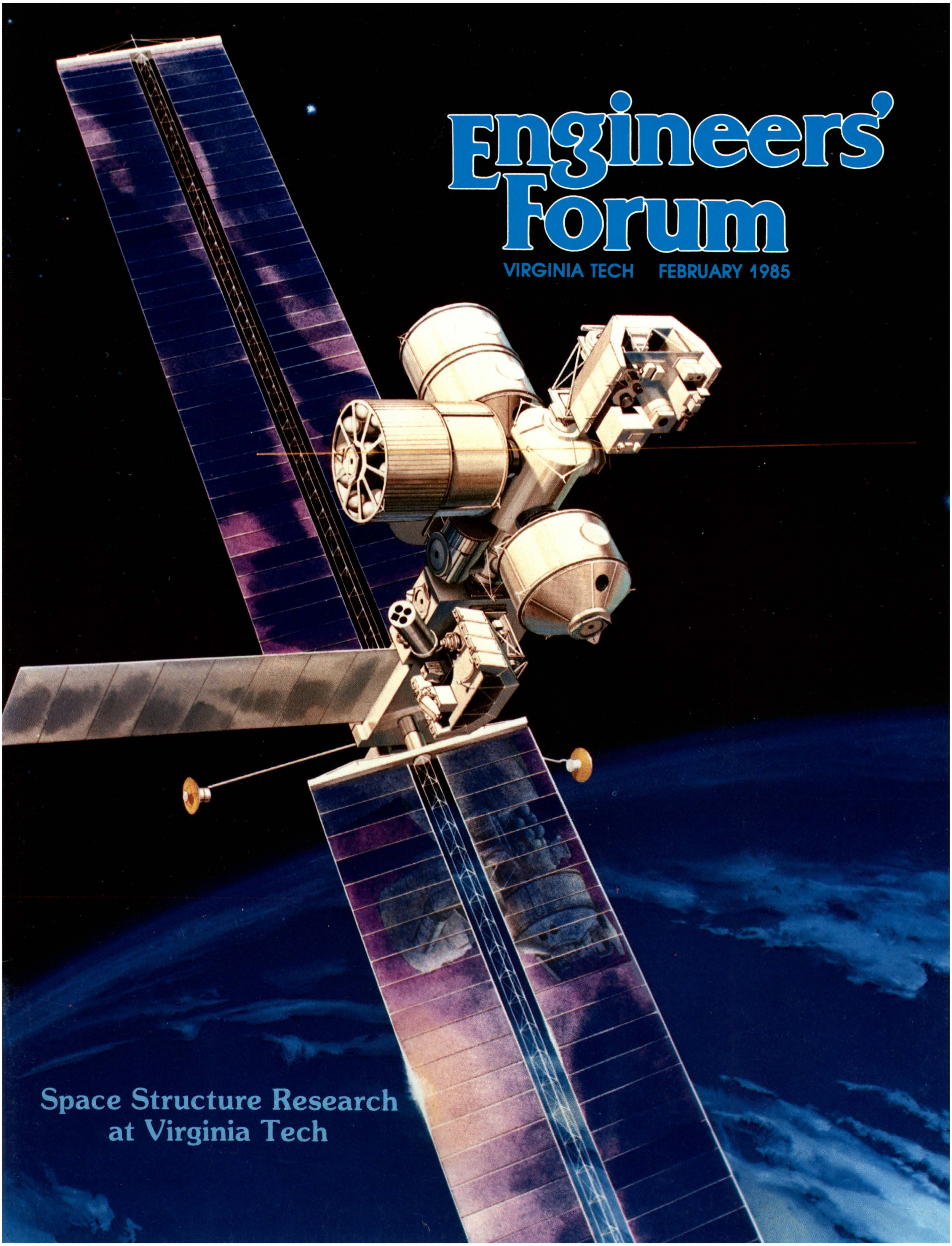
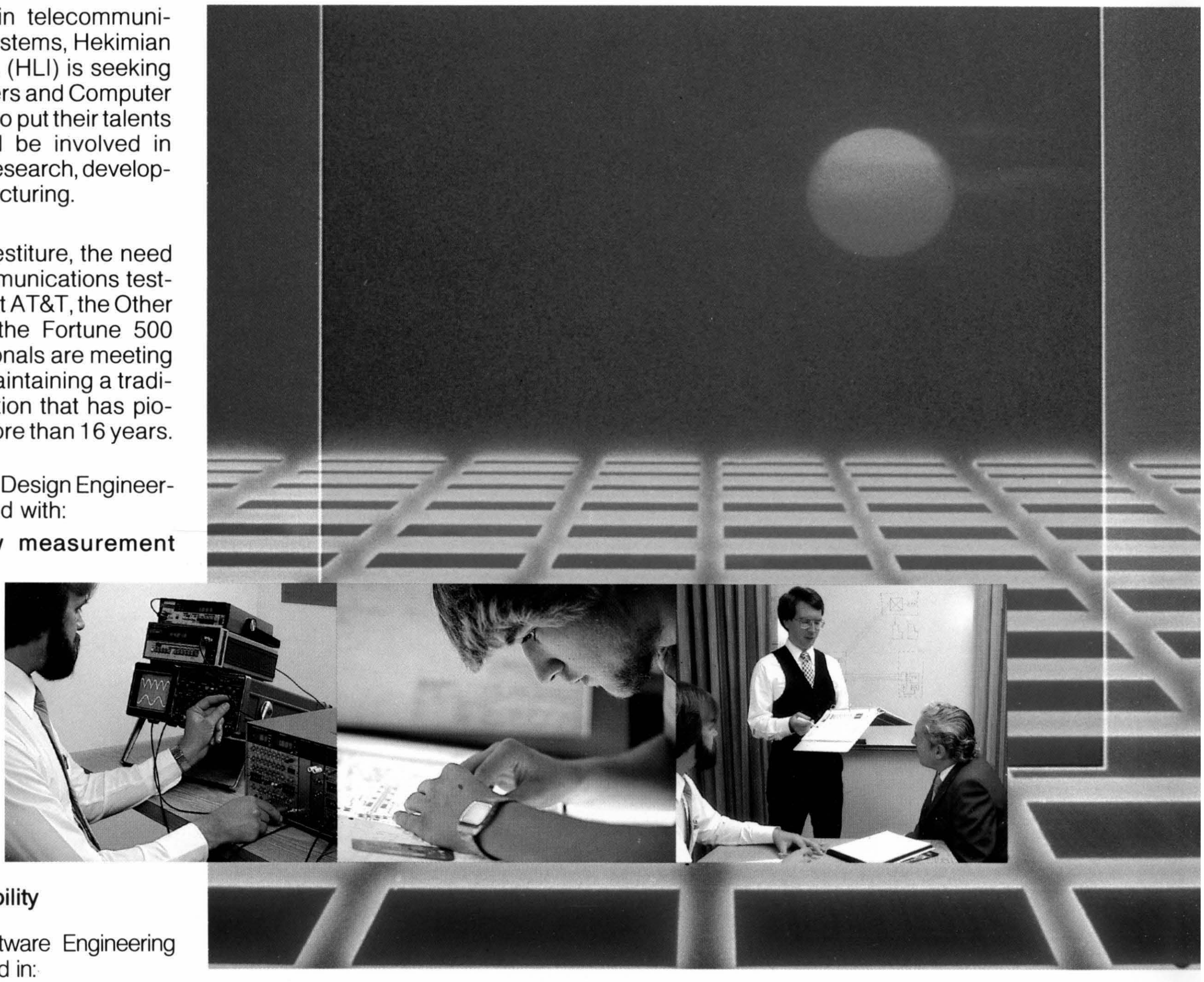
Engineers' Forum

VIRGINIA TECH FEBRUARY 1985



Space Structure Research at Virginia Tech

YOUR FUTURE IS AS LIMITLESS AS YOUR IMAGINATION



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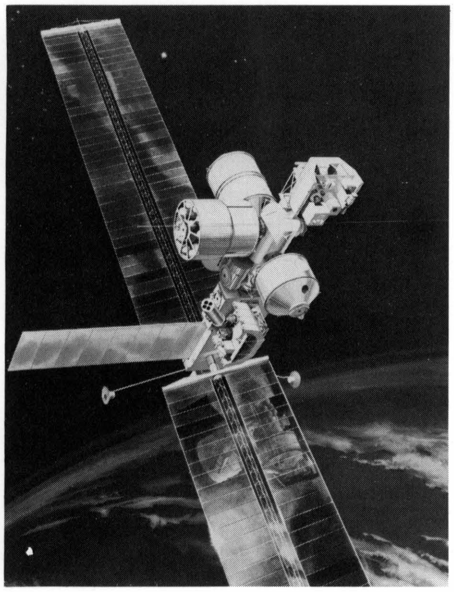

On the cover:
McDonnell Douglas Astronautics Co., Huntington Beach, CA., reference concept for a space station. Shown is the space platform concept developed to one of its potentials as a manned structure. This particular space station is composed of communications antennae, two solar arrays, space radiator, rotating pallets capable of holding space science and applications payloads and an airlock joining two manned modules and a logistics module.

