RNELL UNIVERSITY ANNOUNCEMENTS

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FURTHER INFORMATION

All prospective students should obtain the *Announcement of General Information.* (See below.)

Engineering curricula and course descriptions:

Cornell University Announcements
Edmund Ezra Day Hall
Ithaca, New York

Scholarships:

Office of Scholarships and Financial Aid
Edmund Ezra Day Hall
Ithaca, New York

Admission requirements, procedures, and applications:

Office of Admissions
Edmund Ezra Day Hall
Ithaca, New York

General Information and Other Announcements, listed below:

Cornell University Announcements
Edmund Ezra Day Hall
Ithaca, New York

Announcements are available for other academic divisions of Cornell University as follows: State College of Agriculture (four-year or two-year course), College of Architecture, College of Arts and Sciences, School of Education, Department of Asian Studies, State College of Home Economics, School of Hotel Administration, State School of Industrial and Labor Relations, Military Training, Summer School. Graduate study is described in other Announcements as listed on the cover of the *Announcement of General Information.*

CORNELL UNIVERSITY ANNOUNCEMENTS

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CORNELL UNIVERSITY ANNOUNCEMENT

Engineering at Cornell

1963-1964

The *Announcement of Engineering Courses and Curricula* contains detailed descriptions five-year curricula for each branch of engineering and of the individual courses. An art interest to prospective students, "What Is Engineering School Like?" is also available. may be obtained by writing the Cornell University Announcements Office, Edmund Ezr Hall, Ithaca, New York.

Graw Tower of the Uris undergraduate library at Cornell University ar to approximately 100,000 alumni and 11,000 students. The new rary for research and graduate study is in the foreground.

Contents

A Sketch of Corn

CORNELL is a cosmopolitan community set among the hills of Central New York State. In this setting, scholars and students from all over the United States and the world explore territories of knowledge ranging from the most firmly grounded and tested to the newest and most speculative.

Founded by Ezra Cornell in 1865 as "an institution where any person can find instruction in any study", Cornell dominates a hill between two rocky gorges whose streams flow into Cayuga Lake. The City of Ithaca lies below in the valley. On adjacent hills are situated several modern industrial plants and research laboratories, and expanses of farm land. Distant hills and valleys and Lake Cayuga provide some of the most varied recreation in the east.

Here the colleges of Cornell University are devoted to studies in all of the important arts, sciences, and technologies. Privately endowed colleges united with colleges supported by New York State give Cornell the character of both independent institution and large state university. More than 8800 men and women study in the university's eight undergraduate divisions. A graduate school which accommodates 2900 students at work on advanced degrees, and a faculty devoted to research as well as to undergraduate teaching, make Cornell a community constantly being renewed by new discoveries.

Set apart and self-contained, but equipped with advanced facilities for teaching and research, this community offers unique opportunities for both students and faculty. In its diversity Cornell parallels the world of affairs. Students preparing for careers in business, industry, technology, science, art, and teaching live together, meet in the same courses, govern themselves, join in varied activities, and make their own decisions. Similarly, faculty members are able to concentrate on teaching and research in a context where all lines of knowledge meet. Students and faculty participate together in classroom and laboratory, and at concerts, lectures, and scientific meetings.

The College of Engineering occupies within Cornell University a traditional place and an entirely new campus and equipment. Its faculty sustains a long-standing reputation for excellence in undergraduate teaching. Its research, which varies from invention of new structures and building materials, to development of atomic power, to analysis of business problems by digital computers, to discovery of the conditions of space flight and exploration of the universe, keeps students aware of new fields as they unfold. Programs of study lead to degrees in the established branches of professional engineering and in new fields of engineering science. Nearly 2000 engineering undergraduates can and do take advantage of all the opportunities—academic, social, cultural, extracurricular, and athletic—of the University. Graduates are fully prepared as engineers and as citizens to enter industry, public service, research, or graduate study.

CORNELL was one of the pioneers in bringing technical education side by side with liberal studies. Today engineering has an accepted place in universities everywhere. But now, new problems—those of a time in which science and technology are developing at an incredible rate—present new challenges. The problems which now confront engineering education are far different from those which faced the men who introduced technical studies at Cornell, but the spirit of innovation remains a part of the Cornell tradition. The College of Engineering feels strongly its responsibility to provide education for leadership in a changing world.

Today's engineers are called upon to work in fields which were not thought of a few years ago. They must also make decisions which have far-reaching effects on society. These challenges cannot be avoided. Knowledge about certain standard machines and processes is no longer enough. What is needed is a firm grasp on fundamentals—an ability to apply the principles of mathematics and the sciences to new situations as they evolve, and to do so with as much originality and imagination as possible. Only with this versatility can the country be assured of an engineering work force of long-lived productivity.

Cornell has moved to meet these new conditions in a number of ways. Our job is to teach students to think as well and as deeply as possible, and to give them the intellectual tools they will need in their future professions. Such innovations as the five-year program, increased opportunities for independent work, and a curriculum like engineering physics—which provides as much physics and mathematics as a liberal arts major in these subjects—manifest this concern. Because of Cornell's able student body, all curricula have become more comprehensive and far-reaching. New upperclass programs provide a wider range of choices. Students can prepare more fully for professional practice by deepening their competence in a given field, or can begin work in one of several pre-graduate programs.

At the same time, since engineers apply the discoveries of science in concrete ways to useful purposes, they must still have a feel for the basic instruments and machines with which they give shape to their work. Cornell emphasizes learning by doing, a continual testing of theory by practice, and familiarity with the newest techniques and devices. Such training in the physical tools of engineering, as well as in fundamental techniques and concepts, is made possible by the five-year program. This integrated program provides not only uncommon breadth and depth, but manifold opportunities to develop special interests, and a chance to foster personal growth by study in other branches of the university. Correlation of personal and professional, of technical and social, of scientific and liberal, is a first principle of Cornell engineering education.

No one can predict with certainty what the next years will bring, in technology or in the world. But Cornell, aware that there will be new things in all fields, maintains an attitude of experimentation. The College of Engineering is convinced of the need for a breadth which crosses and combines traditional lines. Its new campus has been built with the idea of flexibility and growth. Research and graduate studies have been continuously expanding, and their influence has strengthened and stimulated undergraduate programs. We expect this to continue and increase.

Only by providing maximum opportunities and maintaining the highest standards of excellence can we satisfy the demands of the modern engineering profession. Only in this way can we hope to insure our national strength and leadership; our ability to solve the future's most pressing problems; and the sense of satisfaction and integrity, both professional and personal, of those who devote themselves to engineering.

DALE R. CORSON, *Dean*

1. Cornell Engineering

CORNELL engineering is moving to meet and even to anticipate challenges brought about by new demands. Courses of study in the traditional engineering fields are pointing in new directions, and new courses have been added. The new engineering campus incorporates the latest equipment for instruction in traditional and pioneering technologies, and for research by both faculty and students. Research creates an air of discovery and points the way to careers in developing technologies and sciences.

High school students who enter Cornell engineering apply themselves to fundamentals of basic sciences and engineering sciences. They study both processes and machines. They expand their abilities to confront and solve new engineering problems, their awareness of new engineering opportunities, and their insight into the world's new social, economic, and political responsibilities.

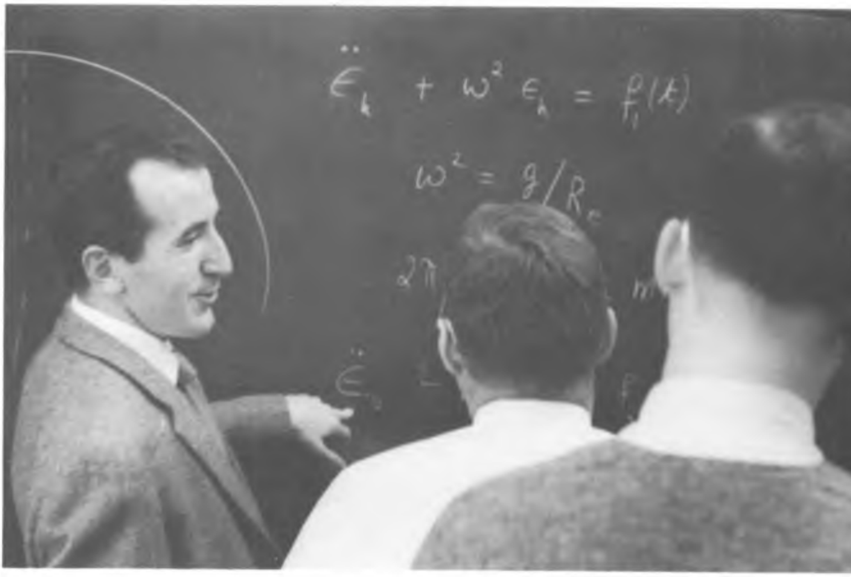
THE CORNELL IDEA

There are certain key concepts which define Cornell engineering. These express themselves in Cornell's faculty, in its academic programs, and in its equipment and facilities.

Fundamentals

Today, and even more in coming years, engineers must be able to find solutions to problems which cannot be solved by knowledge of familiar machines, known structures, and existing organizations. Cornell stresses firm grounding in mathematics, physics, and chemistry, and application of their principles to basic engineering problems and situations. Professor Henry Booker of the School of Electrical Engineering has said that "the objective of an undergraduate education is to exploit what is well known in order to make students' brains work as well as possible." "It is sometimes stated," he says, "that, because much more is known today than thirty years ago, therefore students have much more to learn today. This is untrue. What is true is that there is now more material from which to select in the process of making brains work as well as possible." A mastery of fundamentals makes it possible to keep up with what is and will be new.

Fundamentals underlie many things . . .



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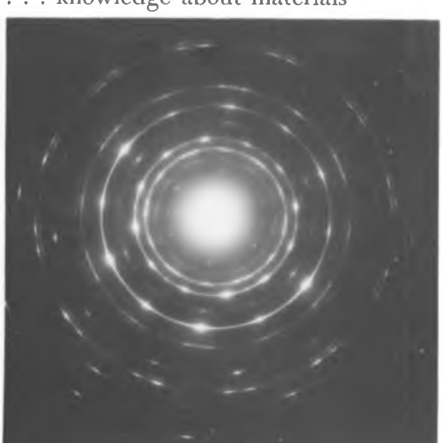

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Depth & Breadth

By explanation, by problem solving, and by working directly on all kinds of equipment in the laboratory, Cornell engineers become competent in an entire branch of engineering. They learn how to solve engineering problems within their own field, and how to approach problems in others. All the traditional branches are expanding, and are requiring a breadth of understanding which comprehends and knows how to use diverse engineering techniques. Nuclear engineering, for instance, requires not only a solid grasp of basic sciences, but a versatile knowledge of principles and practices of chemical, civil, electrical, mechanical, and metallurgical engineering. Cornell's five-year courses of study foster not only competence in a single branch, but expansion toward the breadth required in modern engineering work.

Learning by doin

Flexibility

Cornell encourages the utmost individual initiative and judgment consistent with sound understanding of a chosen field. Engineers are needed in management, production, construction, design, development, and research. Engineering programs have therefore been designed so that students can increase the breadth of their knowledge, or develop from their broad knowledge an engineering specialty. They can prepare for graduate work, or deepen their professional competence to enter directly business or industry. The engineering faculty aims to provide opportunity and direction, but final choice is granted to each student's preference, judgment, and decision.

Perspective

Cornell engineering seeks to graduate men who understand the meanings of their profession in the world of affairs; who can express themselves and their profession clearly, intelligently, and resolutely; who have had the opportunity to gain insight into man, the arts, and the structure of society. One of Cornell's principles is freedom with responsibility; as the late Carl Becker, professor of history, expressed it, "I am free to do what I choose, but I am responsible for what I do." Opportunity to choose studies in other branches of the university encourages the individual student to lay a broader ground for responsible judgment. The diversity of students and faculty at Cornell University promotes a sense of the engineer's place in a social as well as in an academic community.

New Directions through Research

The best way to study engineering is to gain a firm hold on fundamentals; but the best way to learn about what directions the use of those fundamentals is taking, is to be where new frontiers are being explored through research. The engineering faculty itself conducts such research, directs graduate students, and advises senior undergraduates on their own independent projects.

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Fundamental research is conducted in all established engineering fields. But research is also being conducted in new fields not bound by traditional lines. The Center for Radiophysics and Space Research, for instance, brings together investigators in astronomy, engineering physics, electrical engineering, physics, and aerospace engineering. They are studying the atmosphere and properties of space near the planets, development of space vehicle instrumentation, and use of radio astronomy for investigating the solar system and our own and other galaxies. According to Director Thomas Gold, renowned cosmologist and Professor of Astronomy and Electrical Engineering, the purposes of the new center are "to obtain knowledge, to show young people how to obtain knowledge, and to maintain perspective in the teaching of old knowledge—which comes only with the acquisition of the new." Studies like those at Cornell's Nuclear Reactor Facility, Interdisciplinary Materials Science Center, and Computing Center bring the excitement of discovery into the undergraduate classroom. They enable the traditional branches of engineering to participate in the newest developments, and help students to define future engineering problems and opportunities.

Research at Cornell is not a separated entity, but is a planned part of the whole educational program.

