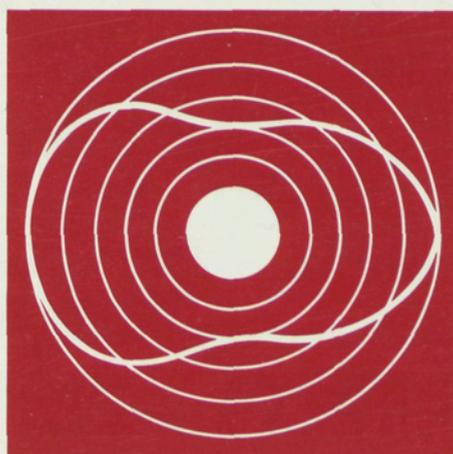
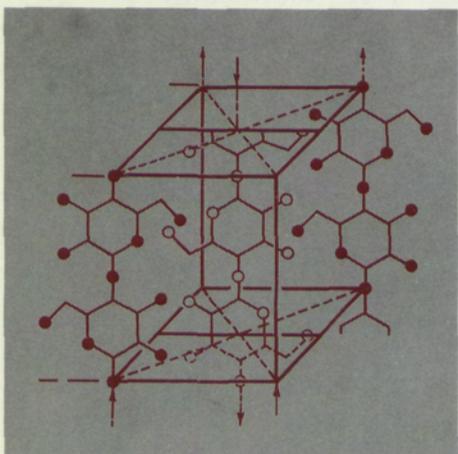
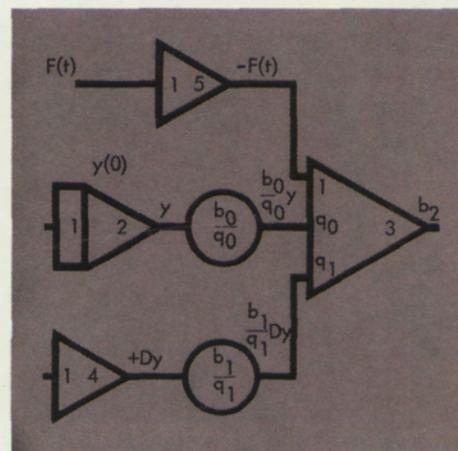
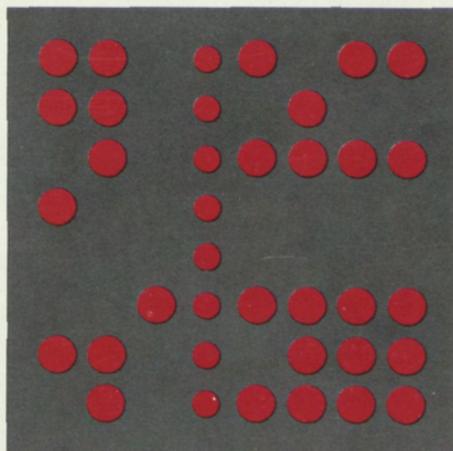
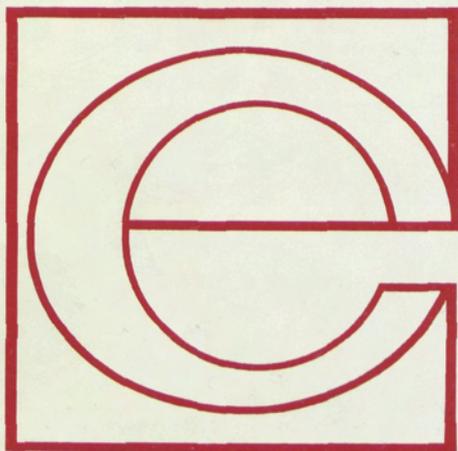


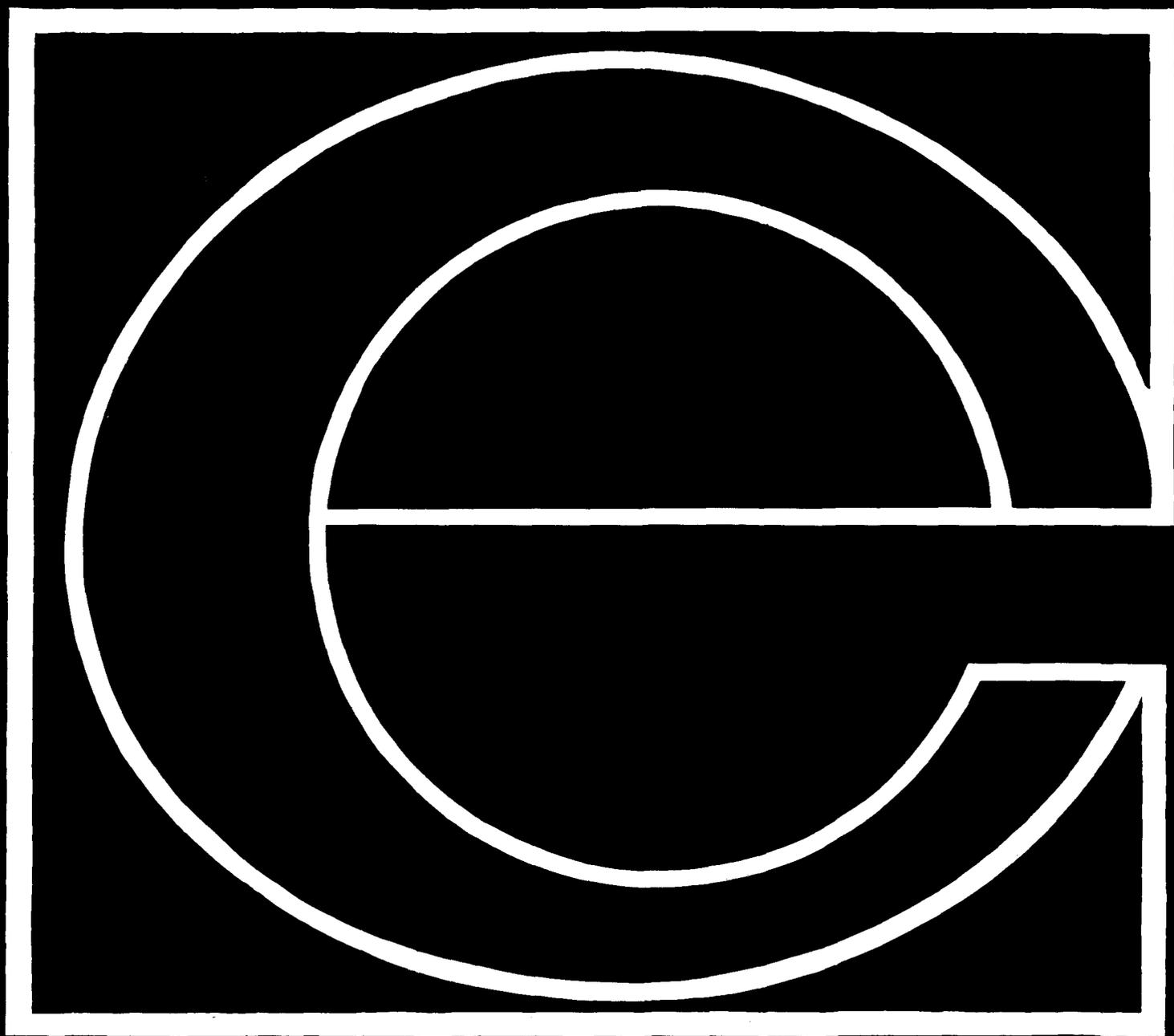
# ENGINEERING

CORNELL QUARTERLY



VOLUME 1  
WINTER 1967

CES -  
CONTINUING  
ENGINEERING  
STUDIES



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*Cover: The symbol of Cornell Engineering's Continuing Education program and illustrations for four of the six short courses that were offered in summer 1966. Nine short courses will be offered in summer 1967.*

# MUTUAL INTERESTS IN CONTINUING EDUCATION

By Andrew Schultz, Jr.

Nowhere is the technological revolution having a more serious impact than among the individuals who are primarily responsible for bringing it about. The engineering spectrum has always been a broad one, ranging from the mundane to the sublime, and in recent years it has been extending at a remarkable rate. As a result of scientific and technological advances, the nation finds itself concerned not only with the whole range of traditional technological problems, but also with new ones undreamed of twenty years ago.

Faced with the problem of obsolescence, industry and education have tended to criticize each other, and often these criticisms have been relevant. Criticism of engineering education and its practices has been voiced, not only by industrial employers, but frequently supported by many engineering faculty. Some of the most common criticisms are: (1) the lack of technological orientation of recent graduates, (2) the increasing tendency toward graduate study, (3) the influence of federal funds on graduate students' choice of programs, and (4) the limited industrial

experience of younger faculty members.

Engineering education isn't alone in being criticized, however, for dynamic technological development has left many industries behind, and critics have charged them with: (1) being unaware of the obsolescence of their engineers, (2) failing to encourage individual engineers to stay abreast of technological developments, and (3) forcing competent engineers to report to and to yield to nontechnical managers.

Many of the criticisms leveled at education are not only justifiable but, to a certain degree, also inevitable in the face of the developments which have occurred. Four-year engineering graduates lack a technological orientation! However, it seems clear that engineering educators see this as a problem, because one of their major concerns is the development of more effective instruction in design. They also see a need for making sharper distinctions between practice-oriented and research-oriented programs, as Cornell has recently done in its professional master's degree programs.

