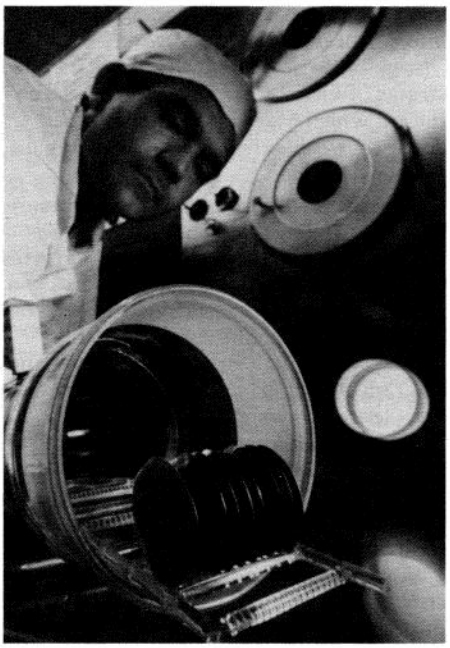
SEAS Reports

Sharing the Destiny of the University

In a dozen short years a century of unparalleled human achievement will give way to a new century in which knowledge and technology will continue to increase by exponential factors. Much of what will be common knowledge and commonplace in the future is yet undreamed. But much of what will blossom in the 21st century will be rooted in the visions and plans of today. The faculty, staff and students of the University of Pennsylvania School of Engineering and Applied Science have focused on the year 2000 and beyond, continuously planning for the School's future and measuring our progress against clear benchmarks, ever mindful of the role we have played and will continue to play in this great university.

During the formal planning process of the past decade, the School has reflected carefully on the special nature of Engineering and Applied Science at Penn. The various disciplines at the University of Pennsylvania are not only in close physical proximity, they also share a close intellectual interaction in both direct and subtle ways. The careers of our graduates and the kinds of research pursued by our faculty give abundant evidence of this. Thus, the planning process reinforced the comparative advantage of Penn Engineering and Applied Science quite vividly: capitalize on the linkages that are the strength of the University. Over the last 10 years, for example, the development of the Management and Technology Program and the Computer and Cognitive Sciences initiative have found few peers. And the creation in 1974 of the alternative general education program, the Applied Science Program, is having national impact.

The School heads toward the 21st century with the strategic objective of enhancing the core engineering disciplines and, upon this base, developing academic excellence and leadership in focused intellectual areas where the School, jointly with the University, excels. In these days of global competitiveness and rapidly changing technologies, at a time when new knowledge is increasingly being created at the interfaces of established disciplines, the School is well positioned to share the destiny of the campus at large.



Sophisticated silicon wafers produced by advanced microfabrication techniques are revolutionizing communications, computational and control systems.

The special integrative character that Penn Engineering has displayed for many years is nicely articulated by the philosopher, Jose Ortega y Gasset. Gasset wrote *Mission of the University* in the 1940's at the same time a team of Penn engineers created ENIAC, the machine that launched the age of information. In his book, Gasset said: "The need to create sound syntheses and systemizations of knowledge . . . will call out a kind of scientific genius which hitherto has existed only as an abberation: the genius for integration. Of necessity this means specialization, as all creative effort inevitably does; but this time, the (person) will be specializing in the construction of the whole."

—Joseph Bordogna
Dean

Pace-Setting Research: Forging a One-University Partnership

Building upon foundations established 136 years ago, Penn Engineering and Applied Science has played a major role in research and technological development. Samuel F. B. Morse's first telegraph message, "What hath God wrought," was transmitted over wire manufactured by Alfred Fitler Moore, progenitor of the Moore School. The rotary tuner used to change channels on the first TV sets was developed by a Penn engineer as was today's remote control TV tuner. Graduates and faculty of the School were also involved in the development of the lunar land rover, the calibration of the nation's first X-ray machines, the liquid crystal display used in digital watches and portable computers, automobile cruise control, the recovery of the first space vehicle to return from orbit, the equipment in satellites that takes high resolution pictures of the earth, the first millimeter wavelength hologram and the unmanned missions to the planets, and even the plastic liter bottle in which juices and soft drinks are now marketed—to name a few.

Today, the School is among the nation's top ranking engineering schools in externally-funded research dollars per capita and in the number of refereed journal articles per faculty member. Pace-setting research within SEAS and in joint efforts with Penn's Medical Schools, SAS, Wharton, and the Annenberg School of Communications provides a solid base for perpetuating the School's tradition of accomplishment, and for enhancing Penn's future as a leading research university.

Machines That Understand Speech

Mitchell Marcus, who joined the University of Pennsylvania last September, is one of the prime movers in developing a computer chip that would be able to decode human speech.

Marcus specializes in an area of computer science called natural language, the effort to understand how human language works so that we can teach computers to understand it.

He and other researchers know enough about language that little stands in the way of building machines that would understand what the user wants it to do, rather than the user's having to remember exactly what the machine understands.

