the DUKENGINEER

Fall 1981 Vol. 44 No. 1 School of Engineering, Duke University, Durham, NC

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Cover:
From left to right: Dean Aleksandar S. Vesić; President Terry Sanford; Dillard Teer, Vice President, Nello L. Teer Co.; Nello Teer, Jr., President, Nello L. Teer Co. Press conference announcing $1.5 million gift from the Teer family to the Library Pavilion. The building will be named for the late Nello L. Teer. (See article on page 20.)

*The **DukEngineer** is published in December and April by the students of the School of Engineering, Duke University, Durham, NC 27706; composition by Printing Services, Duke University; national advertising representative: Littell-Murray-Barnhill, Inc., 1328 Broadway, New York, NY 10001.*

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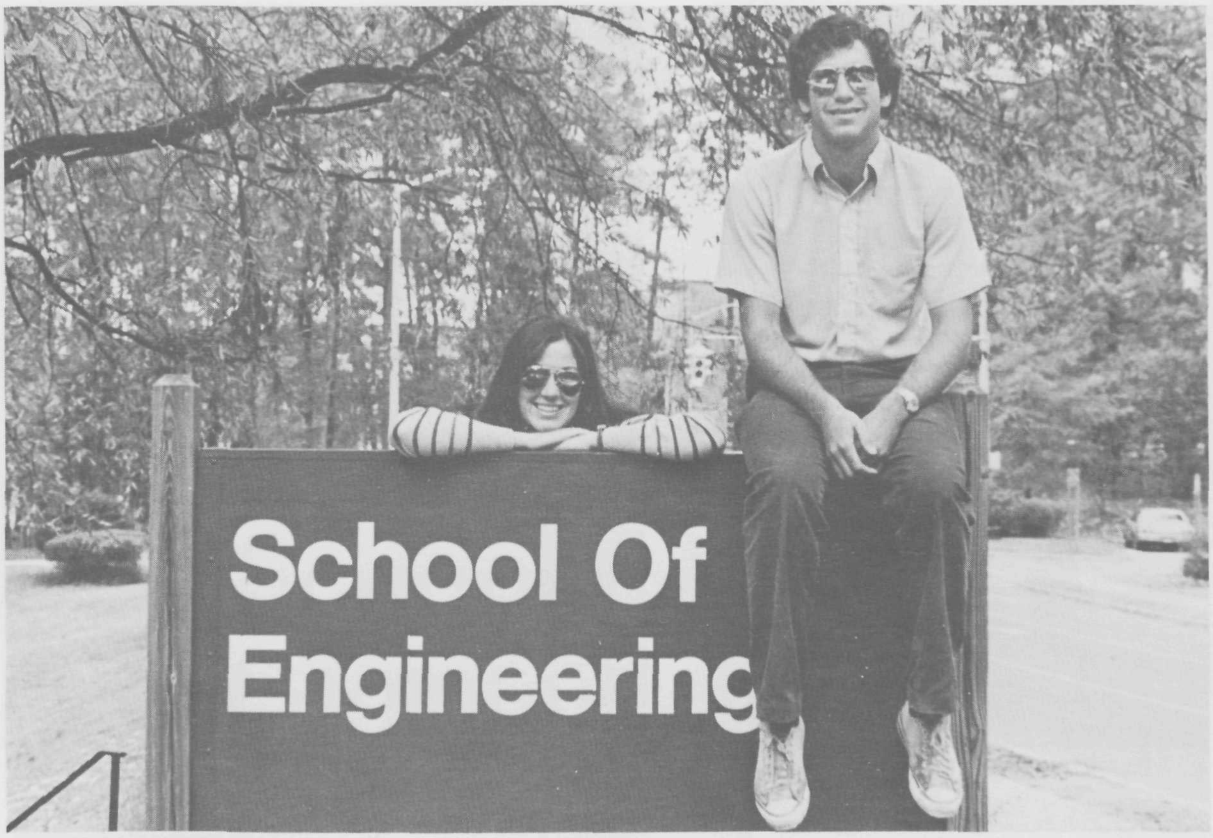


From the Editors

Keeping pace with the technological world, the School of Engineering has acquired its own computer, the MV 8000. Trying to keep pace with the School of Engineering, the *DukEngineer* is out once again, and the feature article is "Computer-Aided Engineering."

As technology advances, moral considerations must also be recognized. This issue is discussed in "Ethics and Engineering", by visiting professor Al Gunn. For similarities between engineers and interior decorators see "Engineering Mural." "When I Grow up . . ." presents some serious and some not-so-serious thoughts of undergrads about their future.

Of course, the old favorites are back. "The Way We Were" and "The Way We Are" show the engineering school, past and present, through they eye of a camera.

Do engineers have a sense of humor? Formulate your own opinion after reading "Jest for Laughs." The various news sections summarize what is going on in and around the engineering school.

A new approach to the *DukEngineer* has been the collaboration of two editors, which has been both successful and enjoyable. Anyone who is interested is encouraged to join the staff or speak to one of the editors or come to the next meeting.

As always, thanks are due to a great many people. The staff put in its usual fine effort, despite the fact that many were seniors. Assistant Dean Robert Kerr assisted in the production, as did Pat Owen, Karen Ray, and Connie Simmons from the Dean's Office. A special thanks go to the staff of the Office of Printing Services, especially the typesetters, who patiently deciphered and typeset the magazine.

Kevin Cleary
Allison Haack

A Rediscovered Partnership

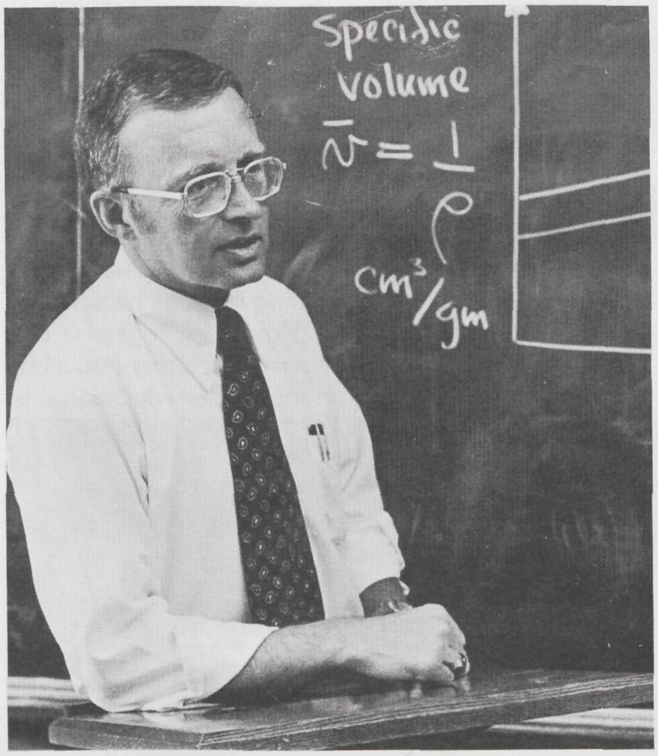
There is a long tradition of partnership of industry and engineering schools in furthering the cause of technological innovation for the benefit of national and world economy. Indeed if we trace the origins of major new scientific and technological ideas that have been at the roots of the enterprise of major industrial corporations of America and the world, we find that they very often were born in an academic environment and taken up by entrepreneurs interested in marketing a product that satisfies a significant need of a large segment of our complex society. Examples of this pattern are abundant; we can cite just two that have had a far reaching impact: the transistor and the digital computer.

The fruitful partnership of engineering schools and industry was in part lost in the fifties and the sixties, when the engineering faculties went, along with their colleagues in pure sciences, under the federal umbrella to find support for their research, while the industries set up their own large R & D operations to do it on their own. The exact causes and consequences of this development are hard to uncover, but the fact remains that by 1970 much of the corporate support for higher education went to social science and management-oriented programs. Thus, when in the early 1970's, the federal support started being curtailed or eliminated, the engineering schools were left alone to cope with increased enrollments, obsolete equipment and inadequate facilities.

It is a most fortuitous development to see the industries and engineering schools rediscovering each other in recent years, albeit under the shadow of an impending national crisis of energy shortage and imbalance of foreign trade. For the first time in many years, we hear national voices from non-engineering circles recognizing the need for a high level of engineering competence, built on the strength of engineering schools, as a necessary prerequisite for enhanced industrial productivity, essential for maintenance of this nation's living standard, as well as technological leadership of the free world.

The engineering community at Duke is excited about the challenge brought by this development. In many ways we are enjoying a golden age. Our 850 undergraduates and 120 graduate students represent by any standard one of the ten finest student bodies in the nation. Our distinguished faculty of about 60 members continues to carry an exciting research program at the forefront of new developments that are shaping our technological and industrial future, with outside sponsorship at the $2 million per year level. As a high caliber private school, we continue our successful role in educating top level industrial and scientific talent for the high-technology industry, which find North Carolina and the Triangle area as one of the most desirable settings for its new ventures. The newly discovered relationship with industry gives us indeed a special sense of direction and professional pride.

Aleksandar S. Vesić



From the Associate Dean

Supply and Demand

Often I am asked by undergraduate students, as well as by prospective students and their parents, questions about the present and future demand for engineers. Questions concerning the number of undergraduate and graduate engineering programs in the United States, and the enrollments in those programs arise also.

The latter questions about supply can be answered definitively by comparison to questions of demand, and since most students, prospective students, and practicing engineers for that matter, don't have easy access to the appropriate statistics, I have collected some. My source is *Engineering Education,* published by the American Society for Engineering Education.

There are 287 engineering schools in the nation which offer undergraduate programs, and graduate programs exist at 206 of them. During the 1970s, undergraduate enrollments reached a low point of 186,705 full-time students in 1973-74, while the corresponding figure for 1980-81 was 365,117. Graduate enrollments experienced a low in 1974-75 when there were 32,627 full-time students (21,999 master's and 10,628 Ph.D. candidates). By 1980-81 those figures had increased to 44,335 (29,870 master's and 14,465 Ph.D. students). Close examination of the enrollment figures show a significant increase in the percentage of women, minorities, and foreign nationals during the 1970s. In 1972, for example, 2.3% of full-time engineering undergraduates were women, 2.2% were blacks, and 4.8 were foreign nationals. In 1980, 13.4% were women, 4.4% were blacks (11% total minorities), and 6.7% foreign nationals. [At Duke, 3% of our undergraduates were women in 1972, 13% in 1974, 20% in 1976, and currently it is 25%. Enrollment of blacks and total minorities at Duke are slightly lower than national figures at 4.1% and 6.8% respectively in 1980.] At the graduate level the increases in enrollments between 1972 and 1980 were 2.3% to 11% for women, 0.7% to 1.3% for blacks, and 24% to 36.4% for foreign nationals.

Of course, supply is related more to the numbers of degrees granted than to enrollments so a brief examination of those statistics is in order. The national retention rate, as measured by the ratio of degrees granted in a given year to the number of matriculants four years earlier, ranged from 55% to 73% over the 1970s. However, these figures do not take into account students who transfer into engineering from other disciplines, nor do they show that the retention rate after the sophomore year is closer to 90%. [The four year retention rate at Duke has exceeded 90% for several years, and the imbalance between transfers into and out of the School have resulted in "retention" rates exceeding 100% in recent years.]

To summarize the supply statistics, the total number of bachelor's degrees granted during the 1970s was 430,123—ranging from a low of 37,970 in 1976 to a high of 52,598 in 1979.

Comments regarding the question asked most frequently, that of demand, must be considered speculative at best. The records of manpower forecasters are often poorer than those of political pundits and economists. Perhaps this is not surprising in view of the influence of political and economic factors on technical manpower requirements. Nevertheless, a few items from *Manpower Comments,* a publication of the Scientific Manpower Commission, and *Engineering Manpower Bulletin,* published by the Engineering Manpower

Commission of the American Association of Engineering Societies, will give some indication of the demand for engineers.

The demand for engineers increased significantly during the second half of the 1970s and for several years has exceeded the supply by a significant margin. In the fall of 1980, a College Placement Council survey of 565 employers showed an anticipated increase of 16% hires of bachelor engineers, 25% more master's, and 53% more doctoral engineers. A survey of Industrial Research Institutes' 255 U.S. member companies showed 91% expected more engineers to be employed by their company in 1985 and 1990 than in 1980. Compared with these forecasts, the actual increase in numbers of hires in 1980-81 over 1979-80 was 10% for bachelor's, 15% for master's, and 22% for doctor's. That year 7% of all graduates were engineers but they received 65% of all job offers.

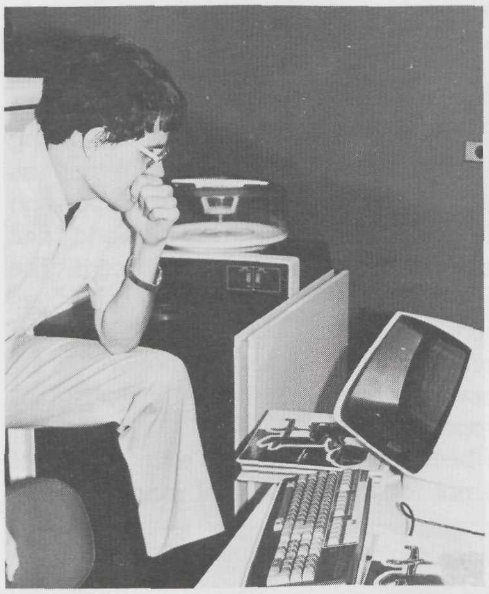
Most corporate recruiters who visit Duke state that their manpower requirements have remained steady during this difficult economic period and expect increased demands during the next decade. These anticipated increases "reflect the enormous range of technical tasks which must be accomplished."

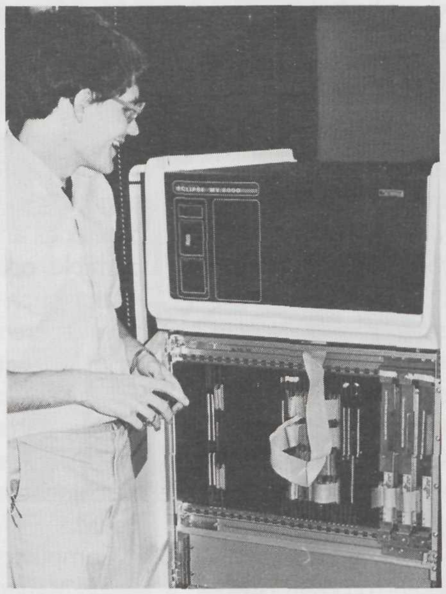
In summary, undergraduate enrollments in engineering are increasing in parallel with increasing demands. They have actually reached a crisis level in some cases in view of the understaffing of engineering faculties nationwide. The problems of supply and demand of engineers are intensified further by the fact that more and more students are recognizing the value of an engineering education as a preparation for careers in other professions—law, medicine, and business—or any pursuit where problems must be faced, analyzed, and solved.

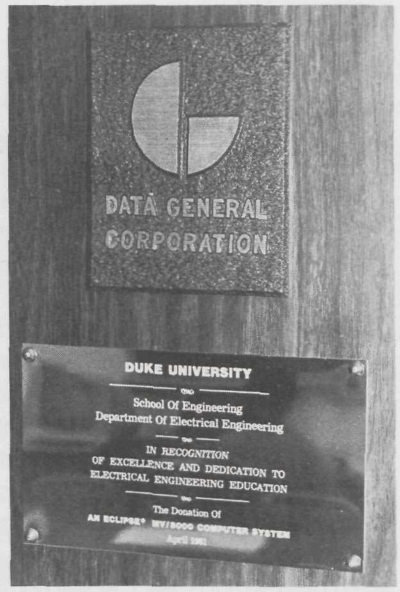
Marion L. Shepard

Computer-Aided Engineering

by KEVIN CLEARY







Assisted by a gift from Data General Corporation, the engineering school has set up the university's first large scale interactive computing network, according to John Board, a graduate student in electrical engineering.