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Engineers' Forum

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The Semester System at Virginia Tech

The majority of universities and colleges throughout the nation operate on the semester system. Virginia Tech stands out as one of the few universities in the nation that still runs on the quarter or trimester system. The issue of whether or not Virginia Tech should change has been discussed for years. The current opinion of most faculty members, although not the engineering faculty, is in support of the early semester system. As the change to the semester system becomes imminent, the apparent question is how this change is going to affect engineering students at Virginia Tech.

A change to the semester system would involve the restructuring of the current engineering curriculum to fit the new time schedule. What this means is that the highly structured series of classes required for specific degree programs would have to be reevaluated. The material from certain courses might have to be extended to last over an entire semester, or a new semester course might incorporate two three-hour courses. Well, so far this seems like a bit of logistics better left to the college administration, unless you are a student that happens to get caught in the middle.

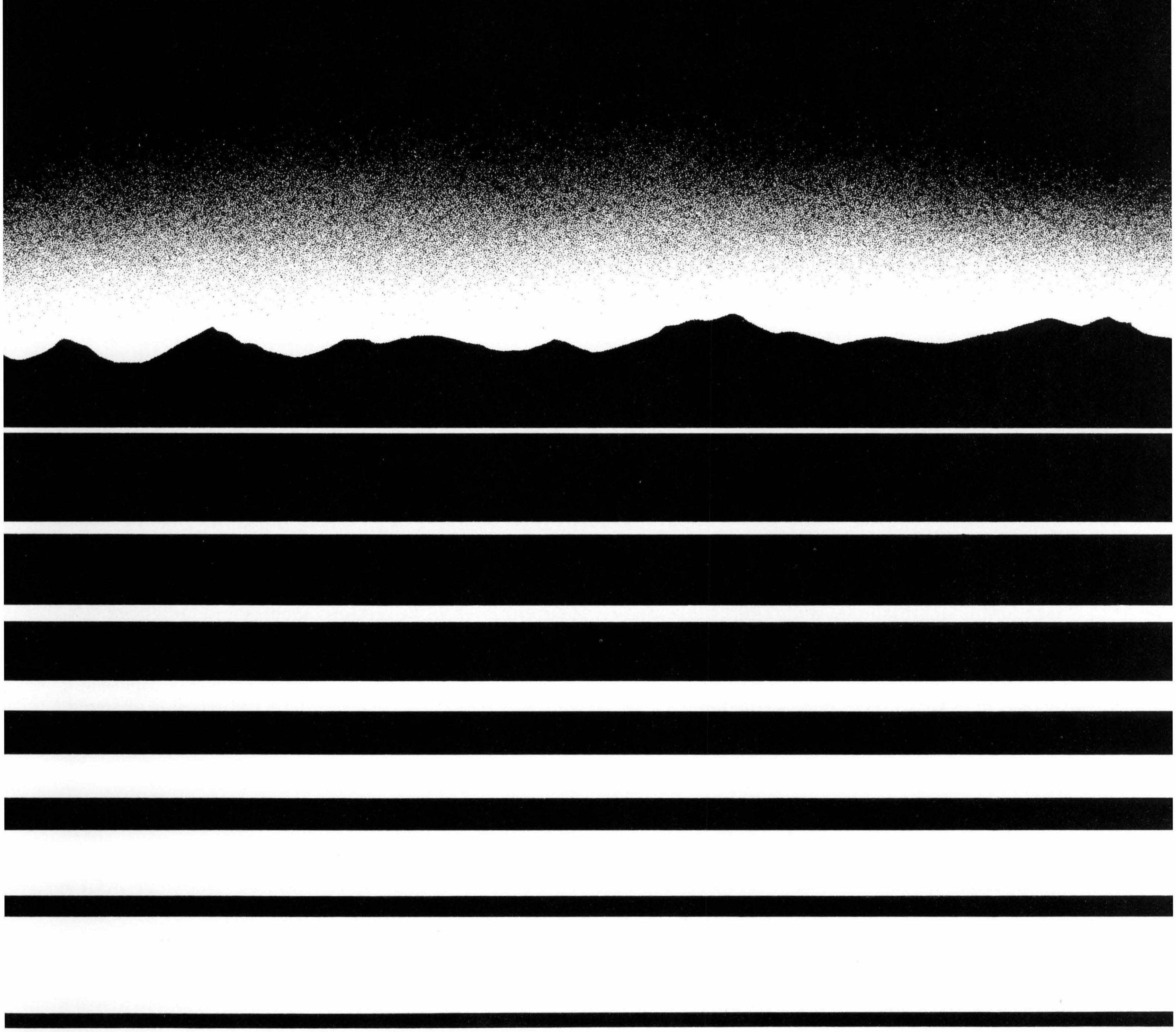
If Virginia Tech changes to the semester system there will be a period of transition with a bit of confusion as the new system settles into its role. The impact on the student is bound to occur as he or she finds that the entire curriculum has been altered. Under the semester system, certain courses taken previously may not count for credit towards graduation. To borrow an analogy from the Dean, Paul Torgersen, the student at Virginia Tech during the change is going to be similar to a transfer student. The student will have a list of classes taken under the quarter system and not all of the credits are going to transfer to his or her curriculum under the semester system. The end result for the students caught in the middle is going to be that they will have to take a few more credits to balance out the requirements for their major. The effects on CO-OP students would be even worse, as both their co-op schedule and their class schedules would be altered in midstream. However, the loss of credits is inevitable in the highly structured course of study offered by the College of Engineering in order to maintain the quality of education.

Despite the personal inconveniences for the engineering students, the change to the semester system does have certain advantages. The change will allow Virginia Tech to become comparable and more competitive with other universities that run on the semester system. In addition, the university stands to considerably reduce the cost of its administrative functions by cutting the three registration periods to only two periods.

The College of Engineering will be able to adapt to the change to semesters without any loss in the quality of education it presents. The students, on the other hand, will have the task of adjusting to curriculum changes; an adjustment that may result in such minor inconveniences as retaking that thermodynamics class that everyone enjoyed so much.

Michael R. Dietrich

TODAY'S CHALLENGES ARE TOMORROW'S OPPORTUNITIES



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Saginaw Steering Gear Recruiters will be on VPI's campus February 19-21, 1985.

Large Structures in Space: Working towards the first space station

by Karen Soos

When it comes to aerospace engineering, the public tends to focus its attention on spectacular successes like the Space Shuttle. Meanwhile, however, several laboratories and universities are conducting research in the much less visible, but no less exciting field of large space structures. Although they are nowhere near the deployment stage, a structure, such as a space station, may be in orbit by the turn of the century.

These orbiting structures will be staggeringly large; many are envisioned to reach a mile or more in length. The framework will be constructed of very light tubes, designed to nest inside one another during transport, to save space. The tubes, or preconstructed units, will be joined in space in one of several ways. They may be packed so as to expand upon release, like an umbrella, into a desired shape; they may be connected by robotic units that crawl along the structure, erecting it as they move; or they may be hand-assembled. The structures will have several applications. They can be used as solar power stations, beaming energy to the earth in microwaves, as large communication antennas, or as space stations for scientific research and industrial manufacturing.

What makes large space structures unique and different from say, the Houston Astrodome, is that they are very flexible. In fact, if these huge structures were to be built on earth, many would collapse under the force of gravity. On the other hand, launching the Astrodome into orbit would be enormously expensive because of its great weight, which results from a framework designed to resist gravity's downward pull. Since there is no need for this strength in the zero-gravity environment of space, the structures can be built of light "tinker-toy" materials, that will minimize the payload weight, and hence the number of Shuttle trips.