Marcus thinks that such equipment will be commercially feasible in 10 years. "We'll know how to do the process, and computing power will cost little enough," he says. "There will be a $2 chip to do all this."

To reach this stage has required 30 years of research, an effort Marcus joined as a Ph.D. student at the Massachusetts Institute of Technology.

Much of the influential work has been done at Penn under Prof. Aravind K. Joshi, who began investigating the structure of language even before he joined the computer science department in 1960. Joshi, Henry Salvatori Professor of Computer and Cognitive Science, is responsible for some of the most important mathematical models linguists have built on.

There are a number of industry research centers that are strong in natural language, but Marcus says it's Penn that stocks most of these centers.

Ever since he joined Bell Labs in 1979, Marcus has had a desire to pull apart the structure of language, and he knew that he would like to wind up some day at Penn. Penn has a strong tradition of cooperation between departments, a real benefit in the study of language, he says. Linguists, psychologists, and philosophers all share their ideas and research with the computer scientists.

When he was offered Penn's RCA Chair of Artificial Intelligence, Marcus accepted it eagerly, although he still spends part of a day each week at Bell Labs in Murray Hill, NJ, pursuing research work there.

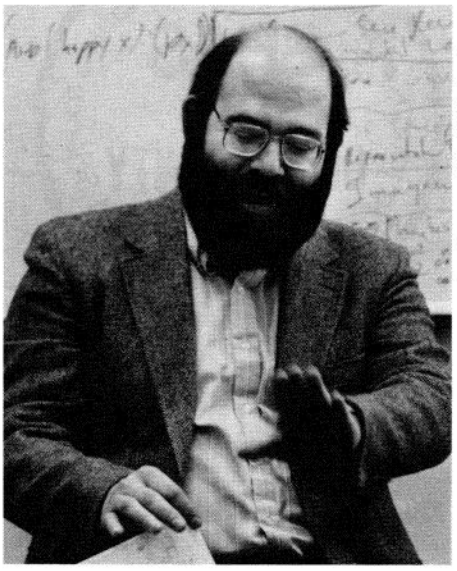
Penn wanted Marcus because he is one of the top two or three people in natural language, according to Joshi. He was one of only a handful of Bell Laboratories scientists profiled in *Three Degrees Above Zero*, a 1984 book about the Labs.

Marcus has taken the parsing of a sentence far beyond what even the most rigorous English teacher could have imagined. His delight is turning English into algebra. In his world, words like "happy" and "dog" are transmogrified into strings of Greek letters wrapped in parentheses, which Marcus says tell as much about the words they represent as any dictionary definition.

His formulas describe not the shapes, colors, or feelings that the word represents, but refer to the function it performs in a sentence. Marcus' algebra is actually a way to diagram a sentence that tells a whole lot more about the relationships among words than the traditional sentence diagram—going so far as to represent even the silences between sounds.

This detailed knowledge of sentence structure is just one of many aspects of language that researchers must understand before they can teach machines how to understand people.

In recent years Joshi has focused on describing the kinds of misconceptions and misunderstandings that can arise, and how to prevent them. "You can ask a computer data base how many students got an 'A' in a course, and it will say 'none' even if the course was not offered," he explains. "What this system has to do is to say that the course wasn't offered." Penn researchers have already solved the problem, and their work is the basis for a few commercially available software packages that offer such feedback.



Amy Huntoon, Philadelphia Inquirer

Joshi and his students are now exploring ways in which systems can be made to give more of the information that would be given by a human in response to a question.

The value of having a machine understand us is multiplied by every electronic device we own, Marcus says.

Right now we have to learn the proper language of button-pushes for every piece of equipment we use, such as VCRs and thermostats, he says. It would make a lot more sense to get the equipment to understand our language.

Equipment to do this is likely to be developed within three to five years, and will probably cost $10,000, Marcus believes. "But in 15 years the same equipment could cost only five dollars."

Marcus has now turned his attention from sentence parsing to an area he calls "the melody of speech," or the way in which intonation can change meaning. A flat "John took my car" is a very different statement from an incredulous "John took my car?" he says.

This difference is important, not just so that the computer can understand us, but so that we can understand it.

"In 15 years, you'll speak to your computer, and it will speak back," he says.

Marcus and Joshi are members of an internationally renowned group of Penn faculty conducting research at the frontiers of the new Cognitive Science. A description of this effort follows.

Cognitive Science at Penn

The Cognitive Science program at Penn involves two schools: SEAS and SAS, and five departments: CIS in SEAS, and Linguistics, Philosophy, Psychology, and more recently Mathematics, all from SAS. The specific, separate, but highly interrelated research themes are:

- Induction: Learning, Problem Solving, and Inferencing
- Perception and Action
- Language and Logic and Computation

Technological aspects of this work include: integration of sensory information; robotic planning; natural language interfaces; spoken language systems; graphic interfaces; expert systems; application of logic to software development; development of computer-assisted interpretations of museum environments. All of these are broadly covered under the general category of artificial intelligence.