"This is the first time that a Duke department has set up a program that is this comprehensive," said Board, who is responsible for running the system. "Now that we have our own computing facilities, we're finally in control of our own destiny."

The new facility centers around what is known as a "maxi-computer." Data General donated such a machine, the MV 8000, to the electrical engineering department last summer. A similar machine was also given to the engineering school at North Carolina State University. The donation represents a gift worth about $200,000, said Craig Casey, chairman of the electrical engineering department.

"As a local company (the firm has a research center in the Research Triangle area) Data General wants to establish good relations with the universities in the area," explained Casey. "We're also working on a research project with them."

The MV 8000 is classified as an interactive computer in computer terminology. Interactive means that the user and computer communicate directly with each other through a terminal of some kind rather than through cards. In the Duke system, operator terminals resembling typewriters with television screens attached are located throughout the engineering building. These terminals are electronically linked to the MV 8000.

The new facility has already been incorporated into some of the school's classes. In assistant mechanical engineering and materials science professor Tim Hight's design class, ME 141, students are using the computer to study the effects of varying loads on a concrete beam. Students merely input the required data, such as the magnitude and position of the load and the size and shape of the beam. The computer then displays the results, both graphically and numerically.

"Right now, its main advantage is the visualization of problems," said Hight. "A student can set up the equations and get a visual display of what's happening."

"It's kind of neat to see the pictures come up on the screen," said Keith Novak, a student in Hight's class. "It's a lot easier than doing it the old way."

The MV 8000 system is part of the engineering school's plan to give students some background in the area of computer-aided engineering. Currently, almost all industrial corporations use computers in solving engineering problems, but very few Duke graduates have any experience in this area.

"We're definitely looking for people with a computer background," said George Weidenhammer, a recruiter in Union Carbide Corporation's university relations department. "I don't think there are many of our engineers who don't get involved with computers."

"Industry is very eager for students to have these skills because your productivity as an engineer goes up very fast if you can use a computer to assist you in your job," added Casey.

In order to help develop a program in computer-aided engineering, the department of mechanical engineering and materials science has hired David Loendorf, who is a specialist in computer-aided engineering, as an associate professor. Before coming to Duke, where he holds a joint appointment with the computer science department, Loendorf spent 11 years at NASA Langley in Hampton, Virginia. At NASA, Loendorf worked in their structures division, developing methodologies for the use of computers in engineering analysis and design.

"I spent two years looking for a faculty member who could come in and lead us in that direction," said Jack Chaddock, chairman of the department. "It is obviously the way of the future."

"I always planned to go into academia at some point in my career," said Loendorf. "My current goal is to set up a course in computer-aided engineering, for I feel the students coming out of engineering schools today aren't well versed in the use of computers."

During the fall, Loendorf is assisting Hight in teaching the ME 141 design course. In the spring, he will teach two courses: ME 265, which will cover advanced computer aided design, and CPS 154, computers and programming. In addition to receiving a bachelor's in civil engineering and master's in structural engineering from Old Dominion University, Loendorf holds a master's in computer information and control engineering from the University of Michigan and is expecting his Ph.D in aerospace engineering from Michigan in late 1981.

In the future, Loendorf hopes to offer a course in interactive design, where students with different majors will work together on design projects. The course should give students a feel for what industry is really like, said Loendorf.

"Over the long haul, I would like to see interactive computing, including graphics, put in the engineering 51 (introduction to computers) class," said Loendorf. "I would also like to have a sequence of courses in computer aided mechanical engineering that will better prepare the students for the computational environment they will find during their early industrial experience."

Before the MV 8000 was installed, most engineering students and faculty had to use the computing facilities available through the Triangle Universities Computation Center. TUCC is a joint computer network shared by Duke, the University of North Carolina at Chapel Hill, and North Carolina State University. Some faculty had access to departmental research computers, but most of these machines had limited capabilities. In addition, turnaround time through TUCC was often slow, particularly during the day when heavy demands for computer time existed.

"First of all, TUCC is very expensive," said graduate student Board. "It's an obsolete way of computing as far as industry is concerned. Now that we have the MV 8000, we're able to consolidate all of our information in one place."

In addition to the MV 8000, the engineering school has also purchased a disc storage system. The system has a 190 megabyte storage capacity, which is approximately equivalent to 300,000 pages of typed text, said Board. While the school currently has 20 operator terminals hooked up, the machine can theoretically handle up to 128 terminals, but not without expanding its memory capability.

In a joint venture with Data General, Board is working with the company in developing a UNIX* operating system. UNIX is a computer operating system that was originally developed on Digital Equipment Corporation machines and is rapidly becoming one of the world's first portable operating systems, according to Board. The reason such a system is useful is that different computers have different operating codes, i.e., they require different input instructions to produce the same output. With UNIX, a user could move from one computer to another and still use the same operating instructions.

"UNIX has been converted for a wide variety of machines but not for a Data General machine," said Board.

Computer-aided engineering programs have also been set up at many other universities. Assisted by a grant from the department of mechanical engineering and materials science, associate professor Don Wright visited 10 other engineering schools, all on the East Coast, over the summer to examine their computing facilities.

"Most of the schools I visited had far better facilities in the area of computer graphics," said Wright.

At Rensselaer Polytechnic Institute in Troy, N.Y., for example, the school has a separate center for interactive computer work which includes 44 graphics terminals. In addition, RPI has terminals for color graphics work.

"We have been well behind at Duke in interactive computing because we had virtually none," said department head Chaddock. "There are certainly other universities ahead of us. But there are lots of other schools in there with us."

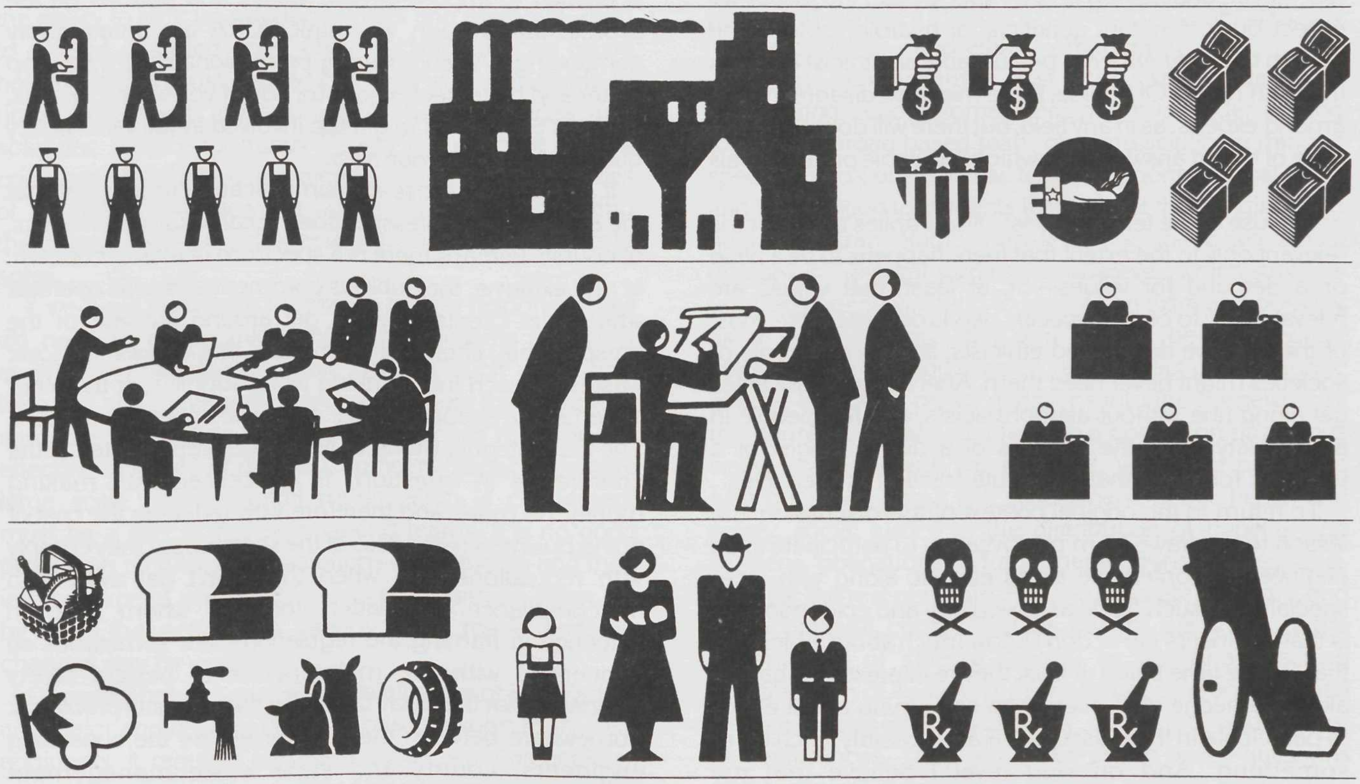
Prospects for computer-aided engineering within the school look bright. According to Chaddock, his department already has a proposal in to one educational foundation requesting support for computer-aided engineering equipment.

"Other universities have realized the same thing that Duke has—computer-aided engineering is going to be a big thing," said Loendorf. "Industry is really clamoring for graduates with this background." ■

*UNIX is a trademark of Bell Laboratories

ETHICS
And the Environmental Engineer

by AL GUNN



Editor's note: Al Gunn is a visiting scholar in the school of engineering from New Zealand.

The theme of this paper is the place of ethics in the engineering professions—particularly environmental engineering. I maintain that traditional and contemporary engineering training and practice give insufficient emphasis (when they give any at all) to the ethical aspects of decisions about technology. The result is that ethical questions are left to nontechnologist academics, citizen pressure groups and the consciences of legislators. I argue that we need to equip our engineers to view engineering problems as more than just technical questions, and that the serious consideration of ethical questions ought to become part of the engineering decision making process.

I was made forcefully aware of these issues when I was recently fortunate enough to attend a Conference on Accountability in Hazardous Waste Management, sponsored by the Engineering Foundation, at Franklin Pierce College, Rindge, New Hampshire. My role was to take part in panel discussions as an "ethicist", along with a number of other specialists in technical and regulatory aspects of hazardous waste management.

I am unsure what precisely an "ethicist" is or does, and the designation was certainly not of my own choosing. Indeed, the only published attempt I have seen to define the term was in a book review in the *New York Times* of August 2, 1981: the author stated that an ethicist is a person who worries about his or her own values, while a moralist worries about everyone else's! But I take it that an ethicist means one who is, or aspires to be, an expert on ethics or values. Just as, if you want to find out about population trends or fossils or data processing, you consult a demographer, a paleontologist or a computer scientist, so if you want to find out about values you consult an ethicist. Since I teach and publish on ethics, and am particularly interested in environmental and public policy issues, presumably I am a practical or applied ethicist.

At the risk of doing myself out of invitations to speak at other engineering conferences, I am inclined to reject the label "ethicist" and the concepts which appear to lie behind the label. The term implies that the study of value problems is reducible to a series of technical problems, which certain highly trained people (recognizable, no doubt, by their Ph.D.'s in philosophy or public policy) are equipped to answer—unlike the rest of humanity. Just as the average person has no pretensions to understand very much about selective breeding or land drainage (so better call in a geneticist or a hydrologist), it is implied that ethics, too, can be understood only by specialists. And just as we expect our consultant geneticist or hydrologist to come up with the *right answers*, presumably an ethicist also has the truth for us. Of course, there might be disagreements among experts, as in any field, but there will doubtless be a state of the art answer upon which reputable professionals agree.

The use of the term "ethicist" also implies that ethics is relevant only to the extent that there happens to be a need or a demand for values—or, at least, that values are relevant only to certain specific needs or areas of life. Most of the time we don't need ethicists, and some people or societies might never need them. After all, lots of societies get along fine without astrophysicists, and few people in any society need the services of a dermatologist or a urologist for more than a minute fraction of their lives.

To return to the original context of this discussion: the lesson to be drawn from my invitation to participate in an engineering conference as an ethicist, along with other specialists is such fields as toxicology and epidemiology, is that engineers *per se* don't know much about ethics, but that for the time being at least they're interested in having along someone who *does* know something about ethics to participate in their discussions and possibly teach them something. And on *that* level I believe that my contribution was modestly successful, because the ideas I presented generated some good discussions, both formally and informally.

Still, I felt that many of the engineers present were interested in ethical questions in much the same ways as they might have enjoyed discussing fishing or movies or how to make a good strawberry margarita. That is, their interest seemed more personal than professional. Engineering problems—specifically, the analysis, transportation, storing and reprocessing of hazardous waste materials—were viewed as technical problems: for a consulting engineer, how to design a secure landfill site that will meet the client's requirement at lowest cost. The only constraints recognized appeared to be a commendable professional pride in doing a technically good job, and a sometimes reluctant acceptance of a responsibility to stay within the law—to fill out manifests of hazardous waste material, to provide liners and coverings of specified standard and soon—because that is what is *required* under the Resource Conservation and Recovery Act (RCRA). There seemed to be some resentment at the degree of regulation and paperwork required under RCRA, perhaps even a sentiment that the maintenance of strict standards is necessary only because that is what the law requires. One's duty to the public, in this context, is what the law requires or exacts of one, not what one feels as a moral obligation to be fulfilled whether or not anyone can enforce it. I did not have the feeling that the profession as a whole has internalized safety standards, nor that they feel it to be a matter of personal responsibility to protect the public from severe risks. The message was: hazardous waste management is a job for professionals. The public is entitled to impose certain values and policies on the profession (though we think RCRA is unreasonably demanding). As engineering professionals, we'll develop better and better techniques for you, if you want to hire us. But don't expect us to get too involved in values or policy questions—that's your area.

It would be a gross oversimplification to suggest that the engineering profession doesn't care at all about ethics, of course. Perhaps there is a spectrum of ethical concern: at one extreme, the dubious commerical landfill operator who offers clients ways to get around the law, or the irresponsible chemical company that allows its toxic wastes to leach into drinking water supplies; at the other extreme, the academic and "idealistic" graduate student. The first category (none of whom was represented at the conference in question) is concerned with making money, no more, and therefore with reducing the cost of doing business regardless of the social costs; they comply with regulations only when they can't get away with noncompliance. The latter, some of whom have an influence in framing the regulations, are sometimes so concerned with the maintenance of perfect safety standards that they may fail to see the practical problems. Somewhere between these extremes are the consulting engineers, county and state waste management personnel and so on, who actually have the job of getting rid of the wastes we *all* produce.

This leads me to note that the production of hazardous wastes, pollutants, and other damages to health and the environment is not a conspiracy on the part of Hooker or Allied Chemical, bent on destroying land and rivers for their own ends. No one *sets out* to do business as a polluter. Society *demands,* in huge quantities and at low prices, products, the manufacture of which, even with the best available technology, produces toxic and other hazardous byproducts and residues—everyday products like car batteries, house paint, pesticides. Evidently the public isn't much interested in the ethical issues here—why should I single out engineers for moral stricture?

I'm not, or at least I don't mean to. One way or another, it is society which decides how its engineers are to be trained, how many of them there will be, how much they earn, and what standards they will abide by. But the majority of society have opted out of their responsibility as citizens. In too many fields we've been content to leave it to experts—physicians, lawyers, politicians, engineers, and now, apparently, ethicists. We have trained engineers to believe that the best solution to any engineering problem is the best *technical* solution, the one which meets the client's specifications at lowest costs, and we have rewarded engineers handsomely for practicing what they were trained to do. Because the engineer does only what the client wants, he or she is free from the responsibility to make value judgements.[1]

Overspecialization is bad for a number of reasons. It breeds inflexibility and narrowness of outlook whereas in a world of rapid economic, political and technological change we need professionals who can adapt, who have the ability to pick up new techniques and methods—and to discard outdated ones. Overspecialization can cause hostility and distrust between experts who are unable to understand each other's ideas, methodologies and solutions. Most importantly for my argument, it breeds compartmentalization and almost guarantees that issues of importance to everyone will be handled by breaking them down into isolated, specialist problems for experts to solve.