Several problems arise from this flexibility, and some of these are under study at Virginia Tech. Design of the large space structures is done at aerospace companies and government facilities like NASA Langley. The work here concentrates primarily on structural dynamics and control research applicable to such structures. In fact, Dr. Leonard Meirovitch, a University Distinguished Professor of Engineering Science and Mechanics, who is carrying out such controls research, also chairs a biannual symposium entitled "Dynamics and Control of Large Structures"; its purpose is to disseminate research information in the field and discuss the state-of-the-art.

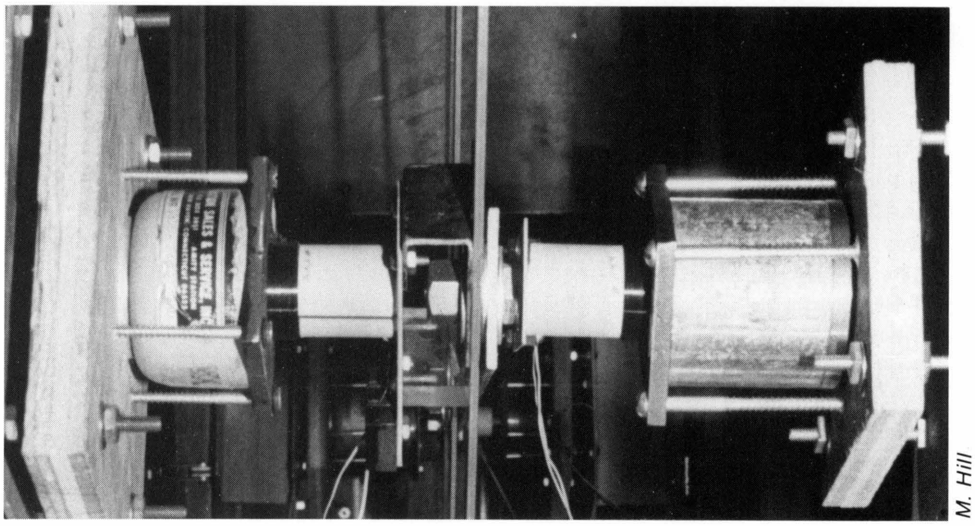
Many forces may act on these structures, and if uncorrected by a control system, can deform or destabilize the body, degrading its performance. Some forces are self-induced; that is, they are caused by attempting to reorient the structure or its components. Dr. Meirovitch used a space station as an example.

Flexible grid in its frame (front view)

It would likely have large solar panels that need to be kept perpendicular to the sun's rays, a communications antenna aimed at a certain point on the earth, and other antennas and instruments to be aimed at various spots in space according to mission objectives. In addition, the entire station itself may have to be reoriented. As Dr. Meirovitch explained, "On earth, reorienting an antenna is no problem, since the earth is large enough to take the reactive forces without visible effects. In space, however, there is nothing to push back—there is no support." Hence, if a torque is applied to reorient a component, disturbances may lead to vibrations that impair the structure's performance over time.

Since many components, like antennas and telescopes, will need near-perfect "pointing accuracy," it is essential to control these vibrations. Dr. William Hallauer, a professor of Aerospace and Ocean Engineering, is studying vibration control in highly flexible structures, and he has been running experiments in the AOE Structural Dynamics Lab.

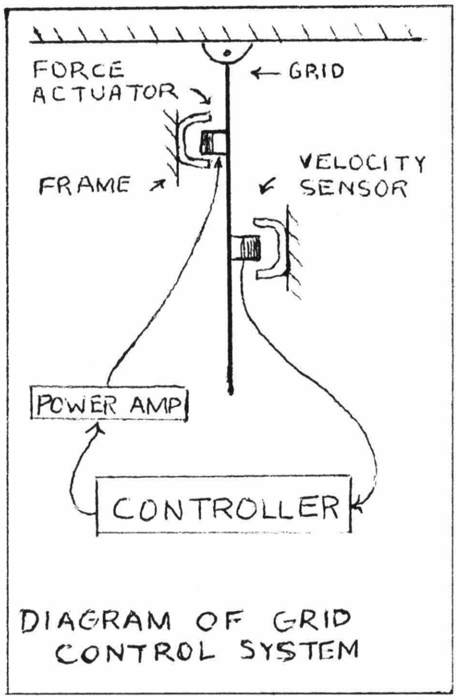
In conjunction with his research assistants, he constructed a grid of light metal beams, fastened tightly together, and vertically suspended by a complex framework so that the grid can swing like a pendulum. If it is started vibrating, it can, without active control, continue to vibrate with very little inherent damping, just as a large space structure would. Several velocity sensors are attached to the grid. Each is a coil that, when the structure vibrates, moves within a fixed magnetic field. Its movement generates a voltage proporational to its velocity, and the voltage from all the sensors are fed into a controller. The controller, a computer system, performs operations on this input data, and sends electric current signals to force actuators, which, like the sensors, are coils attached to the grid, moving within fixed magnetic fields. The interaction of this current in the actuator coil and the magnetic field generates a force proportional to the current, and it is this force that completely, and quickly, damps the vibration.



Closeup of grid: Left, actuator; right, sensor

Dr. Hallauer pointed out two significant ways in which his structure differs from a hypothetical large space structure. First, it is only two-dimensional. It would be virtually impossible to test a highly flexible three-dimensional structure in the lab, because the force of gravity would cause all members not perpendicular to the ground to sag or break. Thus most of this testing will have to be done in space, and will begin within the next decade. Secondly, the grid uses permanent magnets attached to an external, nonvibrating frame. An actual large space structure would require structure-borne sensors and actuators. Such sensors are already available, but actuators are still under development, and not readily available. Despite these differences, this laboratory structure has proved very useful in research, for the researchers have learned a great deal about both the theory and the structure.

Related work is being done by Dr. John Junkins, an ESM professor. He is working on methods to design control systems for such structures. He develops the necessary mathematics, leading to "control laws" for pointing, maneuvering, and shape control of the structure. These laws are implemented as algorithms in an on-board computer, which operates upon the sensor data to yield controller commands. These, in turn, generate actuator commands, which apply forces to control the structure. The control laws are usually based on our best understanding of the structure, but the control system must be "robust"—it must have "stability with respect to ignorance". This means that it must work even though the structural properties aren't completely understood. The control laws are validated based on simulations used to "tune" the critical parameters, and study the consequences of various errors in the model.

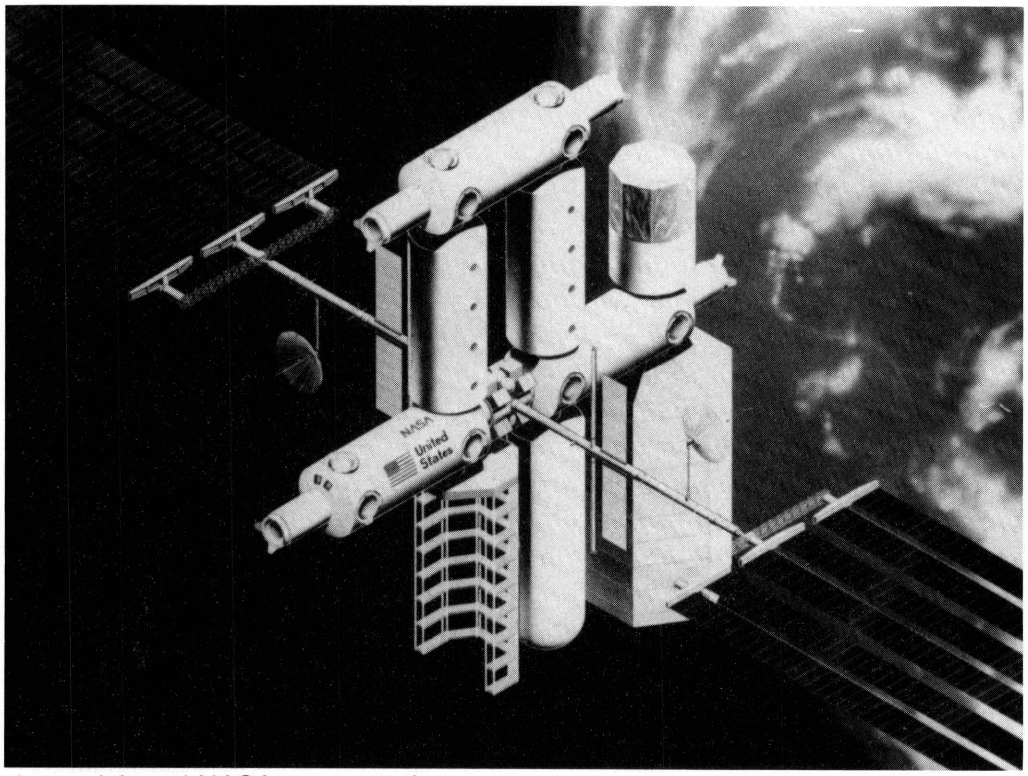


This work is related to Dr. Junkins' second area of research, system identification. This is the process of refining estimates of the values for the structural parameters in the mathematical model, using measurements from on-orbit experiments. To assist in this research, he uses computer simulations of a structure whose characteristics he knows but the identification algorithm doesn't. Given simulated measurements of the structure's vibration, the algorithm must identify the uncertain parameters. Various iterative methods for systematically revising and retesting the structural models can be studied and compared to the known underlying "true" structure. In an actual application to a large flexible structure, of course, the "true" structure is unknown, and the pre-tested identification algorithm will be relied on to provide estimates of acceptable precision.