Some of the senior faculty members involved in this program are: Ruzena Bajcsy, Norman Badler, Peter Buneman, Aravind Joshi, Mitch Marcus, Bonnie Webber, (CIS); Rochel Gelman, Lila Gleitman, Jack Nachmias, Robert Rescorla, Saul Sternberg (Psychology); Tony Kroch, Ellen Prince, Gillian Sankoff, William Labov (Linguistics); Scott Weinstein, Gary Hatfield (Philosophy); Peter Freyd, Andre Scedrov (Mathematics).

To set the pace for educational developments in this new field, Penn initiated an undergraduate dual-degree program in Computer and Cognitive Sciences described on page four of this SEAS Report.

Superconductivity at Penn

The search for a better understanding of the true nature of superconductors is underway right here at the University of Pennsylvania. Under the auspices of the Laboratory for the Research on the Structure of Matter (LRSM) Program for joint interaction between various scientific disciplines, professors in the Materials Science and Engineering, Chemistry and Physics departments are currently exploring the vast realm of superconductor knowledge. MSE Professor Peter Davies is instrumental in leading the University into the age of superconductivity.

Davies, along with professors Paul Chaikin of Physics and David White of Chemistry, have been conducting various superconductor experiments since the dawn of the age in February 1987. Their greatest success thus far has been replacing the oxygen in barium yttrium copper oxide ($Ba_2YCu_3O_7$) with fluorine. This change has given a new insight into the molecular structure of superconductors while preserving their unique properties. "Many have tried changing the other components (Ba, Y, Cu), but we have shown that fluorine definitly does go in," Davies said.

Professor Davies, who has recently received tenure at the University, said that his research has two goals. "First off, we are trying to find a superconducting material that functions at a higher temperature," he said. "But I think the main aim is to just understand why they work." Davies is focusing his efforts in the areas of crystal structures, thermal stability and solid-state chemistry.

On the research environment at Penn, Davies commented that it was conducive to furthering his work. "It is a very stimulating atmosphere here. These are a group of first-rate scientists," Davies said, adding that the strongest part of the University is the highly interdisciplinary nature of research, which makes it easy to collaborate with professors in other departments. "I don't know any other institution that does this as well; everything is state of the art here," he said.

If one is going to be at the cutting-edge of modern science, it is absolutely necessary to step across the borders of traditional disciplines. Quantum jumps are more likely to occur in our work with engineers and physicists as we apply the concepts and experimental techniques from our respective fields to our colleagues' disciplines. (Alan MacDiarmid, professor of chemistry)

What does the future hold? Professor Davies, winner of a National Science Creativity Award last year, sees a broad range of possibilities. "The subject is so new that the whole field is up for grabs. We have made unique contributions, and will make an intense effort to continue to do so," he said.

Bioengineers and Surgeons

Artificial hips, knees, and other prostheses are frequently substituted for people's damaged or diseased joints, but like any spare part, the replacements sometimes develop trouble: bone around the implant can erode; materials in the implant can shed toxic ions; sometimes glue around the implant breaks down. The results can be crippling, even deadly.

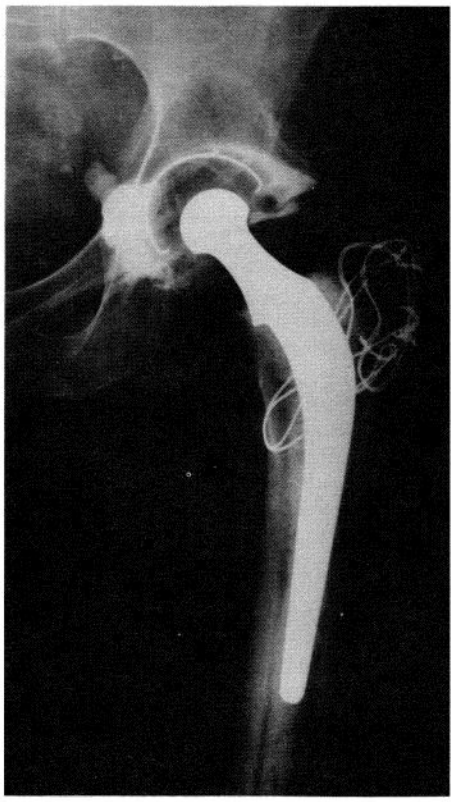
To overcome these problems, bioengineers at Penn Engineering and Applied Science are collaborating with orthopaedists in Penn's Medical Center to design a host of new techniques and materials. Associate Professor of Bioengineering Paul Ducheyne serves as co-director of the Center for Joint Reconstruction at the Medical Center. Working with orthopaedic surgeons such as Drs. John M. Cuckler and Jonathan Black and fellow bioengineer Professor Solomon R. Pollack, and graduate students and medical researchers, he is seeking ways to achieve long-term reliability of implants. In the process, Ducheyne has done some remarkable things to the basic hip implant, a device that looks like a bent railroad spike.