If we want engineers to take on ethical responsibilities we need to stop thinking of *any* problems as purely engineering questions. There are no such questions, because any engineering decision affects the welfare of someone other than the engineer—not to mention the effects on the rest of nature. Engineers (especially where large scale environmental modification is concerned) must be a part of decision-making teams. It is no good producing technological solutions to problems and then inviting experts and the public to comment on them, for by then the policy has already been made and few changes can be expected.

Given the present compartmentalization of knowledge, any major engineering decision has to involve more than engineers. It requires experts in fields, such as ecology, soil sciences, sociology, demography, law, and public policy. But such a multi-disciplinary approach ought to be no more than a stop gap. The true solution, in my view, is to broaden the education of engineers and other experts so that they become less narrowly specialized and more capable of considering the social and public policy aspects of engineering decision making. Needless to say, I also advocate a broader education for specialists in other disciplines, too. Philosophers should not be exempt—anyone who pretends to special competence in the raising of ethical issues in, say, engineering, medicine, law or politics, ought to know something of the practical problems and working methods of these professions. No one can be an expert on everything, of course, but everyone needs a broad general acquaintance with a range of disciplines in order to practice his or her specialty in a responsible—and ethical—manner.

As an experimental first step, some idealistic engineering school somewhere might consider putting together a broad based team of interdisciplinary minded specialists to consider how to feed in nontechnical ideas and information to students throughout their engineering degree program. Rather than designing one or two special courses in "general studies" or whatever, which students (and engineers) will tend to view as an extra and possibly as a tedious chore, the aim should be to integrate considerations of social costs, fair distribution, economic effects, and other policy questions into the framework of the degree program. Students in a course on hazardous waste management, for example, would be presented with questions about risk assessment, public health and safety, social justice in the distribution of benefits and burdens, obligations to future generations and responsibility for the rest of nature. Not in a separate, ancillary, and often optional course, but as part of the study of the techniques of secure landfill or the analysis and identification of wastes. They would become accustomed to considering ethical questions "on the job" and not just at conferences. They would see public policy questions and technical questions as different aspects of the same problem, not as different problems for different experts.

It is time that we took ethics away from the ethicists and spread it around the community. The engineering profession, because of its enormous effects on the face of the earth, the biotic community, and the quality of human life, would be a good place to get started. ■

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[1]Sam Florman, The Existential Pleasure of Engineering, Sr. Martins Press, New York, 1976. See also A.S. Gunn, Ethics, Engineers and the Environemnt," *Soil and Water*, Feb. 1981.

Luis Castellanos mines copper with software.

Most copper is found deep underground. But the Bell System's 995 million miles of copper cable have tons of it above and below ground. That copper provides vital circuit paths to transmit customer voice, data and video signals for today's Information Age needs.

And Luis Castellanos, seven years out of undergraduate school, supervises one of the groups that helps Bell System companies "mine" all that copper. He works with one of the largest computer hardware and software systems in the world—the Trunks Integrated Record Keeping System (TIRKS). Every day it "mines" the vast Bell network for available circuits and equipment. As a result of efficient use of network facilities, the Bell System saves millions by eliminating the need for certain capital expenditures.

Plus, there's more to TIRKS than "mining copper." It also configures circuits and assigns components needed for each circuit path. That allows Bell companies to respond faster to customer requests for complex services like video and data transmission. Employees are more productive too, because TIRKS helps them set up circuits and forecast facility needs.

Before TIRKS was available, keeping track of communications circuits and facilities required enormous amounts of paperwork and manual calculation. Every day, the average Bell System company handles orders involving 1500 circuits and up to 7500 individual components associated with them. Each detail has to be specified and accounted for.

Now, thanks to people like Luis, TIRKS keeps track of all that information instantaneously using computers. Information is up-to-date. It's instantly available. And it's more accurate.

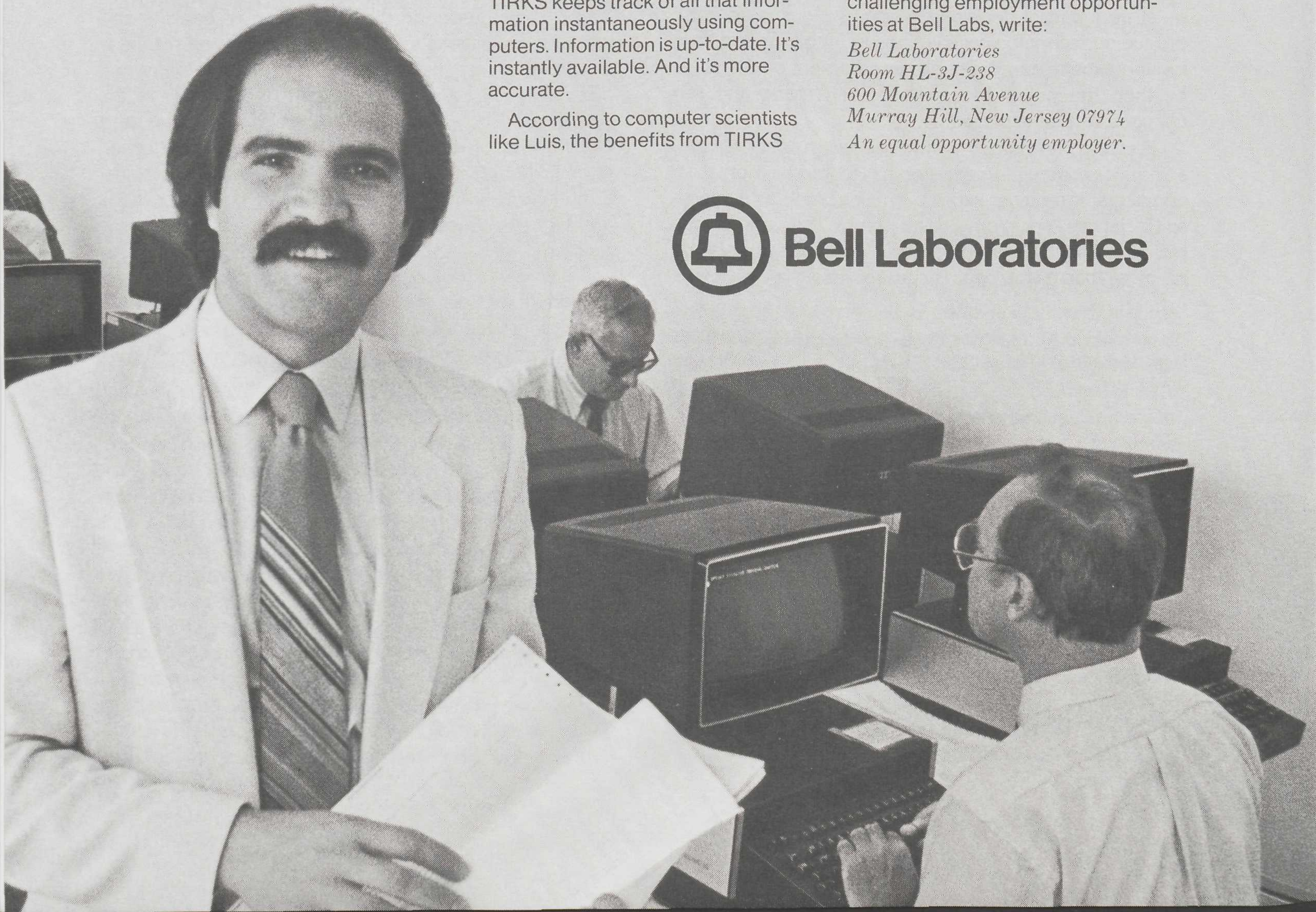
According to computer scientists like Luis, the benefits from TIRKS are just beginning. He believes that, as more computer hardware and software systems like TIRKS interact, new benefits for customers may be possible, as well as additional productivity increases for employees.

Luis joined Bell Labs with a B.S. in computer science from Pratt Institute. Under a company-sponsored graduate study program, he attended Stevens Institute of Technology for his M.S. in computer science. At the same time, he worked part-time assuming responsibility for a large piece of TIRKS software. Working with design teams, he gained valuable insight from experienced members. Now, his technical performance has earned him a promotion to supervisor.

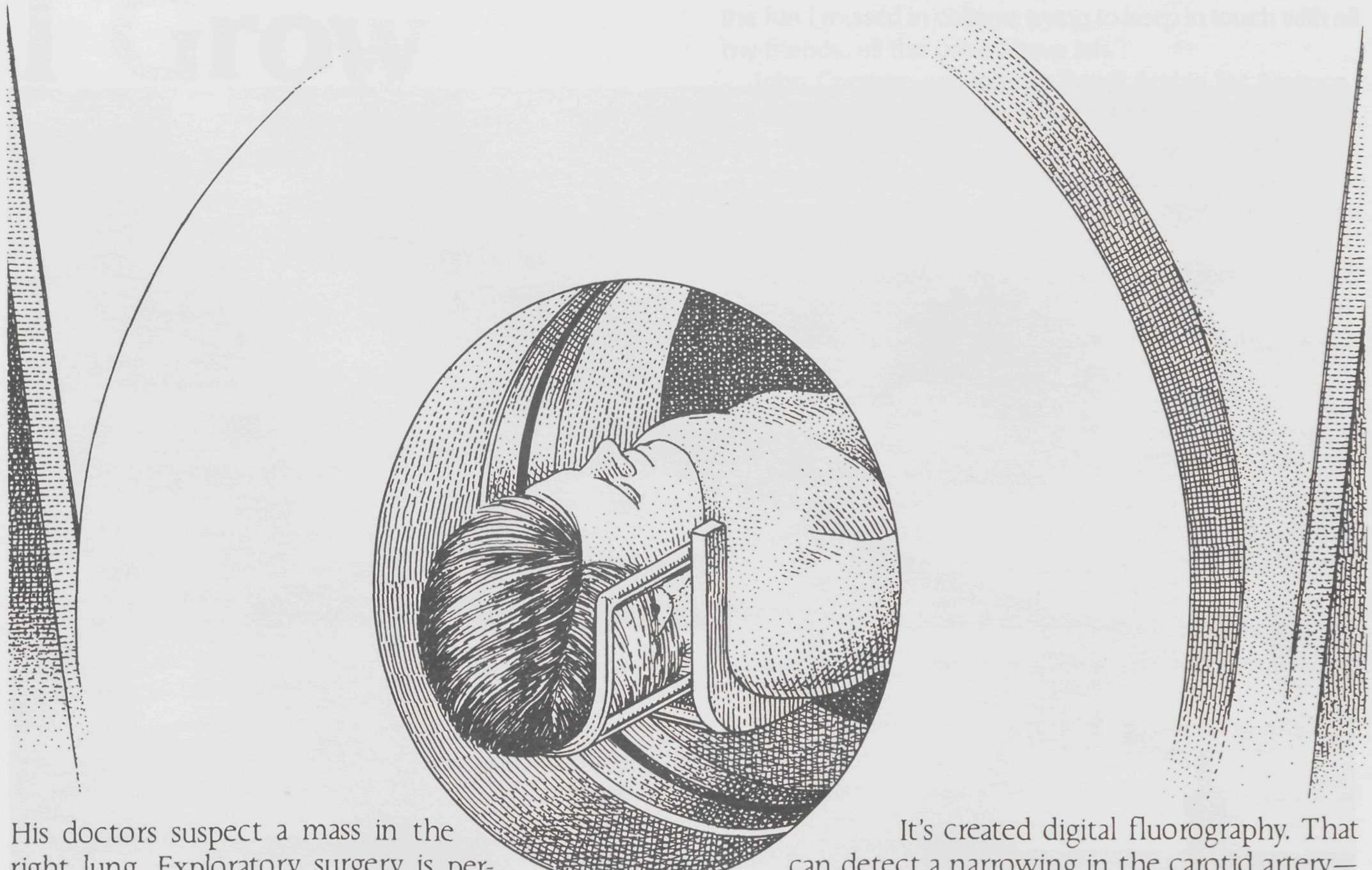
If you're interested in similar challenging employment opportunities at Bell Labs, write:

Bell Laboratories
Room HL-3J-238
600 Mountain Avenue
Murray Hill, New Jersey 07974
An equal opportunity employer.

Bell Laboratories

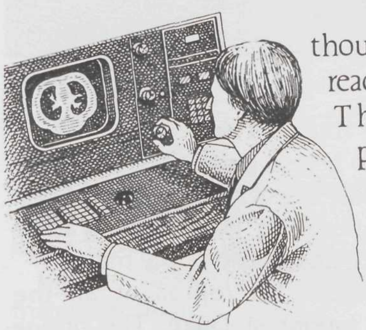


The silicon chip. It's replacing the scalpel.



His doctors suspect a mass in the right lung. Exploratory surgery is performed—but without the surgery.

This is made possible because of a major advance in radiology called the CT Scan (short for computed tomography).



The CT Scan provides thousands of digitized X-ray readings of a patient's body. Then, using a computer, it synthesizes the data into a series of cross-sectional or tomographic images—all within seconds.

The detail is incredible. Often a diagnosis can be arrived at immediately—so the patient is spared the knife.

But it's the heart of the computer that's the real miracle. The silicon chip.

The silicon chip is responsible for a new wave in microelectronics and a remarkable revolution in medical diagnostics.

It's created the digital ultrasound imager. That helps doctors visualize the womb of a pregnant woman with sound waves to monitor fetal development.

It's created digital fluorography. That can detect a narrowing in the carotid artery—without hospitalizing the patient for an angiogram.

General Electric is committed to finding new ways to make the computer chip serve. In medicine. And in other industries.

For instance, we're investing 100 million dollars in our new GE Microelectronics Center.

We've acquired INTERSIL, one of the leading designers of specialized computer chips. We've also acquired CALMA, a company which is using CAD/CAM technology to revitalize the American factory.

GE is even exploring new uses for microelectronics in satellite communications, radar and robotics.

Microelectronics is where the future is. A future that will need talent. Engineering talent.

