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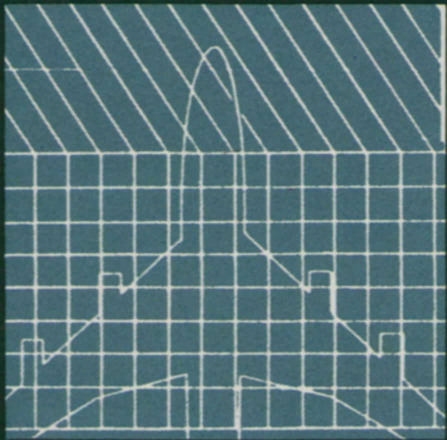

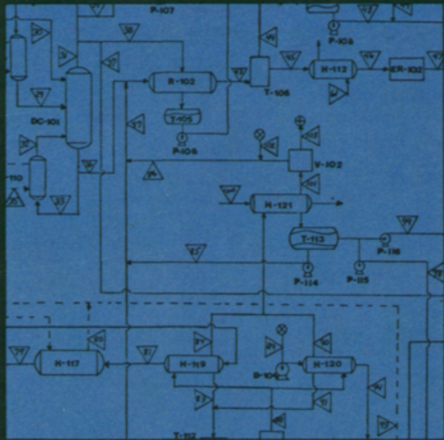

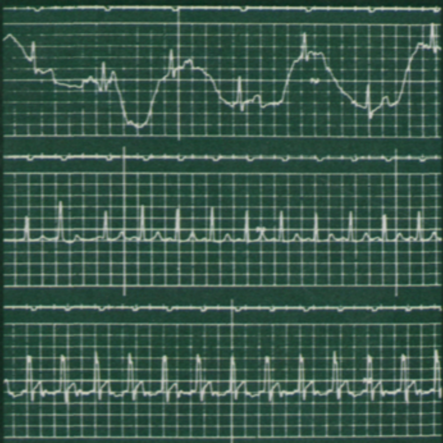

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IN THIS ISSUE

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Outside front cover: Illustrations from the reports of Master of Engineering projects described in this issue include a design for an airport hangar and maintenance facility; a flow sheet for the thermochemical manufacture of hydrogen; electrocardiograms considered in the design of a monitoring system for study of the crib-death syndrome; and a sketch of a steel and plastic canine hip replacement.

PROFESSIONAL ORIENTATION FOR THE ENGINEERING UNDERGRADUATE

by Malcolm S. Burton

A few years ago, during the period of marked student unrest across the country, Cornell engineering students spent many thousands of man hours reviewing the curricula, evaluating courses, and participating in discussions about education, relevance of the curriculum, and similar topics that they saw as important issues of the day. Today, in contrast, the activist furor is gone; the majority of students do not articulate a "student viewpoint." Although a minority remains outspokenly critical of teachers who are less than excellent, teaching assistants who are felt to be inadequate, and courses whose objectives are considered unclear or inadequate, most students appear to be very tolerant of their classes, their curricula, and the faculty.

Nevertheless, awareness of the issues that were raised during the turbulent sixties is still with us. The word "relevance," so overworked a few years ago, is heard less on the campus, but there remains a feeling that the objectives of university education—and of the engineering curriculum—should be clearly defined.

DIFFERENT PERCEPTIONS OF ENGINEERING EDUCATION

Various students see the objectives of baccalaureate education in engineering quite differently. A large fraction undertakes the engineering program because of a specific vocational objective: these students want to be engineers, and an undergraduate program such as Cornell's is the minimum requirement for practice or for more advanced and specific engineering study. A smaller number have specific goals other than engineering practice or professions related to engineering; these students see the quantitative, analytical, science orientation of the undergraduate curriculum as a good preparation for careers in law, medicine, business, etc. Some students elect engineering because they showed aptitude for mathematics and science in high school and were advised to apply to an engineering school. Individual students cite other reasons for being in engineering.

The faculty is not a monolithic group either. Some faculty members assume that all engineering students are preparing to be professional engineers. Others are very aware of the breadth of interests of students enrolled in the College.

The definition of engineering education, then, is not without ambiguity and is frequently understood quite differently by various groups.

CHANGING THE PROGRAM TO FIT THE TIMES

One thing that is very evident is that the curricula and the spectrum of engineering activity have broadened greatly within the past decade. Faculty and students alike are aware that the center of gravity of the Cornell engineering faculty has been displaced toward analytical studies and scientific engineering and research, and away from the more classical applications engineering. The need for this shift was perceived by advanced engineering industries, and by the administration and faculty of the College. Because of expanding student enrollment, new professors with the required background and interests could be hired, and therefore the balance of faculty interests and viewpoints could be changed with a minimum of "retreading" of individuals.

Now there appears to be a feeling among employers and others concerned with engineering manpower, as well as among faculty, school administrators, and students, that there is once again a need for striking a new balance, this time in the direction of the applied aspects of engineering education. In the present time of retrenchment at the university level, however, any development of new outlooks and new missions is more difficult than it was ten years ago. It must be done without increase in faculty size, and rapid change in the overall faculty composition is not possible. Any modification of orientation and outlook must be accomplished within the existing framework.

An important factor in the present situation is that students are much more job-conscious than they have been for some time. They are more interested in finding out about employment opportunities, they make a greater effort to understand what engineers do, and they seek more professional orientation in their college work. Recognizing this trend, the College is implementing numerous programs to bring engineering experience to students, beginning in the freshman year and continuing through the Master of Engineering program in the fifth year.

Freshmen in the mini-course Fluid Flow and Mass Transfer in the Artificial Kidney are happy about the straight-line plot they obtained in their measurements of pressure drop versus flow rate. Demonstrating the linearity with a yardstick are, left to right, Frederick Jaicks, David Lemoine, David Lee, and Debbie Dovenbarger.

BRINGING ENGINEERING EXPERIENCE TO FRESHMEN

All first-year students are required to take course E106, Engineering Perspectives, which is intended to serve as an introduction to the profession. Part of the course is a series of lectures by a number of guest speakers from the "real world" outside the University. It is designed to acquaint freshmen with engineering problems, engineering projects, and practicing engineers.

As part of the E106 course work, the students also take two mini-courses selected from approximately two dozen half-semester courses offered by various members of the faculty. The mini-course concept, first suggested by a faculty study committee, allows professors to try new ideas, develop experimental courses, and teach material which in-

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cludes considerably more engineering and engineering concepts than the more rigidly structured conventional courses. The faculty is not bound by the normally important requirement that each student must learn a multitude of specific ideas, facts, or skills as a prerequisite to a subsequent course. Much more time can be spent on engineering methods, alternative solutions, brainstorming, and group action.

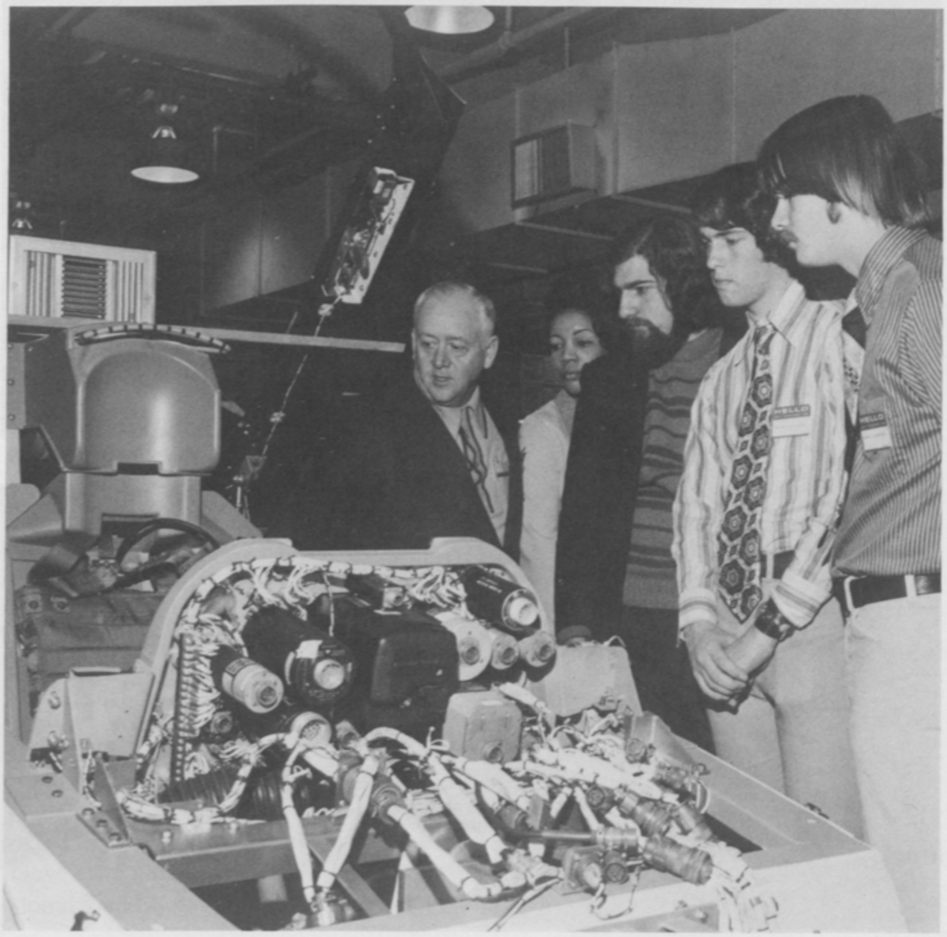
Although most of the mini-courses are related to the particular engineering field with which the teacher is concerned, a few are quite unique. They are offered by instructors who perceive a need and provide a course to satisfy it. For example, Donald Berth, director of engineering projects for the College, felt that students with an entrepreneurial inclination would be more interested in a course that is especially attuned to their individuality and business motivation, and so he offered a mini-course called Working for Yourself. Through this course, we expect to learn more about the programmatic needs of these students.

Most students report that they love mini-courses. Their often expressed desire for close interaction with their teachers is satisfied, and the special attention that professors devote to their mini-courses makes students feel well cared for. The mini-course program has been, by student evaluation, an outstanding orientation to professional engineering.