Medical breakthroughs in prosthesis design and implantation methodology are most likely to occur in collaborative research between engineering-oriented physicians and medically-oriented engineers. Ducheyne's expertise in materials science and his rigorous approach to the design and evaluation of new materials and new prostheses is vital in our efforts to advance the science of orthopaedic surgery. (Dr. John M. Cuckler, Assistant Professor of Orthopaedic Surgery)

Ducheyne and his fellow researchers are experimenting with materials to improve the mechanical stability of a joint that must survive the stress of millions of steps. One of the most promising developments is a special ceramic coating, termed "bioactive," which can be applied to prostheses. The ceramic forms a rough surface that actually seems to stimulate bone growth around it. At the same time, they are also experimenting with biologically inactive materials to form the implant itself. So far, says Ducheyne, titanium has proven the most biocompatible metal, and the research team is now experimenting with various titanium alloys, trying to find the ideal combination.

Ducheyne attributes the rapid and diverse progress he and the others have made in implant research to cross-disciplinary cooperation.

We could each do our research on our own, definitely, he says. But when I want to know about ion transport phenomena in bone, for example, I go to Dr. Pollack, who is an expert in these effects on bone tissue. When I want to know about biological phenomena associated with implants, I go to Dr. Black, Professor of Orthopaedic Surgery. And about 70 percent of my work is in conjunction with Dr. Cuckler, Assistant Professor of Orthopaedic Surgery. The sum of our efforts is greater than the sum of its parts. By joining efforts, we're much better off. (Dr. Paul Ducheyne, Associate Professor of Bioengineering)



Educational Innovation: Integrating Resources for Leadership

Penn Engineering and Applied Science, founded in 1852, is the nation's fifth oldest engineering school. The school offered its first courses—a full decade before MIT—in civil engineering in response to the rapidly growing civil infrastructure of the day. Next mechanical engineering evolved from the need to refine machines to enhance muscle power. Then came electrical engineering in the 1880s in response to the development of dynamos and the electric light, followed by chemical engineering in the 1890s after the realization of oil as a major source of energy.

From the beginning Penn has been a leader in engineering education. It was among the first several universities to offer an electrical engineering course and is tied with another in offering the first chemical engineering program in the United States. Penn also developed the first evening engineering program, the first graduate systems engineering program, and graduated the first Ph.D. in bioengineering. The son of our progenitor, John Henry Towne, wrote what is thought to be the first scholarly paper on management and technology in 1886, and the first endowed chair at the University of Pennsylvania was in engineering—the Asa Whitney Professorship of Dynamical Engineering.

In recent years we have not merely reacted to the changing needs of society but have anticipated them. With our colleagues in SAS and Wharton, we have established innovative educational programs capitalizing on the comparative advantages of our One University.

Management and Technology

In a letter to the president of the University of Pennsylvania, the president of a large corporation wrote, "If I had it to do all over again, I would try to find a college which gives a program in business administration along with a rather thorough knowledge of engineering."

He was voicing what many leaders of business and industry have begun to stress in recent years. An understanding of the fundamentals of engineering and the vital role technology plays in every aspect of modern society is as essential to the background of a future manager in business or industry as is the knowledge of sound management principles.

The world of the 21st century will belong to the technological integrators. (Henry Wendt, President and CEO, SmithKline Beckman Corporation).

In having the world's oldest and arguably the most prestigious business school located on the same campus with a leading engineering school, Penn is capable of offering a range of programs that blend the principles of management and good business practice with the fundamentals of engineering and practical applications of technology.

In 1976 the University took the first major step in this area when it formally announced the undergraduate dual-degree option in Management and Technology. Under this program students at Penn earn a Bachelor of Science in Economics (BSEcon) degree from the Wharton School and either the Bachelor of Applied Science ing (BSE) degree from SEAS.

These options have proved to be extremely popular, attracting the brightest and most diverse group of applicants of any undergraduate program offered by the University.

From almost any perspective the interdisciplinary Management and Technology program garners superlatives; it involves the most gifted of our students in the most rewarding yet demanding of programs under the leadership of many of our most illustrious faculty. When one of my students mentions membership in the 'M & T Program' I know I'm teaching the best! (Professor Nicholas D. Constan, Jr., Legal Studies)

The Management and Technology Program annually admits 40 undergraduates who are pursuing a broad range of career paths. In providing a pool of talented students with strong backgrounds in both engineering and business, the University is responding to a critical national need. Graduates of the M & T Program are among the most heavily recruited student groups in the nation.

Computer and Cognitive Sciences

Established in 1985, this undergraduate dual-degree program is the educational component of Penn's interdisciplinary Cognitive Science Program. It prepares students for leadership positions in a new, rapidly-expanding field which aims to understand the processes of human cognition and communication and to emulate those processes in machines.

As in Management and Technology, individualized curricula marks this highly selective program leading to the BAS or BSE in Computer Science and Engineering and a BA in Linguistics, Philosophy, or Psychology. Graduates are prepared to pursue careers in basic scientific research and technology with industry, government, and academe in fields ranging from the academic disciplines of computer science, linguistics, philosophy, and psychology to the high-technology fields of artificial intelligence, natural and graphic language interfaces to expert systems, decision support systems, robotics, and manufacturing technology.

