various colleges on the basis of scholastic achievement, leadership, and potential for contributing to society.

The Presidential Scholars from the College of Engineering, their majors, and the professors they named as having made the most significant contribution to their education are:

Rebecca Ann Greenberg, electrical engineering, Professor *Herbert J. Carlin.*

Leonard Katz, electrical engineering, Professor *C. Richard Johnson, Jr.*

Jeffrey Koplik, mechanical engineering, Professor *Ming C. Leu.*

Michael Snyder, chemical engineering, Professor *Raymond G. Thorpe.*

Richard Stottler III, mechanical engineering, Professor *Dennis G. Shepherd.*

Rebecca Ann Greenberg receives her award from President Frank H. T. Rhodes while Professor Carlin looks on.

Jeffrey Varker, operations research and industrial engineering, Professor *Peter L. Jackson.*

Thorpe was also named by a Presidential Scholar last year, the initial year of the program. Another member of the engineering faculty, *Lee W. Schruben* of the School of Operations Research and Industrial Engineering, was selected by a student in the College of Arts and Sciences as having contributed most to his education.

■ Engineers on Cornell teams took time out from their rigorous academic programs to turn in outstanding athletic performances during the year.

Chris Chrysostomou broke the Big Red track team record in the long jump with a leap of 26′2″, helping Cornell win its sixth Heptagonal outdoor championship and qualifying him for the NCAA championships. (The previous school long-jump record was set in 1951 by Meredith Gourdine '53, who was on the Olympic team and is now a member of the Engineering College Council.) At the same Heptagonal meet this spring, Chrysostomou also finished second in the triple jump, an event he won at both the indoor and outdoor meets last year. Chrysostomou, a native of Cyprus, is a senior in civil and environmental engineering and ranks near the top of his class academically.

John Bajusz, who was Rookie of the Year as a freshman, had a second great season on the men's basketball team, which had winning seasons both years. This time he made the All-Ivy first team (the only sophomore on the team) and was selected for All-America honorable mention by both the Associated Press and *Sporting News*. He averaged 15.4 points per game and scored ten or more points in sixteen straight games, the longest double-figure streak by a Cornellian since Gregg Morris had 23 in a row in 1965–66. He shot 60.7 percent from the field to rank thirteenth in the country (third among guards) and also broke the school record for best free-throw percentage in a season (.857).

Randy Sprout, co-captain of the men's swimming team, became the first Big Red swimmer to qualify for the NCAA championships since 1976. He did this by setting Eastern championship records in the 50- and 100-yard freestyle events. He also placed second in the 100-yard butterfly at the championships, and set school records in all three events. He led the entire Easterns in points. Sprout, a junior in electrical engineering, has held McFarley and McMullen Scholarships and is a member of the Red Key Athletic Honor Society.

Left: Leane Sinicki '85 excelled in both field hockey and lacrosse.

In baseball, two seniors in mechanical engineering, *Steve Huber* and *Mike Kalfopoulos,* set new Cornell records. Huber, a righthander, appeared in the most games on the mound (45), snapping the old mark of 42 established by another engineer, Gregg Myers '82. Kalfopoulos, a left fielder, set a new career slugging percentage standard of .584, and also set records for the most doubles in a season (16) and career (45). This season he led the team in batting, runs batted in, doubles, triples, and home runs.

Baseball coach *Ted Thoren* (husband of Jeanne, who is executive assistant to the engineering dean) was elected to the American Baseball Coaches Association Hall of Fame.

Freshman *John Bayne* is already making a name for himself in both soccer and track. In the fall he was a starter at midfield in soccer, and during the spring he had an outstanding season as a sprinter on the men's track team. He has been the top performer in the 400-meter, winning three out of four dual-meet races. He placed third in that event at the Heptagonals, helping the Big Red track team win the championship.

Outstanding women among the athletes from Engineering are *Amy Stanzin* in ice hockey and *Leane Sinicki* in field hockey and lacrosse.