TRIPS TO INDUSTRIES FOR FUTURE ENGINEERS

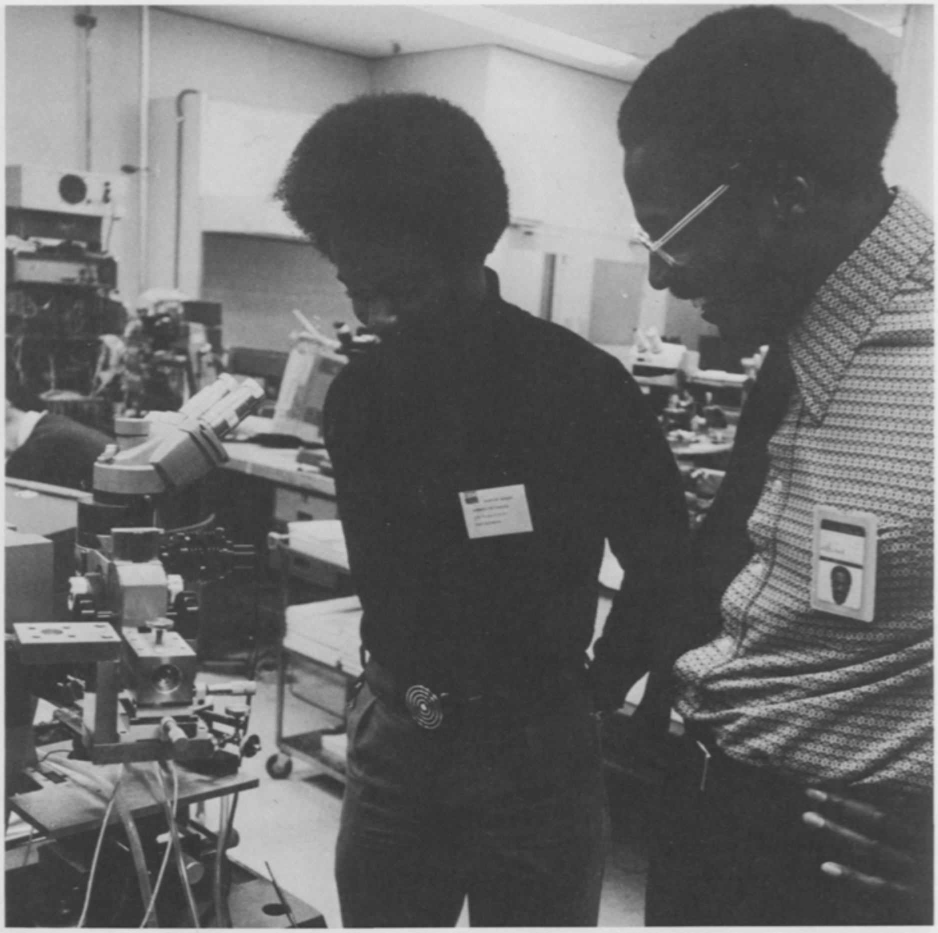
The many complaints by students that they felt isolated from the "real world" led to the establishment of the Engineering Expo program in the spring of 1974. Robert Gardner, director of advising and counseling in the Division of Basic Studies, suggested, planned, and carried out the program. Its objective is to bring students into contact with people and industries actually doing engineering, not through a lecture delivered in a Cornell classroom, but on their home ground. Twelve trips were made, primarily by freshmen and sophomores, to industries and engineering establishments located close enough to Ithaca to allow a one-day trip—if leaving the Straight at 5 a.m. by bus for Schenectady, spending a full day at the General Electric Company, and returning to Cornell at 9 p.m. can be considered a one-day trip!

By participating in Engineering Expo, students were able to observe large and small industry in action, manufacturing processes, consulting engineering, specialty design, and other aspects of engineering practice. They talked with practicing engineers of all ages and were able to relate to them. Evaluation of the trips showed that both students



The Singer Corporation's Simulation Products Division at Binghamton, New York, was one of the companies visited by groups of freshman and sophomore participants in Engineering Expo, an experimental program introduced this spring.
Above: A company engineer explains the operation of a fighter trainer which simulates flight conditions such as gravity and motion.
Below: Three Cornell students, at right, inspect the trainer mechanism with Singer representatives, at left.

Cornell students in the Minority Engineering Exposure Program spend a week or two at industrial facilities.
Right above: Rodney Reynolds (left), who will enter the upperclass electrical engineering Field Program this fall, visited the International Business Machines plant in Endicott, New York. His host was Ray Scherrod.
Right below: Cornell students Jacques Charles and Raymond Wong (second and third from left) consulted with General Electric Company engineers John Alexis (far left) and Ernest Wong (far right) at the armament systems department of the aircraft equipment division in Burlington, Vermont.



and the industrial personnel were highly appreciative of the program; each group learned much about the other. This kind of professional orientation provides invaluable motivation to students who have had no previous firsthand knowledge of what graduate engineers actually do.

ENGINEERING EXPOSURE FOR MINORITY STUDENTS

A somewhat similar opportunity is available in the Minority Engineering Exposure Program, coordinated by LaVoy Spooner, director of engineering minority programs at the College. This was initiated several years ago by Spooner and Donald Dickason, assistant dean of the College, in an effort to compensate for a lack of familiarity with engineering that is especially evident among minority-group students. Each participant spends a week or two during intersession at a company facility, meeting engineers—who are often from minority backgrounds themselves—and observing the day-to-day activity. Participating in the program this past year were thirty-two sophomores and juniors and ten companies: Bell Telephone Laboratories, Chicago Bridge and Iron, General Electric, General Motors, IBM, Eastman Kodak, Polytech Consulting Engineers, Procter & Gamble, Rohm and Haas, and Xerox.

PROFESSIONAL ORIENTATION IN UPPERCLASS PROGRAMS

Specialization is begun in the junior year at the College of Engineering, with each student entering one of seven upperclass Fields or the College Program. Most of the Field Programs, of course, have a strong emphasis on engineering practice, although, as mentioned earlier, faculty interpretations of engineering vary greatly.

Individually structured College Programs are often used by students to prepare for advanced work in a nonengineering field such as medicine, but they can also provide an enhanced engineering component. By developing a curriculum which combines two engineering fields, for example, a College Program student can increase the fraction of true engineering courses in his curriculum and thereby prepare for a particular, perhaps multidisciplinary, engineering career.

A number of specially-sponsored programs have been studied and approved by the College Program Committee, and some have direct professional orientation. Among these is a curriculum in Survey Engineering, planned by faculty from the School of Civil and Environmental Engineering and from the agricultural engineering department of the College of Agriculture and Life Sciences. The curriculum closely follows recommendations of the New York State Association of Professional Land Surveyors, and emphasizes the engineering aspects of surveying. This special College Program, approved late in the 1974 spring term, was created in response to specific requests from practicing engineers and their professional organizations for course work oriented to the rapidly expanding survey engineering branch of land surveying. The program illustrates how the College is able to respond to new situations in the profession.

ENGINEERING COOPERATIVE PROGRAM PARTICIPANTS

American Electric Power Service Corporation
AVCO Everett Research Laboratory
The Badger Company
Chevron Research Company
Chicago Pneumatic Tool Company
Clairol Incorporated
Corning Glass Works
The DuPont Company
Eastman Kodak Company
Eaton Corporation
Emerson Electric Company
Foster Wheeler Corporation
General Electric Company (Electronics Laboratory, Gas Turbine Products Division, Generator Division, Transportation Systems Business Division)
General Motors Corporation (Harrison Radiator Division)
Department of Health, Education, and Welfare (Social Security Administration)
Hewlett-Packard Company (Medical Electronics Division, New Jersey Division)
International Business Machines Corporation
Monsanto Company
Olin Corporation (Chemicals Group)
The Procter & Gamble Company (Engineering Division, Management Systems Division)
Raytheon Company
Sanders Associates, Inc.
Scott Paper Company
S I Handling Systems, Inc.
Structural Dynamics Research Corporation
Supermarkets General Corporation
Xerox Corporation

WORK EXPERIENCE IN THE COOPERATIVE PROGRAM

A particularly appropriate option for those who intend to become practicing engineers is the Engineering Cooperative Program, which provides industrial work experience along with the regular academic curriculum. A surge of interest in the program on the part of both students and companies has occurred recently. In 1974, twenty-nine industrial firms interviewed sophomores who were interested in the Program, and forty-five students began their Program experience this summer. In most cases, students begin by taking courses on campus during the summer preceding their junior year, spend the fall term in full-time employment, and then return to Cornell to complete their junior-year courses in the spring term. The equivalent of almost a full year of industrial experience is completed during subsequent summers, and the student graduates with his class.

The work assignments play a major role in the education of students in this program. By emphasizing the development of the individual in real engineering assignments, the program complements classroom instruction and provides immediate engineering application for many principles learned from textbooks. Invariably, these students are highly motivated toward their studies and toward engineering.

The professional orientation of the Engineering Cooperative Program has been available to students in electrical engineering, engineering physics, industrial engineering and operations research, and mechanical and aerospace engineering. Chemical engineering was added this summer and it is expected that civil and environmental engineering will be added during the coming year.

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4

These four Cornell Engineering Cooperative Program participants received B.S. degrees in June and completed their industrial assignments during the summer.
1. Alfred McDonald, assigned to Eastman Kodak in Rochester, spent his second work period learning about machine shop skills.
2. Gerald Werth, also at Eastman Kodak, handled electrical engineering assignments involving a new movie camera.
3. Mike Spencer spent his three Program assignments at General Electric's Electronics Laboratory in Syracuse.
4. Also at the Electronics Laboratory was Jim McClymonds, who worked on circuit design.

EFFECTIVE TEACHING FOR ENGINEERING STUDENTS

Much of the instructional program for engineering underclassmen consists of nonengineering courses presented by teachers—both faculty members and teaching assistants—from disciplines other than engineering. Freshman-year mathematics, physics, and chemistry, for example, are offered by the corresponding university departments, and a sense of disorientation on the part of engineering students can be troublesome. In an effort to improve the situation, faculty members and advisory personnel have sought and received outside financial support for a new program to enhance the effectiveness of teaching assistants. Tentative plans include a three- or four-day workshop just prior to the beginning of fall-term classes, and a number of meetings during the year. Teaching assistants in mathematics and the basic sciences as well as in some of the engineering core course subjects will participate.

It is hoped that the program will help those instructors who are most immediately involved in the undergraduate engineering curriculum by giving them a better understanding of the needs, aspirations, and motivations of engineering students. This might result, for example, in the inclusion of more engineering applications in course sections for engineers.

Those students who seek strong engineering orientation are able to find it at Cornell. The freshman mini-courses and Engineering Expo help give a "real world" orientation at the outset. Field Programs, special College Programs, and the Engineering Cooperative Program build on the underclass foundation. After receiving the baccalaureate degree, a few students enter engineering employment directly, but most continue their education through a graduate program. For those interested in engineering practice, this is most likely to be the professional Master of Engineering degree program (see the following article in this issue). The M.Eng. curricula are integrated with the upperclass Field Programs and provide professional focus in disciplines introduced at the baccalaureate level.