The controller must be able to correct other disturbances besides those due to vibrations. Many forces are not self-induced; though small and slow-acting, they may yet produce serious structural changes. Dr. Raphael Haftka, of the AOE Department, is currently researching such a force, thermal radiation, in conjunction with NASA. He explained that in a structure such as a communications antenna, the paraboloidal portion facing the earth would receive more earth radiation than the rest of the body, and that the resulting thermal deformations could seriously affect the antenna's performance. He is developing a method that may soon be tested in space, in which inserts with a high coefficient of thermal expansion would be implanted in various areas of the structure. The heating or cooling of these implants would force the structure to shrink or expand in those areas, and would control the structure's shape.

Dr. Haftka works on an additional project with Dr. Hallauer. "Right now," says Dr. Haftka, "there is a communications gap in the scientific community between people who deal with these two types of problems," structures and controls. He and Dr. Hallauer are attempting to determine the technical circumstances under which the two areas may be designed independently of one another, and when they should be designed simultaneously. The criterion to decide when to do it is based on the effect of a small structural change on the control system design. If a small structural change has a small effect on the design of the control system, then there is no need for simultaneous design. If the effect is large, however, the two areas of structure and control design should be worked on simultaneoulsy. Thus they are attempting to develop methods to calculate the sensitivity of the control system to changes in the structure. This area has also been worked on by Dr. Junkins, who recently published a paper entitled "A Unified Approach to Structure and Control System Design Iteration."

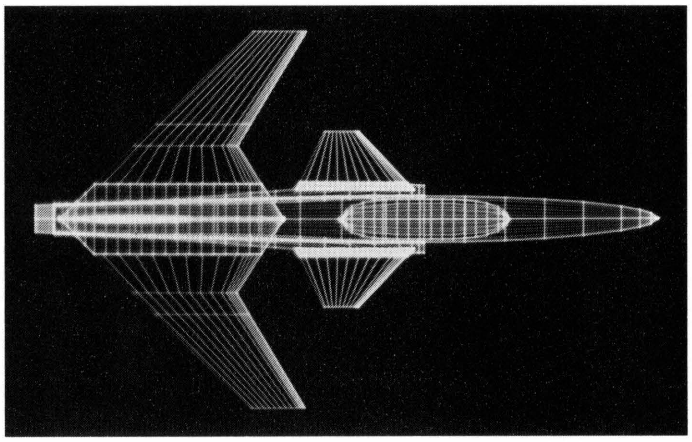
So even though the Space Shuttle is monopolizing the attention of the public today, with the efforts of these four engineers and many others like them throughout the country, and with continued funding and governmental blessings, the large space structure is sure to grab the spotlight within our own lifetimes.



Courtesy of NASA

An envisioned NASA space station

Engineering takes on exciting new dimensions in the Air Force



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Engineering: Science or Technology?

by Michael R. Dietrich

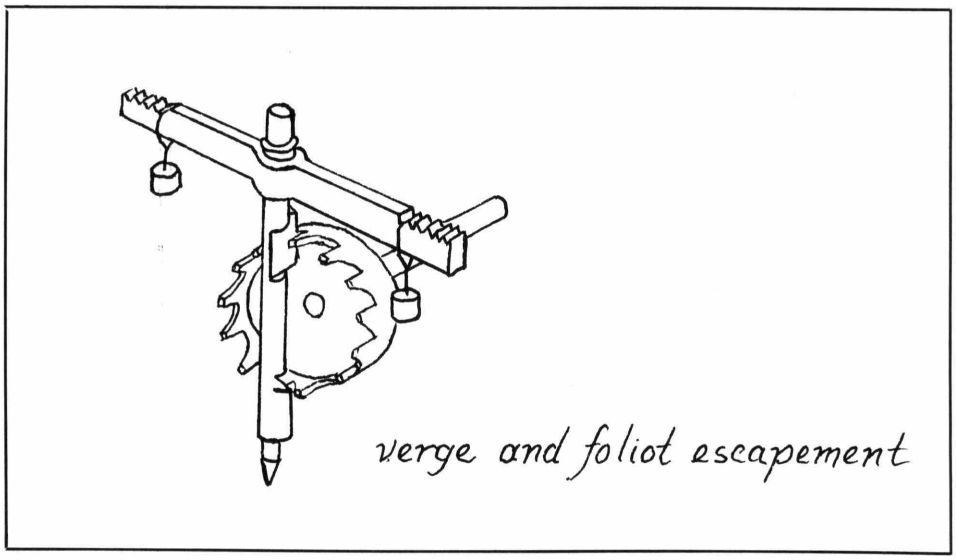
Early in the eighteenth century, the physician Jacob Bigelow coined the word "technology" during a presentation at Harvard University. Technology, as Bigelow defined it, was the pursuit of those useful arts "which involve applications of science." In an age when science and technology were produced in independent communities, Bigelow's definition accurately portrayed the relationship between science and technology. Accordingly, the conception of technology as applied science became part of the public world, as evidenced by the motto of the 1933 Century of Progress World's Fair, "Science Finds, Industry Applies, Man Conforms." However, this fairly simple relationship had already been altered with the rise of science-based industry in the nineteenth century.

The role of the engineer changed just as the relationship between science and technology changed. Many of today's engineers do more than apply science; they actually do science. Initially associated only with technology, the engineering profession has expanded to include the production of new knowledge as well as its application.

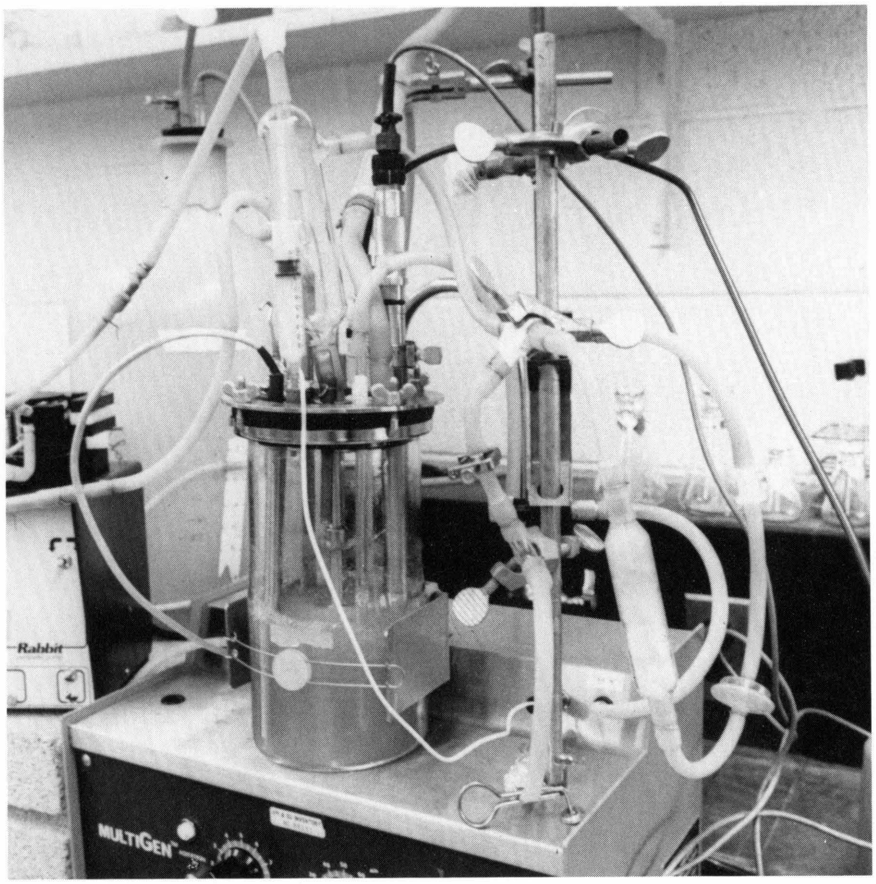
However, the common conception of the engineer remains unchanged. Most people still regard engineers as technologists, not scientists. This perception of the role of the engineer may be due to the fact that professional success for the engineer is whether new knowledge produced by engineers can be applied in the industrial production process. The rise of science-based industry marked the beginnings of the increasingly complex relationship that engineers have with science.