Perhaps, however, the inner quality of Cornell engineering education can best be expressed in the single word "opportunity." Education for a field as dynamic and diversified as engineering can never be completely crystallized. The tradition of Cornell engineering is that instead of keeping pace with the development of the profession, it should provide leadership for such development. As a result, Cornell has shaped its program to provide whatever kind of study a student devises after he has prepared himself in fundamental sciences and engineering principles. The choice is open.

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THE ENGINEERING FACULTY

Cornell's engineering faculty is a group of men devoted to the highest standards of teaching and research. Not only do their activities encompass engineering, but as members of the university faculty they encounter and become interested in points of view in the humanities and social sciences.

The vitality of their research and the range of their interests stimulate fresh thinking and action in Cornell engineering education. They have taken the lead in recognizing that many engineering problems require the knowledge and skill of several engineering fields. Their attitude expresses itself in the programs of individual schools, and in establishment of a division like the Department of Engineering Physics, an example of Cornell's pioneering in engineering education. A growing number of faculty members hold joint appointments in more than one field of engineering, or in both engineering and mathematics or physics.

The close relationship of teaching and research, conducted by the same men, and often in laboratories near their classrooms, makes Cornell a center of learning in which teacher and student are participating together. In addition, Cornell faculty members, aware of engineering opportunities and of the big engineering problems that lie ahead, seek to convey that awareness, and stimulate interest by their own example.

All 150 engineering professors teach undergraduate students; they encourage personal meetings and discussions. Part of education at Cornell is the personal and professional guidance the faculty asks each student to seek.

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CORNELL'S ENGINEERING PROGRAMS

Cornell offers undergraduate degrees in agricultural, chemical, civil, electrical, industrial, mechanical, and metallurgical engineering, and in engineering physics. There are special undergraduate programs in aerospace engineering and nuclear technology.

The Cornell degree represents completion of a five-year program, established throughout the College in 1946 as an educational base for an advancing technological era. It is designed for professional leadership and personal development. It is for serious students who seek more than the ordinary breadth and depth in technical theory and application, and who can benefit also from access to the liberal arts

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for growth in personal and social perspective. Within the five-year programs are special opportunities during the fourth and fifth years to begin preparing for graduate work; to combine study and work experience in the Industrial Co-operative program; to gain fuller preparation in one or more specialized fields in the professional master's degree program; or to gain a year by beginning work on an advanced degree in business and public administration, city and regional planning, or law (these programs are described in Section 4).

Again, responsibility for taking full advantage is the student's. Cornell is a vast resource waiting to be tapped. A recent graduate has said: "As I look back over my five years as an engineering undergraduate and renew the personal associations that appear so clearly in my memory, I am led irretrievably to the fact that an education is determined by the individual and not by the curriculum. It is only when the individual abdicates his fundamental responsibility for choosing, and then constantly modifying, his educational goals that the curriculum determines the scope of his learning."

THE ENGINEERING CAMPUS

The new engineering campus is a symbol of Cornell's pioneering and preparation for the future, and of Cornell engineering graduates' leadership in all fields of industry and research. Eight bright, spacious buildings bring teaching and research together in fourteen acres of floor space and house the finest equipment. In addition to laboratories where students themselves work on almost every conceivable type of engineering device and instrument, there are separate small labora-

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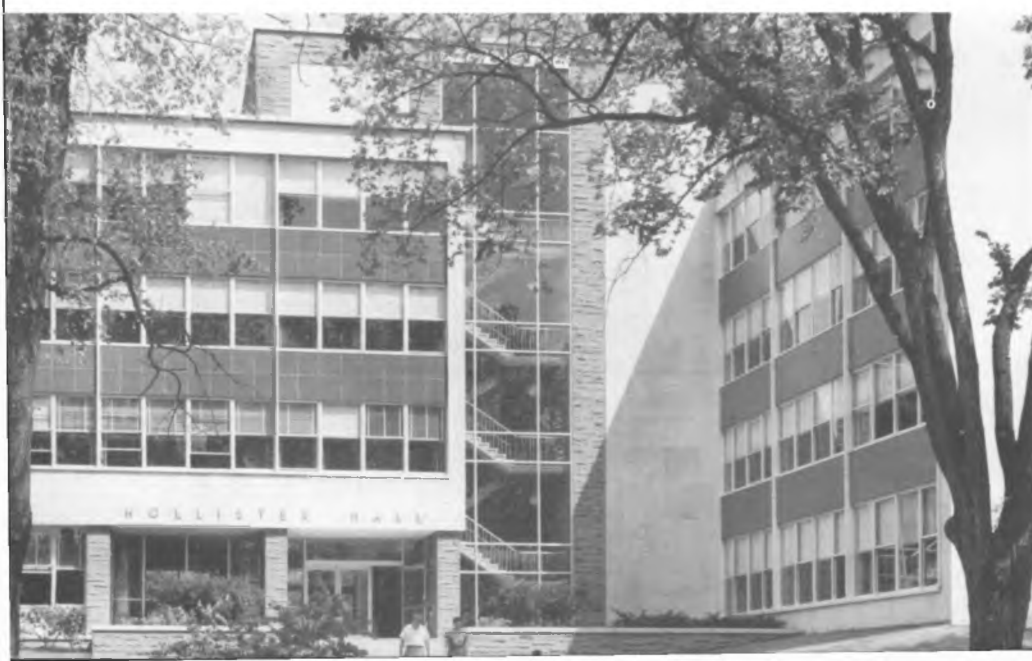

tories where they can conduct independent work. These, used most often by upperclassmen working on projects and by graduate students, are serviced by shops where equipment can be constructed.

Chemical engineering, for instance, has a unit operations laboratory extending through three stories which houses, and in which can be constructed, semi-plant-scale equipment for both instruction and research. Also, it has twenty-five small student laboratories. Hollister Hall, with laboratories for every branch of civil engineering, is typical of the excellence and range of laboratory facilities. Engineering physics operates a fully equipped laboratory of electron microscopy. The Cornell Computing Center, which has recently added a Control Data 1604, one of the largest commercial computers available, enables engineering undergraduates to apply the most modern techniques to their project work. In addition, a Burroughs 220 computer is used extensively for student instruction in course work.

With the completion of the new reactor building in 1961, the College of Engineering has begun to operate a facility unique among educational institutions. A Triga swimming-pool reactor with a moderate power core can be pulsed to very high power for brief periods, affording an intense pulse of neutrons for investigation of various radiation effects. Reactor design can be studied on the zero-power reactor. One of the main purposes of this equipment is that students can use it.

The eight modern buildings have been gifts of distinguished Cornell alumni:

Chemical engineering—the late Franklin W. Olin '86, founder of Olin Mathieson Chemical Corporation and Olin Industries Incorporated.

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Electrical engineering

Electrical engineering—Ellis L. Phillips '95, founder of E. L. Phillips & Company and organizer of numerous gas and electric companies.

Engineering Library and Administration Building—Walter S. Carpenter '10, Chairman of the Board, E. I. du Pont de Nemours and Company.

Mechanical engineering—Maxwell M. Upson '99, Chairman of the Board, Raymond International Incorporated, one of the world's largest international construction firms.

Aerospace engineering—Leroy R. Grumman '16, Chairman of the Board, Grumman Aircraft Corporation, Incorporated.

Civil engineering—Spencer T. Olin '21, director and member of the executive board, Olin Mathieson Chemical Corporation. In memory of his father Franklin W. Olin '86, and in honor of Solomon Cady Hollister, Dean of the College of Engineering 1937-1959.

Engineering Mechanics and Materials (Kimball and Thurston Halls) —given by a group of alumni in honor of former deans of the College.

In addition, work continues on a new metallurgical engineering building donated by Francis N. Bard '04, owner of Barco Manufacturing Company.

The Agricultural Engineering building is located close by on the campus of the College of Agriculture. The near-by Computing Center and several engineering physics laboratories are closely connected with the College of Engineering's work. So are the Radio Astronomy and Radio Wave Propagation Laboratory, the Ionosphere Laboratory, and the High Voltage Laboratory. The new Materials Science Center will have extensive facilities of its own as well as laboratories in the mechanics and materials, and the metallurgical engineering buildings. Some seniors, for their projects, have even pursued studies involving the synchrotron in the Laboratory of Nuclear Studies. Closely associated with the Engineering College is the Cornell Aeronautical Laboratory at Buffalo, where advanced students have had opportunities for summer work.

Cornell's library system has more than two million volumes. The new John M. Olin Library vastly increases its facilities. The spacious Engineering Library in Carpenter Hall is fully equipped for studying and research. It also contains the Albert W. Smith browsing library.

OUTCOMES

One of the main reasons why Cornell engineering offers so many educational opportunities, is that there have never been so many opportunities in so many fields. Cornell graduates are called on to provide leadership as scientists, as professional engineers, and as executives. They must be able to apply knowledge and creativity to the conquest of space, to the development of the automatic factory, to renewal of our cities, or to world problems of power, natural resources, and communications. Such tasks require men who know the problems and know how to approach them; who are challenged by novel situations and unexpected difficulties; who prefer exciting possibilities to routine.

One notable thing about Cornell engineering graduates is the frequency with which they move into administrative responsibilities in both technical and business areas. This is due in part to the nature of engineering at Cornell and in part to Cornell's tradition of education for leadership. Even more important, the university community fosters a personal development and breadth which make the transition from university to career easier and more rich in opportunity.

The leadership of Cornell's engineering graduates is manifested in the new engineering campus. A 1956 study showed that ten of the nation's 100 largest industrial corporations were directed by Cornell alumni, most of them engineers, and 809 other American companies had Cornellians as president or chairman of the board. More than 1000 employment representatives from some 450 concerns come to the campus to interview candidates, and Cornell engineers usually can select from several offers. One of the most frequent observations about Cornell engineers is the competence, breadth, capacity for work, and maturity which they develop in the five-year course of study.

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2. Education at Cornell

EDUCATION at Cornell is a composite affair. As well as being guided by teachers who are acknowledged leaders in their fields, Cornell men and women explore in the company of fellow students who seek understanding in the most diverse subjects, and are preparing for every kind of career. Cornell engineers live as members of an active and responsible society.

Cornell's aim goes beyond competence within a chosen academic study. Just as important is that expanded perspective which is the goal of intellectual growth. At the same time Cornell's tradition of liberalism and freedom maintains an ideal atmosphere for nourishing initiative and judgment, and its busy activity presents manifold opportunities for personal development.

Few can master more than one branch of knowledge in four years or five, whether studying literature or chemistry, or preparing for a career in government or engineering. But Cornell's founders, Ezra Cornell and Andrew Dickson White, believed that if students of history and physics, of art and engineering, live and study together, they come to understand each others' purposes in a unique way.

This has proved true. Students from all sectors of the university, bringing together their individual points of view, reach decisions which direct student government. They plan and conduct their own social affairs. They attend not only many of the same classes, but university lectures on such topics as modern theology, cosmology, or American political parties. In their houses and around their dinner tables sociology majors, engineers, and agriculture students discuss and debate such questions as the underdeveloped areas of the world, raised by a visiting speaker like the president of the Philippines. Such activities and discussions, not to mention the day-to-day pattern of university life, foster an awareness, a growth, and a maturity difficult to measure but nonetheless characteristic of Cornellians. If one thinks of education in its fullest sense as developing the ability to construct a meaningful order out of one's intellectual and personal experience — and this might be one way of stating Cornell's aim — then Cornell students have an ideal opportunity to gain an integrated education in a world whose values, societies, and technologies are undergoing such profound changes.

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Of course one of the reasons Cornell can offer such opportunities is that the University has realized Ezra Cornell's intention to "found an institution where any person can find instruction in any study." Despite its size and scope, however, Cornell still maintains the character of a close and coherent community. Students and faculty concentrate their efforts in a setting removed from the distractions of a metropolitan center. Teachers are easily accessible, and welcome chances to talk over their own fields or students' ideas. To an unusual extent social life is centered on the campus itself. The setting high above Ithaca and Cayuga Lake emphasizes Cornell's homogeneity; its own special character is the way it combines the cosmopolitanism of a great university with personal relationships usually found in smaller colleges.

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STUDENTS

Cornell students come from every part of the United States and from all over the world, and do all kinds of things. Selected from among the most able young people here and abroad, they have demonstrated in high school that they can do work of high quality, that they have purpose and determination, and that they are seeking new knowledge. All of them are by no means bookworms or geniuses. They conduct a strong student government, plan and enjoy a varied social life, carry on existing activities and start new ones, operate student businesses, and take part in almost every kind of intercollegiate and intramural sport. All fifty states—the nation's largest cities, the suburbs of metropolitan areas, and farms—are represented among the 6500 men and 2300 women undergraduates. There are more than 800 foreign students from over 80 countries.

ACADEMIC STUDIES

For the student in engineering this kind of university provides opportunities not available in a self-contained college where science and technology are the dominant studies. At Cornell students are investigating the nature of man and his thought in the departments of philosophy or psychology, or social theories and organizations in economics, government, history, sociology, and anthropology. Strong departments of chemistry, physics, and astronomy conduct and offer studies in the nature of the physical world and the universe, while the mathematics department advances knowledge within its own province and supports study in others. The College of Engineering bases its

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studies and instruction on the ways principles are transformed into useful structures and systems. Organic life is studied in the departments of botany, biology, and zoology, and the dimensions and structure of the earth in geology and geography.