Although undergraduate education at the Cornell College of Engineering is basically preprofessional and adaptable to students with widely varying interests and purposes, the education of the practicing engineers of the future is a primary mission.

The administration of undergraduate engineering education at Cornell is the major responsibility of Malcolm S. Burton, associate dean of the College and professor of materials science and engineering. His leadership in the development of the undergraduate program extends back to the planning and introduction in 1969 of the present core curriculum.

Burton came to Cornell in 1946 as a member of the chemical and metallurgical engineering faculty. He became assistant director of the Department of Materials Science and Engineering when this was organized in 1964, and later served as acting director of the department. He has been a member of the College administrative staff since 1970.

Burton received the Bachelor of Science degree in mechanical engineering from Worcester Polytechnic Institute in 1940 and the Master of Science degree in metallurgy from the Massachusetts Institute of Technology in 1943. Before joining the Cornell faculty, he taught at MIT for several years.

His professional interests center on engineering applications of materials science research. During sabbatic leaves he has served as a research metallurgist for the former Cornell Aeronautical Laboratory and for E. I. duPont de Nemours. His professional publications include a textbook, Applied Metallurgy for Engineers, *published in 1956.*

He is a member of the American Society for Metals, the American Institute of Mining, Metallurgical and Petroleum Engineers, the American Society for Engineering Education, and Sigma Xi.

THE EDUCATION OF PROFESSIONALS

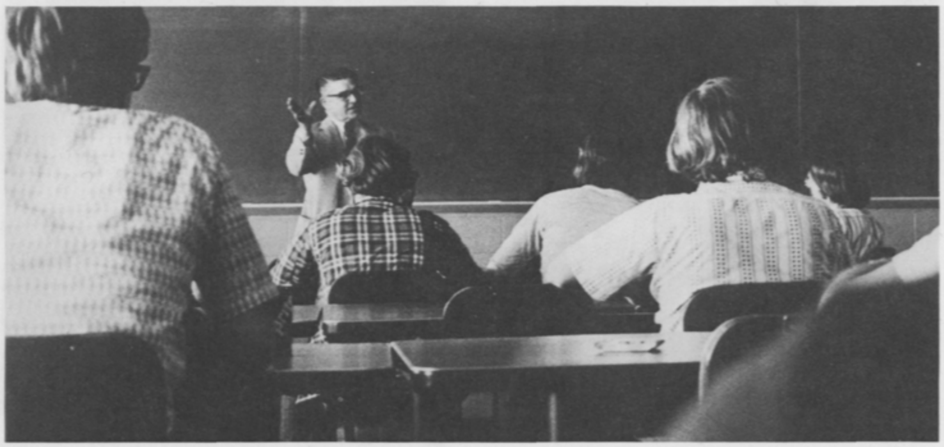
New Impetus in Cornell's M.Eng. Program

How does one prepare to be a professional engineer?

At Cornell the preferred route is the Master of Engineering degree program, one of the liveliest around the College these days. The eleven field-designated degrees available in the program are the ones accredited by the national accrediting agency in engineering, the Engineers' Council for Professional Development.

Ever since the M.Eng. program was introduced in 1965, it has been a popular choice for baccalaureate graduates. About one third of each senior class has continued in this integrated fifth-year course of study. At the present time, on the national scale, there is an increased demand for professionally qualified engineers who can work effectively in a complex society; and accordingly, there is a growing potential for professional education of the kind provided by the Cornell preengineering undergraduate curriculum followed by the M.Eng. program.

The College is seeking to meet this situation by infusing new energy and resources into the professional mas-



Above and left: M.Eng. (Civil) students this spring heard a talk on engineering professionalism and registration by Harry E. Bovay of Bovay Engineers as part of a new required course in Professional Practice in Engineering. Bovay, a 1936 Cornell graduate, was one of a number of professional guest lecturers, many of them alumni. The purpose of the course is to expose students to the many facets of engineering practice, including legal, financial, social, and ethical aspects. Another innovative feature of the program is the use of the three-week period between semesters for intensive work on large-scale "real life" design projects, with professionals serving as consultants.

ter's program. Academically, new approaches are being encouraged and implemented, and there is a heightened emphasis on the involvement of practicing engineers in the educational process. Financially, funds are being sought to support program development and scholarship aid.

The M.Eng. program has been at a financial disadvantage because there has been less external funding available for this practice-oriented stem of graduate engineering education than for the more established and research-directed Master of Science-Doctor of Philosophy stem. During the past year, however, the College has had considerable success in raising seed funds for M.Eng. program development, according to Donald F. Berth, director of special projects. Faculty have been enabled to devote more time to planning design-oriented courses, broadening and strengthening the project work, and devising new ways to bring practitioners into the classrooms and laboratories. A remaining problem is to provide a financial aid base to support professionally inclined students who might otherwise move in the direction of better-funded research programs at Cornell and other institutions. Currently, according to Berth, virtually all research students are supported, whereas only about forty percent of the M.Eng. candidates are receiving financial aid.

Last year a total of 173 students were enrolled in the M.Eng. program, with the largest numbers in electrical and civil engineering. The other specialties available are aerospace, agricultural, chemical, industrial, materials, mechanical, and nuclear engineering; engineering mechanics; and engineering physics.

The experiences of students in the professional program vary from field to field and according to individual interests and circumstances. Although the program is primarily the natural sequence of an undergraduate education in engineering and is usually followed by professional employment, some students become M.Eng. candidates after working for a while and some use the program as a practical foundation for Ph.D. study. The following short articles by some of this year's M.Eng. recipients give an idea of the scope of the program, the nature and variety of the required projects, and the benefits these students feel they have realized from their introduction to engineering practice.

Direction of the Master of Engineering degree program is in the hands of the Graduate Professional Programs Committee, headed by Julian C. Smith and consisting of faculty representatives from each of the eleven engineering disciplines in which the degrees are granted. Regular meetings help coordinate the overall program. The 1973-74 committee included, left to right, Henry P. Goode, industrial engineering; Smith; Thor Rhodin, engineering physics; Nelson Bryant, electrical engineering; and Robert York, chemical engineering.

On the committee for 1974-75, in addition to Smith, York, Rhodin, and Bryant, are P. C. T. de Boer, aerospace; Gerald E. Rehkugler, agricultural; Dwight A. Sangrey, civil; Perino M. Dearing, industrial; Stephen L. Sass, materials; Dennis G. Shepherd, mechanical; K. Bingham Cady, nuclear; and Richard H. Lance, engineering mechanics.

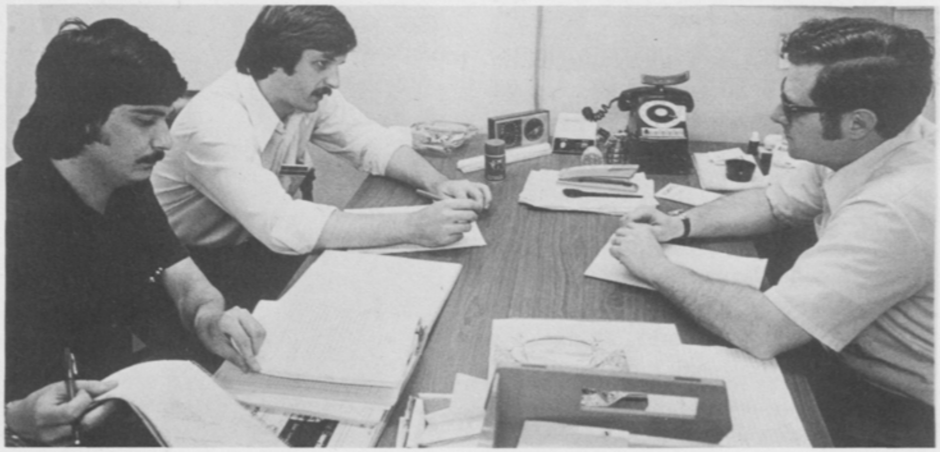
Materials Management at Tompkins County Hospital

by Vic Rzewnicki

Working with an actual problem that does not have the niceties of a contrived homework set often proves to be more instructive and educationally valuable. It didn't take me long to discover this after I began work on my project for the Master of Engineering (Industrial) degree.

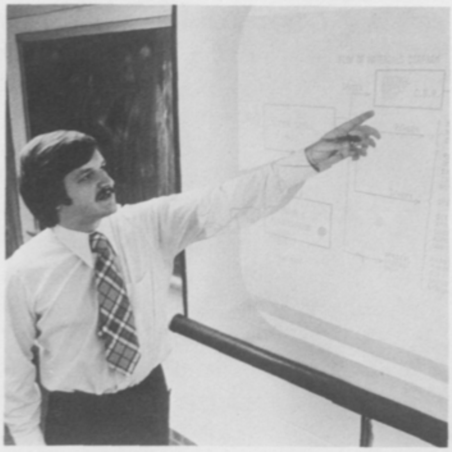
The whole M.Eng. program is intended to be applications-oriented, and the project is an integral part of the year's work. In our school, after an unstructured problem that can be dealt with using industrial engineering techniques is found and a faculty adviser is assigned, the student is turned loose on the problem. I must admit that there were times during the year when I felt that the problem had been turned loose on me.

My partner, Mickey Dickman, and I were confronted with our project early in October. Our area of investigation was the materials management system at Tompkins County Hospital, which had been experiencing problems with stockouts and delays in the processing of requisitions. Also, a recent New York State policy discouraging the par-



Vic Rzewnicki's master's degree project required investigation of records and procedures at Tompkins County Hospital in Ithaca, New York, across the city from the Cornell campus. Left above: Hospital personnel helped provide needed information. Left below: Preliminary conferences with hospital administrators served to define the project topic. Rzewnicki's partner, Mickey Dickman, is at left.

Rzewnicki was awarded the degree of Master of Engineering (Industrial) in June, and has begun work with the management science group of E. I. duPont de Nemours in Wilmington. He expects that his job will involve work very similar to that of his M.Eng. project. Dickman has taken a job with Eli Lilly. A native of Colombia, he expects to be transferred eventually to South America or Europe.



Left: At the end of the year, results of the hospital study were presented at a meeting attended by students and faculty of the School of Industrial Engineering and Operations Research, and by representatives of Tompkins County Hospital. Here Vic Rzewnicki comments on a slide showing a "Flow of Materials Diagram." Rzewnicki expects that at least half of the project study—the plan for reorganizing the hospital's materials handling system—will be adopted by the hospital.