The beginnings of the first science-based industries were responsible for drawing engineers out of the workshop and placing them alongside scientists in the industrial laboratories and plants. Along with the early development of the electrical industry, the American chemical industry provides one of the best examples of the changes that occurred with the rise of science-based industry.

The early chemical industry grew out of advances in physics and chemistry, as well as advantageous developments in patent law. In 1918, the seizure of German patents, and their subsequent redistribution to other countries allowed America to enter into an industry that was previously a German monopoly. This is not to say that the American chemical industry was non-existant before 1918 but that after the redistribution of patents the chemical industry in America was able to flourish and expand. Previously America had dominated the use of electro-chemical processes; now they could edge in on the coal-tar dyestuffs industry that had been the basis of the German monopoly. Thus, through the acquisition of new scientific knowledge, "science-based chemical industry in the United



The technology of days past



M. Hill

Science and Technology today: the Chemical Engineering department's fermentor lab.

States had become a reality." (Noble, p. 16)

As the American chemical industry entered the age of the large chemical corporations that we know today, the role of the chemical engineer was permanently changed. The adoption of the scientific approach by large chemical companies led to large scale industrial research and operations that altered the engineer's duties and responsibilities. In the past, the engineer had been the craftsman in the small family-sized industries; in a science-based industry, the engineer now both assimilates knowledge and creates new knowledge through industrial research processes.

Modern industry demands more of the engineer than just the application of science. At the beginning of science-based industry, "engineers increasingly had to design and carry out research programs of their own to generate the knowledge of the substances and processes that they needed to solve the problems they faced." (Donovan, p. 14) Today this relationship still holds as "twentieth century science and technology relate more through interpenetration than through sequential application." (Donovan, p. 14) A recent example of the interpenetration of science and technology should make this new relationship clear.

Today, biochemical engineering and microbiology have merged together in the industrial research and production processes of the fermentation industry. In industrial research, engineers and biologists are not separated but work together on research teams. While some steps in a project may be strictly biological such as identification of the bacterial strain to be used, the approach to the project involves the team as a whole. The team approach involves engineers with the necessary science and acquaints the biologists with the technologies being used. Neither the biologist nor the engineer can afford to be ignorant of the other's role in the project at hand. Similarly, a team member's contributions are not limited to what has been assumed to be his realm of knowledge. An engineer, for instance, could propose a mutation program for the bacteria at hand and actually decide which techniques should be used and what traits should be selected for. Traditionally, the design of such a mutation program would have fallen wholly in the realm of the biologist working in genetics. The actual distinction between what is science and what is technology often become blurred in the research lab just because of this interpenetration both of the science and technology and of those people that have traditionally done science and technology.

The contemporary relationships among science and technology, scientists and engineers are exceedingly complex. In fact, the slogan "Science Finds, Industry Applies, Man Conforms" cannot be wholly discarded. However, sufficient change in the original conception has occurred to have made a considerable impact on engineering. As the relationship between science and technology has changed, so has the professional identity and job responsibilities of the engineer.

So what is engineering, science or technology? Perhaps the best possible way to answer is that engineering is a blending of both science and technology in a way that somehow furthers the ends of industrial production. Unlike scientists, engineers may not view knowledge as an end in itself, but it is clear that they produce new knowledge as well as apply it.

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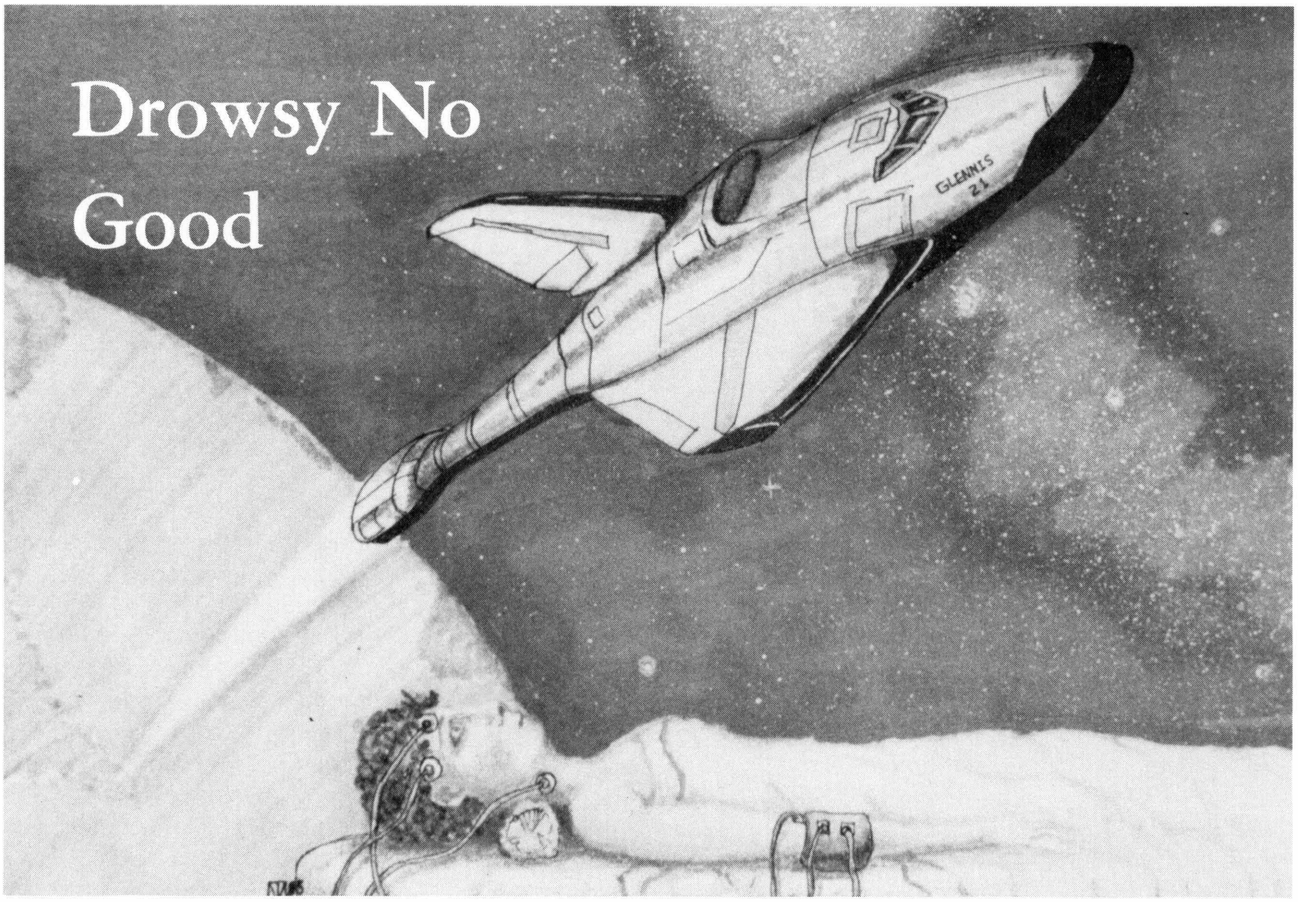
Special thanks to Dr. Gary Downey of the Center for the Study of Science In Society.

Drowsy No Good



Tim Mullins

by Mark Moran

Maybe the executive director of paraspatiology had known all along what would ensue. Certainly she would always remember the knowing smile that played upon the deputy administrator's lips: the calculated restraint evident even as the muscular tug-of-war radiated from contour to contour, the recent sleeplessness transparent.

"I see, then, that you offer no alternative. Yet we are in the midst of a crisis."

The insinuation infuriated Dr. Sayers. In its seven year history, the National Aeronautics and Space Administration's Paraspatials Program had evolved into the formidable giant at the leading edge of modern hypernautical research; Sayers was convinced that Administrator Jordan had decided a month ago what course of action would be followed and had yet to hear the voice of reason.