Technology and the Liberal Arts

As technological innovation accelerates and its applications become increasingly integrated into the fabric of our professional and private lives, consensus is emerging in society that the educated person, regardless of field of study, must understand technology and its pervasive role in modern life.

Over a score of years, a variety of undergraduate courses have been developed at SEAS to introduce non-engineers to the conceptual and analytical processes used to apply technology to creative ends. With support from the Sloan Foundation, five courses currently offered at SEAS are being prepared for distribution to others, particularly professors in liberal arts colleges looking for textual resources on which to build similar courses of their own.

These courses include: Introduction to Bioengineering, Interactive Computing and Creative Thinking, Expert Systems: Applications of Artificial Intelligence, Introduction to Forensic Engineering, and An Introduction to Technological Concepts.

Social Responsibility, Legal Liability

To better prepare engineering students for their professional responsibilities in a lawsuit-prone society and to offer liberal arts students some insight into the legal aspects of engineering design, a new undergraduate course has been created at SEAS by professor of bioengineering Steven Batterman.

The course, "Introduction to Forensic Engineering," explores relationships between engineering, engineers, the law, the insurance industry, and society at large.

Engineers have a societal responsibility and breaching it can cause a lot of harm. There is such a thing as engineering malpractice, and students should know about it before they leave here. In a sense, the new course can help to teach responsibility explicitly, said Batterman.

Batterman believes that national tragedies resulting from known design flaws and bad management decisions, such as the Pinto automobile's exploding gas tank or the space shuttle's flawed booster rockets, show that engineering students must understand both their legal liabilities and social responsibilities before they enter their professions.

In his introduction to the legal framework, he draws on case studies to illustrate not only corporate negligence—liability for harm resulting from poor design or decision making—but legal concepts of strict liability as well. Under strict liability, a manufacturer may be liable for harm resulting from a product simply because it is defective.

Batterman shows his students actual videotapes and transcripts of trials involving suits against auto manufacturers to illustrate the role of the engineer as defendant and as expert witness, and as scheduling permits, experts in the field make classroom presentations on their particular area of expertise.

The course also examines the contributions of industry standards, government regulations, and court litigation, and the limitations of warnings to consumers.

People can invent all kinds of ways to misuse a product: they turn power lawnmowers over to trim hedges, for example, and accidents happen. In the current legal climate it's really a case of 'let the seller beware' (Dr. Batterman).

The New ExMSE Program

Penn Engineering's newly-developed graduate degree program, the Executive Master of Science in Engineering (ExMSE), will be the featured topic at a Seminar on "Engineering for the Twenty-first Century" to be held on campus today.

Erich Bloch, director of the National Science Foundation and the keynote speaker at the Seminar, is scheduled to offer his views on the implications of today's rapid, global technological change for engineering education.

According to University Professor Louis A. Girifalco, the ExMSE curriculum is based on the premise that the successful management of modern technology requires a dramatic broadening of executive knowledge, skills and perspectives, particularly for firms operating at the leading edge in highly competitive markets.

"Our objective is to provide a unique learning experience which furnishes its graduates with the intellectual base to exercise creative leadership in a world of rapid technological change," Girifalco said.

The ExMSE curriculum fosters new insights by transcending traditional academic boundaries and focusing on emerging technologies and the processes by which they are developed and implemented, he explained.

Faculty for the new program have been chosen principally from among distinguished professors across campus who have earned worldwide reputations in both their respective disciplines and their commitment to interdisciplinary research. Joining them will be others of comparable stature from academe and industry.

Commenting on the ExMSE Program, SEAS Dean Joseph Bordogna expressed the view that future leaders must be able to integrate knowledge of current technologies with a broad understanding of factors in the social and economic environments that affect and are affected by them.

In the Twenty-first century, as never before, the quality of human life will depend on enlightened technological innovators. Leaders with the intellectual capacity to integrate the complex factors involved in the creation and implementation of sophisticated new knowledge will be the key to improved productivity, economic growth, government stability, and the preservation and enhancement of our global environment, he stated.

"The importance of integrative skills based on interdisciplinary studies recurs frequently in our discussions about the new curriculum with senior corporate executives and government leaders like Erich Bloch. It is the thing that has excited the most interest in the ExMSE Program. We are fortunate to be part of the Penn community and to be able to draw on the broad intellectual resources of the University to meet this need," Dean Bordogna said.