The second criticism of education,

that a large portion of baccalaureate engineers continue in graduate programs, stems from so many diverse positions that it is more difficult to analyze. Some industrial firms have stated that they don't wish to employ men with master's degrees, but are forced to in order to obtain the quality they desire. Others complain because their employees' graduate study is in the wrong field and does not seem to serve their shorter-range needs. The individual student decides in what field he wants to study and at what level, however, and judging by the economic implications, his decision is frequently a wise one.

The argument with regard to the diversion of potential engineers to research activity is partially owing to a lack of support for graduate study in more applied engineering activities. Industrial support is needed to ensure that individuals who are interested in applied engineering studies can find it economically feasible to undertake the additional year of education for a master's degree.

The matter of young faculty members having only slight industrial experience

# OBSOLESCENCE

## RESOURCES

By Julian C. Smith



is a serious one. Through their policies, academic institutions can do much to correct this situation. For example, we are suggesting that our young assistant professors take a year's leave early in their careers for the purpose of obtaining such experience, and to date we have found ample industrial support for such individuals. Some institutions provide the assistant professor with a semester, after three or four years of service, for this purpose. In my opinion, a year's leave is essential if the experience is to be worthwhile.

Faculty obsolescence is a very difficult problem. Although many articles point out the failure of the professor to spend enough time teaching his students, it is clear that to remain familiar with industrial practice and to keep up-to-date on

new developments, the professor must undertake research on the frontiers of his interest and, through some means, come in contact with relevant counterparts in industry. The day of the "Mr. Chips" in engineering education is gone forever!

### JOINT INTERESTS AND NEEDS

It is clear to me that education must maintain closer technological communication with industry and government. This communication has been adequately sustained in research areas where no proprietary interests are allowed to interfere and where well-developed media of exchange, both in written and associated form, exist. However, a solution to the problem of student motivation and of improving the faculty's ability to do a better job in design depends heavily upon technological communication with industry.

Industrial assistance may take two forms; it should be noted that such assistance could conceivably come from government. First, support is needed for the type of *professional* graduate study

*Andrew Schultz, Jr., who has been Dean of Engineering at Cornell since 1964, played an active early part in continuing education through industrial engineering seminars which were arranged by his former department.*

required to educate engineers to meet our current and future needs, especially for evolving master's level programs in *professional* engineering. While there are a limited number of fellowships available for this purpose, few institutions can adequately fund this type of graduate study themselves. Yet, it is at this level that engineering experience can be infused most effectively into the education process.

Second, industrial assistance can provide the needed stimulus for students through cooperative education programs or summer jobs. But faculty-industry relationships need to be developed on a far broader and much more enduring basis. It is not clear whether this is best done through increased formal consultation, through frequent leaves of absence for faculty so they can participate in major engineering projects, or through the movement of industrial personnel into educational institutions for brief periods.

With limited time available to college students for instruction in a professional specialty, it is all the more important that employers learn how to "finish" the en-

gineer once he is employed. It becomes truer every year that the new graduate is not an engineer; he is potentially an engineer, and will become an engineer only as a result of experience on the job. Few firms appear well prepared to deal with this responsibility effectively today.

Perhaps the most difficult of all the challenges faced by industry is to learn how to organize, assign, and reassign engineers so as not to "spoil" them. This involves a major consideration of not only company short-range objectives, but longer-range objectives and each engineering employee's past experience and future needs. Personnel organizations spend an astonishing amount of time trying to deal with this problem; I have yet to meet one that is happy with its solution. Industry needs considerable support from education in order to achieve these objectives. Most obviously it needs a variety of "continuing educational programs" to support the development of the practicing engineer—such as night classes, summer programs, and short workshops.

Finally, to contribute to research underway at colleges and universities,

industry needs closer liaison with educational institutions. Our educational research programs can be criticized today, but not on the grounds that they are over-supported by the government or that their direction is unduly influenced by government wishes. The complaint is, in my opinion, that relationships with industry are not closer, and that the professor carrying out research is uninformed, and therefore unconcerned, about industry's needs and the needs of technology. The manner in which research funds are allocated to individuals and the freedom of individuals to select or write their own research proposals are unquestioned. Failure to have adequate communication is due to many causes, not the least of which is the proprietary attitude of many industrial firms and their unwillingness to communicate freely. Despite this very logical, essential position, a greater effort could be made on both sides, and it is clear that industry needs this communication if education is to achieve the other objectives which are so essential to the longer-range technological well-being of American industry.

# OBSOLESCENCE

## Rx: CES

By Julian C. Smith

Technical obsolescence is very real. Suppose your doctor expressed little interest in advances in antibiotics, vaccines, artificial organs, or open-heart surgery, claiming to be far too busy with patients to "keep up to date." Fortunately, such doctors are rare. To all of us, concern over technical obsolescence in medicine is obvious. Over fifteen years ago, the American Medical Association developed continuing education programs to combat such obsolescence. Today more than 1,500 refresher courses are given annually to 100,000 doctors by some 400 sponsoring organizations.

For engineers, technical obsolescence is no less real. The flowering of large-scale research, which began about fifteen years ago, has hastened the output of knowledge and brought many practicing engineers face to face with obsolescence. A productive engineer can no longer expect to further his career on "boiler codes," handbooks, or empirical equations. Actually, he never could, but it was easier to "keep up" when changes were less rapid, or, to take a phrase from Tolkien, when "there was less noise and more green." Not only has the



output of knowledge accelerated, the time lag to practical application has almost disappeared. New approaches are required, then, to protect engineers from obsolescence.

### CHANGES IN ENGINEERING EDUCATION

A review of recent developments in undergraduate and graduate education should suggest that new approaches to ensure lasting professional competence are in order.

About a dozen years ago, undergraduate engineering curricula began to increase the emphasis on basic and applied sciences. With more science and mathematics for the student to master, professional engineering subject matter was shifted to the upperclass and graduate years. Today, on a national average, about one-third of the engineering students who receive a bachelor's degree continue at least as far as a master's degree in engineering. At Cornell, more than eighty-five percent of our engineering graduates now go on to further study in engineering or applied science. The "language" of engineering has also changed, reflecting the level of sophistication in engineering subject matter now offered to the undergraduate. As a result, men who were graduated only five years ago are frequently lost in engineering "bull-sessions" with today's graduates.

Lately there has been growing faculty concern with engineering design. The shift to a science-oriented curriculum has tended to lead students toward research careers, and away from engineering practice. To effectively arrest this

trend, closer ties between industry and schools are being sought to build a better storehouse of "design" problems which will interest and challenge engineering students.

From the changes in engineering has come a recognition of the need for more formalized "post-graduate" programs. Night school, part-time studies, and "in-house" industrial programs have filled the needs of many practicing engineers, but they have not proved adequate in the light of today's rapid turnover of knowledge. Most engineers cannot afford the time required to earn an advanced degree, even if they want one. For the majority, then, something else is needed to guarantee their continuing competence as practicing engineers.

#### BEGINNINGS OF NEW ATTITUDES

While a few voices have always been heard, concern for "continuing engineering studies" (CES) was largely ignored until the early 1960's. Then professional and educational leaders became keenly aware of the magnitude of the problem.

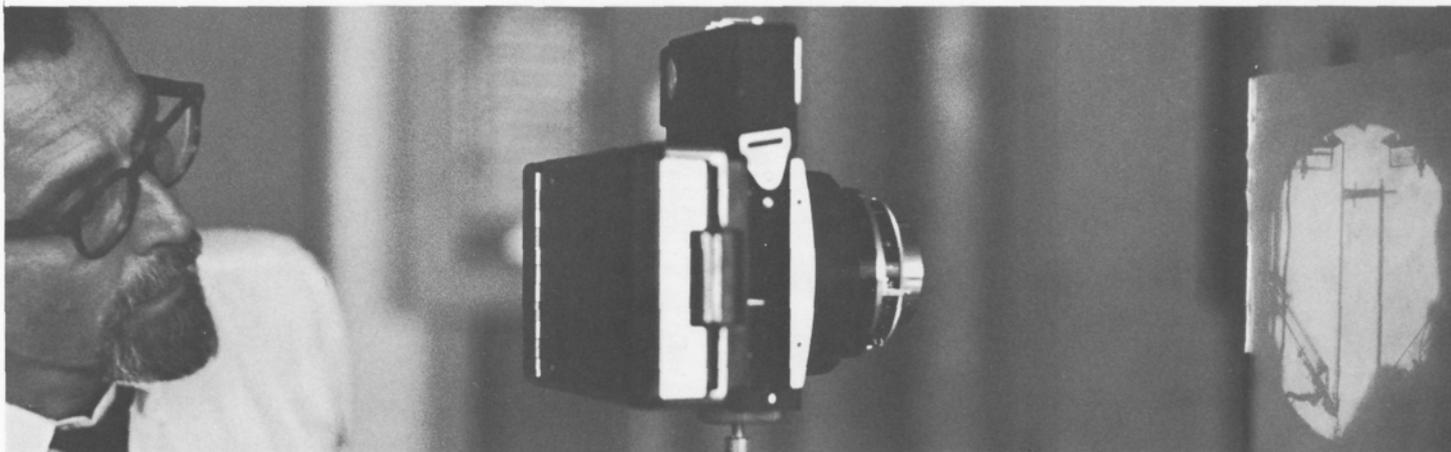
*Right: Professor Benjamin Gebhart, instructor for the short course, Heat Transfer, leads a discussion period in the thermal engineering laboratory in Upson Hall.*

*Opposite page: Professor Gebhart aligns a Schlieren apparatus which he uses to study natural convection patterns in heat transfer.*

At some institutions awareness grew into active programs with thousands of participants. A few schools opened "Continuing Education Centers" for engineers and applied scientists. Technical societies began to offer workshops and short courses for their members. Industrial corporations, especially the larger ones, undertook new and more comprehensive programs, often associated with a college. There has developed an almost insatiable market for books, video tapes, films, and other educational aids.