"Maxwell, the administration has a responsibility here." Her voice, too, betrayed the fatigue of recent weeks.

Yet, had she really known what would ensue, would she not have anticipated all hell's then suddenly breaking loose?

"Damn it! Here we go again—Yates reincarnated!"

"An apt way of putting it," she said.

"Oh, hell, Lisa! When will you land on Earth?" She recognized one of his harsher putdowns. "We are in the middle of a crisis whose governing equations happen to be reality! Don't you see? It isn't a matter of responsibilities; it's not even a matter of right or wrong. There are only cold, indifferent equations. If it's God that worries you, take comfort, Ma'am, in the fact that He is the author of those equations. And you can't sway them any more than I can."

What irked Dr. Lisa Sayers more than anything else was that no one understood the problem better than she—in a sense, she had devoted six and a half years of her life to its forerunners. It had begun in a small, dusty lab back in Huntsville, circa the millenium, where they had formulated the first proposal to subject a human being to paraspace, hoping eventually to cross the greatest physical threshold of all time—the lightspeed barrier. Astronaut Jennifer Yates had volunteered to become the world's first hypernaut—although really it had been more complicated than a simple matter of finding a volunteer. Neuronal structure had always dictated who could or could not be a candidate. Psychiatric examination established that Yates clearly possessed the most sound central nervous system—the least vulnerable to either sensory deprivation or sensory saturation, the greatest capacity to regenerate destroyed neuronal processes and synapses, the quickest ability to recover from CNS trauma, and the greatest knowledge of paraspatiology. All things considered, Jennifer Samantha Yates had wielded by far the most formidable shield against the unforeseeable.

Yet something absolutely impossible by then known laws had happened to hypernaut Jennifer Yates that cloudy September afternoon just two months ago. At Tminus two minutes mission elapsed time (MET), a bird had flown into the yawing scramjet nacelle, triggering an immediate sequence stop. Field Team Gold had scrambled to the site and efficiently extricated the struggling feathered relative of the dinosaurs. A resumption began twenty-six minutes later, Yates reporting to Mission Control that she was becoming somewhat drowsy: a dangerous sign that had been overlooked at the time, everyone assuming that the last ten seconds of launch never failed to work wonders when it came to getting the blood flowing again. And they had been right, in a sense.

With ignition, flames belched from the launchpad and then slowly, *Glennis 21* clawed vertically, more against its own bulk than against the rapidly diminishing column of air above the gleaming bow. But with every passing second, more and more of that bulk was being exhausted and sculpted via sheer velocity into an arcing leaning tower of Clarke that undulated later and then slowly dissipated. Mere hours after liftoff, *Glennis 21* had shorn the shackles of terrestrial gravitation and entered the vastness of interplanetary space.

At that point, mission rules had dictated a rendezvous with the trouble shooter-class pursuer *Little Dipper*, an ungainly porcupine of a spacecraft whose bristles could embrace another vessel the way a CAT-scanner could a patient. Having propelled itself into a translunar orbit fifteen minutes prior to *Glennis 21's* launch, *Little Dipper* nudged up to the other and rendezvoused successfully. By T-plus eight hours MET, *Glennis 21* had finally qualified for the first ever astronaut occupied attempt at a paraspatial maneuver. When the entire trouble board showed only verdant, Mission Control gave Jennifer Yates the go-ahead.

Grasshoppers, mice, swallow-tails, hamsters, tortoises, cats, geese, chickens, dogs, and orangutans had all been subjected to the phenomenon of paraspace—never before a human being. Although every animal ever subjected to paraspace died minutes, hours, or days later, a clear mathematical trend became obvious: with increasing nervous complexity, survival time climbed exponentially. The data left Dr. Sayers and her colleagues in a predicament. Dwindling funds increased the stakes. The last and most ambitious paraspatial excursion had involved the orangutan, and later the facts seemed to suggest that the subject might have survived had his keeper not taken a nap during one critical period of observation. Only a lack of funds halted the animal investigations. When later Chinese paraspatial investigations were disclosed, Congress elected in secret to order the first such experiments with a human subject to take place within a year.

Renderings of an Engineer

And so even then no one could have predicted what would happen to Jennifer Yates.

Today, Dr. Sayers reminded herself, they would have to deal with the consequences. Maybe she had known, too, that in exchange for not being held responsible she would sooner or later have to pay the price.

Just then Reggie Mason thrust his stocky frame into the office. He was one of the principle investigators commissioned to study the phenomena: Dr. Sayers recognized with shock the symptoms of a history of sleepless nights in his worn features and matted hair. She decided not to look in the mirror tonight.

"Howdy," he managed, struggling to act and sound alert. "This phenomenon will drive us all nuts!"

Maxwell Jordan eyed Dr. Sayers, and she watched the neurotic smile spread here and there again. "Reggie's right, Lisa. We really have no choice. How may times have you verified the figures now, Reggie?"

"About eighteen hundred."

"And it's still spreading?"

"On an exponential curve."

"We know for a fact, Maxwell —"

"That Yates will eventually die. What about her present condition?"

"There's a chance —"

"A chance! Damn it! Listen to me, Dr. Sayers, we have already lost two months' sleep over this thing, and I don't intend for us to prolong the suffering anymore. I have made up my mind; the decision is final."

"In that case, Maxwell, I suggest that we get it over with."

The administrator relaxed, nodded. "Excellent idea. Reggie, will you set it all up?"

"Yes, sir."

Half an hour later, the administrator and Dr. Sayers were standing before the Paraspatials Investigation Facility observation window. Within, the comatose form of Hypernaut Jennifer Samatha Yates lay prone on an operating table, wires emerging from the occipital and parietal regions of the skull. Two surgeons and several assistants were gathered around the lifeless body.

"How long will it take?"

"Patience, Dr. Sayers. We cannot force a person out of a two-month coma at the snap of a finger. You might recall Reggie's figures about how much energy she's been draining from her surroundings. That's precisely what's been keeping so many people up these last two months."

Maybe, Dr. Sayers would think later that night in bed, maybe she should have realized all along that Maxwell Jordan had been right.

"They're doing it!"

Indeed. Later, Dr. Sayers would recall how everyone had been staring with bloodshot eyes at the unconscious form; how that form had stirred suddenly and opened its eyes; and how, at the same instant Yates' body became aroused, the whole crew watching (including herself) and even the surgeons and their assistants within the P.I.F. had all nodded their heads forward and drifted into a restorative doze.

Engineers with communications skills
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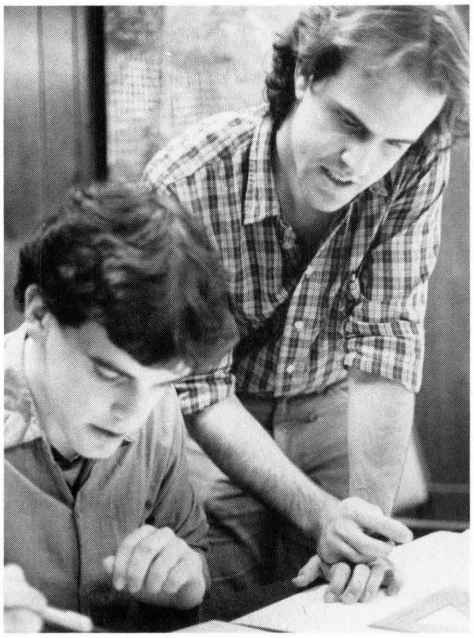
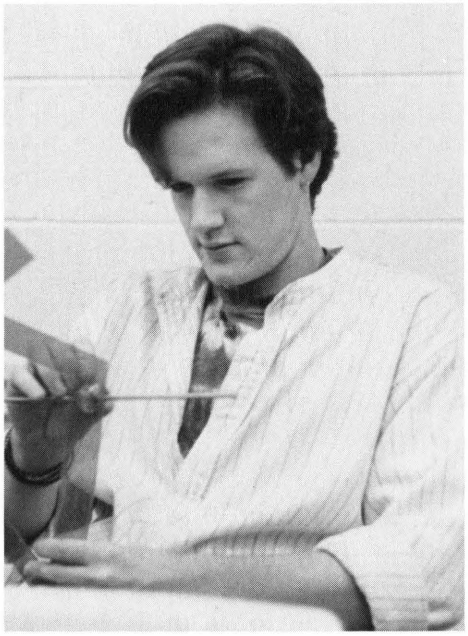