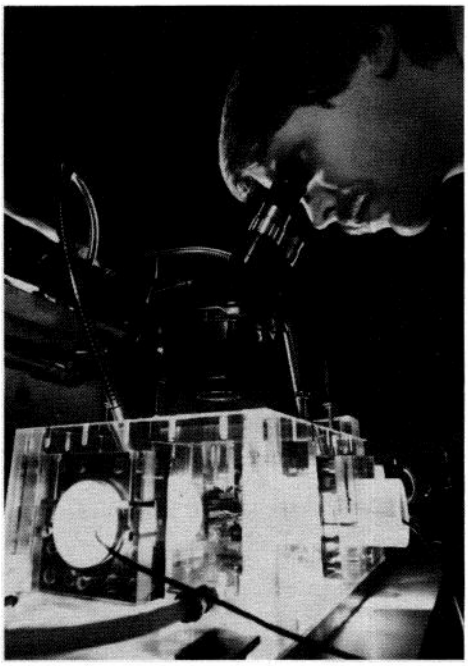
Wayne L. Worrell, Associate Dean for Graduate Education and Research, described the ExMSE Program as rigorous and intensive. "The week-end format, similar to that of Wharton's successful WEMBA Program, will permit ExMSE students to experience close rapport with faculty and fellow students from diverse educational and industrial backgrounds in a close, interdisciplinary setting without having to interrupt their careers."

Today's seminar will include a presentation by Professor Girifalco on the concepts, curriculum, and format of the ExMSE Program and remarks by Dean Bordogna; Jacques Koppel, Director of the Commonwealth of Pennsylvania Office of Technology Development; and John Mulroney, President of Rohm and Haas Company. Mr. Mulroney also chairs SEAS' Board of Overseers and is a University Trustee.

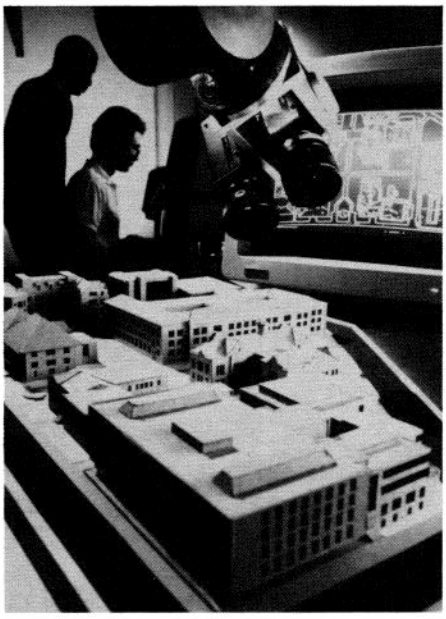
A select group of national and local engineering education leaders, senior executives of regional technology-based firms, and state and local community and political leaders have been invited to join SEAS faculty and University faculty who have assisted in developing the ExMSE curriculum at the Seminar.

A highlight of the Seminar will be the introduction of senior managers from AT&T, Bell of Pennsylvania, Rohm and Haas, SmithKline Beckman, and Unisys, the companies which have provided advice and assistance during the start-up of the ExMSE Program.

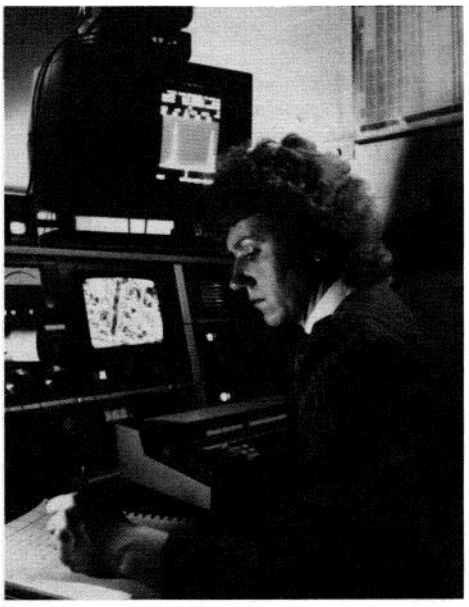
The SEAS faculty recently approved the new ExMSE curriculum after a study of the post-graduate education needs of senior managers of technology-based organizations. Based on an idea by Bioengineering Professor Solomon R. Pollack, the study and initial planning for the program were headed by University Professor Girifalco. Other participants in the interdisciplinary faculty committee coordinating the development of the ExMSE Program were Professors William A. Hamilton, Management and Technology; Dwight L. Jaggard and Kenneth R. Laker, Electrical Engineering; Almarin Phillips, Public Policy; Iraj Zandi, Systems; and Associate Dean Worrell.



Bioengineering studies of the mechanical properties of tissue are leading to improved designs and materials for prosthetic devices.



Robot-mounted cameras coupled with computerized vision analysis programs are fostering new insights into active sensory perception.



New materials required by emerging technologies are developed from electron microscopy studies of the structure and composition of matter.

Penn Engineering: Preparing Leaders for the 21st Century

The quality of our students attests to the current strength of the School. Since the early 1970s, undergraduate enrollment has more than tripled, full-time graduate enrollment has doubled and enrollment of minorities is twice the national average for engineering schools. Throughout this period of rapid growth, the quality of the School's student body has improved as well. Among the nations's 270 engineering schools, Penn is one of only 10 with mean combined SAT scores greater than 1300 for the freshman class, and our graduate students are equally impressive.

The vignettes that follow feature programatic and personal accomplishment underscoring the vitality of the School's educational and research program, and the strength and diversity of its student body.