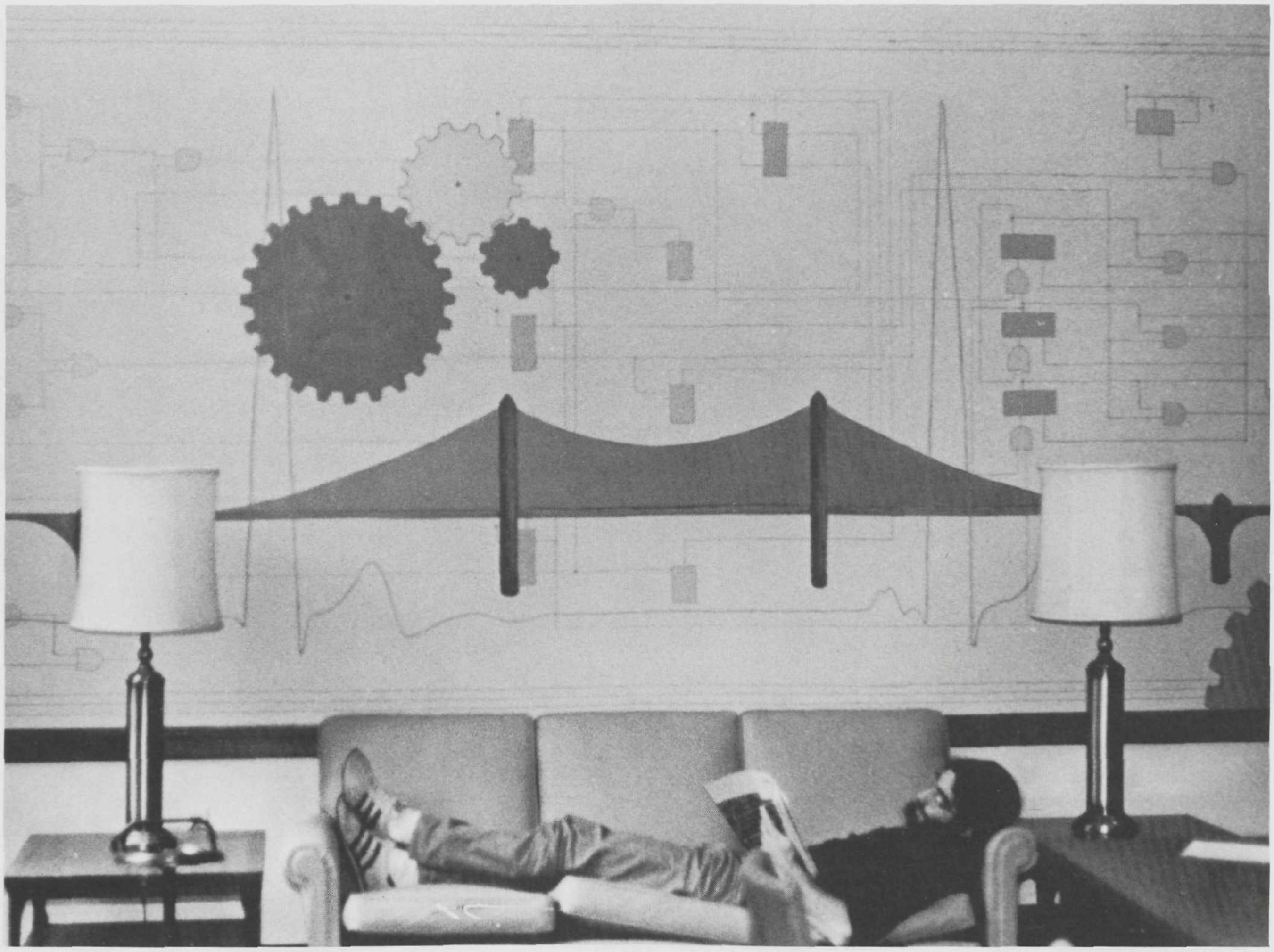
If you'd like to know more about engineering opportunities at GE, check your Placement Office or write to: Engineering, Building 36-504, Schenectady, NY 12345.

GENERAL ELECTRIC

An Equal Opportunity Employer

Engineering Mural

by ALLISON HAACK



The engineering lobby has always been a multifaceted room. Located directly across from the library, it conveniently accepts the overflow of hard-working students who cover the tables with graph paper and calculators. The comfortable chairs are a haven to groggy engineers who catch a few Z's between (and sometimes during) classes. On donut day, this room is transformed by chocolate covered grins and mumbled conversation. Unfortunately, however, the decor of the lobby has always been rather dull.

Last spring improvement began. Within a month, a mural had been mysteriously created on a wall of the lobby. No, there were no artistically inclined elves involved. Six members of Maxwell House, who worked at night, deserve the credit.

Andrea Livingston, a biomedical engineering graduate of 1981, designed the mural. There was quite an assortment of people who helped paint: Chris Guryan, a physics major; Leslie Ruda, a psychology major; Brian Miller, an electrical engineering major; and Taddie Nichols, a political science and public policy major.

The mural was designed to represent all the engineering disciplines taught at Duke. The bridge represents civil engineering. Gears are for mechanical engineering (not "Gearheads"). Biomedical engineers should recognize the electrocardiograph signal and the body (hopefully, everyone recognizes the body). The circuit represents electrical engineering and was actually designed by Andrea to run an elevator.

The engineering lobby now has style and flair, another accomplishment of those imaginative and talented Duke engineers. ■

When I Grow Up . . .

by LISA ARAK, SCOTT KATZ, and JEFF REHM

It seemed to us that there is a common curiosity among members of the senior class as to the plans of their peers upon graduation. So, upon the impetus of this curiosity, we conducted an informal survey of the engineering class of 1982 (and others) and found an interesting array of different plans for the future. Some of the replies were of a whimsical nature, such as BME John Arc's plans to "design and market the world's first Teflon birth control device." Most of the responses, however, were of the serious, straightforward type expected of Duke engineers. Nonetheless, we are pleased to present a nearly comprehensive sampling of Duke engineers' hopes and dreams (mostly dreams).

Rich Aicher—wants to work with advanced energy systems and eventually go into management with his own solar energy company.

Chuck Lutes—"the air force: a great way of life."

John Ortiz—biomechanics, advanced degree in classical engineering applied to biomedical research.

Barb Wolf—oceanstructure engineering—design offshore structures—eventually MS.

Mark Mullen—for lack of nothing better to do, going to Orlando NucPower.

Bill Gex—going into engineering, MBA later.

Meredith Emmett—working at a small solar engineering firm hopefully doing design.

Carolyn Case—failure analysis, mechanical testing, material testing.

Jan Wood—"I want to have a nice job with a good company and make lots of money."

Mike Swanson—masters in philosophy while working part time as an engineer.

Chris Divall—"drink wine."

Scott Katz—"I want to learn how to skate."

Danal Blessis—working—construction management of large utilities.

Robin Klatzkin—graduate school in engineering and business.

Akiko Hayashi—CE grad school specializing in structures.

John Martin—business school; general management in construction.

Debbie Sabitini—"working at being consistent with my ethics and my actions; seeing the world; making up for all the fun I missed in college; trying to keep in touch with all my friends, all the ones I have left."

John Conway—working in Saudi Arabia for Aramco.

Laddeus Sutton—development and research in biomedical engineering; possibly medical school later.

Thaddeus Sutton—design and production of biomedical products and instrumentation; eventually go to medical school.

Reginald Moore—graduate school in biomedical and clinical engineering.

Larry Samuels—medical school, research and design of biomedical/surgical instruments.

Jean Tkach—graduate school—electrical engineering/instrumentation.

Calvin Wilson—medical school.

Alex Knight—R&D, electronic system microprocessor and instrument design.

Simon Lau—engineering grad school—IC and Computer Systems.

Pete Groth—communication—graduate school.

Laura Balch—business school, NASA—become an astronaut.

Mark Kadonoff—wants to go to engineering graduate school in robotics.

Joel Marks—wants to go to graduate school in biomedical engineering in either instrumentation or electonic applications.

John Barton—is going to medical school—yes, at Duke.

Greg Stock—is going to be a real live electrical engineer.

Lee Ann Robinson—is going to medical school to practice.

Melodie Feather—is going to dental school.

Michelle Lester—wants to go into biomedical research and development.

Elisa Bartashvich—work for a medical supply and pharmaceutical company as a BME and eventually go to business school.

Claudia Hardenbergh—design and marketing of BME devices.

Andre Mazzoleni—wants to become a professional baseball player or a fireman.

Dori Ripple—wants to get an MBA and eventually go into international business related to BME.

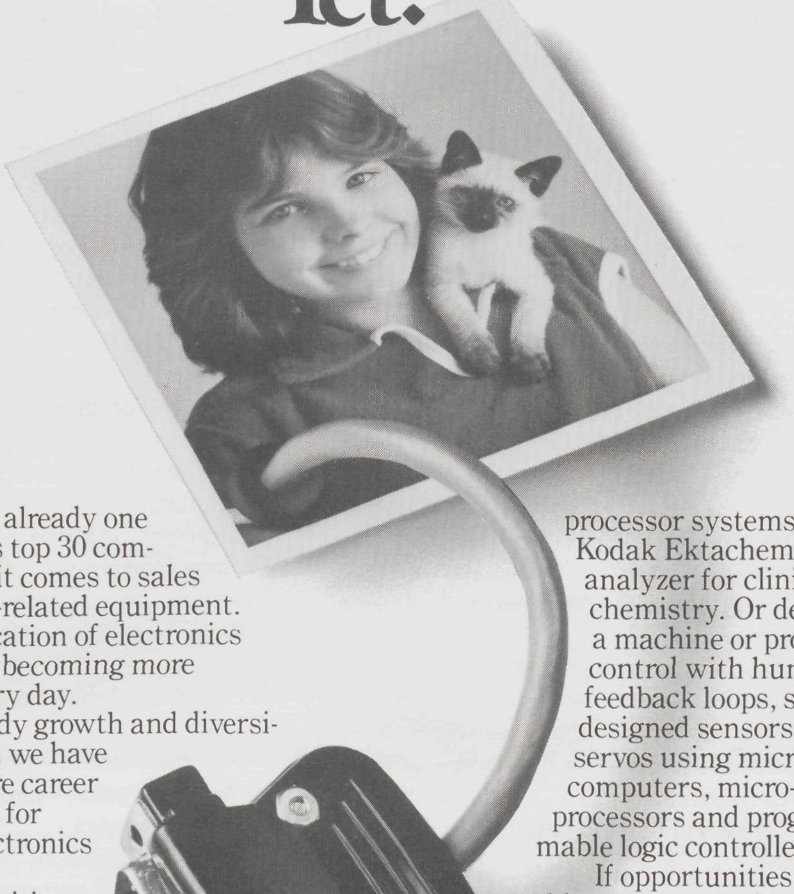
Bill Jemess—work in the pits or get an MBA and go into technical management.

Mike Ruth—work for Budweiser as a taste tester.

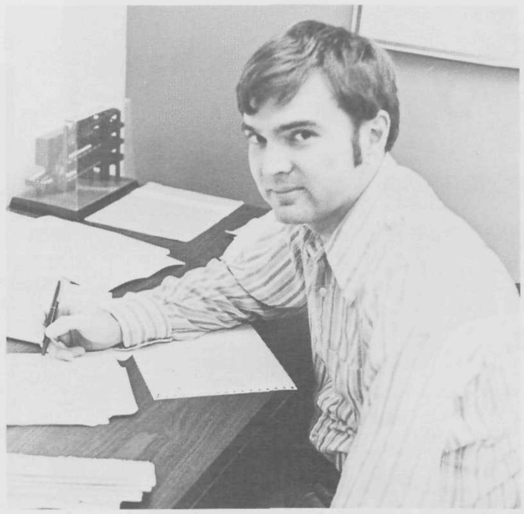
Pam Jenkins—study in Germany, then get married and become a housewife and fix the car in the offseason.

Charlie Nobles—work on a farm.

John Conally—go to law school.



Dr. David Loendorf



Dr. Chris Carroll

Have You Met?

by JOHN ORTIZ

This semester the engineering school has welcomed several new professors in all four disciplines.

The biomedical engineering department confirmed research assistant professorships upon Dr. Maret Maxwell and Dr. Ralph Scallion. Maxwell received his Ph.D. in December 1980 from Duke for his work in gait analysis with Dr. James McElhaney. He has been concentrating on implementation of design improvements in the gait analysis lab, and development of lower limb sensory feedback systems. An unusual combination of ardent caver and computer whiz, he plans to continue his present work using an expanded patient population.

Along a different research track is Dr. Ralph Scallion's involvement in ultrasound research. His 'baby' is a digital imaging device currently being tested. He has worked at Duke since 1977. Scallion received his master's from MIT in electrical engineering and his M.D. from Case Western Reserve. His primary appointment is with Duke Medical School, and he can be found splitting his research time between his labs in the hospital and the BME department.

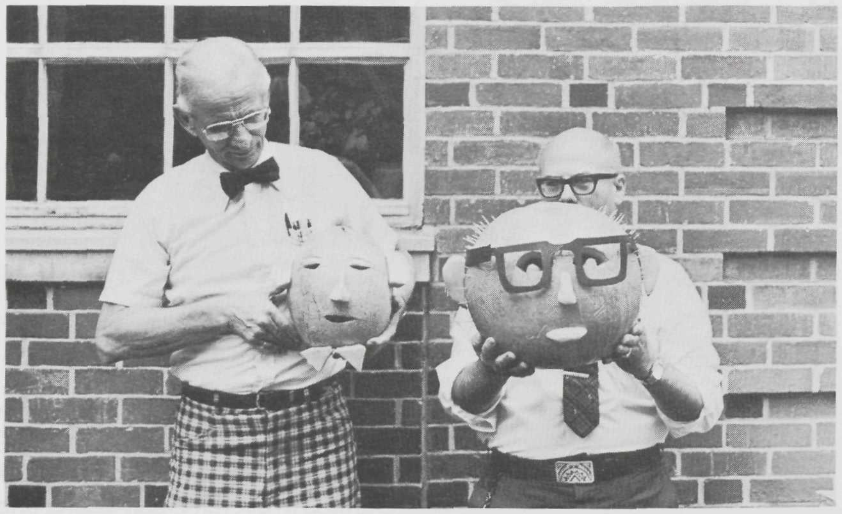
The civil engineers have been joined by two visiting faculty members this fall: Dr. Tomasz Wierzbicki, visiting professor, and Dr. Robert J. Hayduk, visiting associate professor. Wierzbicki comes to Duke on sabbatical from his post as a professor of mechanics at the Polish Academy of Sciences. After spending this past spring performing oceanographic research work at MIT, he is currently teaching undergraduate and graduate courses in continuum mechanics. He has written several articles on plasticity research and the study of crashworthiness. Hayduk also has an extensive background in crashworthiness testing. As a senior research engineer at NASA Langley, he has concentrated in aircraft crash testing and analysis since 1974 with work in aircraft instrumentation and NASA crash simulation tools. Both of these faculty members participated in the Duke University hosted "Crashworthiness Engineering" course held November 4-6.

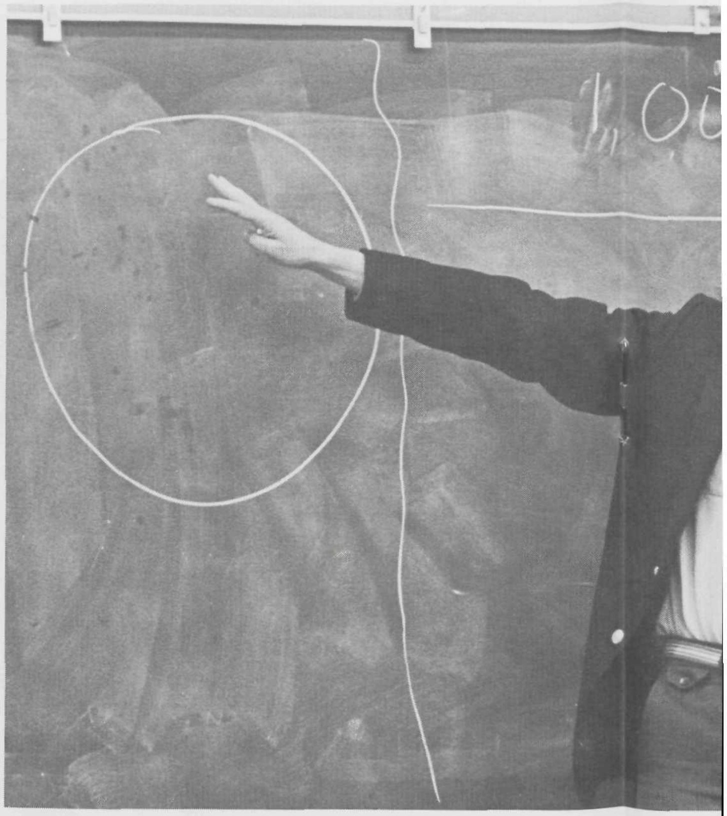
The electrical engineers have added faculty which reflects the Triangle Area's booming micro-electronics/micro-computer growth. Dr. Chris Carroll, an assistant professor, brings Duke a teaching faculty member interested in micro-electronics design, specifically with very large scale integrated circuits. An alumnus of California Institute of Technology where he received advanced degrees in electrical engineering and computer science, he currently teaches switching theory, and will offer a course in the circuit design, architecture, and fabrication of VLSI circuits this spring. Also joining the electrical engineering faculty, as an adjunct professor, is Dr. Norman Strole. Strole currently teaches a course in switching theory at Duke and holds a full time job with IBM in the Research Triangle. He completed both his Master's and Ph.D. studies at Duke while working at IBM.