J. Lisk



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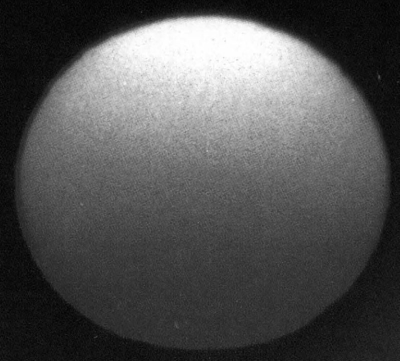

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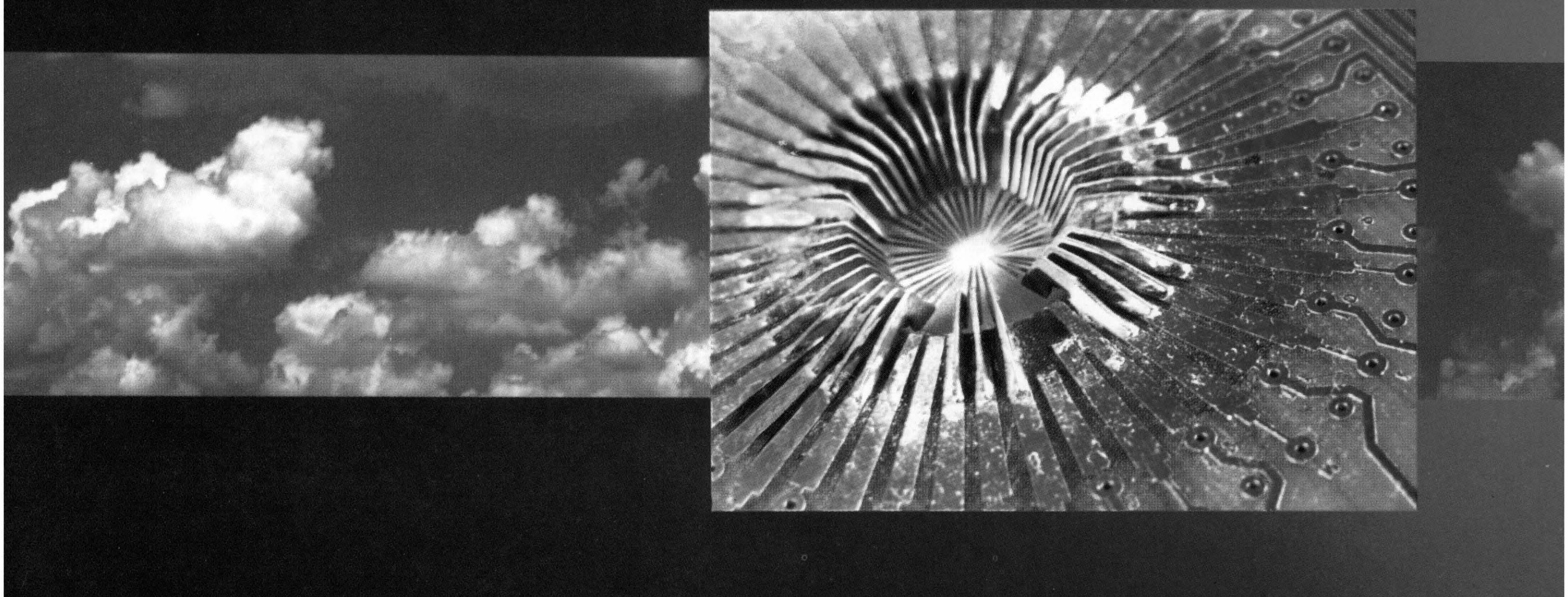


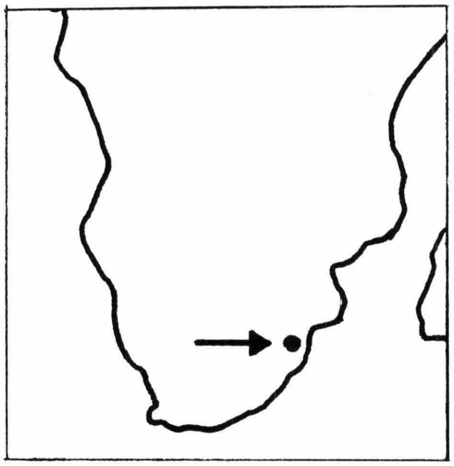
ALLIED Bendix Aerospace

Summer Experience: Swaziland

by James Lisk

While many opportunities exist for engineers to work on humanitarian problems in various countries, most students do not consider volunteering to work a summer overseas. Even if they think of the idea, they wonder if they could really do anything. After, most students want to save money and gain experience in industry from a summer job. Spending a summer volunteering time to a developing country just does not fall into most students' plans.

Yet this past summer Ed Wormald, a Virginia Tech Civil



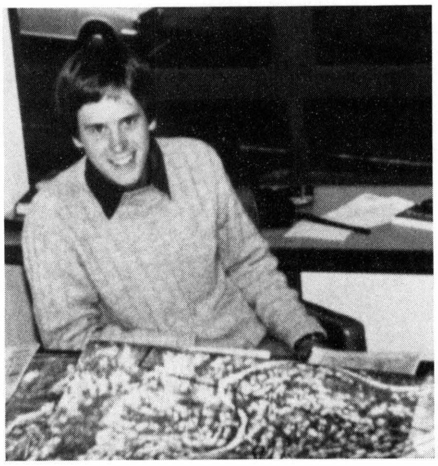
Engineering student, did just that. He raised money through churches, the Campus Crusade for Christ, and with a "Run for Africa" this past spring joined a small group of American students and traveled to Swaziland, in southern Africa, to volunteer his engineering training and time. Swaziland is a country one sixth the size of Virginia. It shares many problems with other developing nations like crowding in cities, unemployment, and inadequate sanitation facilities.

Ed's desire to use his engineering skills to help others is not independent of his Christian beliefs. As Ed said, "I feel like God has blessed me with analytical skills . . . so I have a desire to use my engineering skills to meet the needs of mankind."

Before doing this, he went through cross cultural training in New York, then several days of training in Swaziland. In Swaziland actions such as whistling in someone else's home or sniffing at food are considered insulting and rude; such things could make the difference between acceptance or rejection by this culture.

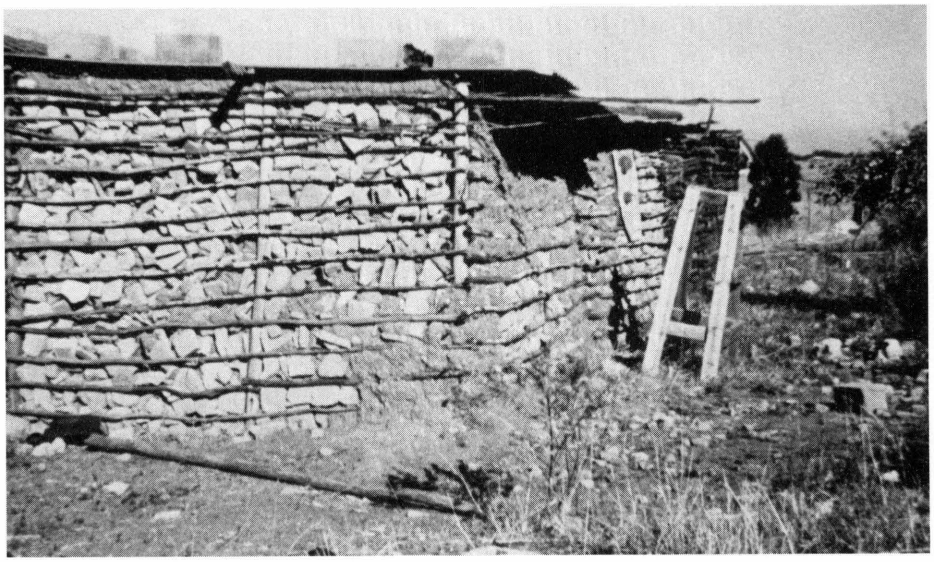
Ed spent one weekend with a rural Swazi family. Just the bus ride to the family's home gave Ed a bit of understanding of the problems facing Swaziland. "They just cram you in (the bus) and they say 'push them back' and they keep pushing them back . . . " Ed described the trip, "pressing against each other all the way for an hour ride." Though he did not know it then, Ed's first project involved the bus system.