Departments of literature, art, music, architecture, drama, and classics explore expressions of man's spirit and his cultural heritage, while a special division of American studies brings together several disciplines for intensive analysis of American civilization. Other nations' languages and cultures are studied in the Division of Modern Languages, which offers courses in fourteen languages, and in the Department of Asian Studies. Cornell's School of Industrial and Labor Relations is one of the largest in the country. In addition to this range of studies available to undergraduates, advanced professional work is being pursued in the graduate schools of business and public administration, law, and education. Undergraduate students can often take courses in these schools in their upperclass years.

Teachers in all Cornell departments are leaders in their fields. The enlarged perspective afforded by the history department's course in the history of science makes it especially pertinent for engineers. Professor Clinton Rossiter, noted authority on American government and political thought, draws students from all parts of the campus. Professor Thomas Gold not only heads the Department of Astronomy, but in the School of Electrical Engineering he teaches electromagnetic wave propagation in the ionosphere and the solar system. Students can study twentieth century literature under Professor Arthur Mizener, or receive instruction from practicing painters or graphic artists in the Department of Art of the College of Architecture. Many seek out Professor Milton Konvitz's course in Development of American Ideals in the School of Industrial and Labor Relations.

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There are no special electives designed for engineers. They must first of all fulfill the exacting requirements of their own curricula and schedules, and it is true that the demands of these are more stringent than the demands confronting most students in a liberal arts college. Nevertheless the latitude is considerable, and the list of courses elected by engineering students ranges through every college of the University.

Lectures and Concerts

Cornell's prominence as an intellectual center brings to the campus a great variety of musical programs, and lectures by foremost figures in politics, art, science, and technology. Symphony orchestras from Philadelphia and Germany, opera singers and string quartets, performed recently in the concert and chamber music series. Large audiences of students and faculty have followed with deep interest series of lectures by Linus Pauling on the molecular basis of life, by Meyer Shapiro on contemporary art, by Paul Tillich on modern theology, and by Fred Hoyle on the origin, structure, and future of the universe. Addresses were delivered by former President Truman and former European prime ministers Clement Attlee and Pierre Mendès-France, by Supreme Court Justice William O. Douglas and disarmament negotiator Arthur H. Dean. In most cases students not only attend such addresses, but can meet with the speakers informally for discussion. Student organizations have brought to the campus the Weavers, Dizzy Gillespie, and Dave Brubeck. With Cornell's large population of foreign students, visits to the campus by foreign persons and groups are frequent and provide chances to enlarge international understanding. Many foreign student groups also conduct programs and exhibits representative of the cultures of their homelands.

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STUDENT LIFE

Students themselves, from all parts of the university, play a big part in conducting and regulating their own affairs. Each year they elect as their representatives the nine members of the Student Government Organization, which coordinates all student activities, administers budgets, and reviews the decisions of all other student groups. It acts as liaison between the students and the faculty and administration, who believe that students should govern themselves as much as possible. Each class has its own elected council which represents it in student government. Student Judiciary Boards have initial jurisdiction over undergraduate disciplinary cases. In addition, several colleges, including the College of Engineering, have their own student councils, which conduct affairs primarily of interest within their own schools.

Kingston Trio
Barton Hall

Societies, Clubs, and Student Organizations

There is something for everybody among the great variety of organizations, clubs, publications, and hobbies conducted by Cornell students. Only a few of them can be listed here. MEN'S and WOMEN'S GLEE CLUBS present concerts on campus and on tour, the Men's Glee Club having travelled as far as Russia to give concerts. The SAGE CHAPEL CHOIR sings at services every Sunday. THE BIG RED BAND, one of the nation's renowned college bands, makes fifty appearances a year, and two CONCERT BANDS give symphonic concerts on campus and nearby. Other musical clubs put on and sponsor musical comedies, jazz, Gilbert and Sullivan, and folk songs.

THE DEBATE ASSOCIATION, a member of the Ivy League Debate Conference, engages in nearly one hundred intercollegiate debates annually, highlighted by a debate with a British university. Each year the CORNELL DRAMATIC CLUB presents in the University Theater six major productions of traditional, modern, and original plays, offering chances to those who want to try their hand at acting, staging, lighting, costuming, and directing.

A strong voice in university affairs is THE CORNELL DAILY SUN, "Ithaca's only morning newspaper." A full-scale newspaper freely operated by students, it carries world, national, and university news. Students also publish the yearbook, and literary and humor magazines. THE CORNELL ENGINEER is one of the finest undergraduate engineering monthlies in the country. Not only does it provide opportunities for editing, business management, and technical writing on the most advanced subjects, but its valuable discussions on engineering

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t. "Ithaca's only
ing newspaper"

programs have kept students and faculty alert to new developments and needs in engineering education.

There are international and political clubs, service clubs, professional and departmental societies, and clubs devoted to almost anyone's hobby. Student announcers and technicians of the CORNELL RADIO GUILD staff and operate the campus station, WVBR. Radio hams of CORNELL AMATEUR RADIO CLUB have a well-equipped radio shack and workshop, own an amateur radio station, and operate a public address system. Lake Cayuga provides excellent sailing for the fleet of the CORNELL CORINTHIAN YACHT CLUB. The PHOTO CLUB has full darkroom facilities. The OUTING CLUB not only takes advantage of Cornell's surroundings for hiking, skating, and skiing, but plans mountain climbing trips to the Adirondacks, the Green Mountains, and even Canada. Other clubs bring together those interested in polo, rifle and pistol, chess, cricket, folk dancing, and many other activities.

Cornellians
Tom Lehre

A large number of these clubs and organizations are centered in the student union building, Willard Straight Hall. The Straight includes several dining rooms and cafeterias, the theater, an arts and crafts workshop, game rooms, a browsing library, a music room with a vast collection of records, and an art room. There are a barber shop, and guest rooms for visiting parents and friends.

Recreation and Social Life

Cornell's men and women are active and exciting young people. Everything from get-togethers in Noyes Lodge overlooking Beebe Lake, to formal dances with name bands, make up student social life. Between classes or after an evening of study in the library, they relax in Willard Straight's Ivy Room for a coffee date or a game of bridge. Fall and Spring weekends are special occasions, with the big football game or crew race, houseparties, and a university dance in Barton Hall. About sixty Cornell fraternities and fifteen sororities, most of them affiliated nationally, hold parties, large and small, on social weekends throughout the year. Fellowship fostered by studying, living, and relaxing together forms ties which last throughout life.

When it gets hot in fall or spring, Beebe Lake is on campus, and it's only a few minutes to excellent swimming at Buttermilk Falls, Enfield Gorge, or Taughannock Park on Lake Cayuga. In winter there's outdoor skating on Beebe Lake (and indoors at Lynah Rink); or, the well-travelled trail to Greek Peak for fine skiing (for beginners or

Left. The Cornell
Club—60 voices

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Recreation for everybody . . . Skating at Beebe Lake

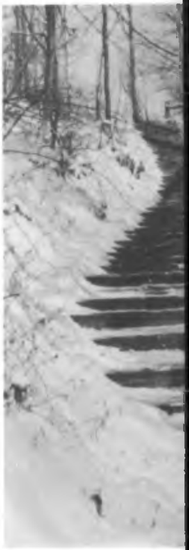
pe in winter

Intramurals

Intercollegiate athletics

experts). Cornell's gorges and streams never cease to be fascinating. For those who prefer just relaxing, the Library Slope has grass, shade, a brilliant view of Cayuga Lake, and sometimes a band concert. There are movies downtown and on campus, concerts, and all kinds of intercollegiate athletic events. White Art Museum brings to Ithaca excellent exhibits and has a growing collection of its own. Astronomy enthusiasts can visit Fuertes Observatory.

There are always things going on, planned and spontaneous, for visitors and students, for large groups and small. At the same time there are bull sessions in dormitory or fraternity, and space to get away for study or reflection.



Athletics

Cornell teams compete against fellow members of the Ivy League and other schools in twenty-two sports. But that is only a small part of its athletic program. Everybody always seems to be playing something — not only intramurals, in which leagues are going throughout the year, but innumerable pick-up games and matches. Students can get instruction in individual sports like swimming, tennis, and squash, or in golf on Cornell's 18-hole course. One of Cornell's aims is to give students a chance to learn and take part in sports that can be carried on after college. Anyone can go out for intercollegiate teams, and he doesn't have to be an expert: many students become varsity members in sports which they first learned at Cornell.

Cornell's forty-eight acres of playing fields are almost all on campus or within walking distance, with tennis courts in various places. Teagle Hall has two swimming pools, a gymnasium, and rooms for wrestling, fencing, boxing, rowing, and exercises. Varsity and intramural basketball, wrestling, and indoor track—including the Ivy League's Heptagonal games — take place in Barton Hall, the huge armory, which also has a rifle and pistol range. Lynah Rink is for hockey and skating, and Grumman has six squash courts. The riding hall is the scene of polo matches and instruction in horsemanship, and Bacon Cage allows indoor baseball and track practice, and instruction in golf. Off campus, Moakley House and Collyer Boat House serve golf and crew. Schoellkopf Field is the home of the Big Red football team. Some of the other outdoor intercollegiate sports are track, cross-country, soccer, and lacrosse.

Religion at Cornell

Anabel Taylor Hall represents Cornell's historic principle of freedom for all religious traditions but control by no single group. As the center of Cornell United Religious Work, it is staffed by twelve university chaplains representing the major religious traditions at Cornell, and by a director and his associates. CURW's thirteen religious groups, as well as students who have no specific religious affiliation, meet for religious enquiry, study, worship, counsel, and fellowship. Anabel Taylor has an interfaith chapel, and is the center of the One World Club, a large group of American and foreign students. In addition, each Sunday distinguished visiting clergymen from throughout the world conduct interdenominational services in Sage Chapel. Ithaca churches welcome Cornell students to their congregations.

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Chapel

Army, Navy, and Air Force ROTC

Each of the armed services conducts four-year courses leading upon graduation from Cornell to commissions in the reserve forces, with opportunity for regular commissions and entry upon military careers. The programs are voluntary and make up part of a participating student's elective program. ROTC students are deferred from military service until graduation, at which time they are on call for active duty as officers.

College Life Is an Education

There are few limits to education at Cornell. Cornell assumes that each of its students is concerned first of all with serious achievement in his chosen course; but it expects that he will build upon that achievement his own place in the Cornell community. No matter what the course – liberal arts, engineering, or agriculture – the University and all of its varied life exist to make going to college as meaningful as possible. As a Cornellian you and your fellow students – men and women – will argue different points of view, compare goals and careers, and come to know people of all sorts. You will attend parties, concerts, and football games, and work on projects and hobbies as well as with books and instruments.

There is never a lack of ideas or a dull moment at Cornell.

3. Engineering: The First Years

YOU have learned what Cornell is like and what the College of Engineering is trying to do. But how does a high school student decide to study engineering? What is it like to begin studying in one of Cornell's engineering schools? What kinds of courses make up the first year? How does Cornell help a student fit himself into his chosen field and into the Cornell community? These are pressing questions to anyone who is about to set out on a college career.

THE ENGINEERING PROFESSION

If you like mathematics and do well at it; if you have enjoyed what science courses you may have had; if you think you would like to apply principles of these studies to create structures and systems for useful purposes – then you probably have the ability to become an engineer. Engineers shape the discoveries of science to meet human needs of all kinds. They develop machines which transform energy into usable power, supervise construction of highways and buildings, direct manufacturing processes, design communications systems, and do experimental work on new materials and chemical processes. What they do is sometimes routine, but more often exciting. As much as or more than the activities of any other profession, their work with society's financial, material, and human resources is determining the shape of our dynamic civilization.

Engineering calls for the best that is in you and helps develop that best. It is a rigorous and demanding intellectual discipline, an excellent training of the mind. The bridge builder or missile maker cannot afford to be right only 70 per cent of the time; for the safety, comfort, convenience, and economy of millions of people he must strive for perfection in machines and structures, and in harnessing natural forces. To master engineering you must develop the ability to concentrate, systematize, and organize your work; make an orderly approach to solving problems; persist in the face of repeated failures; and thrive on all this.

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ınd magni-
alculus . . .

The decision to enroll in engineering is not quite the same as a decision to undertake liberal arts. Those who study the humanities, or the natural or social sciences, are learning about their cultural heritage or the world around them; they are not necessarily preparing for a specific profession. As a result, liberal arts students can do a good bit of experimenting before they have to decide on their major field. The engineering student, on the other hand, has chosen before he arrives on campus for his freshman year. And he has chosen training for a highly developed professional career, like law or medicine. The liberal arts student, while he obtains a broader cultural background, must, if he seeks professional training — in his undergraduate field or in law or medicine — enter graduate school. The engineer, when he receives his bachelor's degree, is ready to enter his profession directly, even though he may subsequently go on to advanced study.