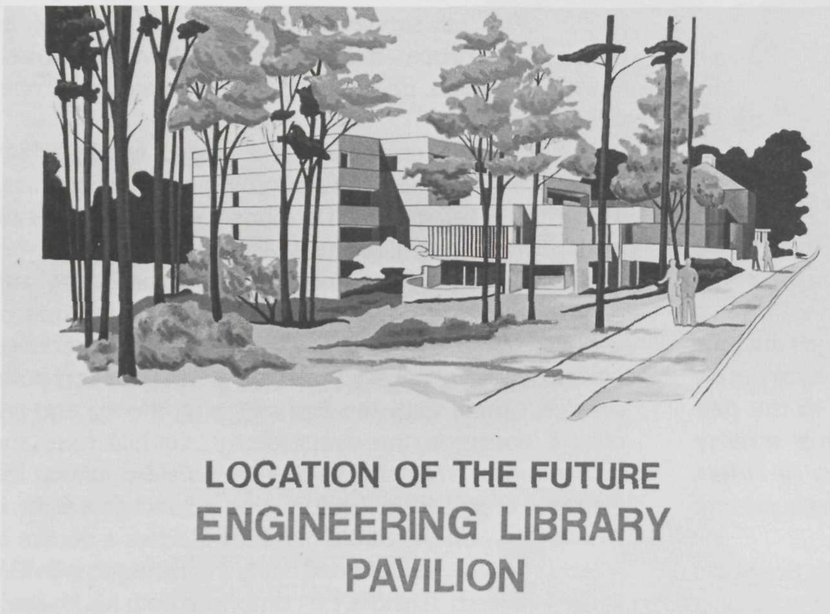
Finally, the mechanical engineering department has added three faculty members. Dr. David Loendorf, an associate professor, came to Duke to initiate a program in computer-aided engineering.

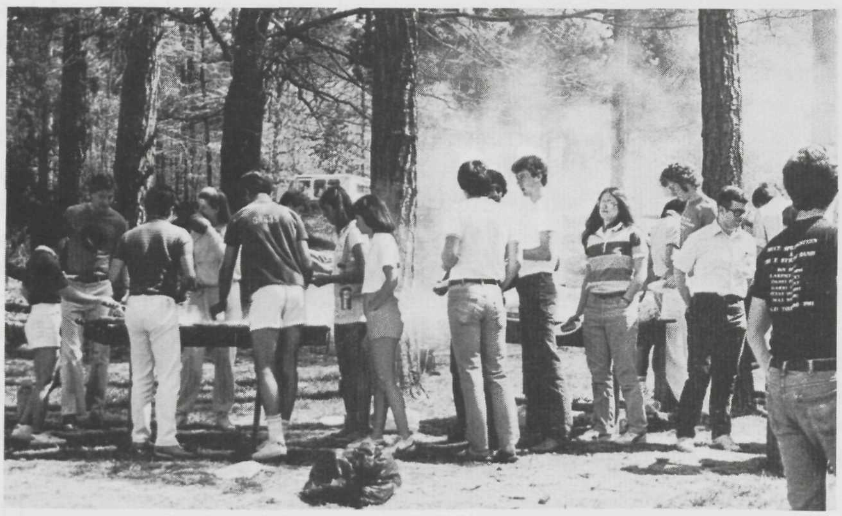
To instruct ME 254, solar energy and thermal processes, both Dr. Richard Whisnat and Dr. Tony Sigmon have received appointments as adjunct associate professors. Whisnat currently works with the energy systems department at the Research Triangle Institute as a technical and administrative supervisor of photovoltaic and thermal energy system analysis. Sigmon also works with the energy systems department as a research engineer. His primary work involves the development and management of programs relating to thermal energy storage systems. ■

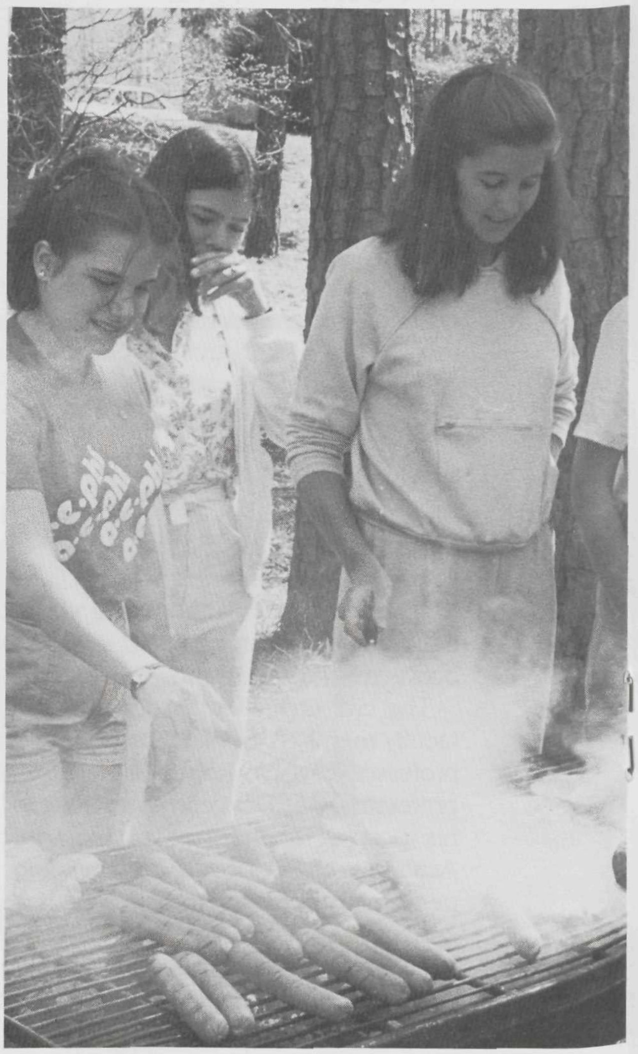
The Way We Are

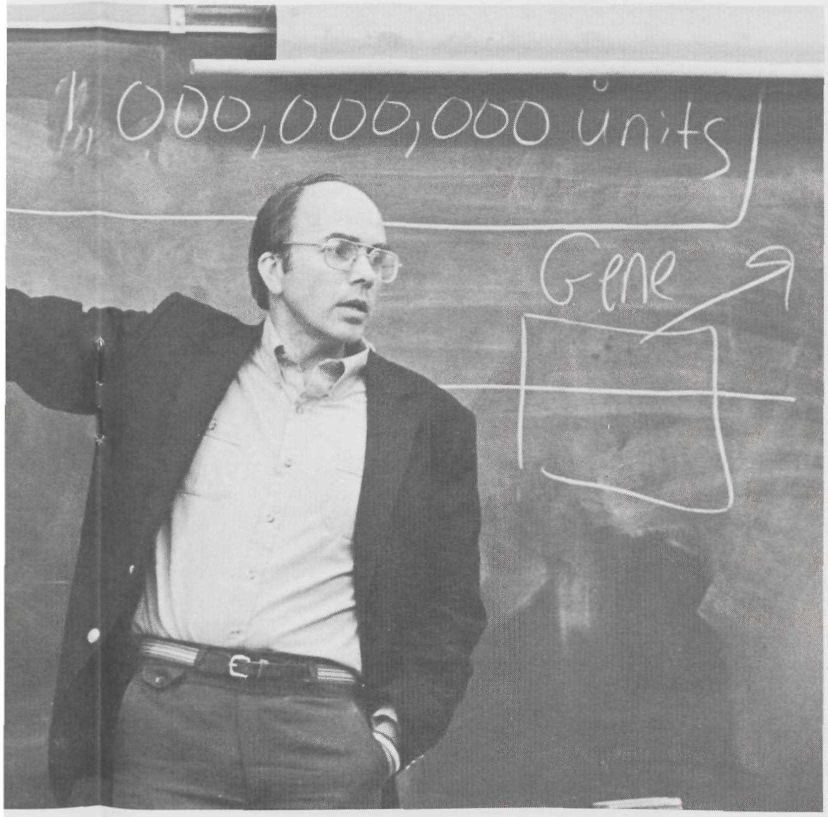








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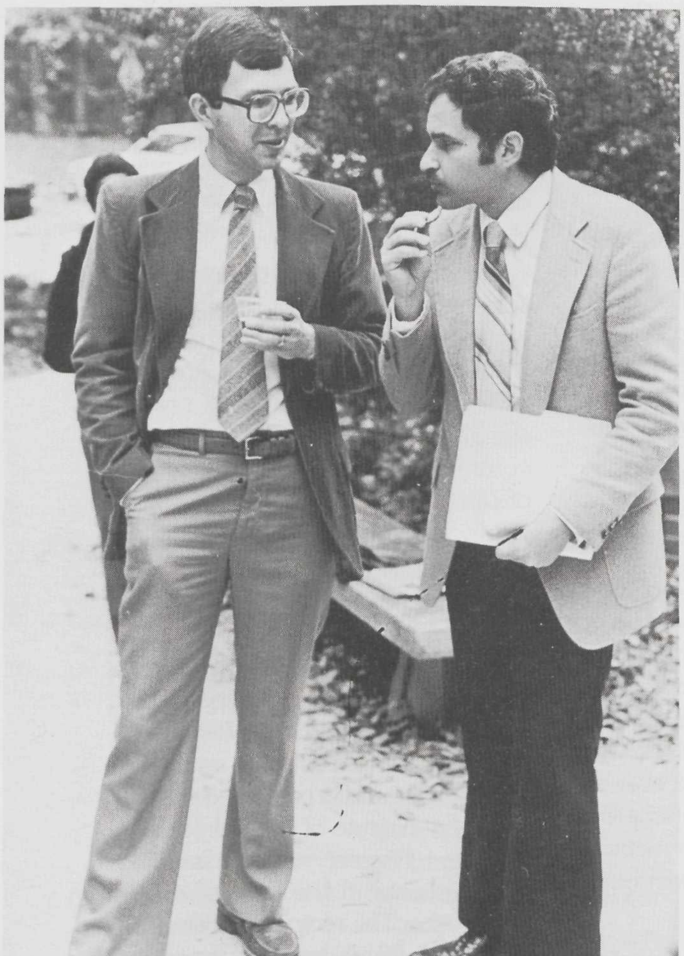
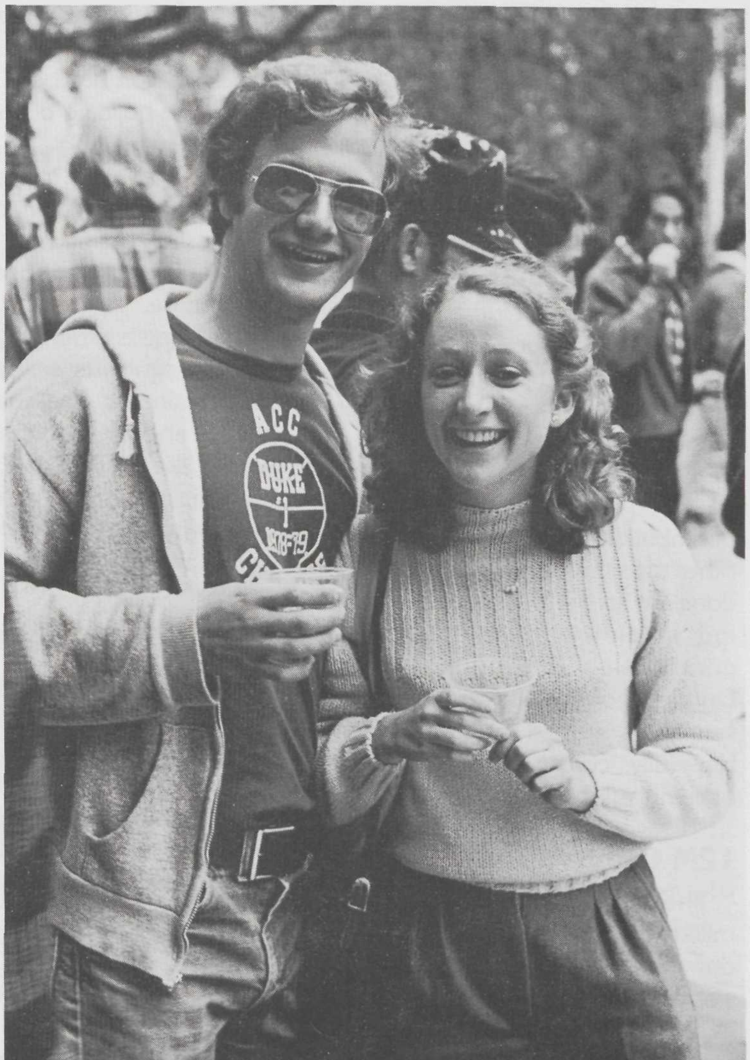



ACC
DUKE

School News

School Receives $1.5 Million

Duke University recently received a donation of $1.5 million from Nello L. Teer, Jr. and R. Dillard Teer and their families, to help finance the $3.5 million library-research building for the School of Engineering. The donation is given in memory of their father, the late Nello L. Teer, whom the new building will be named after.

Teer was once a Durham brick mill employee who founded a world wide construction company in 1909. His company did much of the site preparation for Duke's West Campus in the 1920's and the early 1930's.

The gift is the largest single contribution from a Durham family other than the Dukes, and the largest donation to the School of Engineering in almost thirty years. The contribution is an honor to the Durham community and Duke University, as well as to Nello L. Teer. Hopefully, construction on the new building will begin in 1982.

12M Campaign

The Engineering School's $12 million fund-raising campaign for endowment and program support as well as construction of the new building has bypassed the $4 million mark, and prospects for continuing progress look extremely bright. Annual giving for the 1980-81 year was its highest ever at $95,612, an increase of 22.6 percent over 1979-80.

$2.7 million has been allocated so far for the building of the new library pavilion, leaving an additional $800,000 needed to start construction. If the campaign continues as successfully as it has started, this should be accomplished in the very near future.

Everyone is extremely pleased with the tremendous response to the project since it was announced last March, and the Engineering School would like to thank all the friends, alumni, corporations, and foundations who have so generously supported the school.

Awards

Susan M. Blanchard, a doctoral student in biomedical engineering at Duke, has won second place in the student paper competition at the 34th annual conference on Engineering in Medicine and Biology. Blanchard was the second woman student ever to enter the competition. Blanchard's research involves a computer method of recording hundreds of electrocardiograms at one time.

Kenneth Hepps, a junior majoring in biomedical engineering, has been chosen as one of two 1981-82 recipients of the Central Carolina chapter of the Professional Engineers of North Carolina scholarship. Hepps has consistently made the Dean's list and is a member of Tau Beta Pi, the engineering honor society. His summer work includes biomedical engineering experience and he hopes to make a career of research and development.

Miguel A. Medina, assistant professor in the department of civil engineering, has been selected for the 1981 Outstanding Young Men of America Awards for his outstanding professional achievement, leadership and community service. The 1981 edition of *Outstanding Young Men of America* includes biographical sketches and accomplishments of the recipients of the award each year.

Dr. Thomas G. Wilson of the electrical engineering department has been awarded the William E. Newell Power Electronics award for 1981. The award is presented annually by the Institute of Electronics and Electrical Engineers for outstanding achievements in the field of power electronics. The recipient receives an award of $250 and an inscribed plaque.