National Leadership For Minorities

When Greg Long came to Penn from Stanford University in 1984 to work on his master's degree in mechanical engineering, he intended to stay a year. Three years later, he is still here, working towards his Ph.D. degree and coordinating the undergraduate tutoring program. One of a handful of black graduate engineering students, Long is representative of the quality minority engineers who are attracted to the School of Engineering and Applied Science.

As Tutoring Coordinator, Long works closely with Mr. Harold Haskins, Director, University Tutoring Center and Ms. Cora Ingrum who has directed SEAS in-house program for Minorities in Engineering for more than a decade. In the early seventies, SEAS was a key player in regional and national efforts to increase the representation of minorities in engineering. Joseph Bordogna, then associate dean for undergraduate education, and Ingrum were active in the consortium of regional leaders from government, industry, secondary schools, academe, and neighborhood and civic groups that organized PRIME, Philadelphia Regional Introduction for Minorities to Engineering.

PRIME identifies capable minority students as early as the seventh grade, and during the academic year it provides an enriched skills development program and supplementary activities in math, science, and communications. In the summer, the most talented students receive intensive, pre-college training at area colleges and universities (Drexel, Penn, Temple, Villanova) as part of the Prime Universities Program (PUP). This program begins after 8th grade and culminates after the 11th grade with the students participating in a four-week summer residential program. This program has served as an example for the development of similar consortia nationally and presently has 2,500 students involved locally.

As a vital force in PRIME, SEAS recruited vigorously and matriculated twice the national average of minorities, but the true measure of excellence in minority programs is retention. To address this issue SEAS made an early commitment to minorities in engineering and formalized its own in-house Program for Minorities in Engineering in 1974.

Penn has retained 79% of its minority engineering matriculants between 1971 and 1985. Of the current 1382 SEAS undergraduates, 92 are black, 53 are Hispanic, 201 are of Asian descent, and 281 are women.

SEAS recognized that many students need supportive services to keep up academically and to find their niche socially. At Penn for more than two decades, Ingrum, Assistant to the Dean for Minority Programs, was the ideal person to implement a School-wide program focused on minority retention. Through Ingrum's office, SEAS provides a full-range of academic and personal support services and coordinates a variety of social and career development programs that have created a sense of community among SEAS minority students.

On any day when classes are in session, Ingrum's office is a hub of activity. Although most of her work is with undergrads, Long says, "Her office is an essential place for any minority student." Senior Shirlene Cook, president of the Penn chapter of the National Society of Black Engineers, agrees. "Ms. Ingrum's office has been a great source of support. She's a good friend . . . we have an informal support group; we all know each other and we know we can count on each other."

Even before classes begin, minority students are invited on campus for a pre-freshman program. "They live on campus for several weeks to get a head start on the semester, meet other students, and learn time management, improve intellectual discipline, and get used to a typical schedule," says Ingrum.

Once the fall semester begins, freshmen receive immediate support from Ingrum's office. In regularly scheduled meetings their progress is reviewed, they are encouraged to meet with their academic

Shirlene Cook, President of the National Society of Black Engineers, and Cora Ingrum, Assistant to the Dean for Minority Programs.

advisors, and they are directed to the needed resources, such as the Tutoring Center. Long, as Tutoring Coordinator, augments Ingrum's services. "She helps them cope. They come to me with academic questions."

Students need a great deal of extra help—whether they are minority or not . . . It's our job to see what these students' needs are and to see that they graduate. (Cora M. Ingrum, Assistant to the Dean for Minority Programs)

Hispanic students take advantage of Ingrum's programs too, and they also have a compelling role model in Jorge Santiago-Aviles, associate professor of electrical engineering, who devotes much of his time to helping hispanic engineers. "I try to serve as a medium to decrease the impediments when they come."

Despite all these supports, it is still difficult socially to be a minority student. "A lot of my friends come to Penn gungho, feel disappointment and go through culture shock, coming from poor black backgrounds to an Ivy school with a lot of smart people," says Cook. Mitzi Appling, a senior in mechanical engineering agrees, "It hasn't been easy. I've struggled all four years with the work load. It's hard to go to a school like Penn if you're from a minority background. There's a lot of stress if you have to work and juggle schedules. But it's worth it."

Minority alumni of SEAS also feel the struggle is worth it. After holding a variety of positions in industry, Don Maynard, ChE'71 is now sales manager for the southwest region of the United States for Celanese Chemical Co. in Dallas. Maynard says, "I've seen continued improvement in the quality and number of minority students and women . . . The extra impetus the in-house minorities program gave the School put it in the forefront."

Although Ingrum, Long, and Maynard serve as excellent role models, minority students yearn for a role model on the faculty. The School recognizes this imperative, but until our nation's universities graduate more black Ph.D.s in engineering per year the lack of black faculty in engineering will continue to be a national crisis.

The pipeline in the undergraduate program is there. But if you are going to crack the minority situation, you've got to attract the best, give them the best education, and have them share leadership. We need more people to make an impact and we need them as Ph.D.s. We need faculty to represent their parity in the nation's population. We have another decade of work. (Dean Joseph Bordogna).