Cornell does not expect all students who are interested in engineering to be free of doubts about a decision as difficult and important as this. Those who have made the choice and banished all doubts are in the minority. But Cornell does think, and its experience has shown, that most students who like and have a flair for science and mathematics find they have chosen well. To help decide you should find out as much as you can about engineering by inquiry, observation, and reading. If you come to Cornell having investigated engineering at least enough to feel that your choice might be a reasonable one, you can be enthusiastic and sufficiently motivated to sustain yourself through what may seem one or two quite rigorous years. According to Mr. Donald Moyer, Director of Student Personnel for the College of Engineering, "one of the principal reasons that a large number of engineering students fall by the wayside, especially in their first year, is lack of motivation, and I would add, failure to understand what engineering school is all about. Lack of ability is seldom the reason for failure."

BASIC STUDIES

All students who enroll in Cornell's College of Engineering enter the Division of Basic Studies. During the first two years they study mathematics, physics, chemistry, and English, and begin work in the engineering sciences. In addition they take a sequence of courses in

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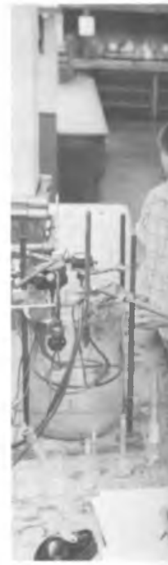
engineering problems and methods. Here they learn the basic skills needed for engineering work, and how to develop and apply methods of thinking which lead to engineering judgments. They investigate through active participation what the problems of the engineering profession are, and how to approach them. They not only learn fundamentals but have a chance to form intelligent judgments about the kind of engineering work they wish to pursue.



Cornell has undergraduate programs leading to degrees in

Agricultural Engineering	Engineering Physics
Chemical Engineering	Industrial Engineering
Civil Engineering	Mechanical Engineering
Electrical Engineering	Metallurgical Engineering

In addition, students can take sequences of courses in aerospace engineering, nuclear technology, and engineering mechanics and materials in their upperclass years.

While no student is obliged to state a preference for a particular branch of engineering until after he has spent a year in the College, those who enter with a preference will be assigned an adviser in the division of their interest.

After one year of mathematics, physics, chemistry, English, and engineering problems and methods, a program of applied mathematics and physics continues for all students in the second year, and a first course in mechanics begins. In addition, all students except those who have decided upon chemical engineering take semester courses in physical chemistry and electrical science, a liberal elective, and a one-term course specified by the professional division for which the student has tentatively expressed a preference. Students who at the end of their freshman year have expressed an interest in chemical engineering take mathematics, physics, chemistry, and two courses in each semester of the sophomore year specified by the School of Chemical Engineering.

After having successfully completed the requirements of the Division of Basic Studies, and the sophomore course or courses required by the division of his choice, the student will be admitted to that professional division ordinarily at the end of the sophomore year. Agricultural engineering students enroll in the College of Agriculture for their first four years (see p. 45).

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ıdy finds many places . . . under Ezra Cornell's eyes

gineering lounge . . . the Straight

Work on basic engineering equipment usually begins in the second year, and increases throughout the third and fourth. After working with the standard equipment of their chosen fields in the third and fourth years, students have the opportunity to work on devices of the latest type, especially if they choose to do independent work in a senior project (the five-year pattern and other special opportunities are described in more detail in the next section of this booklet).

CLASS TIME AND STUDY TIME

If you have mastered your high school work, have a capacity for sustained application, have developed the habit of orderly studying, and have a great desire to accomplish what you have set out to do, you should do well in engineering at Cornell. This is not, of course, always the case. Changing from high school to college is not easy. Therefore you should come to Cornell determined to establish in your first year two habits: of planning your time, and of seeking out the many opportunities Cornell offers for giving you advice and direction. These habits, coupled with two personal traits – conscientiousness and confidence – will help insure that you get the most which not only the College of Engineering, but the Cornell community, has to offer.

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Freshmen spend about 14 hours a week in class and about 12 in laboratory–26 hours in all spread over five-and-a-half days. Most freshmen find that they need two hours to prepare for each class hour, and perhaps a few hours a week for laboratory preparation. That adds up to between 50 and 55 hours a week for academic work alone. This pattern remains about the same during all five years: the level of courses rises at about the same rate as a student's ability to handle it.

This is not a 40-hour week by any means, and the load is heavier than that of a liberal arts student. The difference is less in real load, however, than in actual hours in class and in the minimum work required merely to "get by." The liberal arts student's class schedule is lighter so that he can do more reading; he can do it or skimp. But the engineer's load is built into his class schedule.

In general, an engineering freshman ought to allow himself one evening and one day a week (Saturday night and Sunday for instance) for recreation and entertainment. Unless he cannot avoid it, he ought to forego part-time employment during his first year, while he is getting accustomed to his course and college life. The way to the most expanded education, scholastic and extracurricular, is discipline – not discipline commanded by someone else, but discipline imposed by one's self so as to be able to begin, execute, and conclude a task well.

"the hill", dormitories in foreground

Library tower from the Arts quad

Fall Creek Gorge

Enfield Park Gorge

EXTRACURRICULAR ACTIVITIES

If engineering is so rigorous, is there really time to take advantage of all Cornell's opportunities? Of all, no. Of some, yes. And in one way that is an advantage. For Cornell engineers are known not for the number of activities they undertake, but for the enthusiasm and energy with which they enter one or a few.

In a recent year, for instance, Cornell engineers were presidents of many campus organizations, including the Executive Committee of the Student Government, Willard Straight, Cornell United Religious Work, the Freshman Class, the Navy ROTC brigade, and Sphinx Head, the senior honor society. An engineer was editor-in-chief of the *Cornell Daily Sun*. Engineering students make up the second largest number of varsity athletes in the university; of the nine men of Cornell's 1957 crew which won the Grand Challenge Cup at Henley, England, seven were engineers. Engineers have always played leading parts in Cornell's many music organizations; in 1959–60, for instance, an electrical engineer was president and 20 engineers members of the University Concert Band.

For freshmen, planning their studies, especially during the first weeks, is the key to entering athletics or an activity. Though they must restrict themselves during this crucial year, they ought to be able to take part in athletics or some one student organization without putting their scholastic work in jeopardy.

COUNSELLING AND SPECIAL PROGRAMS FOR FRESHMEN

Cornell has done its best to aid the transition from high school to college, from home life to individual responsibility. All freshmen take part in the University's orientation program the week before classes begin. Tours, discussions, and receptions are held in each of the engineering schools, and students meet their faculty advisers. Members of the engineering faculty are interested in their students as students, as future engineers, and as persons; they want to do all they can to encourage their personal and professional growth. One of a faculty member's chief interests is the students whom he aids during their undergraduate years. Students themselves find that one of the best ways to learn more about what engineering is like and where they are headed is to talk with upperclassmen and observe what they are doing.

Engineers are on Cornell's teams. *Right.* members help tudies, course les, and per- roblems.

Also ready to give advice are upperclass students who live in the dormitories just for that purpose. Or, you can talk to the instructor in one of your courses, the director of your school or the Division of Basic Studies, the dean of students, the director of student personnel, or the dean of the College of Engineering. They will help you reach decisions on any problem that may arise. You can consult them on anything from career opportunities to changes in your course.

LIVING AT CORNELL

Most freshmen live in dormitories which are within convenient distance of academic buildings, libraries, and Willard Straight. Students from the various colleges live together in the same buildings, one or two to a room. Unless they have other preferences, those who request double rooms are assigned a fellow student in the same college: it is often helpful for engineers to begin their college careers living with those taking a similar program. Rooms are bright and attractive, with ample space for study. On the ground floor of each of the freshman buildings there is a large social lounge with a kitchen, and on each of the other three floors a separate lounge. In the central dormitory there is a cafeteria which serves all three meals and is open during the evening. Dormitory students can obtain their meals in various university cafeterias and dining rooms according to their own choice and schedule. Those who wish may save by prepaying for their meals for an entire semester. Women's residential and dining halls are on the other side of the campus.

Though freshman men are not required to live in dormitories, most do; others may make their own off-campus arrangements. About one-third of all Cornell men live in dormitories, one-third off campus, and one-third in fraternity houses. Rushing for fraternities and sororities takes place during the first weeks of the second term; bids are extended shortly thereafter. About half of Cornell men and forty per cent of Cornell women belong to fraternities and sororities. In both dormitories and fraternities there are opportunities for getting help with studies from classmates or upperclassmen, for parties and movies, for meeting faculty members, and for starting or taking a place on intramural athletic teams. There are discussions, record collections, or just plain relaxing. And there are opportunities for friendships of all kinds with all kinds of people.

Left. Fraternit
study table.
Dormitory
are for relaxi

SCHOLARSHIPS, LOANS, EMPLOYMENT, PRIZES

Cornell's integrated program of scholarships, loans, and employment helps students meet the costs of college education. The College of Engineering awards well over $180,000 annually to freshmen alone, and in 1962 over 65 per cent of all engineering students held scholarships. The McMullen Regional Scholarships, for instance, of which fifty or more are awarded each year, are distinguished among American engineering college scholarships. Cornell also participates in many national scholarship programs. In addition, winners of many freshman scholarships are offered the opportunity to borrow money through the University or the National Defense Student Loan Program. While campus employment is provided for some freshman engineering students, it is advisable, when at all possible, for freshmen to avoid employment while classes are in session.

An application for financial aid, issued by the Director of Admissions, entitles the applicant to be considered for all scholarships for which he may be eligible in the college to which he is applying. Scholarships available only to engineers are listed on the next page; engineers are also eligible for other university awards, including the Cornell National Scholarships. Awards are made on a competitive basis, primarily to students whose capabilities indicate that they are likely to achieve a scholastic average in the top third of their class.

Financial assistance to upperclassmen, who were unsuccessful in winning freshman awards, is available in substantial amounts through the Office of Scholarships and Financial Aid; many students are assisted annually by grants, loans, student employment, or a combination of these resources. A limited number of prize scholarships with stipends of from $250 to over $1000 a year are awarded to students in their third, fourth, and fifth years for outstanding academic and extracurricular accomplishments. Need is a secondary factor in competition for these awards.

PHYSICAL EDUCATION AND HEALTH SERVICES

All freshmen and sophomores are required to take physical education for three hours a week. The program, which for freshmen changes every six weeks, includes basketball, golf, tennis, volleyball, wrestling, and swimming. Sophomores concentrate on one or two sports which they can continue during their upperclass years and after graduation.

Complete health services are available at Gannett Medical Clinic and in the Cornell Infirmary, a fully accredited hospital. Student fees cover treatment and care at the Clinic and the Infirmary, with up to two weeks of hospitalization per term.

SCHOLARSHIPS FOR FRESHMEN

AMERICAN SOCIETY FOR METALS SCHOLARSHIP . . . Established by the National Society for Metals Foundation for education and research. Normally awarded to an entering freshman or upperclassman in metallurgical engineering. Tenure, one year. Award, $500.

CHARLES R. ARMINGTON SCHOLARSHIPS IN ENGINEERING . . . Gift of Mr. and Mrs. R. Q. Armington, in memory of their son who was a student in the School of Mechanical Engineering at the time of his death in 1956. Open to men students in any branch of engineering. One scholarship annually with annual stipend up to $2000. Tenure, not limited. Selection based on balance of academic and extracurricular interests with outstanding personal characteristics.

JOHN HENRY BARR SCHOLARSHIP . . . Gift of Mrs. Mabel R. Barr, for a deserving student to be chosen by the University from recommendations of the Cornell Club of the Lehigh Valley. Annual award, up to $2000. Tenure, not limited.

EDWARD P. BURRELL SCHOLARSHIPS . . . Gift under the will of Katherine W. Burrell, in memory of her husband. Open to men and women entering the College of Engineering. Award, up to $800 for freshman year only. Need is an important factor in selecting the winners.

GENERAL MOTORS COLLEGE SCHOLARSHIP . . . Established in 1957 by the General Motors Corporation. Available to men or women who are citizens of the United States and are entering the College of Engineering. One scholarship annually with stipend of from $200 to $2000 depending upon need. Tenure, unlimited. Selection based upon outstanding academic promise, general character, and financial need.

INLAND STEEL FOUNDATION SCHOLARSHIPS . . . Established by the Inland Steel Foundation. Annual award, $1500. Tenure, not limited. Selection is based on scholastic attainment, personal characteristics, and financial need. Summer employment may be offered to recipient by the Inland Steel Company.

MARTIN J. INSULL SCHOLARSHIP . . . Gift of his wife, Mrs. Virginia Insull. Open to men entering the College of Engineering. Annual award, $1500. Tenure, not limited. Further provisions as for the McMullen Regional Scholarships (see below), except that financial need is an essential criterion.

LOCKHEED NATIONAL ENGINEERING SCHOLARSHIP . . . Established by the Lockheed Leadership Fund. Open to entering students in the College of Engineering. Annual award, tuition and fees plus $500. Tenure, unlimited. One award each year to a student who is in a field of engineering applicable to the aircraft industry and whose total personal qualities can be expected upon graduation to offer a significant contribution to the aircraft industry.

JOHN McMULLEN REGIONAL SCHOLARSHIPS . . . Gift under the will of John McMullen. Open to men entering the College of Engineering. Annual award, up to $1800. Tenure, not limited. Fifty or more scholarships awarded annually. Applicants will be selected on the basis of high scholastic achievement and other indications of qualities likely to produce leadership in engineering. Although financial need is not a factor in selecting the winners, full consideration will be given to need in fixing stipends.