Notice

The Engineering Library needs volumes 76 (1950) - 81 (1955) of the ASCE PROCEEDINGS as well as volumes 1-22 (1873-1896).

Nominations are requested for the distinguished alumni awards for the 1981-82 year. Please send any suggestions to Jeff Clark, School of Engineering, Durham, NC. 27706. We look forward to hearing from you.

Service Citation

Dr. Myron Walbarsht, professor of ophthalmology and biomedical engineering, received a service citation from the Society of Photo-Optical Instrumentation Engineers. The citation expresses appreciation to Wolbarsht for serving as co-chairman of the society's 1980 symposium.

Wolbarsht and David H. Slimey published a book, "Ocular Effects on Non-ionizing Radiation," detailing the subject matter presented at the symposium.

Recent Gifts

The school of engineering recently received a $1,500 gift from General Electric Company in recognition of George H. Kellerman's membership in Pi Delta Gamma. Kellerman, who graduated from Duke in 1940 with a bachelor's in electrical engineering, is a General Electric employee.

Duke Engineering 1981

Enrollment (1981-82)	
Undergraduate	849
women	(25%) 210
minorities	(7%) 58
Undergraduate applications	1,409
offered admission	(35%) 490
accepted admission	(40%) 194
Mean SAT scores	
verbal	614
mathematical	701
combined	1,315
Median SAT scores	
verbal	620
mathematical	720
combined	1,340
High school standing	
upper 10%	90%
upper 20%	97%
High school origin	
public schools	73%
independent schools	27%
Geographic origin	
Southeast	28%
Middle Atlantic	16%
Northeast	30%
New England	8%
Midwest	9%
West and foreign	9%
Graduate	116
master's	(51%) 59
doctoral	(49%) 57
Graduate applications	226
offered admission	(50%) 113
accepted admission	(31%) 35
Mean grade point average	3.3
Mean GRE scores	
verbal	584
mathematical	718
combined	1,302
Class of 1982	182
Biomedical Engineering	37
Civil Engineering	23
Electrical Engineering	38
Mechanical Engineering and Materials Science	84
Career plans	
Industry	62%
Government	2%
Graduate school (engineering)	25%
Professional schools	11%
Engineer-in-Training Exam passing rate	94%
Election to Phi Beta Kappa	12%
Active Alumni	3,749
Faculty	66
Professors	31
Associate Professors	12
Assistant Professors	13
Visiting and Adjunct Professors	10
Outside Sponsored Research Expenditures	$1,923,364
Gifts and Grants	$855,480
Private sources	$759,867
Loyalty Fund	95,613

Department News

BIOMEDICAL ENGINEERING

The following faculty have been awarded research and training grants by the National Institutes of Health:

Dr. Robert M. Hochmuth for research on "Red Cell and Membrane Deformation in Capillary Flow," in the amount of $143,291.

Dr. Theo C. Pilkington for research on "Training of Cardiovascular Biomedical Engineers," in the amount of $732,302.

Dr. Frederick L. Thurstone for research on "Dynamic Cardiovascular Measurement Using Ultrasound," in the amount of $570,704.

Dr. Olaf T. von Ramm for research on "High Speed Ultrasound Imaging," in the amount of $299,814.

Professor Pilkington was also recently reappointed for a second three-year term as editor of "IEEE Transactions on Biomedical Engineering."

Susan M. Blanchard was recently awarded second place in the Student Paper Competition at the 34th Annual Conference on Engineering in Medicine and Biology. The paper was based on her research, "A Voltage-Triggered System for Adaptive Sampling in Body Surface Mapping." Blanchard is in the doctoral program in Biomedical Engineering. ■

CIVIL ENGINEERING

Dr. P. Aarne Vesilind of the Civil Engineering Department was promoted to the rank of Professor.

Dr. Miguel A. Medina, Jr. was promoted to the rank of Associate Professor.

Dr. Tomasz Wierzbicki, a Professor of the Polish Academy of Sciences in Warsaw, is visiting in the Civil Engineering Department. While at Duke he is performing research on crashworthiness of thin-walled aircraft structures, presenting an intensive three-day course in Crashworthiness Engineering, and conducting courses on Continuum Mechanics.

The Civil Engineering Department is also honored by the visit of **Dr. Robert Hayduk**, a NASA Senior Research Engineer of Langley Research Center in Hampton, Virginia. During the semester he will pursue research on deformation mechanics of crushing airplane components, and lecture in classes on Crashworthiness Engineering and Engineering Mechanics.

Alastair Gunn, Professor of Philosophy at New Zealand's University of Waikato, is a Visiting Scholar in the Civil Engineering Department this fall. He is studying and writing a dissertation with emphasis on the relation between ethics and decisions in Environmental Engineering. (See article on page 9.)

Dr. Jeffrey Peirce has been added to the regular faculty of the Civil Engineering Department. His specialty is Environmental Engineering. He offers expertise in Hazardous Waste Management.

Kimley-Horn offered a graduate study scholarship through Duke's Civil Engineering Department. The scholarship was awarded to **Lee Shoemaker** for the 1980-1981 school year for outstanding leadership and scholarship in his undergraduate years. His credentials include ASCE's outstanding senior award and Chi Epsilon and Tau Beta Pi honorary elections. He returns to Duke after accumulating six years experience in structural design with the Avondale Shipbuilding Company in New Orleans.

The Schnabel Foundation Engineering Company awarded Duke University a special grant for study of tied-back-wall excavation systems. **Mr. Jose Clemente** has been honored by being named by **Dean Vesić** to support the study.

Professors Utku, Vesilind, and **Petroski** returned to Duke this fall after spending a good part of their summer in Europe. Dr. Utku made a six week NATO sponsored lecture tour visiting the principal technical universities of Turkey. Dr. Vesilind's travels included Portugal, Norway, Finland, Denmark, and Estonia and featured reviews of Resource Recovery laboratories and facilities. Dr. Petroski visited France presenting two papers at the Structural Mechanics in Nuclear Technology Conference.

Dr. Petroski presented a specialty course in Fracture Mechanics in Charlotte, N.C. at the invitation of Duke Power officials. Dr. Petroski's week-long course featured examination of the modern technology and its application to nuclear reactor safety. ■

ELECTRICAL ENGINEERING

Data General Corporation has contributed a $199,400 Eclipse MV/8000 computer system to the department. The computer system has virtual memory capability, and includes one megabyte of random access memory, 190 megabytes of disc memory, dual density magnetic tape drive, and a 300 line per minute printer. There are currently 20 terminals connected to this time sharing system.

There are two new faces in the department this semester. Professor **Richard B. Fair** has a background in the design and fabrication of integrated circuits. He is currently on leave, but will return in the spring to teach EE 218, a graduate course in integrated circuit engineering. Assistant Professor **Christopher R. Carroll** has completed his graduate studies at Cal Tech and will receive his Ph.D. in December. Carroll is experienced in digital systems, VLSI structures, and analog computation.

Professor and department chairman **H. Craig Casey, Jr.** has been reappointed program chairman for the IEEE Device Research Conference. This international conference is concerned with the latest research in semiconductor devices and processing.

Dr. William T. Joines was promoted to full professor in May, 1981. Joines teaches courses in electromagnetic field theory and microwaves.

A new course in robotics, EE 250, has been introduced this semester by **Dr. Paul P. Wang**.

Professor **Thomas G. Wilson** received the William E. Newell Power Electronics Award on July 1, 1981. The award was presented in recognition of his outstanding achievements in the field of power electronics. ■

MECHANICAL ENGINEERING AND MATERIALS SCIENCE

Dr. Jack B. Chaddock was recently installed as President of the American Society of Heating, Refrigerating, and Air Conditioning Engineers at the Society's annual meeting in Cincinnati, Ohio.

Dr. Franklin H. Cocks returned this summer from a six month sabbatical leave at the Division of Applied Science, Harvard University. Cocks has developed two new courses: ME 216, "Materials Science and Solar Technology" and ME 240, "Patent Technology and Law for Engineers."

Dr. Charles M. Harmon was employed as a consultant this summer at Carolina Power and Light. During his sabbatical leave this fall, he will write a textbook on electric power generation.

Dr. Edward J. Shaughnessy has been appointed Director of Graduate Studies for the department.

Dr. Philip L. Jones has been promoted to Associate Professor effective July 1, 1981.

David D. Loendorf has been appointed Associate Professor and will hold a joint appointment in the Department of Computer Science. Loendorf is an expert in computer-aided design. (See related article on page 7).

A new course, EGR 116, "Structures," will be offered by **Dr. George W. Pearsall**, along with Steve Wainwright of the Zoology department and Frank Smullin of the Art department. The course will be cross-listed in all the departments. ■

Research News

BIOMEDICAL ENGINEERING

Mechanical Properties of Human Vertebral Bone

James H. McElheney, principal investigator
Robert A. Casper and Jerome A. Gilbert, research assistants
Sponsored by the National Institutes of Health

Cancellous bone specimens from the human veterbral body were tested in compression. The specimens were unembalmed, and the tests were generally performed not less than five days postmortem. During this period the specimens were kept wet with a calcium buffered solution of isotonic saline. To date over 489 specimens from 81 donors have been tested. Regression analyses indicate a strong dependence of ultimate compressive strength and modulus of elasticity on age and density.

There was no significant difference in the mechanical properties of the human vertebral cancellous bone when loaded in different directions. Histological studies indicated differences in trabecular patterns when sectioned in various directions, however, and work is continuing to document this observation. For many modeling purposes the cancellous bone of the vertebral body may be considered homogeneous and isotropic in the large.

The vertebral body data shows a strong linear correlation between modulus and strength, indicating that a maximum strain theory of failure may be used for cancellous bone from the vertebrae with a maximum failure strain.

The mechanical properties of cancellous bone are strongly influenced by the structural arrangement of the trabeculae. Thus, in these tests, properties such as compressive strength and modulus are structural properties, and the large values of the standard deviations observed for these properties are primarily due to variations in the porosity and internal arrangement of the trabeculae. The similarities of the properties and histology of compact bone indicate that a single material porous block model is justified as a first approximation in describing the relation between structural and mechanical responses.

It has been shown that the modulus of bone is approximately proportional to the third power of the density. Thus, small porosity changes in bone of low relative density result in only small changes in strength and modulus, while small porosity changes in bone of high relative density result in large changes in strength and modulus. The porosity distribution in a given sample of bone is much more significant in this effect on strength and modulus in bone of low relative density than in bone of high relative density. ■

Advanced Techniques in Diagnostic Ultrasound

Olaf T. von Ramm, principal investigator
F.L. Thurstone, Ralph M. Scallion, Richard D. Vann, and Joseph A. Kisslo, co-investigators
Stockton Miller-Jones, David P. Shattuck, Paul A. Magnin, and Marc D. Weinshenker, research assistants
Sponsored by the National Science Foundation and the National Institutes of Health

The research objectives are directed toward the investigation of the interaction of ultrasound with biological tissues, the development of advanced diagnostic instrumentation based on the resultant findings, and clinical studies to assess the diagnostic specificity of prototype devices developed in our laboratories. A parallel effort seeks to address the physics of ultrasound imaging, and the characteristics of ultrasound transducers.

The facilities available for the work are both unique and extensive including well-equipped engineering development and support facilities both in the Engineering School and the Medical Center. A close working relationship exists both with clinical personnel in the Medical Center and with researchers of the F.G. Hall Environmental Laboratories, one of the world's outstanding hyperbaric facilities. Clinical facilities dedicated to the evaluation of prototype ultrasound devices are available, and the resources of the hyperbaric facility can be utilized. In addition, a Vax 11/780, solely dedicated to ultrasound research, is available for image processing, image analysis, and the computation and storage of physiological parameters derived from the ultrasound information. Three minicomputer-controlled and one microprocessor-controlled fully digital phased array ultrasound systems are available for various research projects. This equipment is complemented by commercially available ultrasound instrumentation dedicated to both research and clinical applications.

Current research focuses on several areas. First, an adaptive phased array system has been constructed to convert for the aberrating effects of the adult skull in an effort to provide higher resolution images of cephalic structures. Since ultrasound can provide real-time images, the long-range goal is aimed toward assessing the patency of intercranial vessels.

Another project is directed toward increasing the information content of ultrasound images from myocardial structures in an effort to directly visualize the extent of ischemic or infarcted regions. Early studies using canine models have indicated marked changes in the ecogenicity of affected regions, thus raising the hope of similar results in humans. Studies assessing the accuracy of diagnostic ultrasound in determining ventricular mass, the relationship of wall thickening and thinning to myocardial ischemia, and the efficacy of combined ultrasound doppler and two-dimensional imaging techniques in determining cardiac output are also being conducted.

New instrumentation under development and initial clinical investigation include the first fully digital phased array sector scanner and a unique real-time compound sector scan device applicable to abdominal imaging. These devices will aid greatly in assessing the limitations on data acquisition rates which compromise the performance of all ultrasound instruments and may provide superior diagnostic informations.

The extension of ultrasound techniques to new areas is also a goal of the overall program. The relationship of venous gas phase emboli to the onset of decompression sickness continues to be a vexing problem in hyperbaric medicine. In vitro and in vivo experiments are currently in progrees to assss the applicability of instrumentation under development in our laboratories in determining the gas volume released intravenously subsequent to various dive profiles. ■

CIVIL ENGINEERING

A Unified Approach to the Modeling of Transient Storage, Treatment, and Transport of Urban Point and Nonpoint Water Pollutants

Miguel A. Medina, Jr., principal investigator

Barbara A. Buzun and Donald Greeley, research assistants

Sponsored by the National Science Foundation

Literature on receiving water impacts indicates a recent awareness of potential damages from nonpoint pollutants, but addresses single storm events. Due to the nature of hydrologic events, continuous simulation is required for a better understanding of these impacts. A major benefit of this proposed research will be the refinement of a conceptually sound methodology to screen urban water pollution control strategies.

A model has developed based on the general one-dimensional, transient conservation of mass equation to represent the movement, decay, storage, and treatment of nonconservative pollutants from highly variable *wet weather* flows through the urban environment and the receiving body of water. *Dry weather* wastewater flows are assumed to be steady and their treatment plant efficiencies are fixed. Mixing in combined sewers of wet and dry weather pollutants is simulated and "first flush" effects are accounted for. The oxygen balance of the polluted waters is predicted downstream from the waste sources, and minimum dissolved oxygen frequency curves are derived.

The research objectives of this projects are to:

(1) extend the detailed mathematical application of the principles of continuity to examine the response of conventional dry weather wastewater treatment facilities (while accounting for storage effects);

(2) integrate such a response with that of wet weather flow control systems;

(3) determine the optimal operating policy for regulated flow storage/treatment, including the possibility of dual-purpose operation; and

(4) evaluate these urban water pollution control schemes in terms of their combined and separate impacts on receiving water quality.

It has been demonstrated that the choice of mathematical model for *wet weather* flows storage/treatment systems may lead to different *outflow* pollutographs but, in all cases, adequate detention reduces the peak and variability of the input pollutographs. Treatment is effected by natural decay processes while in storage. Such a detention time is really the hydraulic residence time. In conventional wastewater treatment plants, recirculation requires the definition of a *mean cell residence time.* In terms of the receiving water, waste load allocation may be based on the parameter or parameters determined to be most critical for the study area selected. ■

Minimization of Discretization Error in Finite Element Analysis

Robert J. Melosh, principal investigator

This research addresses evaluating and developing strategies for estimating and reducing finite element discretization errors by selection of mesh parameters.