REU Site For Sensor Technologies

The NSF selected Penn as a Research Experience for Undergraduates (REU) site on the basis of its philosophy toward undergraduate research training, the quality of the participating faculty members from the Center for Sensor Technologies, the appropriateness and value of the research projects being proposed, and because of the superior facilities and equipment available to support the undergraduates' research experiences.

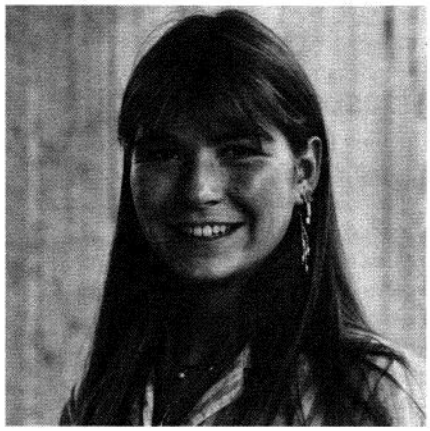
The REU program provides each student with a stipend of $2,500, as well as $750 for materials and supplies. And to further support these undergraduates' research educations, the University's Center for Sensor Technologies is contributing an additional $500 per student, thanks to a generous contribution from the Ford Motor Company.

The NSF program gives undergraduates a unique opportunity to get involved in active, hands-on research, says Jan Van der Spiegel, associate professor of electrical engineering and Lindback Awardee who applied for the grants. By enabling these students to work closely with faculty members and graduate students on what is truly state-of-the-art research, the REU program gives them a true flavor of what research really is.

And that, Van der Spiegel believes, will attract more talented students to do graduate studies in engineering and, eventually, to make valuable research contributions to the field. "During the academic year, most of the undergraduate projects are developmental in nature with predetermined final outcomes," he says. "On those projects the undergraduates are often asked to do work a technician could do. In the REU program, however, they are challenged more because they are doing true research. And that means that they do not always know the final outcome. They have to combine their reading with creativity and good judgment to come up with viable experiments. They have to discuss their ideas and findings with the faculty and graduate students. So, by giving these students hands-on experience in active research, the REU program will help attract talented students to graduate programs and, as a result, to the field in general."

To further promote these undergraduates' involvement in the research community, the students participate in weekly seminars on sensor research. "Since interacting with others in the research group is an integral part of the research experience, the undergraduates attend weekly seminars at which graduate students and visitors present their work," Van der Spiegel reports. "At the end of the summer, the undergraduates present their own work for discussion. Our goal is to have these students continue their research into the following year."

"The program has been very stimulating for both the students and the faculty," Van der Spiegel says. "I am confident that it will be a good way of attracting first-rate, highly motivated students to our research program."



Award Winning Research

It is not every day that you run into undergraduates who are motivated enough about their studies to devote countless hours to the pursuit of research goals. But then again, it is not every day that you run into students the likes of Alison Knauth, a junior in bioengineering when she received the Rose Fund Award.

Knauth was awarded $1,500 from the Rose Fund for a study entitled "Adhesive Polyurethane Dressings for Decreasing Transepidermal Water Loss in Neonates," a project she worked on with Stephen Baumgart, Assistant Professor of Pediatrics at the University of Pennsylvania School of Medicine. But her work with Professor Baumgart actually began back in October 1984, when she was only a freshman.

"I was taking an introductory bioengineering course and we had to do a project for the end of the term," Knauth recalls. "Since I was interested in a study I had read about on the problems premature neonates have with water loss, I decided to go to Children's Hospital to see if I could do my project there. That's when I met Dr. Baumgart and when I first learned of the techniques he was using to reduce this danger in premature babies."

Since then, Knauth has been working with Baumgart on what he terms an "ambitious, original clinical investigation into premature babies' skin and the large evaporative water loss these patients incur." Drawing on her own observation of infants and medical practices in Children's Hospital, as well as on her bioengineering interests, Knauth systematically evaluated the effectiveness of a water-semipermeable polyurethane dressing to protect premature infant skin from environmental stress. She studied the safety of this approach with respect to the infant's thermal balance, as well as the likelihood of skin injury from the dressings.

Knauth's knowledge of thermodynamics and materials science contributed significantly to our groups' analysis of new materials that might be applied directly as artificial skin for the premature human newborn. She interacted as a peer in a very demanding research environment of physicians, graduate fellows, patient care specialists, and parents, and deserves a lot of credit. (Dr. Stephen Baumgart, Assistant Professor of Pediatrics)

On the basis of Knauth's abstract, published in *Pediatric Research*, she was invited to present her research at the National Pediatric Society's meetings this past April—the only non-MD to give a paper.

Measures of Strength

The three tables reproduced here are representative measures of School of Engineering and Applied Science progress during the last 15 years. A planned increase in undergraduate enrollment to 1500 by the year 1990, combined with continuing gains in student diversity and increasing investment and faculty research, is strengthening the School's intellectual and educational contributions to our One University.