Faculty adviser for the project was Stratton C. Jaquette, assistant professor of operations research.

ticipation of nursing personnel in supply functions meant that there had to be a reorganization of at least part of the system we were dealing with. Our goals were: (1) to develop an organizational structure that would satisfy the state policy and at the same time improve operations and service; and (2) to develop inventory-control procedures that would eliminate stockouts of medically critical items and, if possible, also reduce inventory costs.

At first our time was spent in familiarizing ourselves with the organization and procedures that currently existed. Later, immense amounts of data about the items in the hospital's inventory had to be gathered and organized in a meaningful way. It wasn't until late in the year that we found ourselves able to apply the theories and techniques we had learned in the course of our formal education.

The developmental work required to reach a point where we could draw conclusions and develop solutions proved to be by far the biggest part of our effort. This observation about the nature of problem solving had been made and discussed in some of our classes, but its truth wasn't fully appreciated by us until we experienced it firsthand.

Overall, I felt that the project work I engaged in was far and away the most worthwhile, challenging, and interesting experience of my college education.

The Design of a Jumbo Jet Hangar: A Professional Effort by Students

by Richard F. Heine, Jr.

A design for a Boeing 747 hangar and maintenance facility at LaGuardia Airport in New York City was the project my teammates and I completed for our Master of Engineering (Civil) degrees.

In the School of Civil and Environmental Engineering, several groups of M.Eng. students accomplish projects in two different areas—structural and soil engineering and environmental engineering. This year there were enough students in the structures-soils area to form two fifteen-member groups, and since these were assigned to the same project, a competitive dimension was added to the program. I was a member of Group Green.

Our project was under the faculty direction of Dwight A. Sangrey and Gareth R. Thomas. Outside expert consulting services were provided by Lev Zetlin of Zetlin Associates, New York City, and Ray DiPasquale of Raymond A. DiPasquale and Associates, Ithaca, New York. Dr. Zetlin's prior efforts in the design of B-747 hangars have been described in *Civil Engineering* (November 1970) and in *Fortune* (February 1974).

Our problem was to design a structural system to enclose four B-747 aircraft and associated heavy maintenance facilities. In addition, space was to be provided for related support functions, such as computer operations and general administration. The design was to allow for the accommodation of combinations of smaller aircraft, as well as the next generation of jumbo jets.

We began work during the fall term by considering many alternate proposals. Most of the initial "free-thinking" concepts were victims of cost comparisons or were found to be technically infeasible. By October five concepts were still under consideration. These included a concrete shell supported on five exterior pillars and an interior column; a truss system; a system incorporating cantilevered space trusses; and two versions of a hanging cable system.

On November 1 we presented our first preliminary report, describing three basic ideas for further consideration: a concrete shell, a space truss, and a cantilevered roof. Features of the latter two were combined into a single system and our final preliminary report, presented early in December, offered two choices. The one selected by the staff members in charge of our project was the truss-cantilevered roof system. Final design work commenced on January 7 and was completed during the following three weeks of intensive, full-time effort under the supervision of the outside consultants.

The final design incorporates a series of light-gage steel cantilever sections supported on two bisecting trusses and covering a square area 520 feet on each side. Truss loads are carried to ground elevation by groups of columns concentrated in the center of the hangar and at the middle of each side of the hangar.

One of the special problems we had to consider was the design of a foundation suitable for the particular site. The properties of the underlying soil layers at LaGuardia necessitated a careful analysis of many alternative foundation concepts. Because of the presence of a miscellaneous fill layer, for example, conventional methods of handling settlement were inefficient. The solution we arrived at, on the basis of cost considerations, was caisson support for the superstructure and floatation of a cellular concrete slab.

Looking over materials for the Master of Engineering (Civil) degree project of designing a hangar and maintenance facility are (left to right) faculty adviser Gareth R. Thomas, M.Eng. candidate Patricia Pierson, and author Richard F. Heine, Jr. Heine, a lieutenant commander in the U.S. Navy civil engineering corps, was on academic leave in 1973-74. He is a base civil engineer at Annapolis.

During the intensive design period, a critical path method (CPM) of scheduling work assignments was utilized. The CPM resulted in effective task assignment, despite its shortcomings in projecting drafting time, and we found that such a management approach is certainly feasible for design projects. A CPM was also developed for construction of the hangar. That and the 1973 Dodge Manual formed the basis of a construction time estimate of thirty-six months and an estimated construction contractor's cost of $12,552,450.

This design project required not only the exercise of engineering disciplines, but also the use of communication skills. Each student was required to present an oral defense of his work at some stage of the project, to prepare at least one full-size engineering drawing representing his efforts, and to prepare a section of the written report. The design project also served to demonstrate the degree and nature of the interaction that is required in professional practice. For these reasons, I believe a project such as ours more fully prepares a student for work as a practicing engineer.

Designing a Canine Hip Replacement as an Introduction to Biomechanics

by John A. Quenin

My introduction to the Master of Engineering program was as much accidental as intentional. I had planned to use my undergraduate education in mechanical engineering as a background for medical practice and research, but after I graduated I found that I lacked one course needed for admission to medical school. I decided to enroll in the M.Eng. program and satisfy this requirement while devoting most of my attention to a study of biomechanics.

I soon discovered that biomechanics has a broader scope than I had realized, and that each subdivision of the field is more involved than I had thought. My electives had to be carefully chosen to make the best use of available time.

My project was the design of a canine total hip replacement, conducted in cooperation with Cornell's Veterinary College and under the supervision

John A. Quenin uses a tensile-testing machine to measure load and elongation of a tendon. The plotter on the bench automatically records the curve.

Sketch of the canine total hip replacement designed in Quenin's M.Eng. (Mechanical) project. Diseased parts are replaced with a steel and plastic prosthesis.

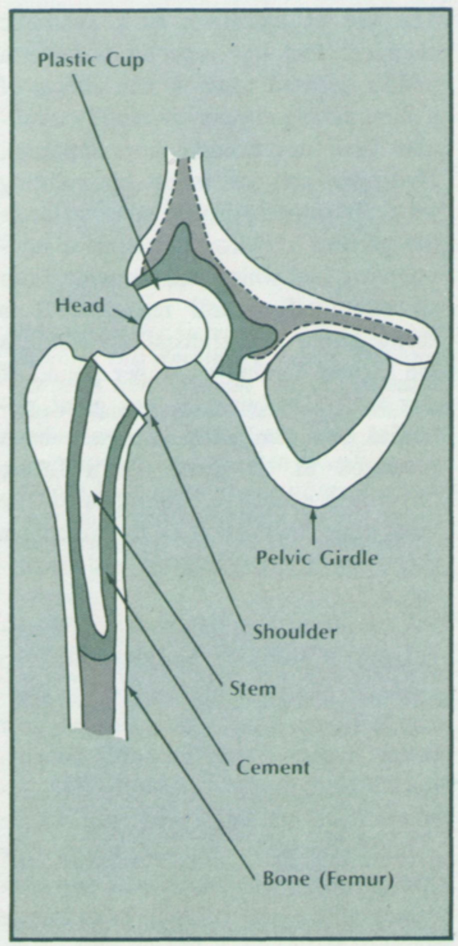
Quenin received his B.S. degree in mechanical engineering in 1973 and the master's degree this spring. He has a summer engineering job with Dravo Corporation, and in the fall may enter medical school or a Ph.D. program in biomedical engineering.

of my adviser in the College of Engineering, Professor Donald L. Bartel. This prosthesis was to be an improvement on a type already in use, primarily to repair the damage caused by a disease that is especially prevalent in German Shepherd dogs. The overall research project is supported by the Seeing Eye Foundation.

The development of the steel and plastic prosthesis was influenced by a number of constraints imposed by the veterinarian with whom I was working, Professor R. Dueland. Most of these constraints might be considered typical of those encountered in engineering design, but all were presented in a context new to me. My undergraduate work served as a background to enable me to make a systematic analysis of the problem, and this led to a number of possible design configurations. Knowledge acquired in graduate courses helped me to evaluate these alternatives and finally to select the most promising for construction of a prototype. The prosthesis I designed has been implanted successfully in three dogs so far, and Dr. Dueland is pleased with the results.

I found in working in the M.Eng. program that a great practical advantage over experience at the undergraduate level is the ready availability of sophisticated equipment and the accessibility of laboratory facilities. I was provided with well equipped working areas on the engineering campus and at the Veterinary College, and often borrowed additional apparatus from the engineering school. Veterinarians and their students gladly supplied biological samples for testing purposes, and helped with dissections when more than two hands were needed. In general, I was given almost complete freedom to pursue the project as I saw fit.

I also found that the program provides the opportunity for a student to look a little more closely at areas of study that are sometimes oversimplified in undergraduate courses, and to begin study in new areas. An integral part of this type of education is the design project, which presents to the student a real problem of practical interest. Professors and students at Cornell are aware that there is more to engineering than ideal systems and perfectly adequate theory.



Electrolysis Versus Thermochemical Cracking: An Analysis of Hydrogen Production Methods

by Douglas Busch and James Sharkness

The use of hydrogen as a synthetic chemical fuel has recently become a widely debated topic as the effects of a diminishing supply of readily available fossil fuels become more apparent. Hydrogen can be made by splitting water; burning hydrogen gives water as the product. Hydrogen is thus a nonpolluting fuel which can be made from an unlimited natural resource. It is easily stored and transmitted and has the highest heating value per pound of any fuel. Obviously, it has great potential as a fuel, and has even been proposed as the basis of a future "hydrogen economy." Methods for the large-scale production of hydrogen are therefore of great interest and importance.