Examinations of the effect of element type, element shape, and trial function degree on solution accuracy; the relation between error and the number and location of nodes; the efficiency of implementation as a function of the relative number of nodes and elements; the characteristics of optimum grids and their development algorithms; and extrapolation techniques for eliminating error, will be used to identify the hierarchy of mesh design parameters on analysis effectiveness. Examinations will include a review of existing theorems, hypotheses, and experience; development of numerical solutions for particular problems which associate with the diffusion equation; and study of these problems results to educe new hypotheses and sort out the existing ones.

The result of this research will be a collection of theorems, meta-theorems, and non-contradicted hypotheses useful for design. Proofs of theorem will be constructed from existing theorems by exception. ■

ELECTRICAL ENGINEERING

Investigation of III-V Compound Semiconductor Materials and Devices

H. Craig Casey, Jr., principal investigator

A research and teaching laboratory for semiconductor devices and materials is being established. Space has been designated for this facility, and the first pieces of equipment have been installed. Silicon devices will be made as part of the undergraduate program, and current research will be devoted to the preparation of III-V compound semiconductor devices and materials. Research in the III-V compounds will be coordinated with North Carolina State University and the Research Triangle Institute through the Microelectronics Center of North Carolina.

The work includes both studies of heterojunction devices based on InP-$Ga_xIn_{1-x}P_yAs_{1-y}$ and metal-insulator semiconductor (MIS) devices based on GaAs-$Al_xGa_{1-x}As$. The studies on the InP-$Ga_xIn_{1-x}P_yAs_{1-y}$ are related to the development of heterostructure lasers, light emitting diodes, and detectors for operation in the $1.3\mu m$ wavelength region where optical fiber losses and dispersion are a minimum. The MIS studies are fundamental studies of III-V compound semiconductor-insulator interfaces. Devices are presently being prepared on wafers grown by molecular-beam epitaxy at the University of Illinois. This work is a continuation of research done at Bell Labs prior to August, 1979. ■

Electronic Power Processing

Thomas G. Wilson and Harry A. Owen, Jr. principal investigators
Rhett T. George, associate investigator
Thomas H. Sloane, Paul M. Wilson and Ronald C. Wong, research assistants

Sponsored by the NASA Lewis Research Center

Future spacecraft electrical power systems will require power levels in the ten to one-hundred kilowatt range. To provide for regulation and conversion of this power, research is being conducted in the analysis and design of highpower, light-weight, high-frequency dc-to-dc converters. The research is currently divided into three major areas in working toward the development of means of reducing weight while increasing the efficiency of high-power circuits. Several converters operating at power levels in the range of one to two kilowatts at a switching frequency of 100 kilohertz have been designed, constructed, and tested. The converter operating at the two-kilowatt power level uses several metal-oxide-semiconductor field-effect transistors (MOSFET's) in a parallel configuration to operate as the power switching element. A converter using a single bipolar junction transistor (BJT) has been operated at the one-kilowatt level. In another area of this research, a large-signal model for a power bipolar junction transistor is under development with a dc model already realized and present work concentrating on the implementation of an ac model. A third emphasis area involves an analytical study of the design parameters which lead to an optimal system design, given some particular objective function such as minimum mass for the converter system.

An important aspect of this research is the instrumentation system to monitor experimental converter performance. Because of the high power levels and the attendant high-energy storage in certain components, safety of research personnel and of the test converters requires special attention. The nature of the high-frequency switching converters and the accompanying high rate of change of currents and voltages within the circuits requires the use of wide-band instrumentation, as well as instruments responding to average currents and voltages. To reliably implement the execution of a well-planned test procedure, the instrumentation system has been placed under the supervision of a laboratory computer system. The computer instrument system, which is developed around the Digital Equipment Corporation PDP-11/03 computer, currently has the following features: video display prompting of the experimenter; response by the experimenter via the computer keyboard before the next procedural step; programmed adjustment of input voltage or other control variable; and automated reading and recording of circuit voltages and currents. A general-purpose data acquisition and processing program has been developed to provide the experimenter quick-look results during the progress of the experiment and to save the data for future detailed analysis and graphic display of results. ■

MECHANICAL ENGINEERING AND MATERIALS SCIENCE

Stress Relaxation in Soft Biological Materials

George W. Pearsall, principal investigator

A simple analytical technique has been developed by which analog stress-relaxation data from soft (low elastic-modulus) materials can be expressed as a discrete sum of a small number of exponential terms (usually three or four). This technique has been applied to biological materials as diverse as spider silk and myometrium (uterine wall muscle).

If the material exhibits a continuous spectrum of relaxation time constants, the technique developed in this research is only a convenience for predicting relaxation stress as a function of time; a discrete representation as a sum of three or four terms is simpler than a relaxation integral. If the material exhibits discrete relaxation mechanisms though, each with its characteristic relaxation time constant,this technique can detect the transition from one mechanism to another. If the relaxation time constants of two "adjacent" mechanisms differ by more than a factor of 20, the stress relaxation behavior of the material is detectably different from that of a relaxation time constant continuum. However, mechanisms with time constants closer than a factor of 20 will blend into one another as time increases.

The pre-exponential factor in each exponential term provides an indication of how much that time constant is weighted in the behavior of the material. The smaller the pre-exponential term the less significant is the mechanism represented by that term in determining the overall stress relaxation behavior of the material.

The application of this research to human myometrium (uterine wall muscle) should aid in understanding how the mechanical properties of myometrium change with age and pregnancy. Short-term relaxation time constants are important during labor contractions, and long-term relaxation time constants may be important in returning the uterus to its undeformed shape after pregnancy. The analytical technique being refined in this research may help determine the relative importance of active muscle stress, compared to stress relaxation, in restoring uterine shape and dimensions. ■

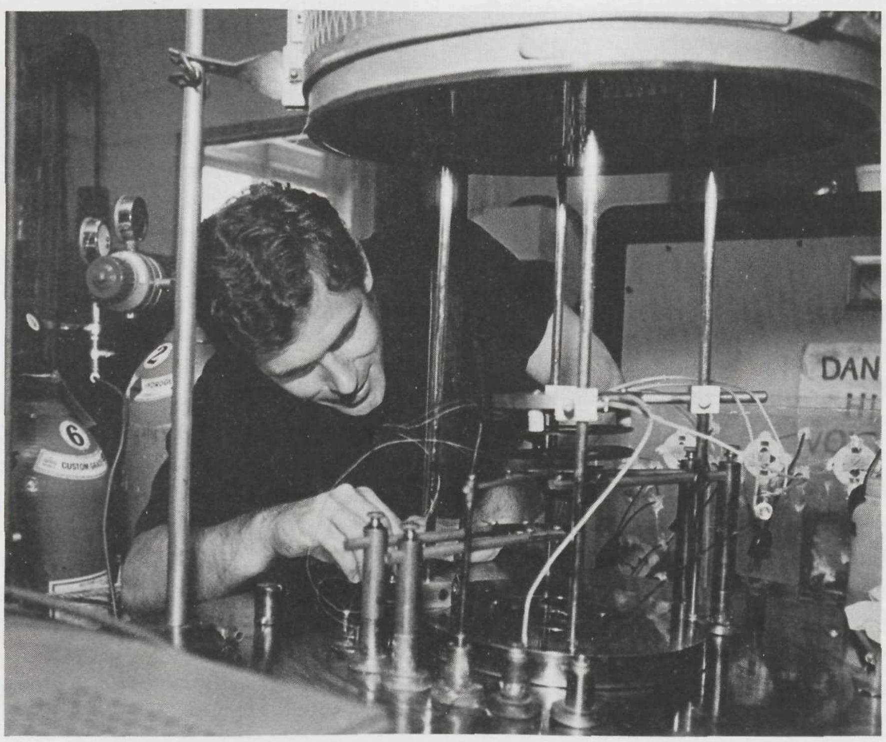
The Development of Selenium Thin Film Photovoltaic Cells for Large Scale Terrestrial Solar Energy Conversion

Franklin H. Cocks, principal investigator
Michael J. Peterson, research assistant

Sponsored by the Selenium Tellurium Development Association

The original aim of this work was the production of p/n homojunction Se solar cells since theoretical calculations show that such cells could have efficiencies of over 17%. Se is normally a p-type semiconductor and almost all known dopants increase this p-type behavior. In the present work, we have confirmed that thallium can be used to produce n-type selenium. In the course of this work we discovered that thin vacuum evaporated films of Te can have unusual anisotropic optical properties. It was orginally thought that these films were the result of the reaction of Sn and Te, but x-ray analysis revealed that this was not the case and that the films are pure Te. Scanning electron microscopy reveals the unique dense acellular structure of these films. The absorptive and emissive properties of these films have been determined and extraordinary selective absorptivity has been found, with absorptivity to emissivity ratios of 33:1. Such films can, of course, have application in solar heat collectors and we believe that this 33:1 ratio is the highest that has ever been reported.

The proposed program is aimed at p/n Se homojunction cell fabrication and we consider that the selective absorber work is now essentially complete. We believe that it is reasonable to expect, in view of our development of methods for preparing both p and n type selenium, that p/n homojunction cells can have higher effectiveness than any Se cells produced previously; this aim is the goal of the program. ■



Society News

Biomedical Society

The Biomedical Engineering Society has been one of the most active engineering societies at Duke and this year they boast over 50 active members. Because of their size, the group has formed three committees to handle activities.

The summer job committee has coordinated efforts with the placement office to compile a list of summer job availabilities for undergraduates, as well as a post-graduate review of the job market and opinions of recent alumni on the dpartment's curriculum. The group has endeavored to provide students with a broad understanding of what the biomedical engineering field has to offer and how it relates to their coursework.

Activities include an assortment of lectures and guest speakers as well as visits to labs in Duke Medical Center to help students get a feel for the current problems and developments in the medical field. Picnics, parties, and student-faculty luncheons provide a relaxed atmosphere where students can mingle with each other and with faculty to promote departmental unity.

"The Pulse" is the BME's publication which provides students with lecture reviews and general departmental news as well as "spotlights" on various BME professors.

Eta Kappa Nu

Besides honoring outstanding electrical engineers, the main activity of this honor society is their tutoring service. Eta Kappa Nu members give aid to EE Majors in virtually every area. This year, the group also plans to start a recruitment process. Tours of the engineering facilities, as well as question and answer sessions are planned to help acquaint prospective students with the engineering school.

Dr. Rhett George, the faculty advisor, will host a traditional initiation banquet in early November for new members. Requirements for membership is academic standing in the top third of the senior class or the top fourth of the junior class.

American Society of Mechanical Engineers

This organization of mechanical engineers has many activities planned for this year. Their annual fall egg-drop was a success with entrees from throughout the Duke community. Participants attempted to design egg-carriers that survived a plunge from atop the engineering building with egg intact. This year's entrees were as zany as ever, and prizes were given in several categories.

ASME also sponsors job opportunity seminars and this year plans to hold some activities in conjunction with the professional mechanical engineering society in Raleigh. The group also hold various luncheons and cocktail parties for department faculty and students.

Tau Beta Pi

Tau Beta Pi is the only national non-departmental society available for Duke engineers which aims to honor those undergraduates in all disciplines who have earned recognition through exceptional scholarship and character. Membership eligibility includes those in the top eight of the junior engineering class and those in the top fifth of the senior engineering class. The society looks forward to initiating about 35 new members in early December.

Projects for this year include tutoring services for engineering undergraduates in all areas. Society members offer help in courses in their specialty to any student having difficulty. Plans for a Tau Beta Pi bench are in the making, and the group hopes to have it erected in conjunction with the new engineering library, complete with their traditional brass symbol. Such benches are a tradition of many Tau Beta Pi chapters.

American Society of Civil Engineers

One of the main activities of ASCE this year will be an overnight trip to the Duke Power design office and nuclear power plant, where students will get an inside look at the processes involved with the production of this energy source. Duke CE's will get together with other area ASCE chapters this year to exchange ideas and hold joint lectures and meetings. Later this spring, the society will design, build, and race a concrete canoe in a competition with other area schools.

The society mainly tries to promote a better understanding of "real-world" applications of civil engineering among CE undergraduates through these activities, as well as enhance student-faculty interaction through cookouts, kegs, and softball games.

Order of St. Patrick

This unusually named society is made up of engineers from all departments who have displayed active participation in extra-curricular activities and generally contributed to the environment of the engineering school. New members are by invitation only and are chosen by present members each fall and spring.

The Order of St. Patrick sponsors student-faculty luncheons in the Oak room every other week and is currently working on a project to bring the engineering bell back to the West campus.

Pi Tau Sigma

Pi Iota is Duke's chapter of Pi Tau Sigma, the national honor society for mechanical engineers. This society seeks to honor those M.E.'s with superior academic achievement, exemplary character, and outstanding leadership. This traditionally includes the top third of the senior class and the top fourth of the junior class. Inductions will take place on November 5th this year. Last year, Dr. Philip Jones was inducted as an honorary faculty member. Another staunch supporter of the group is Mr. Ernie Elsevier, who has been the group's sponsor for over thirty years.

The society's activities include annual review lectures for students taking the Engineers-In-Training exam. This year they plan to put together a booklet of old test questions and general references as an additional aide for the test. Pi Iota is primarily a service organization and plans are to increase their activities this year.

Chi Epsilon

The civil engineering honor society honors outstanding civil engineering students in the top quarter of the junior class and the top third of the senior class. The group's main goal is to increase communication between faculty and staff to get the most out of their department.

Annual activities include a curriculum forum where professors and students get together to discuss merits and changes in the present curriculum. This presents an excellent opportunity for student input into the department's course scheduling process.

Another service that the society offers C.E. majors is a summer job book compiled of students' experience with summer employment in the field of civil engineering designed to aid others seeking similar experiences.

Engineering Student Government

The Engineering Student Government strives to unify the engineering school by offering a variety of academic and non-academic activities for engineers of all disciplines. ESG sponsors student-faculty cocktail parties, kegs, cookouts, and other functions which give students an opportunity to intermingle with professors and other engineers. They are involved in the planning and development of engineering facilities, and serve as co-ordinator for many of the other engineering societies. This fall they plan to offer continued social activities, including the traditional Hane's mixer and Engineering Games.

National Society of Black Engineers

The Duke chapter of the National Society of Black Engineers is in its fourth year and thus far has been very successful in promoting minority interests in the field of engineering. The goal of this group is to assist minority students in the engineering school both during matriculation and in career and graduate school opportunities upon graduation. Activities include various social functions as well as seminars and field trips.

Institute of Electrical and Electronic Engineers

The Duke Chapter of IEEE seeks to provide electrical engineers with an opportunity to interact with faculty and other students and learn about the professional side of electrical engineering. This year they hope to implement an educational program designed to help juniors start thinking about their post-graduation plans. The group also sponsors bi-weekly seminars on pertinent electrical engineering topics such as computer-aided design. A tour of General Electric's microelectronics center is also on the fall agenda. ■

DukEngineer

The *DukEngineer* is the official student magazine of the School of Engineering, published twice yearly. Any freshman or upperclassman interested in working on the magazine should contact the editor or Associate Dean Marion Shepard thru the Dean's Office. An introductory meeting will also be held in early February. We need writers, photographers, copy editors, and general helpers. Get involved early in your years at Duke—the *DukEngineer* is a great way to meet people around the Engineering School.

Jest for Laughs

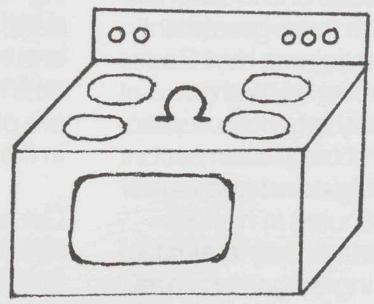
Many people think that engineers and others such as accountants, scientists, etc., are a bunch of boring clods who don't know how to laugh or have a good time. One running joke is that engineers are the group that sits around on Saturday night telling math jokes. Well, maybe that is true, so this article will transcend the practice of mere joke telling and add a new dimension to Saturday night joke sessions. First, however, I must give you a short quiz to see if you are ready for the bizarre and cornball humor to follow. No one may read on until they have a 100 percent understanding of the material covered on the test.