OWENS-ILLINOIS SCHOLARSHIP . . . Established by Owens-Illinois. Open to men. Annual award, tuition and fees plus $125 for books and supplies in the freshman year and $100 annually thereafter. Tenure, not limited. Selection will be based on scholastic achievement, personality, and financial need. Summer employment may be offered by Owens-Illinois.

PROCTER AND GAMBLE SCHOLARSHIPS . . . Established by the Procter and Gamble Company. Open to men or women entering the College of Engineering. Annual award, tuition and fees plus $115 for books and supplies. Tenure, unlimited. Selection based on academic achievement, character, and financial need.

ALFRED P. SLOAN NATIONAL SCHOLARSHIPS . . . Established by the Alfred P. Sloan Foundation. Open to men entering the College of Engineering. Annual award varies from a prize scholarship of $200 to as much as $2000, depending upon financial need. Tenure, not limited. Nine scholarships awarded annually. Applicants will be selected on the basis of high character, sound personality, leadership potential, and professional promise.

UNION CARBIDE ENGINEERING SCHOLARSHIPS . . . Established in 1960 by the Union Carbide Corporation. One scholarship awarded annually to an entering student with a preference for chemical, mechanical, or metallurgical engineering. Award equal to the amount of tuition and fees plus $100 for books and supplies. Tenure, not limited. Same requirements as for the McMullen Regional Scholarships.

JESSEL STUART WHYTE SCHOLARSHIP . . . Gift of Mrs. Anna Jessel Whyte in memory of her son. Open to entering students with a preference for mechanical engineering. Annual award, $1000. Tenure, not limited. Preference will be given to residents of Illinois, Iowa, Michigan, Minnesota, and Wisconsin. Further provision as for McMullen Regional Scholarships.

4. Opportunities in Cornell Engineering

EVER since its founding in 1865 Cornell has been a pioneer in engineering education. To meet the modern engineer's need for more fundamentals, for professional breadth and depth, and for increased personal and social perspective, the College of Engineering in 1946 adopted five-year programs in all of its schools. As was pointed out in Section 3, during the first two years students build the indispensable foundation in mathematics, physics, and chemistry and begin learning how to think about engineering problems. The second and third years emphasize basic engineering sciences, and extensive laboratory work begins. Students concentrate in the fourth year on the sciences and technologies of their chosen fields. As they achieve fuller grasp of these fields, opportunities develop for more intensive study and independent work. The latitude of the fourth and fifth years allows concentration on some special aspect within a branch of engineering, or broader coverage of the field, or interdepartmental study. Superior students may enroll in the Graduate School during their fifth year in the Engineering Graduate Honors Program.

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THE FIVE-YEAR PROGRAM

A principal feature of Cornell's five-year program is the extent to which a student not only gains command of all the important aspects of a field, but can concentrate on a special interest as well. Mechanical engineers, for instance, get extensive training in such branches as industrial and administrative engineering, machine design, engineering materials and materials processing, and thermal engineering. If they wish further concentration in one of these, they can elect a sequence of advanced courses adapted to their special interest. Thus a student interested in thermal engineering can build a full thermal engineering program on top of a basic program in mechanical engineering.

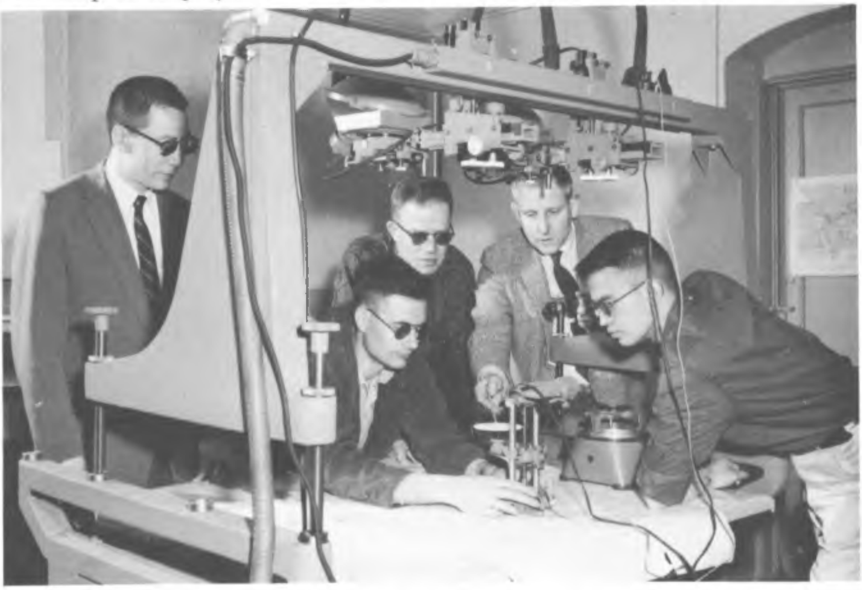
A civil engineering student, after a thorough grounding in structural, transportation, sanitary, and hydraulics engineering, and construction engineering and administration, can pursue further any one of these or extend his competence in several. In electrical engineering special advanced sequences can be selected in such areas as electric network theory, industrial electronics, feedback control systems and computers, communication systems, radio science, and many others. Engineering physics and metallurgical engineering students can obtain unusually sound training in materials science, or engineering physicists

. . . a senior mechanical engineer in an aerospace engineering lab

Theory and ideas tested in the laboratories . . .

. . . evaporator project

. . . FM radio transmission



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can select a series of courses in space science and technology. In chemical engineering, after thorough coverage of the field, students can carry out specialized studies in biochemical engineering, plastics, rubbers, reaction kinetics, or process instrumentation and automation. These are only some of the possibilities. In addition, there are more formal elective programs in nuclear technology and aerospace engineering (described below).

Opportunities for independent work are provided in the senior project, required in some schools, optional in others. It is a piece of work which a student initiates, plans, and carries out himself, with advice from a faculty member who is often an outstanding authority in the field. Such "open ended" investigations, which have no fixed time for completion and allow a student to go as far as he can see worthwhile things to do, stimulate his ability to think and to do original work. Such projects can be conducted with pencil, paper, and slide rule or computer; or on equipment which the student designs, constructs, and tests.

Some projects have employed the Control Data 1604 and the Burroughs 220 at the Cornell Computing Center, or the Synchrotron in Cornell's Laboratory of Nuclear Studies. The new reactor facility expands opportunities still further. Students can take advantage of the considerable laboratory space available in all of the engineering buildings, and of the many group and individual project rooms. Some undergraduate projects have been highly original work of distinctly graduate caliber or have been adopted in industry. Often they work into some part of Cornell's extensive research program; students help professors who are conducting advanced investigations, or design equipment which later becomes a device used in undergraduate laboratory courses. Nor are opportunities to work on research projects limited to the senior year. Some students get first-hand research experience during the summer as assistants to faculty members or graduate students.

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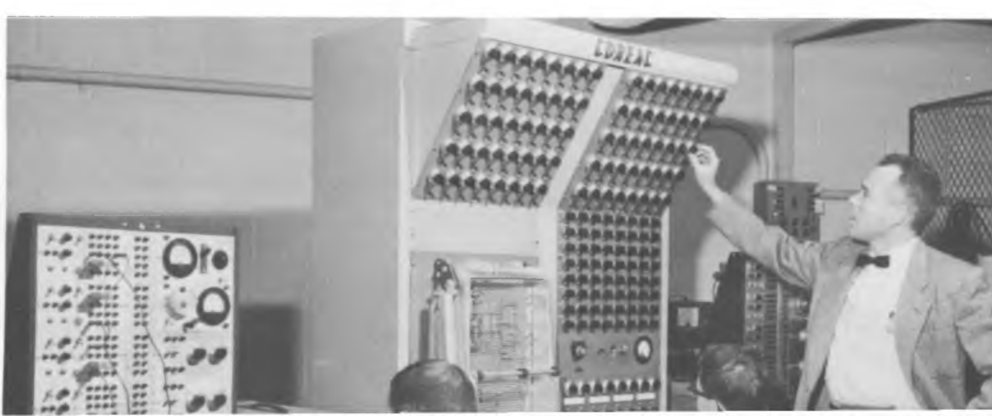

Cornell believes that its five-year curriculum offers prospective engineers the best chance to develop from a proper foundation not only full competence in an engineering field, but adequate opportunity for general, managerial, and liberal studies.

In this integrated program courses build upon each other, so that understanding increases in an orderly way. Students are better able to correlate their knowledge of subjects within engineering and between engineering and other studies. Since opportunities for elected courses are spaced over several years, students can take advantage of the stimulus excited by newly discovered interests and of their growing intellectual maturity, to plan engineering electives, independent work, and liberal studies.

Usually, beginning even in the second year and increasing through the fifth, students can expand their personal horizons by electing courses in art, literature, history, philosophy, economics, or social sciences. Some familiarity with man's expressions through thinking, writing, or painting is an invaluable stimulus to further explorations throughout life. The best education not only trains the mind and introduces new techniques, but enlarges one as a person. It induces understanding and respect for problems upon which men have reflected during times of doubt and illumination. Each school requires some study in the humanities and social sciences. Moreover, each provides for free electives that can be used to explore further in these fields, to develop more fully an engineering technology, or to prepare for graduate study.

The engineering profession is changing. Old fields are becoming transformed, new ones are evolving, and engineers are more and more often required to make judgments which have extensive social and political implications. These conditions demand integration and flexibility. Cornell's five-year program helps provide them. Whether a graduate is going into industry directly or intends to continue his studies in graduate school, the five-year program provides a level of achievement which is unique.

Nuclear physic
laboratory

SPECIAL OPPORTUNITIES

Graduate Honors Program

Most Cornell engineering students find the standard five-year programs amply challenging with their extensive work in both technical and liberal studies. However, the opportunity exists for superior students who have achieved high scholastic performance during their first four years to enroll in the graduate division in their fifth year. This materially advances their graduate studies and enables such candidates to obtain graduate degrees at an earlier date. Throughout the undergraduate years, students exhibiting special competence in individual subjects as well as strong over-all scholastic performance are enrolled in enriched sections of these subjects, providing a sound foundation for the upperclass Graduate Honors Program. At present approximately 40 per cent of the graduating classes in engineering continue in graduate programs subsequent to the completion of their undergraduate work, with about half of this group being eligible for consideration for the Graduate Honors Program.

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Industrial Cooperative Program

Students who select electrical or mechanical engineering, or engineering physics, and who did well in their first two years, can gain first-hand experience by combining college and industrial work. By working in a participating industry* two terms and a summer, and by completing the two terms' work during two summer sessions, they still graduate with their class. Within the regular activity of the company, the work programs are adapted to the interests of each student and provide opportunities seldom available in ordinary summer jobs. The purpose of the plan is educational, but students receive a substantial salary from industry during the three work periods.

Nuclear Technology

The elective program in nuclear technology is an example of how Cornell's advanced research becomes translated into an undergraduate course of study. Undergraduates can elect the nuclear technology pro-

*Air Reduction Company, American Electric Power Service Corporation, Anaconda Wire & Cable Company, Cornell Aeronautical Laboratory, Emerson Electric Company, Stromberg-Carlson Corporation, General Electric Company, General Radio Company, The Gleason Works, International Business Machines Corporation, Philco Corporation, Procter and Gamble, and Raytheon Manufacturing Company.

know machines in
l engineering

gram in their fourth and fifth years. It focuses basic engineering and scientific principles on one of today's most exciting technologies. The College of Engineering believes that the best preparation for work in nuclear technology is a coordinated study of the principles of nuclear science and of the major branches of engineering. Cornell's reactor facility provides a unique installation for teaching and research. The program can also lead to graduate study in this new field.

Engineering Mechanics and Materials

Most future advances in technology will depend upon a scientific understanding of materials and of their proper engineering applications. Students can elect advanced courses in applied mathematics, applied mechanics, and materials science in their upperclass years. These courses are especially suited to students who have demonstrated superior analytical or experimental ability, and who wish to develop it. The studies cut across many fields of design and development.

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test set-

Aerospace Engineering

Space flight, mechanics of rockets and space vehicles, controls and communications systems for missiles—these are the newest problems confronting engineering physicists, mechanical engineers, and electrical engineers. Students with good records in these branches of engineering can obtain an unusually sound aerospace engineering education by building onto their basic programs, during the fourth and fifth years, specialized studies in the Graduate School of Aerospace Engineering.

Professional Masters' Degrees

Cornell recognizes that while there is a growing emphasis on engineering sciences, on advanced study, and on research, the bulk of engineering work must continue to be done by graduates who enter professional practice directly. Dean Corson has declared, "Cornell, because of its tradition, because of its size, because of the nature of its student body, and because of the availability of strong programs in the sciences and in business administration, for example, must excel in both the scientific and the professional aspects of engineering education."