Stanzin, a junior in agricultural engineering, played center and led the Red women skaters in scoring, with 19 goals and 20 assists. A co-captain, she ranked fourth in the Ivies in scoring and was named to the All-Ivy second team.

Sinicki, a mechanical engineering senior, made the All-Ivy first team in field hockey in the fall and was named best offensive player; in the two previous seasons she received best overall player awards. This spring she was one of the defensive stalwarts on the lacrosse team, which finished third at the state tournament.

■ A Cornell Ph.D. in nuclear science and engineering, *E. Linn Draper, Jr.*, is the newly elected president of the American Nuclear Society. After he received his doctorate in 1970, Draper was a professor of mechanical engineering at the University of Texas. He is now with Gulf States Utilities in Beaumont, Texas.

■ The College's alumni organization, the Cornell Society of Engineers, has a new slate of officers and directors and is making plans for an expanded membership and the institution of meetings in cities around the country.

The officers are Eli Manchester, Jr. '52, president; L. Jack Bradt '52 and William G. Ohaus '49, vice-presidents; David S. Kessler '61, secretary; and Roger K. Berman '70, treasurer.

VANTAGE

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■ On-campus events this spring included the culminating symposium in celebration of the centennial of electrical engineering at Cornell. "Electrical Engineering: Its Societal Impact and Future Directions" was the general topic at the Ithaca meeting; in five other cities the discussions centered on microelectronics, computers, communications, atmospheric and space sciences, and energy for the future. Participating were some seven hundred faculty members and alumni, including national leaders in the field.

Speakers at the electrical engineering symposium in Ithaca included (1) Alfred E. Kahn, professor of economics, who discussed telecommunications regulation; (2) Hans Bethe, professor emeritus of physics and Nobel laureate, who spoke about nuclear power; and (3) Ralph Ketchum of General Electric, the luncheon speaker.

Other participants included L. Pearce Williams '48, history of science professor; President Frank H. T. Rhodes; Dale R. Corson, president emeritus of the University and former engineering dean; John A. Nation, director of the School of Electrical Engineering; Maurice Bernard, director of the Ecole Polytechnique, Palaiseau, France; Lewis M. Branscomb of IBM; and S. J. Buchsbaum of AT&T Bell Laboratories.

Photographed (4) with the centennial traveling exhibit are Professors Lester F. Eastman (at left) and Simpson Linke. Supervising the preparation of the exhibit was one of Linke's many centennial activities.

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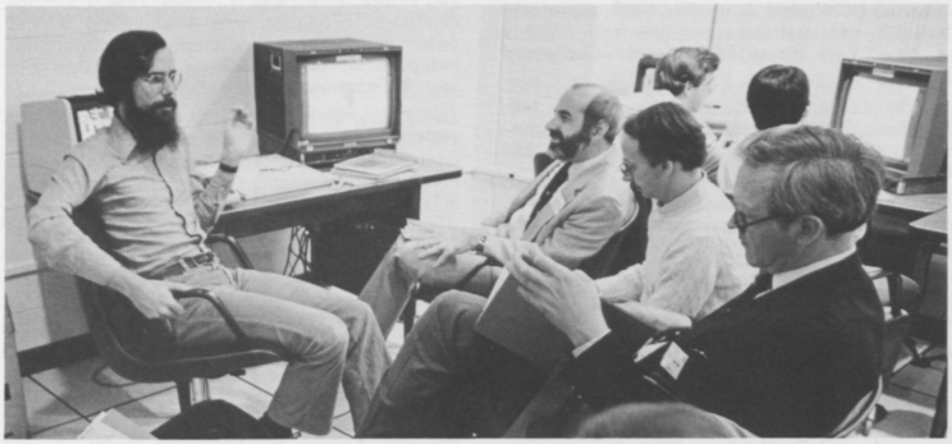
■ The inaugural talk in the new W. R. Sears Distinguished Lecture Series was held in April, with Itiro Tani from the University of Tokyo as speaker. The honored guest was Sears, the "father of aerospace engineering at Cornell," who is now at the University of Arizona. Among Sears' honors is membership in both the National Academy of Sciences and the National Academy of Engineering.