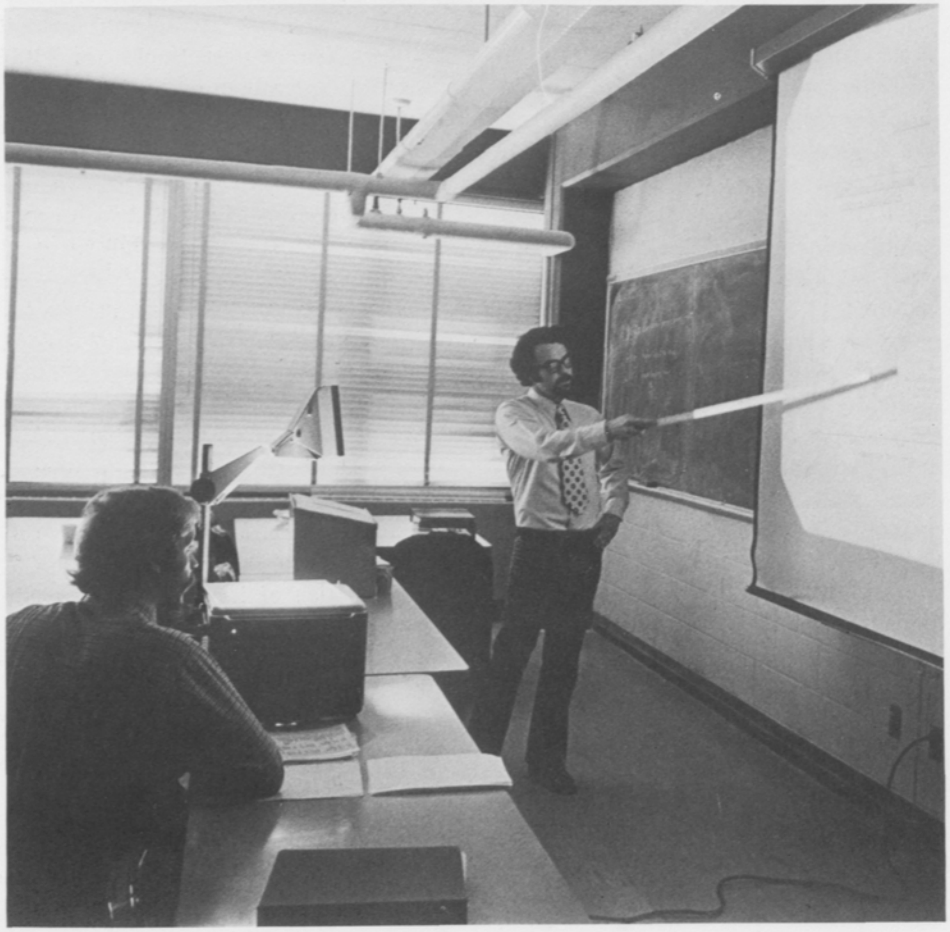
Our project for the Master of Engineering (Chemical) program was to evaluate alternate methods of producing hydrogen from water. In the near future hydrogen will probably be produced from coal, but since coal resources are limited, a nonfossil source would eventually be necessary. Our comparison, therefore, was of two processes which use nuclear heat as the energy source: electrolysis and a thermochemical closed-cycle process. For each method we designed a system to produce hydrogen at a rate equivalent to a 1,000-megawatt power station.

The production of hydrogen by the electrolysis of water is a well-known process that has been in commercial use for many years, and advanced electrolysis cells are being developed for large-scale hydrogen production. The drawback to electrolysis lies in the electricity-generating step: in converting nuclear heat to electricity, 33% efficiency is about the best that can be achieved. A thermochemical closed-cycle process, on the other hand, uses nuclear heat directly to decompose water and thus has the potential to be more efficient than electrolysis.

A thermochemical closed-cycle is a multi-step sequence of chemical reactions whose end result is the splitting of water to form hydrogen and oxygen; other compounds in the sequence are regenerated as part of the cycle. The closed-cycle process we investigated is the Mark 1 cycle based on reactions involving calcium, bromine, and mercury. Since this cycle was proposed only a few years ago, little information was available in the literature. We had to develop our own flow scheme and make numerous assumptions.

Once the processes were designed, capital and production costs for each were estimated and compared. Our finding was that electrolysis had lower capital requirements, lower production costs, and a higher overall efficiency than the Mark 1 process. A general opinion as expressed in the literature is that some thermochemical cycles should be superior to electrolysis in these three areas; our study suggested that Mark 1 is not one of these. On the basis of the problems encountered with Mark 1, we made recommendations for proceeding with a search for more feasible closed-cycle processes that might be competitive with electrolysis.

We feel that the design project was the most valuable part of our M.Eng. program. The various aspects of chemical engineering studied during our undergraduate years and during the fifth year were all brought together and applied in the project.



Project results were presented in an open meeting this spring by James Sharkness (at left) and Douglas Busch. Attending were students and faculty not only in chemical engineering, but also in other engineering disciplines in which energy-supply investigations are of great current interest. Faculty advisers for the project were Julian C. Smith and John L. Anderson of the School of Chemical Engineering.

Both Busch and Sharkness did their undergraduate as well as graduate work in chemical engineering at Cornell. After receiving their master's degrees in June, both entered industrial employment—Busch with the Dow Chemical Company in Midland, Michigan, as a process development engineer, and Sharkness with E. I. duPont de Nemours and Company in Houston, Texas, as a process engineer in the areas of pesticides and biochemicals.

From Ceramic Technology to Astronomy via the Master of Engineering Program

by Steven J. Ostro

For me, the professional master's program in engineering physics has been a means of transition.

I entered Cornell with a B.A. in liberal arts, a B.S. in ceramic science, and a year and a half of experience in industrial glass melting research. By means of the M.Eng. program, I have changed my field from ceramic technology to astronomy. Next fall I will begin Ph.D. work in planetary radar astronomy at the Massachusetts Institute of Technology.

I consider my project, done in the Laboratory for Planetary Studies of the Department of Astronomy and under the supervision of Professor Joseph Veverka, to have been the most rewarding and educationally significant part of my years at Cornell. It has drawn on my past education and industrial work and has provided a stimulating introduction to both planetary astronomy and the analysis of the scattering of electromagnetic radiation from macroscopically complex surfaces. The latter will be essential in my future work in radar astronomy.

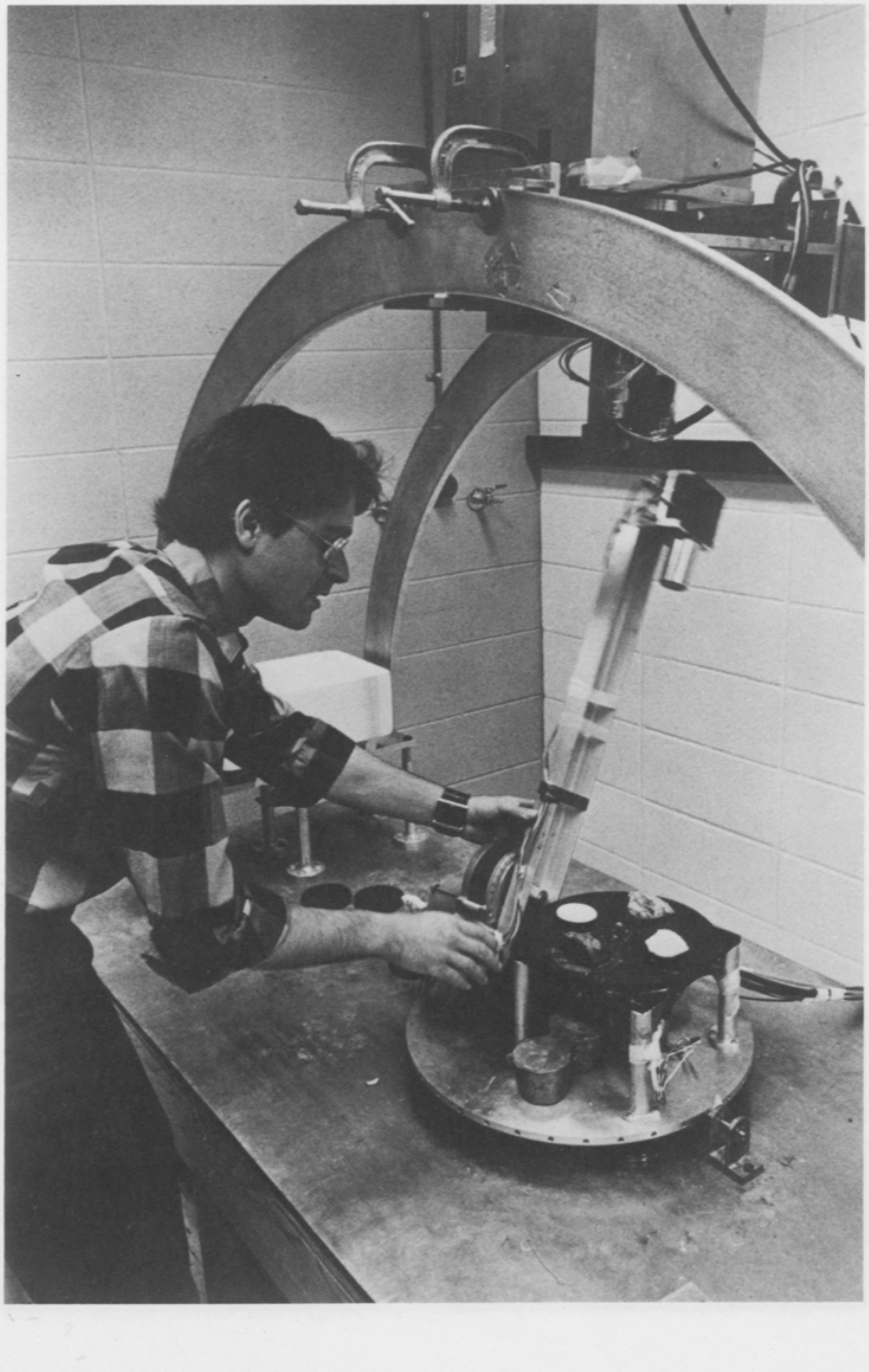
The project involved the photometric properties of solid particulate surfaces. This problem is not amenable to precise analytic solution. Rather, empirical interpolation functions must be used to describe optical scattering from such surfaces as planetary regoliths. There are several laws of diffuse reflection which can approximate scattering of light from surfaces of certain texture, brightness, and particulate macrostructure, and each contains several free parameters which completely describe the photometric properties of the surface.

Before such a law is used in conjunction with astronomical observations to reveal structural or compositional surface characteristics of an asteroid, planet, or satellite, two kinds of information are needed: (1) the ranges of surface brightness and texture over which a given law is valid; and (2) for a given law, the values of free parameters for earth materials and their dependence on wavelength and phase angle.

A typical scattering law gives reflected intensity as a function of incident flux, phase angle, angle of incidence of radiation, and angle of reflection of radiation. Using the goniometer in the Laboratory for Planetary Studies, I was able to duplicate various combinations of these angles for 5500 Angstrom illumination of a series of samples. In addition to sample preparation and measurement, major aspects of the project included computer reduction and interpretation of data, instrument modification, and development of measurement techniques.

At one stage of the project, photometric properties of powdered bright translucent materials were determined. At another stage, I examined the validity of different scattering laws for a bright Lambert surface contaminated with varying amounts of low-albedo (reflecting) material. The latter has application to the construction of photometric models of the satellites of Jupiter and to the Martian polar caps, where the CO_2-H_2O frost is mixed with low-albedo particles during a dust storm.

The results of this work are expected to be published in *Icarus; International Journal of the Solar System,* and I feel that the project was not only educationally valuable to me, but will be a useful addition to knowledge in this area.