This breadth of choice already is manifested in the opportunities offered by Cornell's five-year program. But the demands of modern engineering practice have led to the establishment of professional

A river model for st
hydro-power problem

masters' programs in chemical, civil, electrical, industrial, mechanical, and metallurgical engineering. These programs, consisting of advanced course work but no graduate thesis, provide opportunity to prepare in considerable depth for work in one or more specialized areas. Superior students can plan their programs to begin work on this advanced degree in their senior year, and often complete their work in only one extra term. The professional degrees represent the five-and-one-half to six year level of university work, which normally requires one to two years of additional study beyond a four-year undergraduate course.

microscopy

Business and Public Administration
City and Regional Planning
Law

The increasing demand for engineers as administrators in business, industry, and public affairs has led Cornell to institute programs which allow selected students to obtain both a bachelor's degree in engineering, and an advanced degree in business and public administration, city and regional planning, or law, in one year less than the normal period. The programs take advantage of the presence on the Cornell University campus of the College of Architecture, the Graduate School of Business and Public Administration, and the Law School. Students in chemical, civil, electrical, industrial, mechanical, and metallurgical engineering can begin planning programs in these directions in their fourth and fifth years.

Graduate Study in Engineering

Original work is being carried out by graduate students in all fields and subdivisions of the College of Engineering. The graduate programs are growing in all schools as part of Cornell's advancement of scientific and technological research. Under the leadership of the Cornell faculty, and supported by considerable research grants, students can take advantage of the most advanced equipment and unique re-

Discussion in machine design

search facilities to pursue work toward master of science or doctor of philosophy degrees.

PROFESSIONAL GUIDANCE AND PLACEMENT

Engineering students have particularly good opportunities to discover what is going on in the engineering profession and where the exciting possibilities lie. During their first two years they can explore the branches of engineering before deciding which they want to enter. In their courses in engineering methods they investigate the problems which confront each branch, and how to approach them. Advisers are eager to help, and Cornell research projects are excellent barometers of new directions. Also, the College of Engineering is closely associated with local branches of national engineering societies, including the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, Society of Automotive Engineers, and Institute of Radio Engineers. With them are affiliated student branches, which also include branches of the American Institute of Chemical Engineers, American Institute of Aeronautics and Astronautics, American Institute of Mining and Metallurgical Engineers, and American Nuclear Society. National and local honor societies—Tau Beta Pi, Phi Kappa Phi, Sigma Xi, Pi Tau Sigma, Chi Epsilon, Rod and Bob, Pyramid, Atmos, Kappa Tau Chi, and Eta Kappa Nu—also function in the College of Engineering.

Job inter
through
placemen

The Student Personnel Office of the College of Engineering is the center for helping a student get the sort of job he wants following graduation. It works with the University Placement Service to arrange interviews with employers, and to assemble and present personnel records. Cornell engineers are eagerly sought by employers in business and industry, large and small. Their professional achievement and maturity are recognized in their starting salaries and in positions which offer excellent opportunities for advancement.

Testing samples in metallurgical engineering

5. Entering Cornell

ADMISSION to Cornell is based primarily upon a candidate's ability to do academic work of high quality. His ability is judged by his high school or private school record, by the recommendations of his principal or headmaster, and by tests of the College Entrance Examination Board. Cornell also takes into account other indications of his professional promise, such as the way he has made use of his time in the extracurricular activities of his school and in his community, and his personal character. Capacity for leadership, ability to work and learn, enthusiasm, curiosity, persistence—these are some of the qualities which lead to both academic achievement and professional excellence. As it was stated earlier, conscientiousness and confidence are the keys to taking best advantage of Cornell opportunities.

SCHOLASTIC BACKGROUND

There are certain minimum requirements for being admitted to engineering at Cornell, but there are also ideal ones. If Cornell could talk to high school freshmen, and to their parents, teachers, and counsellors—and it would be immensely beneficial—it would urge that students take as many courses as possible in English, history, social studies, and languages. The habit and ability to read and write well, a mind capable of seeing relationships and stretching to absorb ideas, a curiosity that has been stimulated by mental effort—these, as well as mathematics and science, develop the patterns of thought of the first-rate engineer and scientist. Furthermore, though you will have op-

portunities to elect such courses at Cornell, the majority of your courses will be scientific and technical.

Scholastic Requirements

Scholastic requirements are made up of certain fixed essentials and of other secondary school courses selected by the student himself. Essential are:

English	4 units
History	2 units
One foreign language	2 units
Algebra (elementary and intermediate)	2 units
Plane geometry	1 unit
Trigonometry	½ unit
Advanced algebra, or solid geometry	½ unit
Chemistry or physics	1 unit
	13 units

Cornell requires 16 units.* Of the remaining three units, further study in language or history is recommended along with the completion of both physics and chemistry. If a choice is possible, advanced algebra is recommended rather than solid geometry. Candidates with a preference for chemical engineering are encouraged to offer chemistry (one unit). The mathematics units listed above may be taken as separate courses or may be included within four units of comprehensive college preparatory mathematics.

*A unit is one year of study, made up of 120 hours of classroom work; that is, a minimum of 160 class periods if each is forty-five minutes long.

HOW TO APPLY

Detailed information concerning requirements for admission and methods of procedure are outlined in the University's *Announcement of General Information,* which every candidate should read carefully. It can be obtained by writing to the Cornell University Announcements Office. All correspondence concerning admission to the College of Engineering should be addressed to the Office of Admissions, Edmund Ezra Day Hall, Cornell University, Ithaca, New York, which will forward necessary application blanks on request. Places to write for further information are listed inside the front cover.

College Board Test Requirements

Each candidate for admission is required to take the Scholastic Aptitude Test of the College Entrance Examination Board, and to request the Board to report the results to the Office of Admissions, Cornell University. Candidates are urged to take the test in December or January of their senior year.

All candidates must take the CEEB achievement tests in mathematics and in chemistry or physics. Applicants who will have completed elementary and intermediate algebra and plane geometry by the end of the junior year should take the intermediate mathematics test in May of the junior year, or in December or January of the senior year. Applicants in accelerated programs who complete trigonometry and solid geometry or advanced algebra by the end of the junior year should take the advanced mathematics test at the above times.

Applicants should take the achievement test in chemistry or physics in May of the junior year or in December or January of the senior year, provided they have completed one year of study in the subject in the junior year.

Advanced Placement

Freshman students seeking advanced placement in physics are required to take the College Board advanced placement examination in physics. Those seeking advanced placement in chemistry or mathematics are advised to take CEEB advanced placement examinations in those subjects. For advanced placement in mathematics, an examination given by the Cornell Department of Mathematics must be taken during freshman orientation week. Students with a preference for engineering physics who wish to apply for exemption from the requirement of one term's work in a modern foreign language, or for advanced placement, must take the appropriate language achievement test of the Board.

Transfer Students

Students who wish to transfer to Cornell engineering from another college or university should write to the Office of Admissions for special information about filing applications.

WHEN TO APPLY

Secondary school students should, if possible, initiate their applications in the fall of the year preceding their entry to college. All applications should be filed by January 1.

Candidates who desire financial assistance, including scholarship aid, should file scholarship applications by January 1.

The following dates should be noted carefully: scholarship applications, January 1; applications for admission, January 1; dormitory room applications, June 1.

THE COST OF ATTENDING CORNELL

The cost of the first year at Cornell includes a $45 registration fee to be paid upon acceptance, tuition of $1400, and fees of $300.* These cover about half of what it costs the University, the rest coming from the University's endowment. Living expenses are $380 in a double dormitory room, or $430 in a single; most students spend $550 to $650 for meals, and $50 to $80 for laundry and cleaning of their personal belongings. Engineers usually spend about $100 for books and supplies their first year, and from $150 to $200 for personal expenses and incidentals. You should also take account of traveling expenses, including those vacations during which you plan to go home. Except for the registration fee, these basic costs apply throughout a student's undergraduate career; he may meet some of them through such financial aid as scholarships, loans, and part-time employment.

Since agricultural engineering students are registered in the College of Agriculture during their first four years, they pay the tuition of that college ($400 a year for residents of New York State, $600 for nonresidents). Residents of the state pay a General Fee of $100, nonresidents $300, a year. Charges for about forty credit hours taken in the College of Engineering during their first four years occur mostly in the third and fourth. During the fifth year these students pay tuition and fees of the College of Engineering.

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*These amounts apply to 1963-1964. *Tuition and fees are subject to change without notice.*

6. Cornell's Engineering Divisions

The following pages describe the divisions of the College of Engineering:

Aerospace Engineering — Engineering Mechanics and Materials
Agricultural Engineering — Engineering Physics
Chemical Engineering — Industrial Engineering
Civil Engineering — Mechanical Engineering
Electrical Engineering — Metallurgical Engineering

Also described is the work which engineers in the several fields do.

All engineering students (except those in agricultural engineering) enroll in the Division of Basic Studies for their first two years. During that time they will have ample opportunity to explore the various branches of engineering, not only in their course work, but by talking to upperclassmen, to their advisers and instructors, and to the directors of the various schools.

As described in earlier sections, Cornell's courses of study provide unusual breadth and depth, and many special opportunities. Detailed descriptions of the five-year curricula and of the individual courses may be obtained by writing the Cornell University Announcements Office, Edmund Ezra Day Hall, Ithaca, asking specifically for the Announcement entitled *Engineering Courses and Curricula*.

GRADUATE SCHOOL OF AEROSPACE ENGINEERING

The "aerospace" industry – the aeronautical industry in its new setting, "the space age"—has been given the *systems* responsibility for such exploratory projects as satellites, space probes, and putting man into space. "*Systems* responsibility" means the entire planning and design, beginning with the basic question "How is the mission to be accomplished?" Then it has to be decided: What component parts and subsystems are required? What shall be the size and weight? The trajectory? What power plant and guidance system will do the job?

These are questions to which there are no stereotyped answers. The aerospace industry may not be unique in its emphasis on new advances, but few others require such continuing concern with research and development. Engineers, physicists, and applied mathematicians are in tremendous demand. Men with mechanical engineering backgrounds are at work on power plants, electrical engineers on guidance systems, and engineers with strong backgrounds in physics and mathematics on problems of gasdynamics, behavior of materials, and the temperature barrier. It is hard to discern any retrenchment or levelling off.

It is the Graduate School of Aerospace Engineering's job to educate for this exciting, research-conscious industry. To do this job means, first of all, *not* to mass-produce the traditional four-year aero engineer, a fellow who knows something about airplane performance, stability, and structural loads; today the airplane itself is part of a "system" that includes power plant, armament, guidance, ground support, etc. Rather, the Graduate School of Aerospace Engineering attracts the best of that category from several colleges which mass-produce them, and some of the best electrical and mechanical engineers, plus some applied physicists (like Cornell's engineering physicists) and applied mathematics majors, and prepares them for the aerospace industry as follows:

1. They need more mathematics and physics, so these are picked up where their undergraduate programs left off.

2. Stress is put on such aerospace disciplines as aerodynamics, dynamics of flying vehicles, and propulsion, particularly as they apply to "astronautics," or space flight.

3. All get a research experience as members of a School vigorously engaged in engineering research. The School is investigating principles which apply to new kinds of propulsion systems for space rockets, changes in the composition of air over bodies travelling at space vehicle velocities, and drag on satellites with long flight periods. Studies of "magneto-fluid dynamics" concern flows of electrically conducting fluids, such as ionized air, in the presence of electromagnetic fields.

Of these the third is most important.

The aerospace engineering faculty is absolutely convinced of the value to society of a system of higher education which places students in a research environment and exposes them to teaching by men engaged in research. It is not only the *only* system that can teach research, but also the best system to educate engineers for this fast-moving, research-oriented second half of the 20th century.

The Graduate School of Aerospace Engineering does not try to do several other educational jobs simultaneously, but only to carry out this particular responsibility well. The whole group is small and intimate. Students all know one another and discuss their problems together. Research students get almost unlimited personal attention from their professors. Office doors are open. Everyone reports on his research in seminars and colloquia, and when the whole group comes together for such a purpose it is small enough to permit informal discussion and questions.

Though the School's main concern is its graduate program, it offers excellent opportunities for mechanical engineers, electrical engineers, and engineering physics students in Cornell's five-year undergraduate program. They can elect basic aerospace training in their upperclass years, and take full advantage of the School's laboratories and professors for independent senior projects. Good students can get their Masters' degrees (M.Aero.E.) in one year of graduate study instead of the two usually required.

AGRICULTURAL ENGINEERING

Agricultural engineering entails some facets of all other engineering fields. For instance, specialists in engineering mechanics and materials study properties of construction materials and their performance under stress. The agricultural engineer must study these too, but he must also understand the properties of various seeds, fruits, and vegetables to prevent damage in handling and storage. The mechanical engineer solves vibration problems of springs and masses analytically or by analog. Vibrating cherries from a tree or grapes from a vine is a very complicated spring-mass problem which defies complete analytical or analogy solution, for nature doesn't make all vines the same or each cherry or grape with the same mass. Livestock, because it produces varying amounts of heat and may be moving about, yields a truly unsteady state condition; this poses special problems in the design of structures. No other engineer is so affected by nature with so little opportunity to control it or adapt it.