Right: Old friends of Sears (at left) included astronomy professor Thomas Gold.



■ Another attraction for visitors was the second annual Alumni Council Convocation held in early May. The three-day event included lectures and panel discussions on managing change—human, technological, and manufacturing. There were also tours and "updates" on College programs. The Cornell Society of Engineers held meetings for delegates from the various regions.

Left: Professor Kevin Karplus talks with alumni during a convocation tour.

■ On the same weekend as the alumni convocation, the annual end-of-the-year party sponsored by the Society of Women Engineers was held on the engineering quad. The SWE party has become a traditional celebration for engineering students, their guests, faculty and staff members, and—this year—alumni. Features included singing by Cayuga's Waiters (students in the hotel school), a barbecue, and games.

Left: The weather was fine for this year's SWE party celebrating the end of classes.

FACULTY PUBLICATIONS

Current research activities at the Cornell University College of Engineering are represented by the following publications and conference papers that appeared or were presented during the four-month period October 1984 through January 1985. (Earlier entries omitted from previous Quarterly *listings are included here with the year of publication in parentheses.) The names of Cornell personnel are in italics.*

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LETTERS

■ In the recent issue on the electrical engineering centennial, Professor Simpson Linke produced an excellent record of radio astronomy at Cornell. [I would like to contribute] some notes on the early days of the space radio telescope at Cornell.

In about 1948 the WHCU transmitter was being automated, and True McLean, for whom I ran the transmitter on weekends, encouraged me to look instead at the work in radio astronomy being done by the EE department. Some time previously a Dr. Dicke had built a microwave radio receiver, arranged a rotating shutter, much like a movie-camera shutter, in front of the antenna, and switched the receiver output in synchronism with the shutter. When he pointed his "Dicke Radiometer" at the sun or at selected areas of space, he detected white-noise signals well above the background levels. From then on, people began building bigger and bigger dishes for their radio telescopes. One, about 30 feet across as I remember it, was at the new Ithaca airport.

The radio astronomy program, guided by Dr. Henry Booker, employed a number of technicians, many of them students, to build the low-noise amplifiers for use in the telescope. Among the students, besides myself, were Lyman Howe '49 and Larry White '50. Both went on to lifetime careers at Westinghouse in Elmira/Horseheads. Also involved was Bill Gordon, who later built the Arecibo facility....The amplifiers were a state-of-the-art design and great importance was put on being able to design the system on paper and then build the components under such control that (1) the actual performance met the calculated performance and (2) all the amplifiers performed the same. It was an excellent exercise in system design for us students.

There was room for innovation, too. There was a need to control the temperature of the amplifiers. Since they were, of course, all vacuum-tube designs, they generated considerable heat. I got the job of designing a temperature controller. My first thought was to make a conventional make-and-break metallic thermostat. That got ruled out immediately because the arcing of the contacts would generate too much radio noise. Finally I built a plywood box with a fan and a large flapper vane over a window. I went down to the local GLF farm supply store and got several thermostats for chicken brooders. They consisted of sealed bellows containing a hydrocarbon fluid that vaporized at about 95 degrees F. The gas expanded the bellows by about half an inch. I cascaded three of them, put them in the exhaust stream of the window, and connected them through a series of levers to the vane. As the amplifier heated up, the bellows expanded, the window vane opened, and the fan cooled down the amplifier. With this rig I was able to hold the air temperature around the amplifier within a couple of degrees of 98 degrees F. I doubt if my chicken-brooder thermostat ever made it to Arecibo, but it was fun making it....

The Cornell radio telescope was pretty unique at the time, as the Arecibo telescope is today. A large number of men prominent in radio astronomy today came to Ithaca while I was there, studied there, and then went on to other centers around the world....