Steven J. Ostro used a goniometer in the Laboratory for Planetary Studies for his M.Eng. (Engineering Physics) project work. For Ostro, the M.Eng. program served as preparation for Ph.D. research.

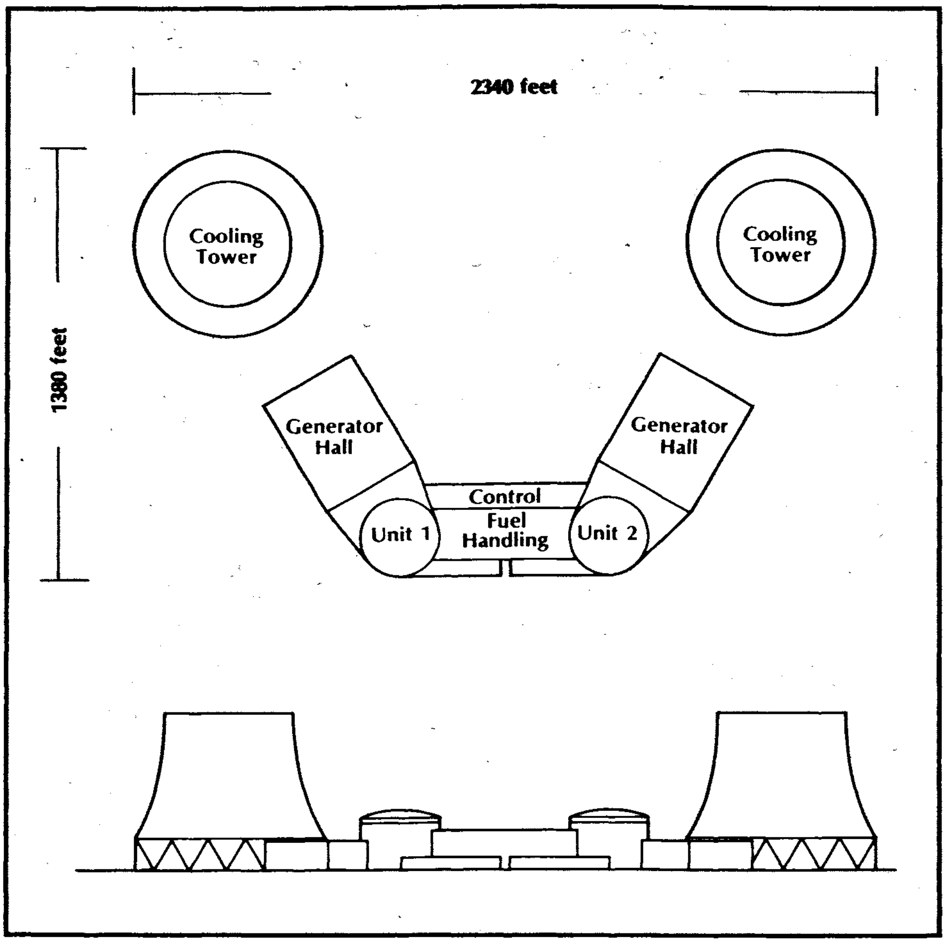
The Design of a Fast Reactor Park as a Project in Nuclear Engineering

by Robert J. Dunki-Jacobs

As the United States steps up its use of nuclear power-generating plants, the location and siting of facilities will become increasingly important. The idea of centralizing the various units needed for a complete operation has been proposed, and the conceptual design of such a reactor park was the project of my group in the Master of Engineering (Nuclear) program.

After a year's work, we emerged with a 280-page report outlining details of a Fast Reactor Park planned for a site on Lake Ontario near Oswego. Included in the design are facilities for all the operations associated with the nuclear fuel cycle except mining and ultimate waste disposal. These are a liquid metal fast breeder reactor (LMFBR), a fuel-reprocessing plant, a fuel-fabrication facility, a unit for temporary surface storage of nuclear waste material, and internal and external transportation facilities. To our knowledge, this is the first actual plan for a reactor park that has been completed.

A project such as this is an important part of the M.Eng. (Nuclear) program, which seeks to prepare students for



Left: Eight of these two-unit facilities were included in the conceptual design for a Fast Reactor Park.
Above: Project team members included John Sherwood (at left) and Robert J. Dunki-Jacobs. The others were Kurt Ahnert, Jorge Alba, David Ernst, and James Moore. Faculty adviser was K. Bingham Cady. Dunki-Jacobs and Alba accepted positions with the nuclear energy systems division of Westinghouse Electric Corporation, Sherwood with the American Electric Power Company, and Ahnert with the Knolls Atomic Power Laboratory. Ernst planned to enter the Air Force, and Moore to study for an M.S. in nuclear science and engineering.

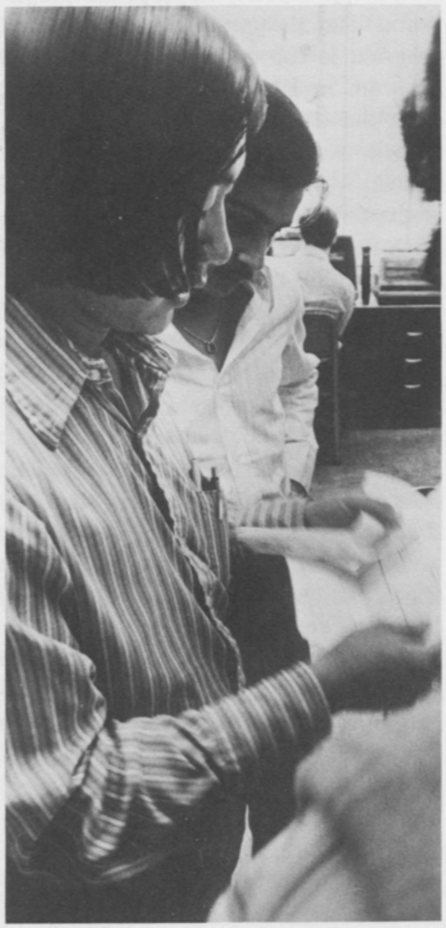
professional work in a very diverse field. The nuclear engineer must have a working knowledge in each of the several engineering disciplines that have contributed to the so-called nuclear age. He must be a mechanical engineer, an electrical engineer, a thermal engineer, and a physicist. At Cornell, the M.Eng. program draws engineering graduates from many different fields and gives to each an understanding of the role his particular specialty plays in the development, design, licensing, construction, and operation of a nuclear energy system. A particularly appropriate preparation for the graduate professional program is the undergraduate College Program in Energy Conversion.

In the professional program, about half the student's time is occupied with course work in nuclear physics and engineering, reactor theory, and related laboratory work. The project takes up the rest of his time. It is usually a group effort which explores some new and exciting topic in nuclear engineering. Recent projects included the design of a LMFBR and a nuclear-powered artificial heart.

Such a project requires the student to strike out on his own and discover the tools with which an engineer solves problems. His discussions with other team members and the coordinating professor encourage a sense of inquiry and "enlightened questioning." Often he finds himself working in an engineering field different from the one he is most comfortable in. These mechanisms help develop an independent, thorough, versatile nuclear engineer who is prepared to assume a vital role in the technological advancement of his profession.

Developing Electronic Circuits for the Study of Crib Death

by Tremont Miao



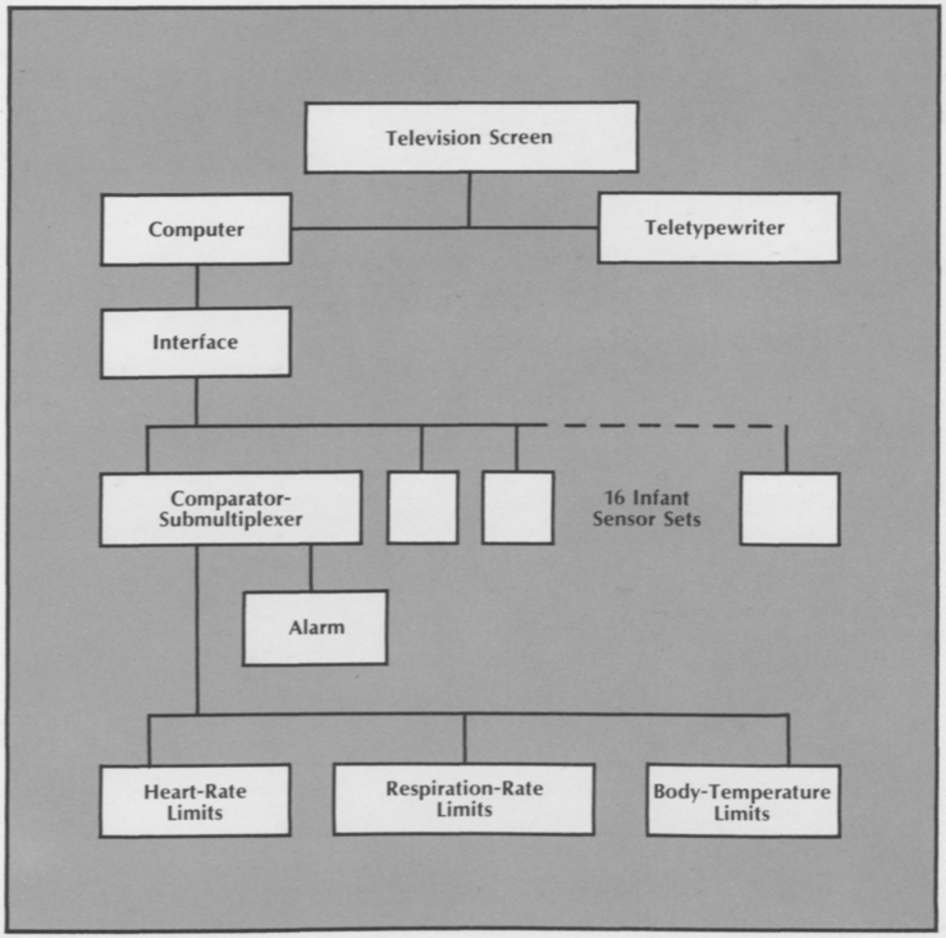
This is a decade in which there is a greater need for applications of technology—for putting to good uses the techniques we already have—than for the development of new technology. For this reason, I feel that the group project in which I was involved this year in the Master of Engineering (Electrical) program was an especially valuable one.

Our group of seven students worked on the design of an electronic computerized system to monitor infants in a study of the so-called crib death syndrome, a largely neglected and unexplained cause of infant death. Often the cause seems to be respiratory failure involving a membrane covering the bronchial passages, and it is known that if a baby who has stopped breathing is just picked up, he may resume breathing. It appears, therefore, that constant monitoring, with an alarm system, would be helpful.