Most programs now in existence were not designed—they just grew to fill specific needs at a particular time. How well they met such needs was reflected in their prosperity over time. Yet, the development of an industry-engineering college CES program is very complex; guidelines, even "rules of thumb," are few, and far from clear. In the final analysis, any successful CES program must be responsive to the needs, limitations, and desires of the *individual* engineer. While there are limitations imposed by the industrial firm and the cooperating college, the chief one is the prospective "student's" lack of time.





*Short courses account for the major effort in continuing education programs. Typically, they are two weeks long and are held during the summer. Cornell's College of Engineering began a program of short courses in the summer of 1966, offering the following six courses:*

Introduction to Digital Computing  
 Engineering Statistics  
 Principles of Polymer Systems  
 Reaction Kinetics and Chemical  
 Reactor Design  
 Developments in Heat Transfer  
 Dynamics of Machinery

Let's consider the hypothetical situation of "John Jones," a bright, young engineer. In charge of a small process development group in a chemical manufacturing company, John is anxious to continue his professional and personal development. He was married three years ago, has one child and another on the way, and has just bought a new home. What does the manufacturing management expect from John? All too often it seems to John that the "typical week" is as follows: two nights for technical self-education; two nights for cul-

tural development through general reading, plays, concerts, public lectures; two nights in civic work; two nights on company problems. And what time is left for his wife and family? John's immediate supervisor may have other ideas, different from those of the company's top management, of what John should be doing to meet the demands of the job. Unless John's supervisor is convinced that the continuing education of his men is important, and even provides an example by continuing his own education, young engineers like John Jones have little hope of avoiding technical obsolescence.

Continuing education programs must therefore be designed with the assistance and collaboration of industry and must receive whole-hearted support throughout their organizations. The time limitations of the individual engineer must also be considered.

#### CES CRITERIA

The following representative questions, by no means independent of each other, illustrate some of the considera-

tions that go into the design of any CES program.

- What are the objectives?
- What programs are most appropriate?
- Are the programs to be directed to a few or many?
- Will they stress breadth or depth of subject?
- Who will participate and who will teach?
- How will the value of the program be measured?
- How much will the program cost and who will pay for it?
- What effect will it have on the college's formal degree program?

General objectives are conditioned by the nature and location of the cooperating college. A metropolitan institution can structure programs that may be inappropriate for a more isolated college. A state university has different obligations from those of a privately endowed one. A mutually productive program should satisfy the aims and obligations of the engineering school, and those engineers and companies for which it is designed.



2



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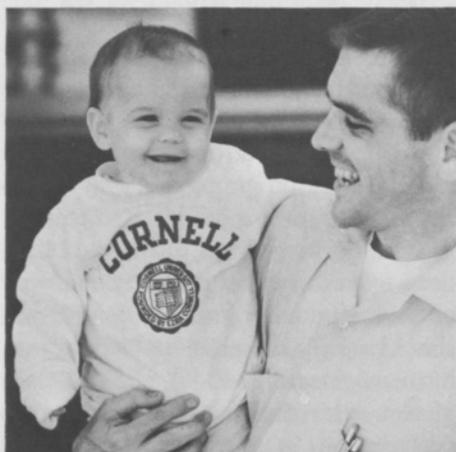
1. Young and old alike enjoy a visit to Ithaca in the summer.

2. The short course participants lunched together many times during their stay at Cornell.

3. Ferdinand Rodriguez, Professor of Chemical Engineering, will again teach the summer short course, Polymer Systems, for the continuing education program.

4. Coffee breaks during the morning session offered opportunities for discussion of the day's work.

1



4

8

We at Cornell seek in our "continuing engineering studies" to accomplish the following:

- to update, advance, or broaden professional knowledge and skills of engineers and applied scientists
- to develop and strengthen technical management capabilities, especially those required to manage large groups of technical personnel
- to develop sound habits of self-education, especially in younger engineers

We're selfish too! We believe that our teaching abilities in engineering, particularly in design, can be greatly enhanced by our faculty's exposure to the "real world" of the practicing engineers participating in our programs.

## PROSPECTIVE STUDENTS

Even among engineering graduates, there are several varieties of "students" to whom continuing education programs might be addressed. There are men, fortunately rare, who have done almost nothing for many years to keep themselves up-to-date, and whose knowledge,

ideas, and approach to problems are almost hopelessly obsolete. A large fraction of practicing engineers, more than five years out of college, form a second group which, while doing good engineering work, is showing signs of obsolescence. This often becomes apparent when they undertake new responsibilities that require technical knowledge of a kind they do not possess. Finally, there is the group of the very recent engineering graduates with limited industrial experience.

Different kinds of programs are needed for each group. However, they all must be designed with the expectation that, as in most things, the men who need them most are those least likely to attend. As I see it, the problem of the first kind—"retreading" the really obsolete engineer—is analogous to rebuilding a machine after its internal parts have rusted together. By far, the greatest number of CES programs have been directed to the second group: engineers who are aware of the threat of obsolescence and who wish to do something about it. The needs of those men at the threshold of their professional careers

*The short courses included lectures, discussion periods, problem-solving sessions, and laboratory periods for from five to six hours a day, five days a week.*

*An intensive course of this kind moves quickly and covers about the same subject matter as a one-term academic course. Generally, one such course at a time is enough work—and sometimes more than enough—for the engineer who returns from industry.*

*Sixty-eight persons from industry and government agencies and sixteen members of the Cornell faculty and staff attended the first summer sessions. Sixteen states and one foreign country were represented among those participants from outside the Cornell community. The "average" participant was thirty-three years old, held a position of intermediate responsibility in industry, and had received a bachelor's degree in engineering ten years ago.*

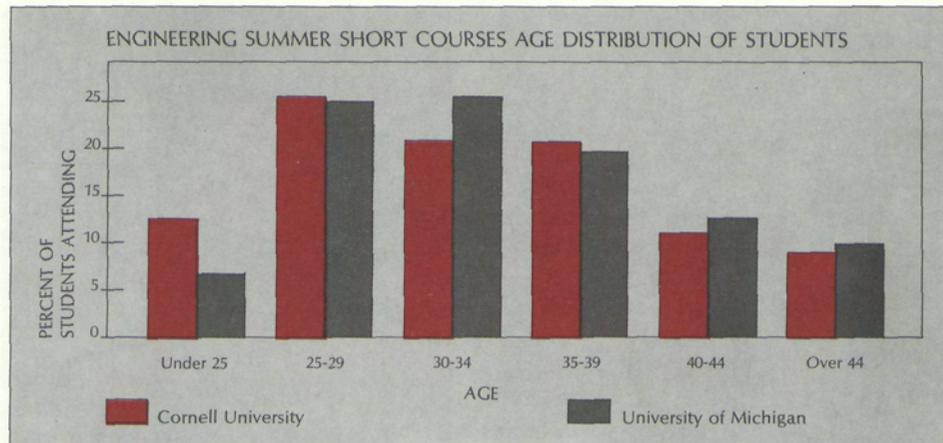


Figure 1

have only just begun to be recognized. They need continuing education also, for although the “machinery” is bright and shiny and in good running order, a program of “preventive maintenance” is essential if it is to be kept that way.

Is there a typical CES participant? In the Cornell programs we have found that fewer than five percent of the participants had no college degree, and twenty-five percent had a master’s or a doctoral degree. This distribution compares with the University of Michigan’s experience in CES programs. Although the majority of our participants are engineering graduates, a number of other disciplines have been represented, including botany, chemistry and biochemistry, business administration, education, English, forestry, mathematics, medicine, and physics. The age distribution of the participants is shown in Figure 1. The “typical” participant is thirty-three years old, holds a position of intermediate responsibility in industry, and received a bachelor’s degree in engineering ten years ago. A majority come because they are sent by their employers; almost without exception the employer pays the pro-

gram fee, and often the travel and subsistence costs as well.

#### SUBJECT MATTER

Surveys have shown that only a minority of practicing engineers are interested in degree programs, but that almost all indicate interest in some kind of self-advancement through formal study. Most of those who express interest in advanced degrees would seek a degree in business administration; a smaller fraction, between twenty and thirty percent of this total, is interested in advanced degrees in engineering. A few companies have made an advanced degree in engineering an explicit requirement for advancement or even for continued employment. For men in this situation, interest in advanced degree programs is understandably high!