The apparatus has changed, the science has changed, the people have changed, but the Cornell tradition that put an undergraduate student into a contributing position at the cutting edge of new science—that has not changed. I'm glad to have been even a little part of it all.

Wilson Greatbatch '50
President, Greatbatch Enterprises, Inc.
Clarence, New York

Editor's Note: A news release on file in the *Quarterly* office notes that Wilson Greatbatch received the highest award of the Association for the Advancement of Medical Instrumentation several years ago for "his diverse and significant contributions to innovation in the development of implantable devices." The AAMI Foundation Harold Laufman Award has been described as the most prestigious in biomedical engineering. Greatbatch played a key role in the development and invention of the cardiac pacemaker in 1960.

■ I have just read our *Engineering: Cornell Quarterly* from cover to cover, and am full of nostalgia. I graduated at Sibley (in mechanical engineering) in 1931....

It happens that I play the violin, and a fraternity brother, George Paul Cooke of Honolulu, played the viola. Professor Karapetoff played the cello and spent most evenings doing so. Pepi Cooke and I used to stop at his house after supper and join in his repertoire, following which his wife would serve us hot chocolate and cookies. It was then I would ask for an explanation of a "sparky" problem or theory that perplexed me. His usual answer began, "Schtupid, it's very simple." It was in that relaxed atmosphere that a lowly ME became electrified! Another professor who was helpful in the same way was Walter B. "Doc" Carver, who was head of the math department. Many breakthroughs in calculus (for me) occurred over hot chocolate and cookies at his home.

[In regard to comments] made in the *Quarterly* on the occasion of our EE centennial: Computers, microelectronics, communications, robotics and control, distribution, and so on, are all dependent on an ample and dependable source of power, and increasingly power of finite and continuous frequency, voltage, and amperage.... [It is stated that] "greater use must be made of small-scale generating devices such as fuel cells, solar-power converters, medium-sized hydro units, and wind-turbine generators." Nothing has been said about co-generation....Your reference to the Moler dynamo (page 45) calls to mind the fact that our earliest public utilities were, of necessity, co-generators. Steam-engine exhaust was dissipated through steam heating loops to hotels, hospitals, and office buildings reasonably close to the power-generating station, as at Philadelphia Electric Co., Con Edison, etc. The tremendous and rapid growth in load eliminated the possibility of continued co-generation and the efficiency of large-scale central station power generation, and resultant low cost to the consumer, turned industry away from co-generation in-plant....Many utility companies throughout the United States are now [interested] in co-gen applications, and the ultimate power generation resulting from this discipline is soundly projected....

Frank L. O'Brien, Jr. '31
Ft. Lauderdale, Florida

Note from Simpson Linke: It is of interest that co-generation was in service at Cornell from the early forties until about 1960, when it was discontinued for reasons of economy. A steam turbine took primary steam from the University power plant and drove a 250-kW, 2400-volt a-c generator that operated in parallel with the campus power mains. The turbine exhaust was circulated through the campus heating system, which served as the necessary steam condenser.

Recent comprehensive studies have resulted in a decision to install modern co-generation facilities on campus in conjunction with expansion of the University steam plant. An 1800-kVA unit will be on line by the end of this year. A 6800-kVA unit is planned for completion in 1986. With the capacity of the recently rejuvenated Fall Creek hydro plant included, eventual on-campus generation will allow internal supply of about 12 percent of the annual campus electric-energy load. Additional energy savings will be obtained, of course, from heating the campus with by-product steam.

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C. Hadley Smith did special restorative copy work on the photo on the bottom of page 16.

Please address any correspondence, including notification of change of address, to *ENGINEERING: Cornell Quarterly,* Carpenter Hall, Ithaca, New York 14853-2201.

Opposite: Volleyball on the quad was a way to celebrate the end of classes at this spring's annual party sponsored by SWE, the Society of Women Engineers.


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