The major areas of agricultural engineering are farm power and machinery, crop processing and rural electrification, soil and water engineering, and farm structures. Engineering principles are continually being applied to agriculture in new ways. These offer intriguing and exciting challenges. Atomic energy, and solar batteries and fuel cells, are being studied as possible sources of power on the farm. Radioactive substances are used to trace the flow of nutrients in plants, wear of engine parts, the amount of moisture in the soil, and densities of materials. Electronically controlled mechanisms are being studied for uniform loading of such machines as forage harvesters and combined harvester threshers, and are being used for automation of livestock feeding. New materials are being adopted in farm structures. Cornell's agricultural engineering faculty is pursuing research on such problems as these.

Opportunities are almost unlimited. As the world population grows, land resources and farm population shrink. Fewer men with more equipment and larger land holdings have to produce more food on a smaller total land area. If our standard of living is to be maintained, more qualified men will be required to help farmers attain maximum production and higher efficiency while improving the quality of their products.

Cornell's five-year program prepares a student to work equally well in any field of agricultural engineering. Because he enters technological courses after thorough grounding in basic principles, he can look more deeply into a problem, define its limits, and proceed to a logical solution much as he would do on the job.

Cornell's curriculum includes five basic fields of learning:

1. Basic science: mathematics, chemistry, physics, biology, bacteriology.

2. Engineering science: mechanics, properties of materials, thermodynamics, heat transfer, electrical theory.

3. Engineering application: structural design, hydraulics, surveying, power units, machinery design, water control and management.

4. Agriculture: soils, field crops, livestock feeding, farm management.

5. General studies: English, social and humanistic study, public speaking, free electives.

In the fifth year students have, through technical electives, an opportunity to pursue a chosen specialty in the agricultural engineering field through directed design and analysis studies.

Students register in the College of Agriculture during the first four years, and in the fifth in the College of Engineering, which grants the degree. During all five years students are advised by the agricultural engineering faculty. Since no adviser has more than 20 advisees, close relationships are developed and maintained.

Their broad training allows Cornell graduates unusual freedom of choice. They are found in all phases of agricultural engineering, from design of rubber tires and farm machinery, to teaching and research, to processing and packaging fruit and vegetables. They find employment in manufacturing, marketing, public utilities, consulting firms, government agencies, and many other forms of business.

CHEMICAL ENGINEERING

Recently the chemical engineer has been deeply involved in the development of new plastics, synthetic fibers, high-energy fuels, paints, rubbers, and the reduction and use of waste materials. Jet, rocket, and atomic reactor fuels have imposed new and difficult problems still not completely solved. Disposal of atomic wastes is also an ever increasing problem. Shortage of good water, predicted to be very severe in the near future, must be relieved by large, economical installations conceived by the chemical engineer. The world's rapidly increasing population will require more processed foods, and the problem of pollution of air and water around large population centers is rapidly becoming more urgent.

Chemical engineering is chiefly concerned with the process industries. In these industries raw materials are treated to effect a change of state or of energy content, or a chemical conversion, to make useful products. The chemical engineer traditionally supplies engineers in other fields with new and better materials to help them solve their problems and build better machines and structures. The electrical engineer relies on rubber and plastics for insulation, without which most electrical equipment could not exist. Such metals as titanium, zirconium, and tantalum, produced by chemical processes, give promise of major changes in structures and machines. Fuels for rockets and space vehicles are also products of chemical plants, as are the fuels which supply atomic reactors.

Among present chemical engineering research projects at Cornell are the reclaiming of sea water by a freezing process, and improvement of the efficiency of pulsed columns in transferring a solute from one liquid phase to another for purification and recovery. Investigations of continuous fermentation, agitation, and aeration are being carried out in the biochemical engineering laboratory. Several projects on insulating compounds, fillers, and reenforcing agents are underway in the Geer Laboratory for Rubber and Plastics.

Cornell inaugurated a five-year curriculum in Chemical Engineering in 1932. Long experience has proved that this course permits more thorough coverage in both chemistry and chemical engineering, and offers opportunities to those students who wish more nontechnical education. It also provides enough electives so that students may start on a particular specialty if they so desire. Project courses in research and design, given in the fifth year, require application of much of the subject matter of previous work. They are specifically designed to develop initiative and self-reliance.

Chemical engineering has always been closely associated with chemistry, and undergraduates take the same courses as chemistry majors. If they elect an advanced chemistry course in the fourth or fifth year, they complete the minimum chemistry requirements for a chemistry major, making it possible to go on to graduate work in pure chemistry. For research chemists working in industry, this is frequently an ideal combination, since they are trained in the economical and applied aspects of the science, as well as the theoretical.

Courses are offered in the design and operation of processing plants, and in associated problems of economic evaluation and new product development. Students learn about the varied dimensions of chemical engineering, including petroleum refining, polymeric materials, nuclear engineering, properties of materials, and food processing. Sequences of advanced courses can be elected in biochemical engineering, plastics, rubbers, reaction kinetics, and process instrumentation and automation. There are not only the large unit operations laboratory and 25 small project rooms, but several of these fields have their own specialized laboratories.

Qualified students who seek careers in research or teaching may be admitted to a predoctoral honors program. They prepare for doctoral studies by taking advanced theoretical subjects and engaging in original research projects.

Graduates find employment in research, development, operation, design, and administration of processes and process plants. They are frequently required to make economic evaluations of both existing and proposed processes and developments. This type of work quickly develops administrative skills. As a result, a large proportion of Cornell graduates end up in managerial positions at a relatively early age.

CIVIL ENGINEERING

Civil engineering is a profession that has many facets. It is part science and part art, and deals with those material needs that are basic to community living, industry, and commerce: with water resources, rivers, harbors, irrigation, and drainage; with water supplies, waste disposal, and pollution; with transportation by land, water, and air; with large fixed structures—bridges, dams, tunnels, buildings, and even structures for aircraft, space vehicles, radio telescopes, and nuclear power plants—and with the orderly integration and operation of public works and utilities that are so vital to our burgeoning urban complexes. Most of the world is still underdeveloped, and a large part of its present physical plant is inadequate and outdated. Construction, already our largest single industry, must expand still further to meet the demands of the awakening masses for better standards of living. It is a restless ever-changing world whose population may double in the next fifty years. Today, not enough civil engineers are being trained to cope with these demands.

Men are required who have the vision to foresee these needs and who have the imagination and the technical competence to devise means and ways to satisfy them in ample time, and with due regard to the social, political, economic, legal, and aesthetic aspects that are involved. The profession demands men who are expert in one or more subfields. It also requires expert generalists who can coordinate the work of other engineers and non-engineers into team efforts. No two civil engineering projects are alike. Each must be tailored to suit a particular site and set of conditions, and each involves men of many different occupations. To perform these duties civil engineers must be well grounded in mathematics, science, and engineering technology, and they should have a good general education. Their work varies from research and development to broad planning, technical design, construction, operation, maintenance, applications and sales, analysis and testing, and administration and management. They must be familiar with the scientific tools developed by men in other disciplines so they can use them in solving their problems. Since and develop their own basic techniques.

The five-year curriculum is designed to equip students to meet those challenges. After a student has completed the two-year common program he takes courses in each of the major subfields of civil engineering—surveying, hydraulics, sanitary engineering, soils, transportation, structures, and construction and administration. This will help him determine his interests and aptitudes and enable him to handle elementary problems in each subfield. He may then devote from 16 to 25 credit hours to programs of professional selections, either concentrating in one subfield or taking further work in all areas. He may include work in other parts of the University such as geology, business and public administration, and city and regional planning. A limited number of students may enter the Graduate School at the end of the fourth year to begin graduate studies which will enable them to earn their graduate degrees in a shorter period of time.

Instruction is vitalized by the School's continuous research programs. Projects at present include research in photogrammetry, interpretation of terrestrial conditions from aerial photographs, strengths of soils, pile foundation phenomena, frost action in soils, movement of groundwater and compaction of soils by electro-osmosis, the flow of liquids and slurries in pipes and open channels, the use of systems analysis in water resource studies and sanitary engineering, the design and behavior of bituminous concretes, traffic analysis, new structural forms and materials which combine high strength with light weight, thin-shell structures, the strength of structural connections, and the fundamental concepts of fracture in reinforced concrete.

Civil engineers have a wide choice of employment both at home and abroad. Some conduct their own consulting and construction businesses. Others work for engineering firms, contractors, industries, and utilities. Many serve important functions in federal, state, and local governments and in the military service while some go into teaching and other branches of the profession. Variety and the opportunity to achieve those inner satisfactions that stem from solving challenging problems and creating things that

ECTRICAL ENGINEERING

Electrical engineers develop and use electrical science in the fields of electronics, communication, power, and controls. They devise electronic devices and apply them to various systems for transmitting and processing information. They design and manage systems for producing, distributing, and utilizing electric power. Electrical controls are required in such applications as automatic machine tools, missile guidance systems, and nuclear reactor operation.

Electrical engineering is in the forefront of some of the most exciting developments in modern science and technology. Members of Cornell's faculty, for instance, are supervising construction of the world's largest radar, whose powerful feed antenna and 1000-foot diameter dish are expected to send signals and obtain echoes from as far as Jupiter, 400 million miles away. This Department of Defense Ionospheric Research Facility, sponsored by the Advanced Research Projects Agency under Air Force Cambridge Research Laboratories with Cornell, is being built in Puerto Rico. Cornell's Center for Radio-physics and Space Research hopes to use it, with facilities in Ithaca, to expand its study of the upper atmosphere and its exploration of space by radio astronomy and radar.

Cornell's most extensive electrical engineering research is in electronics. Work in microwave tubes for generating and receiving microwave signals seeks to improve radar systems, microwave T-V links, and communication links. There are considerable supporting programs in high-vacuum techniques and vacuum tubes. Other investigations are being conducted in gaseous electronics, cathode research to produce electrons for electron guns, and network synthesis for communications systems. Cornell's is one of the large academic research efforts in electronics, and is supported by one of the best equipped microwave and high vacuum laboratories.

Other research is being conducted in semi-conductors and in underground cables. Also, new programs are beginning in electrical power engineering.

Much of this research is going on in the electrical engineering building itself, which has laboratories devoted to all important phases of electrical engineering. There are analog and digital computer laboratories, a senior project laboratory in which students can construct and test electronic apparatus of their own design, and a special laboratory for investigation of the directional characteristics of antennas. The a-c network calculator is designed to study problems arising in complex electrical networks. The fluid network analyzer uses electrical analogies to solve problems of pressure and flow in fluid distribution systems.

Electrical engineers used to be able to count on finding in industry the machines they worked on in college. But now the emphasis is on principles which can be applied in many circumstances and can prepare for future developments. Cornell provides a thorough background in mathematics, physics, and electrical sciences as the essential basis for competence in rapidly evolving fields. Utilizing this foundation of electrical field theory, electric circuit theory, and associated mathematical techniques, students elect advanced work in a variety of electrical engineering applications.

They may choose courses in network and information theory, computers and servo control theory, and radio, television, and radar systems. They may obtain knowledge in the theory of such electronic components as vacuum tubes, transistors, and masers. Courses are offered in power systems and machinery, involving analysis of motors, generators, transmission networks, and high voltage phenomena. There are sequences in radio astronomy, propagation of electromagnetic waves, and illumination.

Programs of study in electrical engineering may be designed to emphasize either applications and operations, or a more theoretical background necessary for research; the special program in mathematics provides an expanded background for graduate work. Upperclass electrical engineering students often find exciting possibilities in aerospace engineering, preparing for work on guidance systems for space vehicles, or on instrumentation for study of gases in the solar system. Cornell electrical engineers are limited only by their own desire and curiosity from exploring the many opportunities available to them.

ENGINEERING MECHANICS AND MATERIALS

A thick-walled bathyscaph exploring the ocean depths, a nuclear container protecting man from danger, a thin-walled flying pressure vessel (a rocket) on a distant space adventure—all these are designed by using the same principles. Engineers realize such achievements by a process of conception, analysis, experiment, and development. Applying fundamental principles in each part of this process, they reach out in new directions to strange and unknown environments. The art and applications may vary from industry to industry, and the different branches of engineering often appear distinct. But the principles are the same, and therefore engineering education is focusing on the common aspects underlying the entire engineering profession.

Every engineer must acquire proficiency in applied mechanics, materials science, and applied mathematics. Cornell's Department of Mechanics and Materials is responsible for undergraduate instruction in these three sciences and is engaged in vigorous graduate and research programs. Professors with varied scientific and engineering backgrounds exchange ideas and plan educational programs. They are studying the mathematical principles of the Perceptron, a machine which can memorize symbols and patterns and then identify them. Professors and graduate students are investigating the dynamic loading of machine parts, and the behavior of materials and physical laws under pressures thousands of times that of the atmosphere. Analysis of elastic wave propagation is being applied to studies of movements within the earth. Also being studied are the fundamental mechanisms of cracking in concrete, the trajectories and orbits of space vehicles and satellites, and the static and dynamic behavior of thin-walled structures in unknown environments.

In their first years all engineering undergraduates take applied mathematics, materials science, and applied mechanics. Here they learn the fundamentals which underlie later courses in structures, machine design, engineering analysis, fluid flow, and materials. Materials science treats internal forces and crystal structure and relates these to the important mechanical, electrical, and magnetic properties. Applied mathematics introduces new methods of analysis, emphasizing the derivation of mathematical expressions for engineering problems. Applied mechanics involves the theory of statics, strength of materials, and dynamics.