The results of surveys of interest in non-degree programs are in general agreement. Typical are the findings of the 1965 American Society for Engineering Education study of over 4,000 practicing engineers (see Figure 2) which showed greatest interest in management practices, economics, law prac-

tices, technical communications, and “applied” psychology. Of the “engineering” subjects, only probability and statistics registered with a majority, although interest in industrial engineering and operations research, computers and controls systems, mathematics, and heat transfer was also apparent.

Such surveys, while providing some guidelines, have limited value. Some CES offerings, among them probability and statistics, are in great demand; other frequently mentioned topics attract few participants. In part, this stems from lack of clear definition of terms. “Heat transfer,” for example, means different things to different engineers. Little interest may be shown in a general heat transfer course, whereas a course in a more specific area—thermal radiation, for instance—may attract considerable numbers. “New look” topics, such as systems analysis and linear programming, also prove popular. The value of a particular course can be measured by a very practical criterion: if the course is well attended year after year, it satisfies a need; if it isn’t, it doesn’t. In selecting program offerings, faculty members who

SUBJECT	PERCENT OF RESPONDENTS
<b>Management</b>	
Management practices	65.4
Business practices (marketing, finance economics)	50.8
Economics	37.1
<b>Communications</b>	
Technical writing	64.0
Public Speaking	59.8
Speed reading	53.6
Talking with people	53.4
<b>Industrial Engineering and Operations Research</b>	
Probability and statistics	60.2
Systems programming	37.3
Applications programming	32.9
Reliability	31.2
<b>Applied Psychology</b>	
Creative thinking	56.9
Working with individuals	56.6
Working with groups	55.1
Logic	34.3
Psychology	32.9
<b>Information Systems, Computers, Control Systems</b>	
Survey of computer uses	48.2
Instrumentation and measurements	40.4
Data processing	39.8
<b>Mathematics</b>	
Ordinary differential equations	37.1
Vector analysis	31.1
La Place transformations	30.4
<b>Miscellaneous</b>	
Heat transfer	43.1
Electronic systems engineering (circuit design)	30.5
Solid state physics	30.4
Electro-mechanical energy transformation	29.8

*Below: Richard Phelan, instructor for the short course, Mechanical Dynamics, and some of his students observing the dynamic response of a vibrating system.*



have an active association with industry are usually in the best position to determine what topics would prove most worthwhile to practicing engineers.

If a particular CES program extends over a long period of time, feedback information from participants can ensure greater responsiveness in content, arrangement of material, and level of presentation. Prior study of the subject matter before entry into "long-continuing" programs minimizes the problems faced by the "one-shot" course that seeks to operate at a compromise level.

## SELECTION OF INSTRUCTORS

Instructors in continuing education programs are by no means limited to members of college faculty, even when operated by an engineering college. Engineers and scientists in industry, government, technical societies, and in private consulting are often asked to assist the faculty of the sponsoring college.

However, most programs are operated under the supervision of the college faculty, although in a few universities CES programs are staffed almost entirely from outside the institution. More typical is this distribution in programs offered by the University of Michigan: twenty-five percent of the staff came from the faculty in engineering; twenty-four percent from their other University departments; eighteen percent were faculty members from other universities; twenty-eight percent came from industry; and five percent were from government. Cornell's recently established programs have relied much more heavily on Cornell faculty. Within the past two years, forty-eight members of the College of Engineering faculty have partici-



*Left: Professor Ferdinand Rodriguez setting up a tensile test machine for his demonstration laboratory in the short course, Polymer Systems.*

pated, with five instructors drawn from other divisions at Cornell, and four from industry and government.

It would seem, *a priori*, that an experienced university professor would be more effective than an assistant professor or a graduate instructor; that a man whose business is teaching would be more effective than a man who has devoted his time to engineering practice; or that a teacher who has had industrial experience would be more effective than one who has not. However, there are many exceptions to such "rules." The best predicting factor appears to be an instructor's previously successful experience in other continuing education programs.

## COSTS

Continuing education programs are not cheap; in fact, they are so expensive that it is the rare individual who can afford to pay the costs out of his own pocket. The tuition fee is usually paid by the participant's employer, who often pays the other costs as well. The chief cost for the cooperating employer, how-

ever, is not the fee, lodging, or travel; it is the man-hours lost from work by each participant. Many companies have realized that the total cost of the program is a worthwhile investment in the engineer's future, and that it is unrealistic to expect an employee to devote his vacation to a refresher course. Furthermore, they find that company support of continued professional development makes an attractive "fringe benefit" in recruiting new engineering graduates.

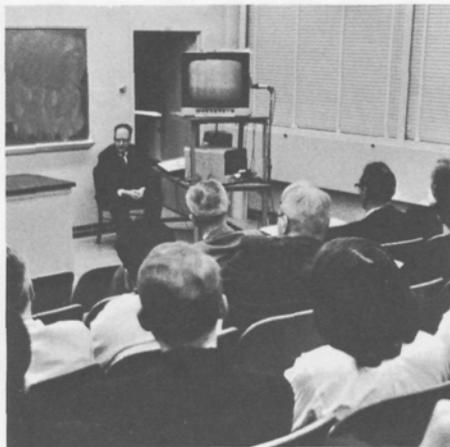
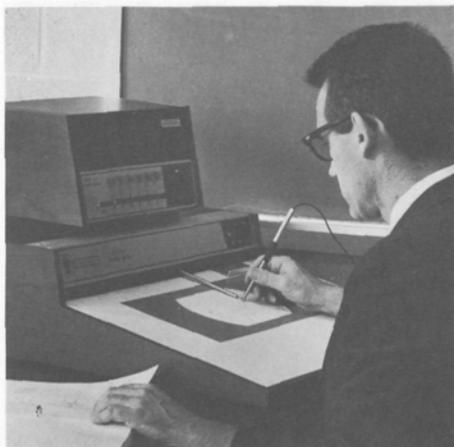
In most colleges, continuing education courses must be self-supporting; no funds are normally contributed by the institution itself. So in addition to faculty salaries, the program must generate enough money to cover, among other things, secretarial help, publicity, texts and notes, computer charges, and program development.

## EVALUATION OF A CES PROGRAM

How can a CES program's effectiveness be measured? Usually no examination or grades are given. The inverse of the traditional degree program prevails;

the participants evaluate the instructor. Through their assessments, types of courses to be offered and level of staff competence needed can be defined for future programs. Whether the programs are actually meeting the long-range needs of the participants is much more difficult to determine.

Recognition of a participant's effort is another major concern. In credit-free programs he usually receives a certificate saying that he participated, nothing more. Some institutions, it is true, offer "professional credits" for continuing education programs; after accumulating a specified number of such "credits" in a planned sequence, the participant is awarded a certificate. The matter of professional credit and its place in CES programs is under active debate these days. Its proponents claim that it gives coherence and meaning to offerings which would otherwise be sporadic and ineffective, and that it is necessary to obtain financial support from some government agencies. Its opponents believe that "professional credit" is largely meaningless, and that awarding any form of credit for such courses means



## BLACKBOARD BY WIRE

■ In the fall term, 1966, a unique venture in continuing education was launched. A four-hour course in physical metallurgy, taught by Professor R. W. Balluffi of the Department of Materials Science and Engineering, was given simultaneously to a regular class of fourteen Cornell students and to ten engineers of the Chemical and Metallurgical Division, Sylvania Electric Products, Inc., in Towanda, Pennsylvania, about fifty-five miles from Cornell. The course was given by long-distance telephone, with two-way communication for the voice on one telephone circuit, and on another, transmission of written material using the Sylvania "Blackboard-by-Wire" system.

■ In using the newly developed "Blackboard-by-Wire" system, the professor does not use a conventional blackboard: he does all his writing while sitting at a desk, drawing figures or writing equations with an ordinary ball-point pen on a six by eight inch panel. The pen is connected to a lever arm whose position is sensed electronically, and the resulting signal is coded and sent over the telephone circuit to the receiver, where it is decoded and appears as an image on a television screen. A similar screen is used for the benefit of the Cornell students, and one is used as a monitor by the instructor.

■ Although the instructor must adapt his lectures somewhat in order to make effective use of this new technique, both voice and images can be preserved, if desired, by recording them on a two-track tape recorder, and the telephone lectures may be supplemented by slides, notes, or other material sent in advance to the remote location. The technique saves much precious time, quite apart from travel. The professor need give his lectures only once; furthermore, he is assured that the course he gives off-campus is identical to that offered to regularly enrolled students, always an important consideration in offering a credit course off-campus.

restrictions such as prerequisites, accreditation, and grades—all the paraphernalia of academic degree programs—that would stifle the free development of CES programs which are tailored to the needs of practicing engineers and scientists. Coherence and meaning, they claim, can be given to the programs without "professional credit."

### WHAT OF THE FUTURE?

In the rapidly changing pattern of engineering education, growth of continuing education studies is bound to have an increased impact on the undergraduate and graduate curricula of engineering colleges and technical institutes. While the opinions of faculty members and administrators of engineering colleges concerning the future significance of CES are by no means unanimous, it is hard to see how continuing education can fail to become a major part of the practicing engineer's professional activity. He *must* keep up, he *must* grow. Otherwise, he soon won't be an engineer, and his employer will have to find someone else whose training is better suited to the job.