This project has been conducted in cooperation with Dr. William Frayer of the New York Hospital, and with the help and financial support of the Universal Instruments Company of Binghamton. Dr. Frayer is interested in a monitoring system primarily for purposes of research into the origin and possible prediction of the crib death syndrome; he is the clinical member of the research group and will eventually supervise clinical testing of the equipment. Universal Instruments is interested in manufacturing a machine which might be used routinely in hospital nurseries or with certain babies if a way of detecting a predisposition to the syndrome is identified. Eldred H. Paufve, chief electrical engineer at Universal Instruments, and a 1951 Cornell engineering physics graduate, has been our industrial consultant, and Professor Nelson Bryant is faculty adviser.

Our objective was to design a system that would collect, store, and display data on heart rate, respiration rate, and body temperature, and that would constitute a continuous monitoring system for sixteen infants. There are many special problems, such as how to devise safe and effective sensors feasible for use with babies, and how to compensate for the effect of body movement on the sensitive heart-rate signal.

We feel that in our work we have successfully completed the design of a



A block diagram outlines the vital signs monitoring system designed by a team of students in the M.Eng. (Electrical) degree program. The computerized electronic system, planned for hospital monitoring of a group of infants, would activate an alarm if heart rate, respiration rate, or body temperature deviated from limits that were individually set for each infant. Visual display and storage of data are also provided for.

The team was headed by Tremont Miao; other members were Ranjit Bhavnani, Kartikeya Kilachand, Scott Blackstone, Peter Manchester, Kurt Shellack, Richard Wilson, and Kamlesh Saraiya. All these students were awarded the degree in June, but several continued work on the project into the late spring. All of them have begun work with industrial companies or will begin further graduate study in the fall. Miao, who graduated from Cornell in 1970 with a B.S. in electrical engineering and then worked for three years with a computer manufacturing company, has accepted a position with the medical electronics division of Hewlett-Packard.

software program for data collection and display, the design of an interface between the computer and the display mechanism, an interface between the electronic equipment and each of the sixteen infants, and instrumentation to permit the setting of an alarm system adjustable for each set of signals from each patient. This latter equipment could be used for routine monitoring without the computer data-handling components.

Of the different teams who worked on units for detecting the signals, the group headed by Richard Wilson managed to get their respiration-measurement unit working before the end of the year. They studied a number of alternative techniques, all previously used clinically, and chose a chest impedance measurement. Much remains to be done, of course, and we expect that the project will be continued by other groups of M.Eng. students.

I feel that this project is extremely relevant both educationally and in terms of its potential usefulness. Educationally, it provides experience in engineering teamwork, which is the predominant mode of engineering design in the real world. I have found, for example, both in this M.Eng. project and in earlier work in industry, that engineering practice often requires the ability to adjust to personality differences and different levels of motivation and competence.

The particular project our team worked on also has tremendous appeal as a technological application of real benefit to people. Medical electronics is a popular and rewarding field for electrical engineering students to enter.

VANTAGE

Sidelights of 1973-74

New programs and events, many of them related to the College's interest in promoting interaction with the professional world, marked the past academic year.

1

1. Representatives of some sixty industrial firms attended Research Reviews, *a type of conference initiated by the College this year. The purpose is to promote the exchange of ideas and information on research of mutual interest to industry and to College faculty and students. At the two sessions held this year, highlights of current research activities were summarized and delegates had the opportunity to visit laboratories and converse informally with College personnel.*

2

2. A lecture series on Energy Policy: Issues and Options *brought leaders from government and industry to the campus this spring (see Vol. 9 No. 1 of the* Quarterly *for coverage of the lectures). An informal coffee hour preceding each lecture provided students and faculty additional opportunity for discussion. This group includes Roger Boyd, second from right, of the Division of Licensing of the Atomic Energy Commission; and Franklin A. Long, at right, the Henry R. Luce Professor of Science and Society at Cornell.*

3

3. Career Workshop: Women in Engineering *was another new forum this year. The weekend event in February, sponsored by the Cornell chapter of the Society of Women Engineers, included a panel discussion on industry and the woman engineer. Left to right: Jennie Farley, director of Cornell's Women's Studies Program; Terry Leventhal, B.S. '70, M.Eng. '71, of Bell Telephone Laboratories; Amy Spear, B.E.E. '48, senior research scientist at RCA; Diana Rice and Faith Kelley, research engineers at Procter & Gamble; and John L. Munschauer, director of Cornell's Career Center. Sue Kupelian, B.S. '73, M.Eng. '74, was moderator.*

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4. Edmund T. Cranch is the first Joseph Silbert Dean of Engineering at Cornell. The deanship, intended to support participation by the dean in wide-ranging activities of relevance to engineering education, was endowed this year by Silbert, A.B. '15, founder of the American Allsafe Company, a manufacturer of industrial safety equipment.

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5. Nonresident registration in graduate-level courses became available with the installation last fall of a studio in Phillips Hall for the video taping of lectures in progress. Students in the group subscription program may earn regular academic credit.

Several professors and a former dean received special recognition during the year from associates, students, and alumni.

6. The Charles C. Winding Scholarship Fund was established by chemical engineering alumni in honor of their former professor. Winding, the Herbert Fisk Johnson Professor of Industrial Engineering and former director of the School of Chemical Engineering, has been a member of the faculty for almost forty years. The fund, inaugurated at a testimonial dinner in November, will provide financial aid to Master of Engineering (Chemical) degree candidates.

6

7. Solomon Cady Hollister, emeritus professor of civil engineering and former dean of the College, was honored at a special dinner attended by faculty members of the School of Civil and Environmental Engineering. He was presented with a plaque inscribed, ". . . engineer, educator, administrator and, most important, a revered colleague." In addition, he was presented with a collection of objects symbolic of his long career: a brick and jars of water, sand, and cement; chalk and a blackboard pointer; and a paperweight made from stone used in the construction of Hollister Hall, the School's facility named in his honor. At left in the photo is Walter R. Lynn, present director of the School.

8. Selected by student vote for this year's $1,000 Excellence in Teaching Award was Raymond G. Thorpe, associate professor of chemical engineering. The award, sponsored by Tau Beta Pi and the Cornell Society of Engineers, was presented by Society president Michael Bandler at the alumni reunion luncheon in June.

9. Named chairman of the Department of Environmental Engineering was Associate Professor Daniel P. Loucks, a specialist in water resources and environmental quality management systems. Loucks, a Cornell Ph.D., has been a member of the faculty since 1965. He heads a department of nineteen members.

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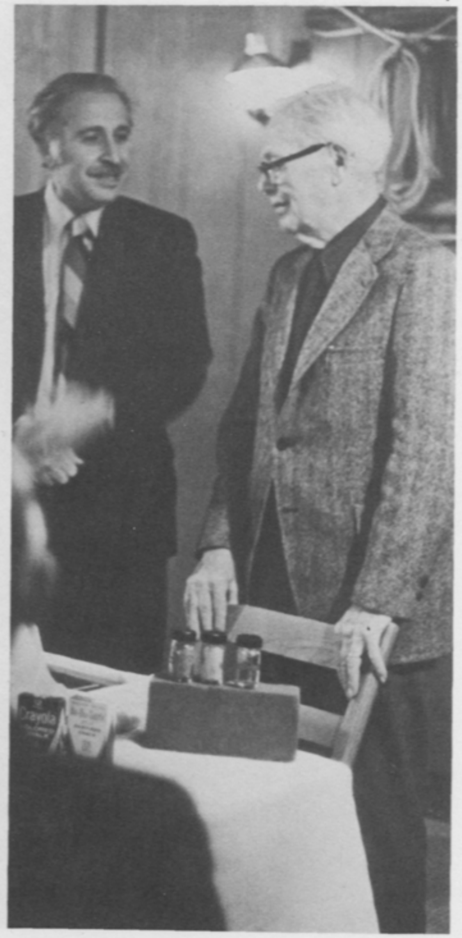

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10. *A highlight of the spring for civil engineering students was the national concrete canoe race. Their entry didn't win in the race on the Schuylkill River at Philadelphia, but it was out in front for a while. Crew members were Bill Wood (in front) and Steve Sawle, both seniors.*

The race, sponsored by the American Concrete Institute, was preceded at Cornell by busy afternoons in the Concrete Lab, where members of the student chapter of the American Society of Civil Engineers built the canoe on a wire frame according to specifications (e.g., "the canoe must float when filled with water.") The construction crew of ten, headed by senior Al Cristafaro, report that they had a bit of valuable technical advice from instructor-technician Stanley Olsefski and words of encouragement from their faculty adviser, Dwight Sangrey.

The 14-foot, 295-pound Cornell entry was in competition with 37 canoes from 24 schools, and lost out in the second preliminary heat. Undaunted—it was the first time Cornell had entered the annual race—the crew brought back their concrete canoe, entered it in the local whitewater canoe race on Fall Creek near Ithaca, and almost made it to the finish line before they crashed. They were officially listed as "sunk" in that contest.

11

11. *Elected dean of the University faculty for a three-year term beginning this summer is Byron Saunders, a member of the engineering faculty since 1947. His most recent posts at the College have been as director of the School of Industrial Engineering and Operations Research and as director of continuing education. In University affairs, his activities have included participation in the Faculty Council, the Cornell University Council, and the Senate. Saunders was selected for the deanship by mail ballot of all Cornell faculty members.*

12

12. *Stainless steel engravings of early American ironmasters' houses, now hanging in the Hollister Hall lobby, are the gift of the Lukens Steel Company of Coatesville, Pennsylvania. William E. Mullestein, at left, president of the company, is a 1932 Cornell graduate in civil engineering. On hand for the presentation ceremony and reception in December were Nancy Blackman Thompson, the artist who made the original pen and ink drawings and supervised the preparation of the etchings, and Dale R. Corson, president of the University. Depicted in the engravings are eight houses, located in the vicinity of the Lukens Steel Company, which figured significantly in the early history of the American steel industry.*

Alumni Reunion 1974

Exhibits set up at Barton Hall for alumni during reunion weekend in June included four sponsored by the College of Engineering.

1. Alumni and professors discuss the exhibits—and Cornell engineering today and in previous years.

2 and 3. Cornell's electric car is explained to alumni visitors by George Halstead, a graduate student in electrical engineering. The design of systems to control propulsion has been a continuing project of Master of Engineering (Electrical) students under the supervision of Professor Joseph L. Rosson.