During their fourth and fifth years students who wish to pursue such topics more deeply can elect advanced courses in vibration theory, crystal mechanics, or theoretical and experimental stress analysis. Or, they can study numerical methods in engineering analysis, orbit theory, and other subjects which bear on many of the unsolved problems at the horizon of technology. Students are encouraged to do their fifth-year projects under the direction of staff members who can guide them in experimental and analytical investigations. Elective course sequences, coupled with a project, make possible an effective start toward graduate work.

Because of excellent laboratory facilities, studies can range from the microscopic, using X-ray and metallographic techniques, to the full-size static and dynamic testing of structures under actual operating conditions. As a part of the Materials Science Center, the department maintains a laboratory where materials are studied when subjected to extremely high pressures. Undergraduates use the laboratory in their course work and in their projects.

Graduates who have elected to work in applied mechanics and mathematics or in materials science have before them a wide choice of job opportunities. Persons deeply rooted in fundamentals, who have analytical skill, are in continuous and great demand. They are sought by long-established industries and by newer industries whose existence depends on research and development. Materials, for instance, is a historic art which has developed into the vast metals industry. Yet, engineers are now having to invent new materials in almost every field. Students freqently pursue graduate work, which leads to research and development careers in industry or universities, or to careers in technical management.

ENGINEERING PHYSICS

The advances in most engineering fields are going to come primarily from people trained very well in basic physics and mathematics, who also have considerable experience in applying the principles of these sciences to engineering technologies. What, technically, the next quarter of a century will bring, is beyond imagination. But the man solidly and broadly trained will be in a position to meet, use, and understand the new and unexpected, and, in fact, to precipitate it.

Cornell's curriculum in engineering physics provides the type of education and training which effectively bridges the gap between basic sciences and conventional engineering practice. The growth of research programs in industry, government, and educational institutions has created a still growing need for persons with such training. Cornell's program puts major emphasis on mathematics and physics. It develops understanding of the properties of materials, all the way from their constituent atoms and molecules to their bulk physical, electrical, and chemical properties. A faculty made up of members from several science departments of the College of Arts and Sciences, as well as from several of the engineering divisions, manifests the Department's emphasis on new directions which cut across traditional lines. This training enables engineering physicists to solve new types of fundamental engineering problems which may be the basis for major technological advances with far-reaching consequences.

For training in engineering research, a fifth year student carries out a research-like project in his chosen field under the direction of a faculty member who is an authority in it. These projects often work into new fields in which Cornell is especially strong. Sequences of advanced courses establish a substantial background for them. The program in nuclear technology, for instance, provides a sequence in reactor physics, nuclear measurements, thermonuclear power principles, advanced heat transfer, and the physics of solids underlying radiation damage. Out of such a program can come projects in atomic and nuclear physics, reactor technology, or nuclear instrumentation. The new reactor facility enhances opportunities in such studies.

Other such programs are those in materials science, space science and technology, and aerospace engineering. Cornell's Interdisciplinary Materials Science Center concentrates studies in a field which can hold the key to further technological progress in any branch of engineering. Course sequences can prepare for projects in electron optics and electron microscopy, surface structure and reactions, defects in crystals, and other aspects of solid state physics. Several faculty members have strong research interests in space science and technology, and are available to supervise senior projects in gasdynamics, radio wave propagation, astronomy, relativity, and related subjects. Advanced courses in aerospace engineering can lead to projects connected with various aspects of space flight.

The exceptional flexibility of the engineering physics program is a result of the large number of elective hours, particularly in the fourth and fifth years. Its effectiveness is demonstrated by the wide range of projects chosen by students, and by the success of alumni in a variety of research and development activities.

Students in engineering physics are welcomed in the fully equipped laboratories in electron microscopy, solid state and surface physics, and nuclear technology. In their project studies students also have access to other engineering laboratories. They can also use laboratories in the University's various science departments.

Undergraduate projects often work in closely with research being done by faculty members and graduate students. There are opportunities for summer work on research projects of this kind both at Cornell, and with industrial and governmental organizations. These stimulate students and play an important role in their training.

INDUSTRIAL ENGINEERING

Industrial engineering, defined in part as ". . . . . the design, improvement, or installation of integrated systems of men, materials, and equipment . . ." has had a place in engineering at Cornell since 1904 as a part of the School of Mechanical Engineering. In 1962, however, it was given identification as a discipline distinct from the other branches of engineering. Because of rapid developments in mathematics, especially in probability, statistics, and the computer sciences in the period following World War II, and because of the many developments which emerged from research efforts during the war, industrial engineering that had been largely qualitative and empirical has given way to "new" industrial engineering founded on quantitative bases with more sophisticated methods of analysis and design.

The curriculum that has been developed to train industrial engineers has its principal foundation in mathematical and statistical sciences. In addition, because of the complexities of systems encountered, the computational, data collection, and processing problems are such that sound training in computer sciences and technology is also essential. From this framework, engineering analysis and design courses are developed to provide insight into the application and uses of these techniques to systems problems. Courses dealing with operating problems and the decision process are also developed. Concurrently, through elective courses the relevant social sciences can be studied in the College of Arts and Sciences.

A system of interest to industrial engineers can perhaps be distinguished from one of interest to other engineers by three characteristics: (1) the emphasis and importance of men in the system; (2) the looseness of coupling between components of the system and the great variance of response; (3) the action in the system tends to be discrete, rather than continuous.

Consider queuing systems which have in common the characteristic that there is a facility providing a service to a sequence of arriving customers. Such customers compete for the service of the facility, and the balance between capacity and demand typically is such that interference situations or

include airport and airplanes, maintenan man and production machines, telephor system and subscribers, toll booths on e pressway and traffic, supermarket checko counter and customers, and machines an jobs in a manufacturing shop.

The performance of a queuing syste may be studied abstractly, without dire consideration of the actual objects whic act as customers and as service facilitie Results obtained from such a study—th knowledge of how the system behaves an lytically—are then applied by the industri engineer in the design of an appropria service facility, or in the specification of a operating discipline for a facility already existence.

Inventory systems are also of interest industrial engineers. In such cases a "com modity" is stocked in anticipation of a d mand whose magnitude is not complete known at the time the stocking decisio must be made. Seats on an airplane, proces ing capacity of a manufacturing plant, an the life of a machine tool can each be co sidered a form of inventory. Costs of secu ing and holding inventories and in the lev of customer service provided are perform ance parameters which are used in creatin models for ultimate inventory system desig

Optimization is implied in any industri engineering model analysis and there is no some theoretical basis for many major desig decisions. Today industrial engineers are ofte found working in positions with other tha industrial engineering designations, for e ample, operations research, manageme science, systems analysis, and operatio analysis. They are employed in transporta tion, distribution, military logistics, weapo systems analysis, finance, public health, an the service industries, and as frequently i the process industries as with the mechan ical manufacturing industries.

Many engineers have as an ultimate goa the desire for managerial responsibilities an positions. The types of training offered i industrial engineering provide an ideal ap proach for individuals with this objectiv not only because of the basic engineerin that is included, but also because the mod ern trends in management science and dec

ᴧECHANICAL ENGINEERING

Mechanical engineers are concerned with ιergy, with machinery, and with manu-ιcture. Many are directly involved in de-ɜloping or designing machinery which will ansform heat, fluid flow, or electricity, uclear or solar energy, or the force of ravity, into usable power. Or, they super-ise and control manufacture of the neces-ιry machines and equipment. Some are ɔncerned with the application and sale of ιachinery, still others supervise its opera-on. Because their activities are closely re-.ted to profits, many mechanical engineers ventually assume high management posts.

Mechanical engineers also work with sci-ntists and engineers of other fields. It is sually their job to take a device or system ·hich has been proposed and proved in rinciple; to design it into an assembly of ɜal components; to analyze and improve ritical mechanical features; to make cost nalysis; and to follow the parts through roduction: in other words, to design and roduce the "hardware." This means, for ıstance, starting with such fundamentals as ıe principles of heat transfer and power eneration, and evolving conventional and uclear power plants; steam and gas tur-ines; reciprocating and jet and rocket en-ines; or devices for heating, refrigerating, nd air conditioning. One of today's most ressing problems is how to design engines ᴧhich can use solid and liquid propellants ɔ drive space vehicles.

The design of strong and durable machine ıarts can be an extremely important part of whole system. In the reliability of a mis-ile, for instance, most failures are mechani-al ones due to fracture, vibration, wear, or ɜakage; or to looseness or binding from hermal expansion or dimensional inac-uracies. The mechanical engineer must nticipate and prevent such troubles by de-ign and control of product quality.

Because new machines, new methods, nd new sources of energy are continually ıeing required or discovered, it is not suf-icient that the mechanical engineer be amiliar with the existing store of knowl-·dge in a particular field. Thus he is con-tantly engaged in research to obtain new lesign data, both for known systems and for

physical and chemical phenomena, mechanical engineers will be in at the early stages of experimentation, as they are now in thermoelectric power and solar energy. Also, new mechanical developments occur continually in established industries.

Cornell's five-year program provides a broad background in all of these aspects of mechanical engineering, as well as opportunities to concentrate in one or more during the upperclass years. The growing emphasis on engineering principles increases the possibilities for fruitful independent work in the senior project. Students who select the nuclear technology or aerospace engineering options can gain especially thorough training in the newest power field or in missiles and space flight.

Of all groups of engineers, mechanical engineers are employed in the widest range of industries; therefore it is difficult to limit and describe the opportunities available to them. Companies in the chemical process field, the electrical field, the construction field, and others, as well as the widespread mechanical field, all hire mechanical engineers. In fact, the greatest demand by industry as a whole for any single group is for mechanical engineers.

The function in industry that the young engineer will perform depends on his interests and capabilities, and the specific needs of his employer. The breadth of his education, however, is apt to lead rapidly to management responsibilities if he has the necessary personal qualifications.

The elective requirements of the mechanical engineering curriculum offer many attractive possibilities. The student may concentrate on a special field of interest within mechanical engineering, such as thermal engineering, design and development, materials processing, or industrial design. Or, if he wishes, he may expand his background in industrial engineering, electrical engineering, engineering mechanics, or materials of engineering; the required portion of the curriculum has already laid a firm foundation in all these areas. The required program of courses in mechanical engineering, supplemented by a carefully planned elective program, assures a student

METALLURGICAL ENGINEERING

Metallurgical engineers may before long be referred to not by their customary title, but by the title "materials engineers." In this era of nose cones, rocket motors, and nuclear reactors, familiar metals are not always adequate. For applications where metals used to be taken for granted as the only feasible material, ceramics, polymers, and other non-metals are coming more and more into use. Experiment to discover and develop new materials, metallic and non-metallic, has become one of today's most urgent engineering problems.

Cornell's Materials Science Center, recently established, is an example of this trend. It provides advanced modern facilities for materials research, and brings together solid-state physicists, chemists, and engineering scientists in the field of metallurgy and materials to enhance research and graduate training. The effects of the Center are being felt in undergraduate programs not only in fifth year projects, but in the interaction between laboratory teaching equipment and experiments, and the Center's facilities. During the summer of 1963, Cornell's Department of Metallurgical Engineering will move into an entirely new and fully equipped building whose equipment will be unsurpassed among the nation's universities. There will be strong ties between the Department and the Center. Already metallurgical engineering students may receive training in materials science and technology in their upperclass years by electing courses in advanced physical chemistry, electronic structure, ceramics, alloy steels, high temperature materials, nuclear materials, foundry engineering, polymeric materials, and advanced microscopy.

The strong emphasis on both physics and chemistry throughout the curriculum itself uniquely qualifies the student in the rapidly expanding materials science field, since the underlying principles essential to understanding metals serve equally well for an understanding of materials generally. As a result graduates are in demand in connection with developments of many new type of materials. An outstanding example ha been the contribution of metallurgists to th development of semi-conducting materia of great interest for electrical and thermo electrical devices.

After laying a firm foundation in basi and engineering sciences, Cornell meta lurgical engineering students develop bot a theoretical and a practical understandin of all aspects of metallurgical engineerin Their training is both broad and dee Physical metallurgy, the branch most closel related to materials science, is based upo the physics of internal structure as it a fects metallic properties. There is instructio in mechanical metallurgy; here principles c physics and engineering mechanics are ap plied to processing and shaping metals t obtain useful products, and to obtain a understanding of their behavior under stres in airborne devices, in chemical proces plants, and in machine parts. Students als learn the principles underlying the prepara tion of materials.

Since metals play an important part i almost every kind of engineering activity graduates have an unexcelled diversity c opportunities for employment. They ma find positions in the basic metallurgical in dustries, the manufacturing industries, i advanced engineering and research, or tech nical sales. Industries which fabricate an consume metals, such as the automobile aircraft, chemical, and electronics industries are dependent on metallurgical engineer for proper selection and utilization o metals.

Opportunities are also excellent in nu clear engineering, because of the man challenging materials problems concerne with manufacture of fuel elements and re actor vessels, as well as with piping, hea exchangers, and more conventional parts The developing aerospace industry is mak ing very heavy demands on the supply an quality of metallurgical engineers and sci entists.

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