*“We believe that our teaching abilities in engineering, particularly in design, can be greatly enhanced by our faculty’s exposure to the ‘real world’ of the practicing engineers participating in our programs.”*

Employers can’t afford this turnover, nor can practicing engineers afford to lose jobs. Different means will be sought to maintain professional competence. Industry, if it must, will develop its own programs for this purpose. Most companies, however, are understandably reluctant to do so; they feel that institutions founded for the purpose of education should undertake the responsibility even if it means substantial changes in the colleges’ method of operation.

Current indications are that engineering colleges will accept this responsibility. Many colleges now have a director of continuing education or the equivalent, and are attempting to work more closely with industrial firms, technical societies, and government agencies in developing new programs. Many are involved in State Technical Services programs that may well have considerable influence on industry-education relationships.

It seems reasonable to predict that CES programs will eventually be an accepted activity of most engineering colleges, comparable in magnitude to





*Opposite page: Steven Muller, Vice President for Public Affairs at Cornell, concludes the two-week program at an informal luncheon.*

*Above: Olin Library provides the backdrop for the 1966 short course participants.*

today's undergraduate or graduate programs. Faculty will be expected to participate on a regular basis, as a part of their normal duties. Possibly, though hopefully not, such programs will be accredited by a national agency or technical society. New methods will have been developed, but they will be well established; the excitement of the first experiments will largely be gone. But excitement or not, if CES programs develop in this way they will have far-reaching and beneficial effects on the education of undergraduate and graduate students. Closer association between industry and education will bring increased realism to the classroom.

Some plan of continuing education will soon be expected of all practicing engineering graduates. Engineering education won't stop with graduation, or

even with a doctorate, but will be a life-long undertaking—what the professional has undoubtedly always thought it to be. The engineering college of the future will bear little resemblance to today's model; its structure, staff and activities will be strongly influenced by its responsibilities to continuing education studies. Most of all, it will be much more clearly involved with industry in promoting the growth and sustenance of the engineering profession.

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*Julian C. Smith is Director of Continuing Education in the College of Engineering, and Professor of Chemical Engineering at Cornell. He earned the Bachelor of Chemistry degree in 1941 and the professional degree, Chemical Engineer, in 1942, both from Cornell.*

*From 1942 until 1946, he was employed by E. I. du Pont de Nemours and Company, Inc., first at their Jackson Laboratory and later in their engineering department. He continues his association with du Pont as a consultant; he is also a consultant to the United States Army Corps of Engineers.*

*Returning to Cornell in 1946, Professor Smith became an Assistant Professor in the School of Chemical Engineering; he was named Professor in 1953. In addition to the duties he assumed upon becoming Director of Continuing Education in 1965, Professor Smith continues an active teaching program in chemical engineering, giving graduate-level courses in equipment design and solids handling and in heat transfer. He served as chairman of the College's Graduate Professional Engineering Programs Committee in 1965–66.*

*With W. L. McCabe, the Dean of Engineering, Emeritus, of the Polytechnic Institute of Brooklyn, he is co-author of Unit Operations of Chemical Engineering, a major text used throughout the world. Professor Smith has written more than forty-five papers dealing with chemical engineering and chemistry.*

*He is a member of the American Chemical Society, the American Institute of Chemical Engineers, the American Society for Engineering Education, Sigma Xi, Phi Kappa Phi, and Tau Beta Pi, and he is a registered Professional Engineer in New York State.*

# DEVELOPING TOMORROW'S ENGINEER TODAY

By Jerrier A. Haddad

The computer industry is scarcely fifteen years old, and yet technological obsolescence is one of its biggest problems today. In 1950, there were few people who could have visualized such growth and direction for the computer industry. There were even fewer who could have imagined that the first electronic computers were only a low plateau from which a dynamic surge of technological creativity would rise.

The creativity of many engineers who graduated from college during the early years of the computer industry has already reached a dead end. These are the men who have isolated themselves from recent advances in the physical and engineering sciences, advances that have proven to be major factors in sustaining technological creativity. Some believe the "stuff" that spawns inventiveness can be sustained under any circumstances and any conditions. However, I have become convinced that more and more cooperative effort by industry with government and the universities all over the nation is necessary to keep our ever-growing population of engineers alert to the currents of new knowledge and

ideas. We must remind ourselves that the sum total of innovative capacity of industry moves forward by the efforts of many, not just a few.

Encouraging professional growth among the bulk of the technical work force is, then, a continuing need, especially for those industries that must rely on dynamic innovation. As some of you know, IBM has had a long history of providing educational opportunities for all its people. Beginning with a series of "after-working-hours" courses and specific on-the-job training programs, we have been an early participator and, in some instances, a pioneer in tuition refund programs, cooperative work-study efforts, and resident graduate study programs.

For example, in Endicott, New York, one "work-study" effort has involved the establishment of an off-campus program in selected disciplines that included area engineers from General Electric, Link, Anso, and IBM. In Maryland, we are presently working with the National Bureau of Standards and other area industries to begin a similar program.

Recently, at IBM, we began a series

of educational projects which are expressly tailored to cultivate tomorrow's technical leaders within our laboratories. One such program was Cornell's *Modern Engineering Concepts for Technical Management* program given to IBM employees in Endicott and Owego last year. Similar programs are the Polytechnic Institute of Brooklyn's courses in material sciences, prepared for our Components Division, and the Santa Clara program, given at San Jose with a tutorial staff selected from several sources in the San Francisco Bay area.

All of these programs are intended for experienced professionals, and have had as instructors some of the finest academicians with practical experience that the universities can provide. All seek to bridge the gap between the past and the future: the experienced professional's previous education, the technological and pertinent scientific changes which have occurred in the interim, and what the future appears to have in store for us in terms of emerging engineering problems. Hopefully, through participation in such activity, an experienced engineer will find himself better equipped



to read tomorrow's technical literature and enter into more meaningful discussions with his colleagues—in short, to continue his own self-education. It's a mighty tall order!

The Ford Foundation "Residencies in Engineering Practice Program" has also aided in bringing faculty and practicing engineers into closer association. Not only are the selected faculty members exposed to the "real world" of industry, but they also provide industry's engineers with fresh outlooks on technical problems.

But a business based on technical creativity requires something more tangible than a favorable climate for people to grasp new knowledge and ideas. While creativity may have its own inner rewards for individuals, recognition is an essential ingredient for creative productivity in the broad sense. This means recognition by management, *for all to know*, that an especially creative contribution has been made by an individual. At IBM we have an Invention Award Plan, which provides cash awards to individuals for both the quantity and quality of inventions. Another program provides awards for outstanding contributions which are not patentable but often are as creative in nature or opportunity. Both types of awards are presented by the division in which the individual works, and both are subject to review and upward revision in terms of dollar amounts at the corporate level. Some individuals have received as much as \$30,000 and \$40,000 in this manner.

Among the factors that may enter into an award of this size is the estimated value of the patent rights to the company. These awards are continu-

ously reviewed and additional sums may be granted as further recognition of the value of what the individual created or contributed.

The IBM Fellow Program offers unique possibilities in recognizing creative achievement. The Fellows, selected on the basis of their past achievement and their future promise, are set apart within our organization and are free to pursue special projects or interests of their own choosing, with no more administrative responsibility than they desire. Special status is accorded them as consultants to other scientists and engineers, and to management within IBM.

Often, too, interchanging men between line and staff positions is useful in determining where they can best develop themselves and benefit others. For example, an engineer with line responsibility may be charged with meeting a deadline on a project assignment. He may or may not be creative under pressure. On the other hand, a staff advisory engineer may take a more detached view of the problem. He may offer ideas and suggestions that help stimulate innovation. Or, perhaps, through a negative

# DEVELOPING TOMORROW

By Jerrier A. Haddad



influence such as skepticism, he may stimulate a better, more imaginative solution. In fact, several transfers, when thoughtfully conceived, between line and staff during a man's career can be highly stimulating and rewarding.

We at IBM, like other companies, face the age-old problem of trying to divert resources from funded projects in order to support developments by individuals in our laboratories. To come to grips with it, we have encouraged our development laboratory personnel, and others for that matter, to submit their ideas to their management for evaluation. There is no set format for these proposals, but each must contain a summary statement of the concept and any available supporting data. If the proposal is rejected, there are still channels open to division management, and to my office. If the proposal is accepted at either of these levels, the individual's manager is informed. Seed money is provided to cultivate those ideas with potential until it becomes clear they should either be adopted or abandoned. No restrictions on the long-range backing are made if the idea shows promise.

## MODERN ENGINEERING CONCEPTS FOR TECHNICAL MANAGEMENT

TOPIC	NUMBER OF LECTURES
Industrial Engineering and Operations Research	19
Electrical Engineering	17
Materials Science and Engineering	7
Theoretical and Applied Mechanics	7
Nuclear Science and Engineering	6
Mathematics	5
Measurements	2
Mechanical Engineering	1
TOTAL	64

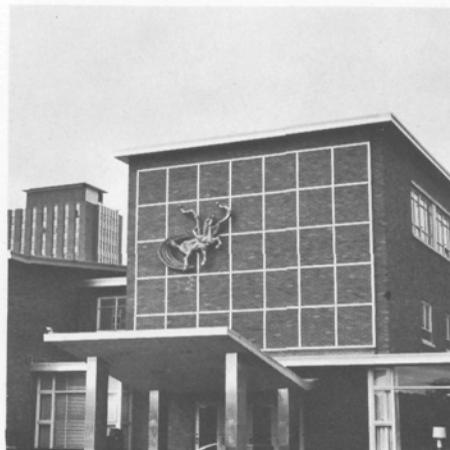


As you might expect, there are not as many proposals as there would be complaints if such an opportunity was not available; nevertheless about twenty-five percent of the proposals submitted have been accepted and all of these have made a return on investment which has exceeded that of many of our planned projects. It opens up another route for both individual professional career development and company growth.