Match the engineering term with the proper definition:

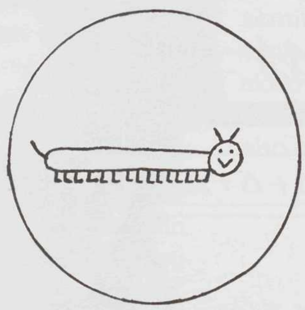
1. Planck's constant	a. inhabitants of the planet Center
2. creep	b. job in Alaska
3. truss	c. Mr. and Mrs. Force
4. center of mass	d. high grade lumber
5. moment of inertia	e. what a boy does to ice cream
6. cold work	f. something to relax with
7. semilog	g. the Vatican
8. couple	h. product of half a tree
9. helix	i. a few seconds in limbo
10. centroid	j. cross between a truck and a bus

Answers: 1. d 2. f 3. j 4. g 5. i 6. b 7. h 8. c 9. e 10. a

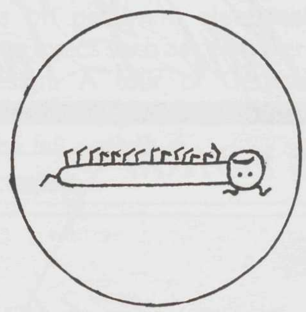
Now that you are in the right mood, I will reveal the new concept that will revolutionize humor sessions, engineering comics! These are just a few of the possibilities:



OHM ON THE RANGE

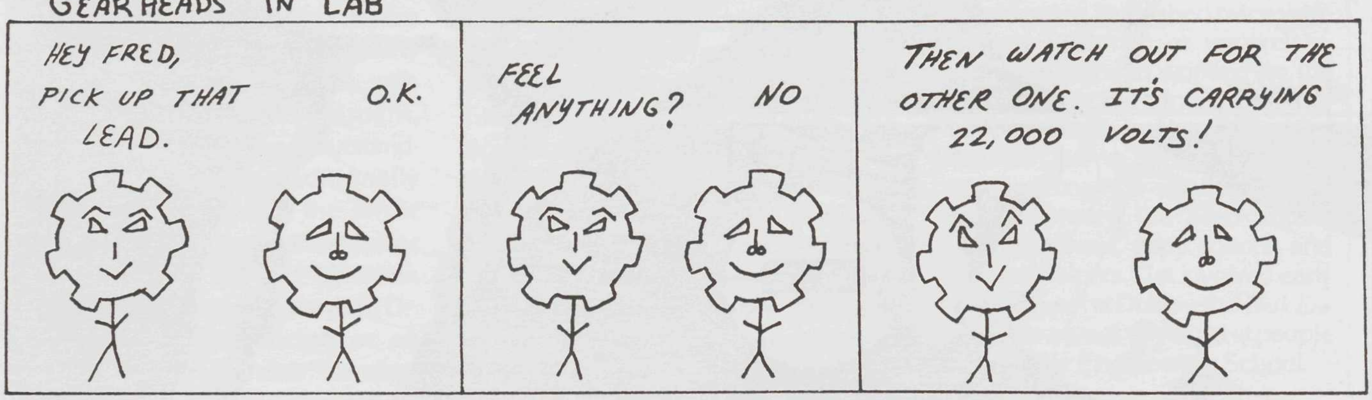


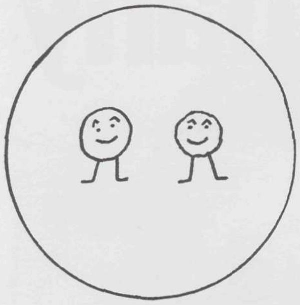
CENTIMETER



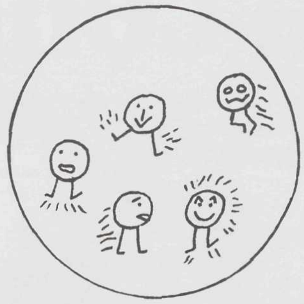
DYNE-CENTIMETER

GEARHEADS IN LAB

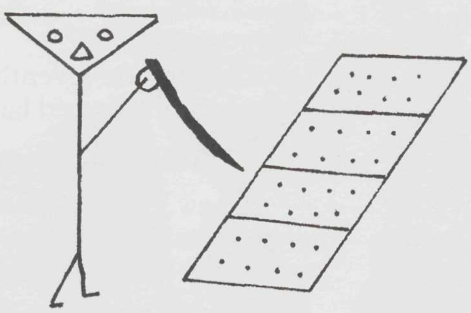




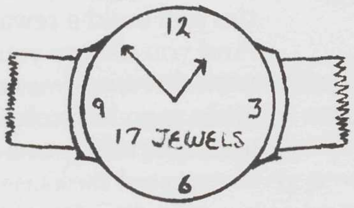
PARA-BOLAS



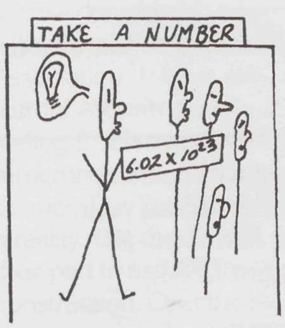
HYPER-BOLAS



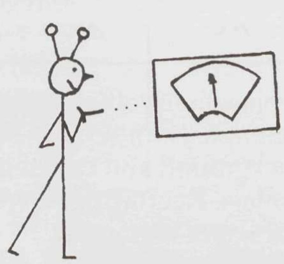
KILOGRAM



17 JOULES



AVOGADRO MAKES HISTORY



KILOMETER

An old gentleman riding the top of a London bus noticed every few minutes the conductor would come from the back and dangle a piece of string down before the driver beneath—whereupon the driver would utter profanity terrible to hear. Finally the old gentleman could not stand it any longer and so he asked the conductor why the driver swore.

"Oh," the conductor said, "his father's being hung tomorrow and I'm just kidding him a little bit."

Two drunks were walking down a railroad:

First drunk: "This is the longest flight of stairs I've ever seen."

Second drunk: "I don't mind that, but the handrail is too low."

Coed: "Where did you learn to kiss like that?"

Engineer: "Siphoning gas."

I serve one purpose in this school,
Upon which none can frown:
I sit quietly in every class
And keep the average down.

Since we all call professors "profs", it's easy to figure out what we ought to call their assistants.

"You can't beat the system," said one student to another at the end of another bad semester. "I decided to take basketweaving for a crip course, but two Navajos enrolled and raised the curve, and I flunked."

The house guests were assembled in the living room after dinner, chatting pleasantly, when the five-year-old daughter of the host appeared suddenly in the room, her clothes dripping with water. She was so upset she could hardly speak, so her parents worriedly went to see what was the matter.

"You-you," the little girl blabbered, pointing at the male guest, "You're the one who left the seat up."

First Father: "Has your son's Liberal Arts education proved helpful since you took him into the business?"

Second Father: "Oh, yes, whenever we have a board meeting we let him mix the cocktails."

Rumor has it that the prerequisite for Egr 123 is a previous course in Egr 123.

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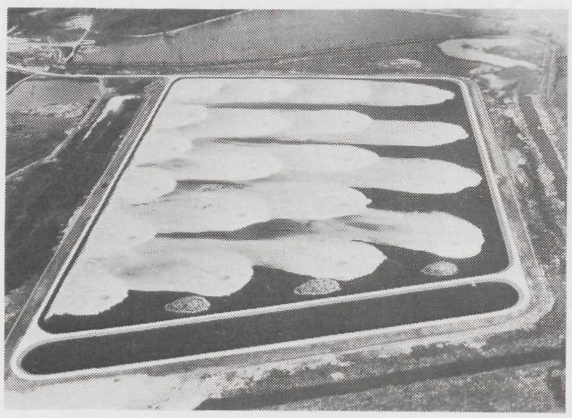

Tougher clean air and water quality standards require innovative approaches.

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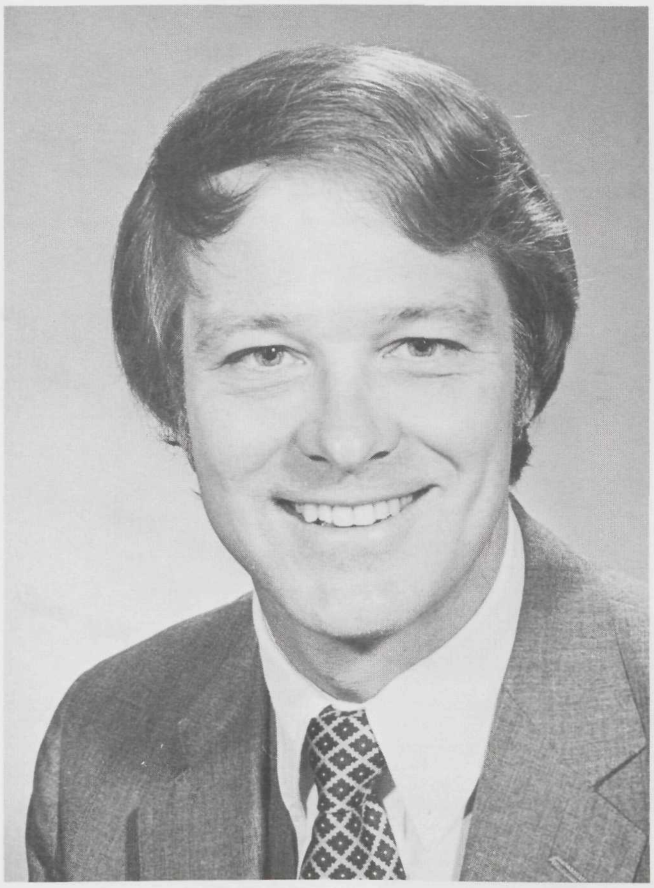


From the Engineering Alumni Council

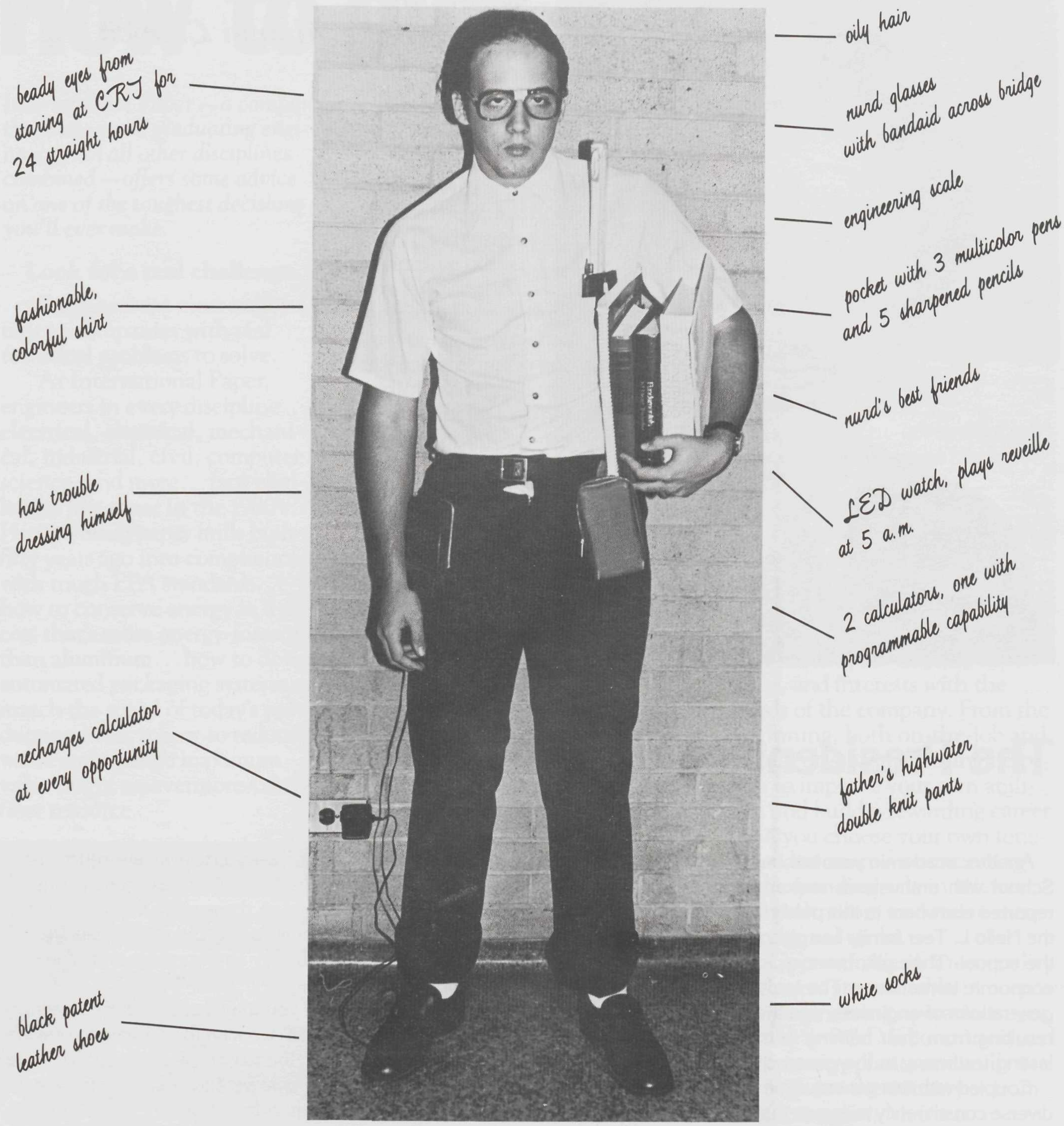
The President's Letter

Another academic year has begun at the Engineering School with enthusiasm and an air of anticipation. As reported elsewhere in this publication (see School News) the Nello L. Teer family has given a very generous gift to the school. Their gift, however, cannot be measured in economic terms alone. The impact it will have on future generations of engineers, and the society they will serve, resulting from their training in the new facility, will be a lasting testimony to the generosity of this family.

Coupled with this generous gift must be support from a diverse constituency to ensure that the new library pavilion will be constructed. As president of the Alumni Association I have the opportunity to contact many alumni and am gaining a greater respect for the depth of feeling that we as alumni have for the school. Many of us remember the "promises" to build an addition to the School. The Teer family has almost made these promises a reality. But the alumni, in effect, have a challenge to do their part to assist in raising the additional capital to begin construction. Over the next several months each of us will have an opportunity to assist in that effort by pledging economic support to the Engineering School. I urge you to consider how Duke Engineering molded your personal development, and in turn, ask you to evaluate the impact a gift, of any size, would have on future generations of engineers as they learn in these new facilities. In this increasingly technological society Duke engineers should have the opportunity to play an important part. You can help financially.

On another note, as you may know, your Engineering Alumni Council has been working to find ways to provide meaningful services to the alumni. To that end, we have completed a survey of over seventy engineering schools throughout the country to establish how they are conducting and developing outreach programs for their alumni. Duke appears to be doing some good things, but we can all benefit from these findings. We are sending the results of this survey to each of you in the near future and will welcome your comments. The Council and those in the Alumni office are here to serve you in whatever way we can. We welcome and encourage your comments to strengthen our ties to both Duke and the Engineering School. We have a school we can justifiably be proud of and the opportunity, through our individual generosity, to help it continue to prosper and grow.

Alan E. Rimer



ARE YOU AN ENGINURD?

You know the type. He destroys the curve in every class. He spends his spare time in the library reading professional journals even the profs don't understand. He got summer job offers from H-P, Exxon and IBM. He turned them all down to work on a perpetual-motion machine he is building in his basement at home. Santa gave him a minicomputer for Christmas that he uses to solve finite-difference equations for fun. Let's hope you don't fit this mold.

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