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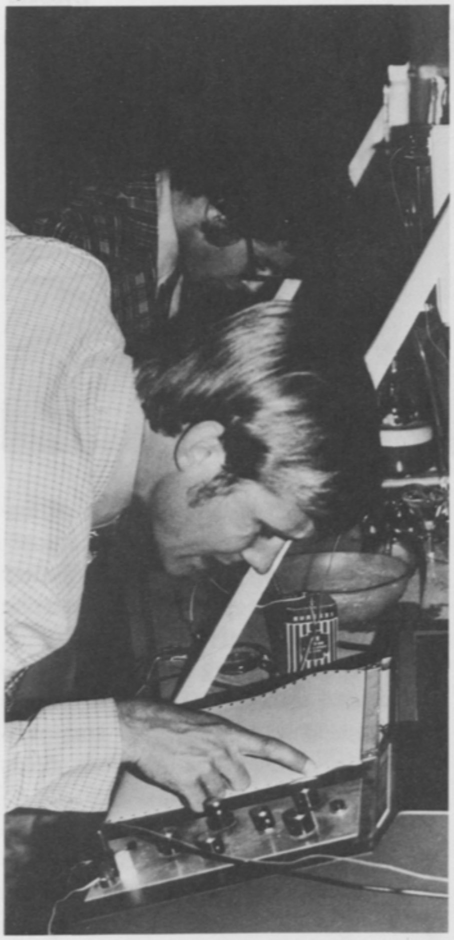

4 and 5. *Research on the artificial kidney was the subject of an exhibit from the School of Chemical Engineering.*

4. Assistant Professor John L. Anderson (foreground) and senior student Neal Zislin examine equipment for analyzing the flow characteristics of an artificial kidney.

5. Results obtained by freshmen in a mini-course experiment (see also page 3) formed part of the display. Assistant Professor James F. Stevenson offered the course.

6. On hand to discuss activities of the Program on Policies for Science and Technology in Developing Nations were Fernando Nasmyth (at left), a graduate student, and Frank Ahimaz (at right), assistant director of the Program and assistant dean at the College of Engineering. Engineering Dean Edmund T. Cranch is Program director.

7. The design of prostheses is an area of research directed by Donald L. Bartel, professor of mechanical engineering. The Barton Hall exhibit demonstrated one application of design efforts in this area.

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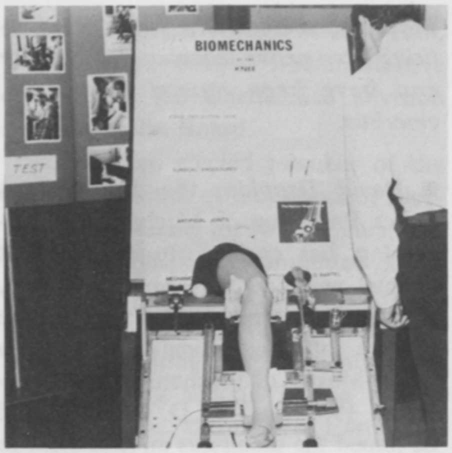

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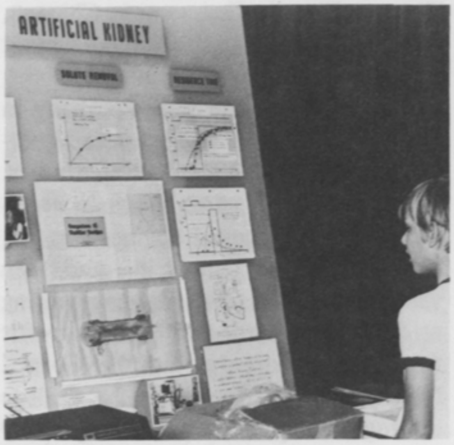

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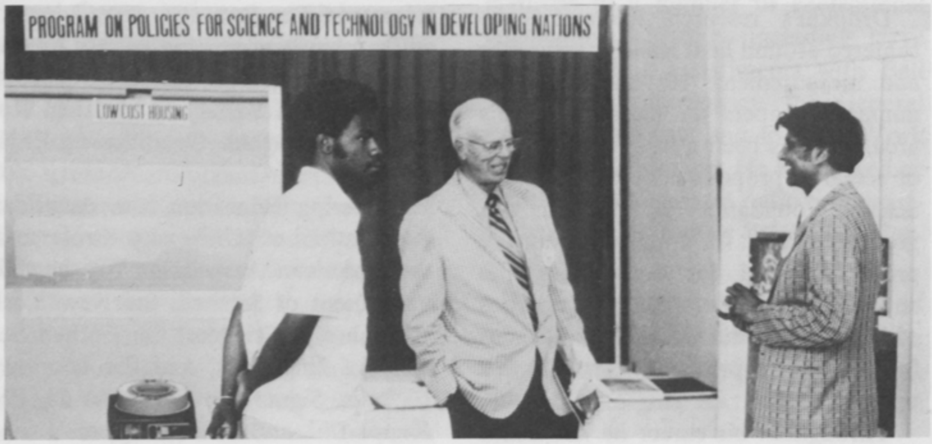

REGISTER

Dropkin

Three members of the faculty are retiring from active teaching this summer and have been named professors, emeritus.

■ *David Dropkin,* the John Edson Sweet Professor of Mechanical Engineering, has spent forty-five years at Cornell as student, research associate, and faculty member. He received the degrees of Mechanical Engineer in 1933, Master of Mechanical Engineering in 1935, and Ph.D. in 1938, and he joined the faculty as an instructor in mechanical engineering in 1941.

Dropkin's research interests have centered around heat transfer processes and measurement. He has published numerous papers on research in this area, and has been a frequent reviewer of research proposals for the National Science Foundation. In 1969 he was granted a patent for a high-temperature probe designed for determining the enthalpies and other thermal properties of high-temperature gases and plasmas flowing at supersonic or subsonic velocities.

Throughout his career he has maintained connections with industrial and research organizations through sabbatical and summer affiliations and consulting assignments. Among these have been positions at the Brookhaven National Laboratory and at Avco Corporation. During a recent leave, he was a visiting professor at the University of Cardiff, Wales.

At Cornell, he has served in recent years as Field Representative of the Graduate Field of Mechanical Engineering. In 1969 he received the annual Excellence in Teaching Award sponsored by the Cornell Society of Engineers and Tau Beta Pi.

Dropkin is a member of the American Society of Mechanical Engineers, the American Society of Heating, Refrigerating and Air Conditioning Engineers, the American Society for Engineering Education, the American Association of University Professors, the American Association for the Advancement of Science, the New York Academy of Sciences, the Cornell Society of Engineers, and the honorary societies Sigma Xi, Tau Beta Pi, Phi Kappa Phi, and Pi Tau Sigma.

■ *Henry P. Goode,* professor of industrial engineering and operations research, came to Cornell in 1957 after some twenty-five years of experience in industry and university teaching. A specialist in sampling and testing techniques and industrial statistics, he has practiced, taught, consulted, and published in these and related fields throughout his career.

Goode was educated at the University of Kansas, earning the B.S. degree in industrial engineering in 1930 and the M.S. in the same field in 1934. His early career in industry was with the Western Electric Company in Chicago, where he worked on the design of plant layout and materials handling systems, and at the American Can Company in Kansas City, where he supervised quality control and cost-reduction studies.

From 1941 to 1952 he was a member of the mechanical engineering faculty at Stanford University, and then was professor of industrial engineering at Southern Methodist University for five years before joining the Cornell faculty. In recent years at the College of Engineering, he has been especially

Goode

active in the Graduate Professional Programs and in continuing education activities. He has spent sabbatic leaves at the College of Advanced Technology in Birmingham, England, and, most recently, at the Cranfield Institute of Technology in England and the Technological Institute of the Olivetti Corporation in Ivrea, Italy.

His publications include a number of technical reports, published by the United States government, on new sampling inspection procedures and tables for product life and reliability testing. A pioneering work in his specialty field, *Sampling Inspection by Variables,* written with A. H. Bowker, was published in 1952.

Goode is a member of the American Society for Quality Control, the American Institute of Industrial Engineers, the American Society for Engineering Education, the American Association of University Professors, and the honorary professional societies Sigma Xi, Tau Beta Pi, Sigma Tau, Phi Kappa Phi, and Alpha Pi Mu. He was a registered professional engineer in California for many years.

■ *Howard G. Smith,* professor of electrical engineering, holds three degrees from Cornell and has spent his entire career as a member of the faculty. He received the degree of Electrical Engineer in 1930, the Master of Electrical Engineering in 1931, and the Ph.D. in 1937. After serving as a teaching assistant in the Department of Physics for three years, he began his teaching career in the College of Engineering in 1934.

In addition to teaching in his specialty areas of communications engineering and electrical circuit theory, he has carried out many administrative functions. These include ten years of service as director of the Division of Basic Studies in the College of Engineering, beginning at the time of its inception in 1961 when the underclass curricula of the various academic departments were combined into an overall two-year program. An area of special interest to him during his years with the Division was the admission and counseling of foreign students.

During World War II, he was in administrative charge of a Pre-Radar School held at Cornell for the U.S. Signal Corps. Later he administered a school for engineering employees of the New York Telephone Company that was operated on campus by the School of Electrical Engineering from 1957 to 1961. He was involved also in the establishment of the University-affiliated General Electric Advanced Electronics Center at Ithaca, and served as consultant to that division.

At Cornell Smith has served on many committees and administrative groups, including the University Faculty Council, the Boards of Managers and Governors of Willard Straight Hall, the Summer Session Administrative Board, and the Unclassified Division Administrative Board.

Smith

He was an elected member of the policy committee of the School of Electrical Engineering for twelve years, and served on the policy committee of the College of Engineering for eleven years.

Smith spent parts of three sabbatic leaves consulting with administrators in engineering schools in the United States, Europe, and the Far East. During his years at Cornell, he was also involved in a number of professional engineering activities, including leave and consulting assignments with Bell Telephone Laboratories, the General Electric Company, and the New York Telephone Company. He has served as a consultant to several radio broadcasting stations, including WHCU of Cornell University.

He is a member of the Institute of Electrical and Electronics Engineers, the American Society for Engineering Education, Sigma Xi, and Eta Kappa Nu.

FACULTY PUBLICATIONS

The following publications and conference papers by faculty members and graduate students of the Cornell College of Engineering were published or presented during the period November 1973 through January 1974. Earlier publications inadvertently omitted from previous listings are included here with the date in parentheses. The names of Cornell personnel are in italics.

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About Photographs

The effect of electrostatic precipitators on stack emissions is illustrated in the above photograph of Milliken Station, supplied by the New York State Electric & Gas Corporation as amplification to our Spring 1974 issue on the subject of energy. This photograph, taken in the summer of 1972, shows the effluent from a stack in which precipitators have not yet been installed (at right) and from a stack with newly installed precipitators. Our photo in the Spring 1974 issue was taken prior to the installation.

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