Patent engineers can also play a role in innovation. They can evaluate the results of innovation and are able to channel new technological information to appropriate development areas for productive use. Because they are in close proximity to both innovators and technological problems, patent engineers can often help define the problem areas.

In conclusion, here are a few additional guidelines which can make all the difference in stimulating innovation:

1. Employ engineering managers who will listen to the ideas of the junior engineer. By being creative himself, the manager can often inspire innovation in others.
2. Have the ability to distinguish be-



tween the employees who must be left alone to concentrate on a specialty in which they excel, and the more assertive employees who are most productive in group situations.

3. Place administrative or management responsibilities on only those suited in temperament and ability to direct others.
4. Be able to recognize the need for change within those teams that seem to have "gotten off the track" on projects, thus helping them to avoid the sense of futility and defeat that is an anathema to innovation.
5. Have the ability to discover the creative engineer, without relying solely on high academic records. Experience has shown us that highly imaginative individuals may be found in the bottom half of a graduating class.
6. Maintain proper internal communications aimed at bringing together professionals who have common interests and common technical problems.

Modern Engineering Concepts for Technical Management has been given twice by Cornell to engineers of the IBM Corporation at Endicott, New York. It is a four-week, full-time program designed to acquaint middle-management personnel of laboratories and production facilities with the current concepts, techniques, and vocabulary of a variety of technical subjects.

Opposite page: Henry P. Goode, Professor of Industrial Engineering and Operations Research, is shown on the far right during a coffee break.

Above:

1. Julian C. Smith, Director of Continuing Education, introducing one of the many Cornell faculty that taught in the program.

2. The four-week IBM course utilized the facilities of the Harpur College campus of the State University of New York, close to the IBM quarters.

*“...A business  
based on technical  
creativity requires  
something more  
tangible than  
a favorable  
climate...”*

*The Concepts program is not expected to develop expertise; it provides an introduction to and an overview of several topics in areas of interest to engineers who received their training in a particular discipline—say electrical engineering—but whose responsibilities make it necessary for them to have at least some knowledge in other fields.*

For any company, a manager who can create an atmosphere of healthy inquiry within his group, and who can combine a thorough understanding of technology with the art of creative leadership—quite an accomplishment—is certainly worth the time, money, and effort required to find and to develop him.

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*Jerrier A. Haddad, a 1944 graduate of Cornell's School of Electrical Engineering, is vice-president of engineering, programming, and technology for International Business Machines Corporation. After a year as a teaching assistant at Cornell, he joined IBM in the technical research department at the Endicott, New York laboratory. He served successively as technical engineer, devel-*

*opment engineer, manager of the component department, manager of the IBM engineering laboratory at Endicott, and director of advanced machine development. He was in charge of the design and construction of the IBM 701, the first of the Company's large scale electronic computers.*

*In 1956, Mr. Haddad was named general manager of the IBM special engineering division, and in 1959 he became general manager of the advanced systems development division. He became vice-president and assistant general manager of the data systems development division in May, 1961, and was named vice-president, systems design and engineering for the data processing division in July, 1962. In 1963, he became director of engineering, programming, and technology. He has held his present position since March, 1967.*

*Mr. Haddad holds thirteen American patents with foreign filings. He is a member of the Association for Computing Machinery, IEEE, the American Association for the Advancement of Science, Sigma Xi, Tau Beta Pi, and Eta Kappa Nu.*

# GUIDEPOST

By Donald F. Berth

There are at least three characteristics common to all *continuing engineering studies* programs, good or bad. First, most of such programs are "one-shot": participants enroll in a short course of one or two weeks duration. Second, communication becomes one-way, partly because of the brevity of these CES efforts; the "students" when exposed to instruction frequently assume a passive role. Third, in order to maintain the solvency of general CES offerings, participants are enrolled who have diverse professional experience, making it difficult to fit the level of instruction to a majority of participants.

These three characteristics, if ill-considered in the planning of any CES offering, can yield superficial results. How often has a program coordinator heard the complaints: "That professor just isn't aware of what's going on in the outside world" or "These participants are less capable than our undergraduates." Too frequently, both comments are valid. They are symptomatic of today's communications gap between experienced professional engineers and engineering college faculty members.

Frequently, engineering faculty members, particularly those with minimal industrial experience or contact, are unaware of engineering practices in modern organizations. Faced with attractive research contracts and eager graduate students, it is understandable that the path of least resistance is one that favors greater unawareness of modern industrial practices. This does not imply that engineering research is irrelevant to technology; it does suggest that practitioners and educators are losing sight of one another.

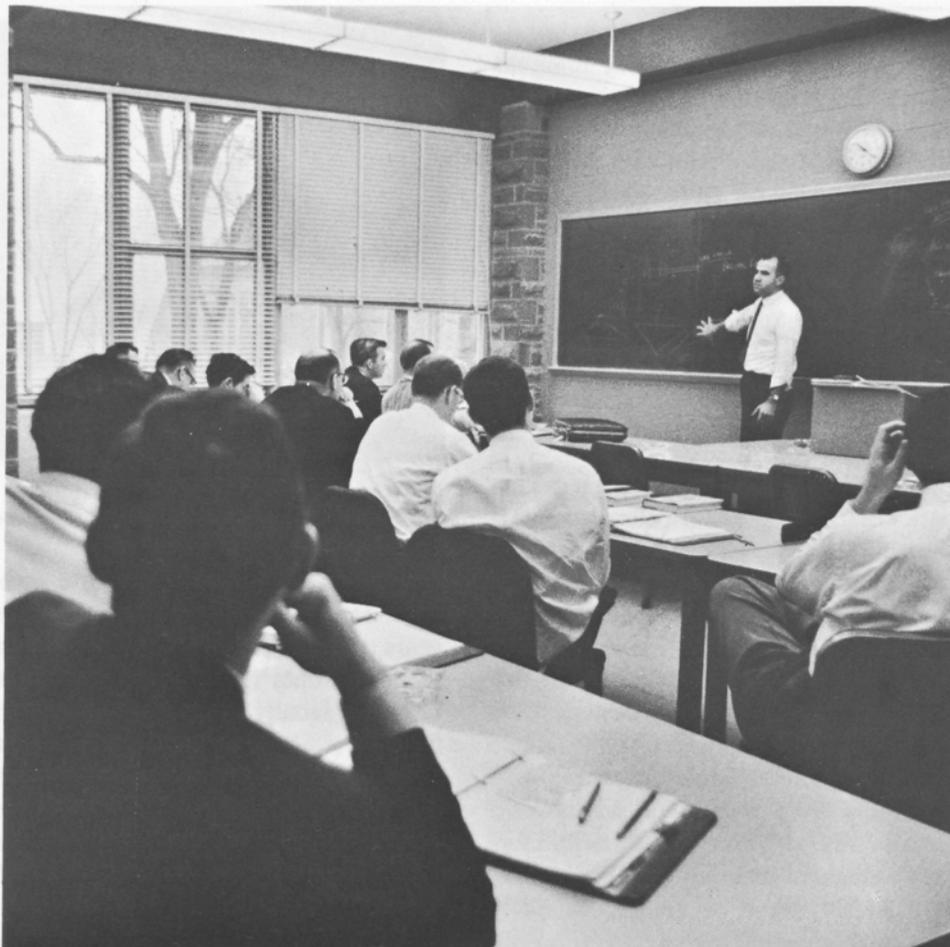
It was recognition of such characteristics that led Cornell's College of Engineering to create a new pattern for *continuing engineering studies*. Two weeks away from a man's work, assuming he is in a position of some responsibility, seemed a maximum period to involve him in full-time study. The College ruled out after-work programs on two counts: first, their effectiveness was diminished by the daily pressures of professional and family activities, and second, Cornell is located in an area with relatively few industries. It seemed more likely that the idea of self-education would



"take" if continuity was established beyond the "one-shot" effort.

By coordinating three to five two-week campus sessions over a period of years, the intervals between the campus sessions would furnish ample opportunity for faculty members to observe first-hand the daily engineering responsibilities of participants. Faculty visits, averaging perhaps two to three a year at a participant's place of employment, would do two things: (1) provide feedback in order to make succeeding programs more responsive, and (2) help

*Shown below is the group of construction engineers enrolled in the special GUIDEPOST program for the Construction Industry. Professor George H. Blesis was one of the instructors for the course.*



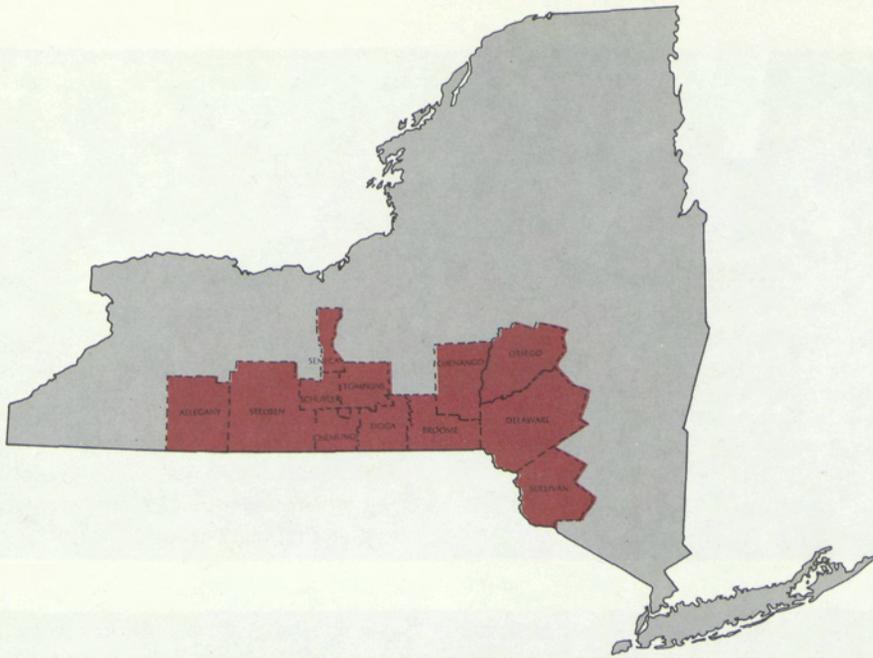
prepare the engineer for subsequent on-campus sessions. Such contacts would, of course, provide an opportunity for faculty members to better understand the "outside world."

Finally, the question of diversity of participants, both in age and background, was resolved. The College decided to "trail-blaze" with younger men who had limited professional experience. Focusing on engineers employed in a particular class of industry—say machine tool producers—would add the degree of homogeneity lacking in most continuing education programs.

Cornell's program for continuing education, GUIDEPOST, was distilled from these ideas to form a plan which extends over a longer period of time than most CES programs; involves participants and teaching staff in a joint educational experience; and concentrates on relatively similar groups of engineers, both in age and work function.

#### *GUIDEPOST FOR THE CONSTRUCTION INDUSTRY*

The construction industry has played a major role in improving the quality of man's environment. Considering the industry's relative isolation from advances in previously non-related fields of engineering, Cornell introduced a GUIDEPOST program for construction engineers in January 1967. The initial development of this program was supported partly through a grant from the United States Department of Commerce, under the State Technical Services Act of 1965. It is expected that the program will eventually be self-supporting through active participation of the construction industry.



## STATE TECHNICAL SERVICES

Another service to industry is being provided with federal and state sponsorship under the State Technical Services Act of 1965 (Public Law 89-182). The Act has as its objective: to promote "the wider diffusion and more effective application of science and technology to business, commerce, and industry." The main part of the national program is being operated through "designated agencies." Usually, there is one in each state, but in the larger states the responsibility is further delegated to "participating institutions" which are concerned with industry in a particular local area. Cornell's College of Engineering is the participating institution responsible for programs in the twelve-county Southern Tier area of New York State.

The Cornell State Technical Services Program is designed to bring available technical information to industry, especially the smaller firms, in a form that can be of use to them, and to promote:

- The dissemination of technical information through newsletters, loan or rental of technical films, and other means.
- The development of a Technical Information Center and Referral Service, where on request a company in the area may obtain references to appropriate readings or to names of suitable experts or consultants. This service will also provide periodic notices of educational opportunities in the area.
- The offering of workshops, seminars, and special courses to meet the needs of industry in the Southern Tier, including on-campus and off-campus courses, usually not involving academic credit. Some may be offered using "Blackboard-by-Wire" equipment.

*Below and opposite is the "break away" luncheon for the Construction Industry group who have completed their two-week campus session and are now involved in their guided home-study program.*





Two of our faculty members, Professor George H. Blessis and Professor Henry P. Goode, with Julian C. Smith, Director of Continuing Education at the College, drew up the initial proposal for a three-year GUIDEPOST program. Professor Blessis has had fifteen years of experience in the construction industry, and Professor Goode has had many years of continuing education teaching experiences at Stanford, Southern Methodist University, and Cornell. Last May, about thirty construction industry representatives met with College representatives at Cornell to consider the merits of the proposal. From this group, an advisory team helped refine the first two-week campus session held from January 23 to February 3, 1967. Perhaps Paul K. Vipond of Vipond and Vipond, Inc., a heavy and highway construction firm in Pennsylvania, put it best for an article on the program which appeared in *Engineering News-Record*: "The impact of change has made such a difference that I'm firmly convinced that if you plan to

the next five years as you did in the last five, you will not be in business. One good job, better bid and better executed by the three men we have in the program, could pay for the training many times over."

#### THE FIRST TWO-WEEK SESSION

Engineering economy, bidding strategy and simulation, probability and statistics, critical path method, resource allocation, digital computer programming, labor law and union negotiations, construction bonds and insurance, cost control, project organization, new construction techniques and materials; these represented the major topics that were presented during the inaugural campus session. Mornings began at 8:00 a.m., with a coffee break and discussion at mid-morning, and instruction paused at noon. The "students" returned at 1:00 p.m., and the afternoon program continued until 5:00 p.m. Generally, morning and afternoon sessions were divided into two periods. Lectures, discussions, and problem-solving sessions were pre-

sented by twelve Cornell faculty members and five guest lecturers. During four evenings of this two-week period, special problem sessions covered bidding strategy, computer programming, and engineering economy.

Sixteen participants from eleven companies enrolled in this program. Most are project engineers and field superintendents. Their median age was thirty-five. Among the eleven companies were large process construction firms; medium to large firms in heavy construction, highway construction, or buildings; and small general construction firms.

The content of the second and third years of the construction industry program will reflect experience gained from this two-week program and feedback from faculty contact with the individual participants in the field. Presently it is anticipated that the second campus session, in late January 1968, will cover advanced applications of statistics and engineering economy; the third, in 1969, will focus on the analysis of complex construction systems.



*“An unusual opportunity for a genuine ‘give-and-take’ partnership awaits those who accept the challenge...”*

#### THE CONTINUING CONTACT FEATURE

This “dynamic programming,” which will spark the program, has five objectives:

1. To help prepare the engineer for subsequent on-campus sessions.
2. To assist him in applying what he has learned during the first session.
3. To provide guidance for his home study.
4. To keep him informed of important new developments.
5. To enhance faculty awareness of the day-to-day practical problems of the construction engineer.

This continuing contact feature of GUIDEPOST lasts until the conclusion of the construction industry program, the third two-week campus session.

#### OTHER GUIDEPOST PROGRAMS

Two other industrial groupings, the chemical process industries and the mechanical manufacturing industries, are being surveyed to determine whether a

tailored GUIDEPOST program can be developed for them. Each group is a major employer of engineers and applied scientists, and each could profit by supporting a coordinated educational program similar to that offered to the construction industry. In both instances, the program should appeal particularly to large companies with decentralized production operations, and to the small companies with limited numbers of technical personnel.

#### INDUSTRY-EDUCATION PARTNERSHIP

There is currently a trend toward comprehensive CES programs of long duration like Cornell's GUIDEPOST, designed to serve particular engineering professions, industries, or geographical areas. One such illustration is the State Technical Services Program which is intended to serve industry in various geographical areas. Such a trend suggests that the industry-education partnership, which has frequently been more fiction than fact, is becoming a more

meaningful one. College faculties and industry need continuing education if both are to remain responsive to tomorrow's opportunities.

If industry really believes that engineering faculties have lost sight of their mission, here's one school that is seeking to do something about it. An unusual opportunity for a genuine “give-and-take” partnership awaits those who accept the challenge offered by Cornell's GUIDEPOST.

*Professors George H. Blessis and Henry P. Goode organized the first campus session for the Construction Industry program. More than a dozen faculty and invited guests participated in the instruction of the course. The course included lectures on topics ranging from project control techniques to bidding strategy.*

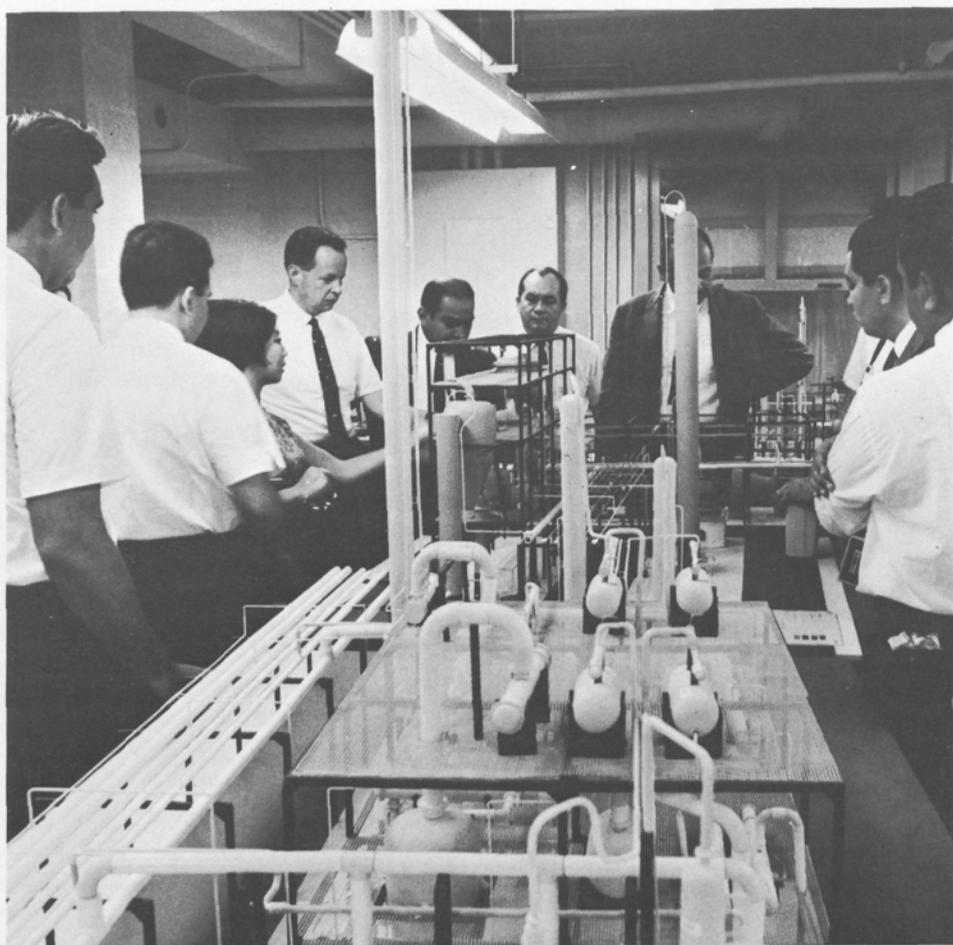
*Opposite: An informal morning break for the construction engineers.*

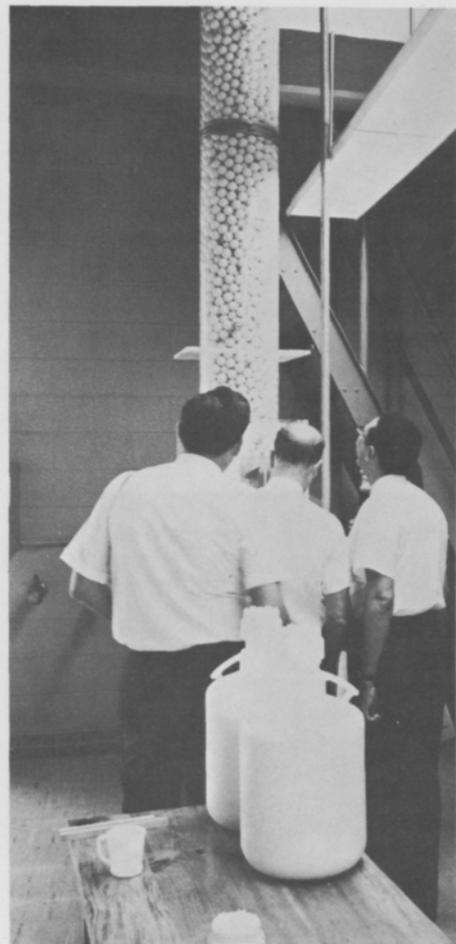
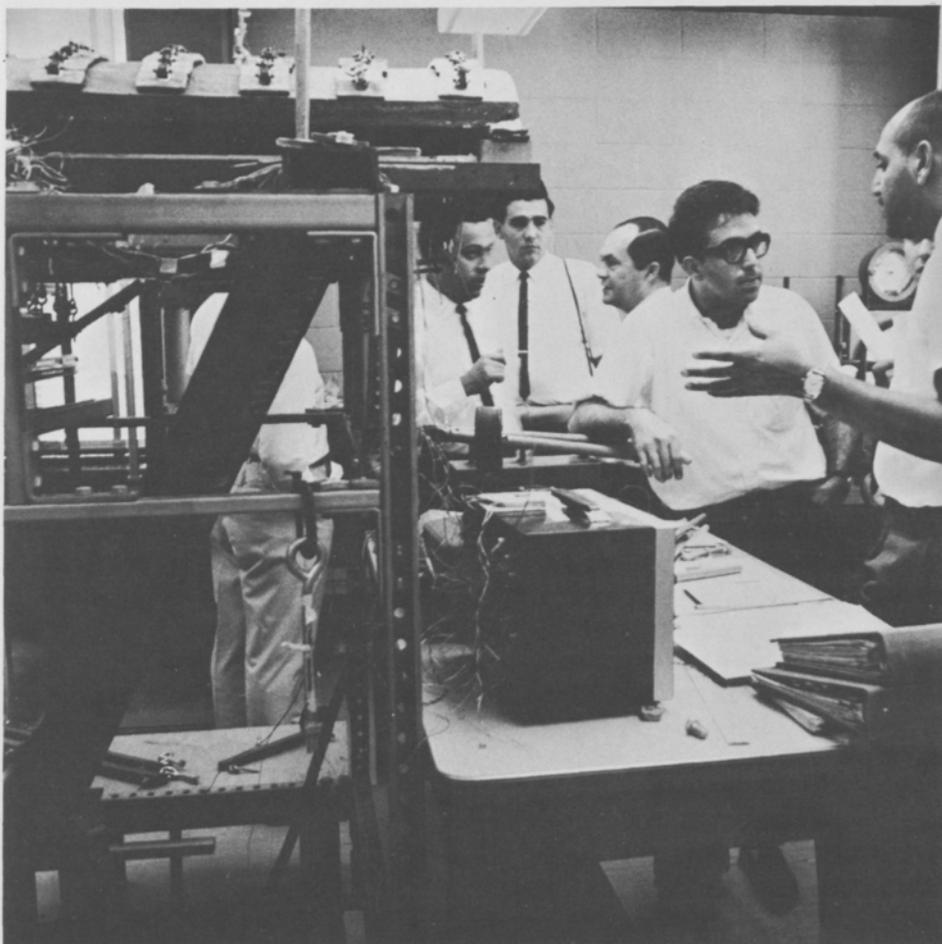
# VANTAGE

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While formal continuing engineering studies are more representative of the College of Engineering's role in public service, each year the College hosts several conferences and visiting groups. These guests come to meet with the Cornell faculty to discuss their own fields of interest and to examine Cornell's modern engineering campus. This *Vantage* photo story describes one such visit, that of a group of engineering faculty members from the University of Zulia, Maracaibo, Venezuela, which was sponsored by the United States Department of State. While in the United States during the summer of 1966, these Venezuelan engineers explored technological and scientific research, engineering projects, and the engineering departments of several American universities.

1. *The Venezuelan professors examine plant design models, chemical engineering projects done by students studying for the professional master's degree.*
2. *The structural models laboratory in the School of Civil Engineering provides several good illustrations of unique undergraduate design experiments.*
3. *The visitors learn about new activities under way in Civil Engineering's Water Resources Engineering Department.*









*Opposite page:*

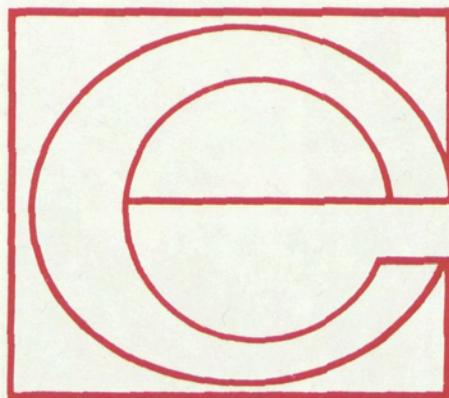
1. Here, with the discussion centering on the activities of the University Planning Office, the visiting professors examine a model of the University.
2. The Spanish and English flow freely as several interpreters describe the activities in one of the many electronics project laboratories in the School of Electrical Engineering.
3. Professor Melvin Esrig of Geotechnical Engineering, one of the four departments in Civil Engineering, explains the use of the triaxial soil test apparatus in the foreground.

*This page:*

1. Our guests peer into the Structural Test Bay, which is used for large-scale testing of structural materials and designs.
2. The Venezuelan professors and Cornell engineering students from Venezuela enjoy a farewell luncheon before the visitors leave for Chicago's Illinois Institute of Technology and the University of Illinois.

*All Vantage photos by David Ruether.*





CORNELL UNIVERSITY  
ENGINEERING SHORT COURSES  
SUMMER 1967

Introduction to Digital Computing  
Engineering Applications of Statistics  
Operations Research: Theory and  
Applications  
Thermal Radiation Transfer: Space  
and Process Applications  
Introduction to Quantum Electronics  
Nuclear Measurements  
Principles of Polymer Systems  
Introduction to Dynamics of  
Mechanical Systems  
Composites: High-Strength and  
High-Temperature Applications

*The first five short courses will be  
given June 19 through June 30, and the  
last four will be given July 10 through  
July 21.*

For further information write:  
Director of Continuing Education  
Room 251  
Carpenter Hall  
Cornell University  
Ithaca, New York 14850