Ed and the two other engineering students sent to Mbabane, Swaziland's capital, saw a mix of the old traditions and the new ideas. In town, Ed was cursed by a witch doctor for not buying one of his charms. At the home they visited, the women carried large clay pots of water on their heads while the children played with a toy car made of wire and cans. The house's walls were of stick, stone, and mud



Ed Wormald studying the aerial photographs of Kelly's Farm, Mbabane, Swaziland.

construction, but the roof was covered with metal sheets. The family ate mostly ground corn mixed in water, but the students brought food as is the Swazi custom.



E. Wormald

This home is being built in the Swazi countryside. It is constructed of rocks and poles, and will be covered with a layer of mud plastering. The roof is corrugated sheet metal.

These children are residents of Kelly's Farm.

Ed and the other two American students, John, an electrical engineer and Dave, another civil engineer reported to Alford Diamimi, Mbabame's only city engineer. They worked with him for six weeks on many different projects. When they arrived, the first project was waiting. After a quick introduction to the people in the office, Mr. Diamimi explained the problem with the new bus terminal. The people were boycotting it because it had no restrooms or shelters for waiting. With that, the three began work on designing shelters to put in the bus terminal.

Lack of proper planning, Ed noted, was likely to blame for this and many situations in Swaziland. In many cases contractors did only the minimum amount of work, knowing that there are too few engineers to inspect each job. Had engineers or other planners inspected the bus terminal plans, the terminal would not have to be partially torn up to install shelters.

Ed's second project also involved correcting a planning mistake. A small landslide occured as a result of a storm in January and threatened to block the road and destroy a church. In June, Ed inspected the site and recommended a retaining wall. Had the contractor who built the road stabilized the slope, the landslide might not have occurred. Another case of poor planning Ed saw was a partially constructed road. The road's hill was too steep to finish construction.

At times the students wondered about the city's priorities. John spent part of his time working on lights for tennis courts. Repairing the water fountain in the center of town received the most public attention. Yet, Ed's biggest project felt more related with his motives in going to Swaziland.

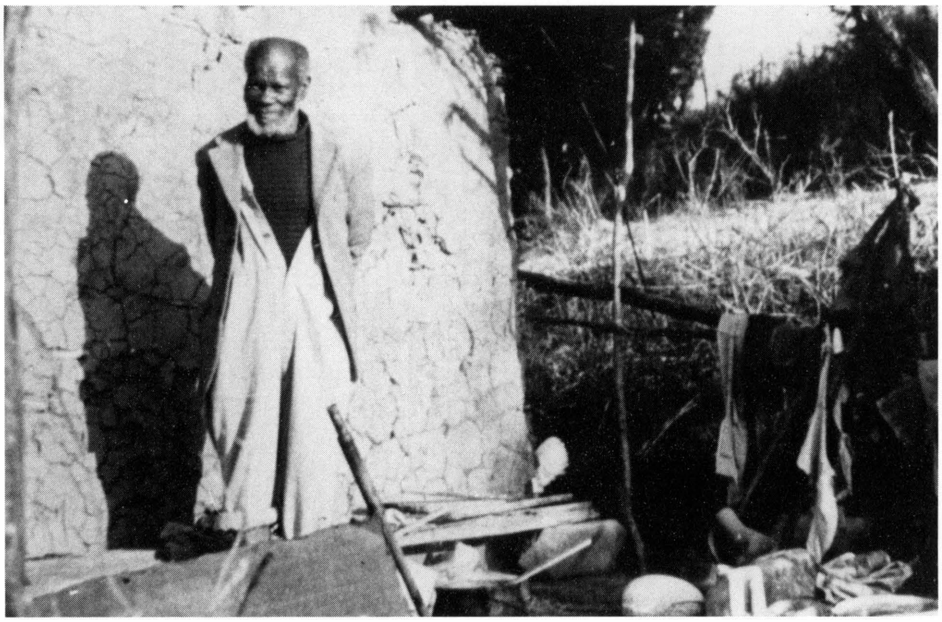
Many people in Swaziland and other developing nations are leaving their farms to look for jobs in the city. This is happening in Mbabane, creating growing numbers of unemployed called squatters.

The squatters move into the city believing they can find jobs. They bring their families, live stock and watever they can carry. The money they may have is soon spent while they set camp on government land. One such area, called "Kelly's farm" is either uninhabitable or used by squatters. The people dig small channels from a nearby stream or spring and the "water slowly goes down this channel to their area" as Ed saw it," . . . but it's sick because they've got tons of animals and people going to the bathroom everywhere and all this gets into that little water supply that they have made to their house." He also saw widespread disease as could be expected.

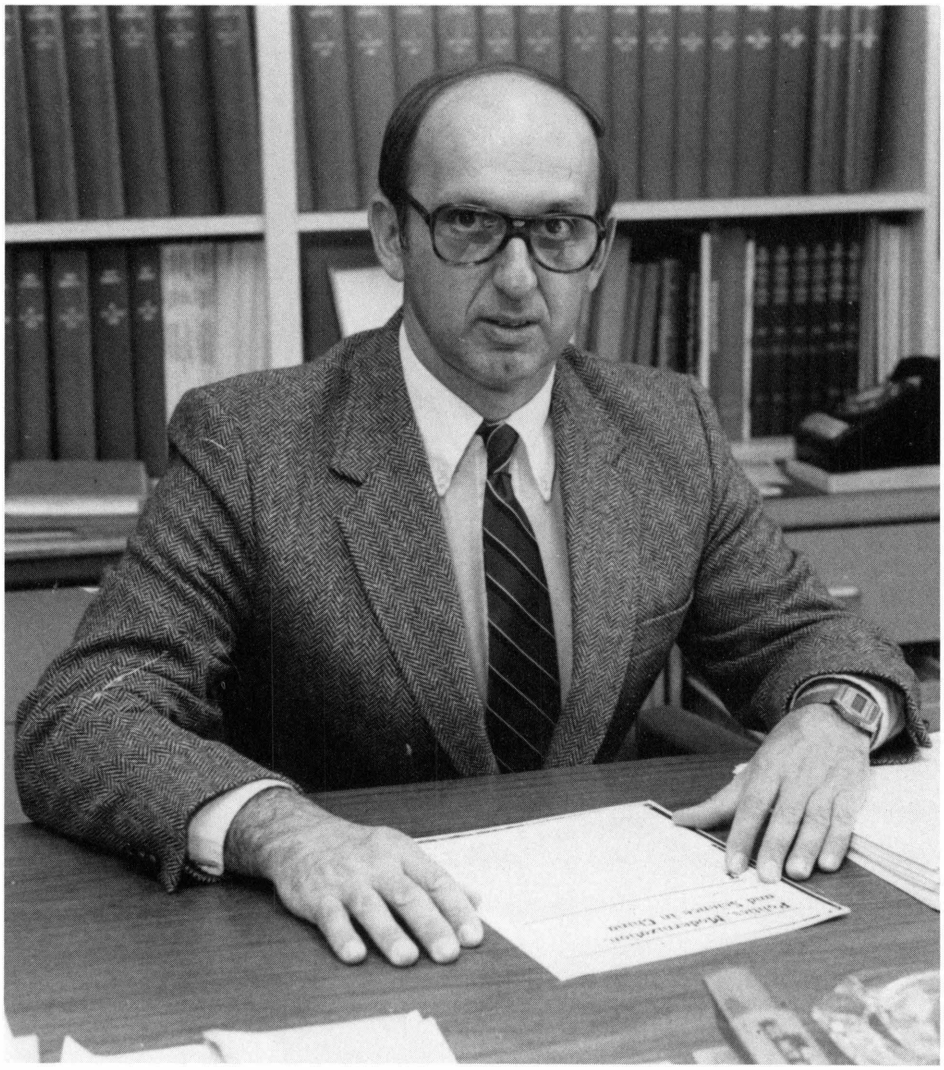
Ed drew plans for roads for Kelly's farm to divide the land into lots so the squatters will build permanent homes. Sanitation facilities and clean water supplies will follow in an attempt to upgrade these people's lives.

Skeptics will say "but the roads are not built, they are only lines on a map. How do we know they will be built?" Perhaps they will not be, but at least now the plans are made. The man power is not lacking to build them, and the plans have been thoughtfully designed to make certain the hills are not too steep.

Engineering students who like Ed, John, and Dave share a commitment to human welfare are needed today. They can help nations develop and do so, not for the sake of their wallets, but because they care.



This man is one of Swaziland's oldest citizens. He lives in Kelly's Farm.



M. Hill

Dr. Schetz on the High Road to China

by Bill Duncan

The Committee on Scholarly Communications with the People's Republic of China (CSCPRC) selects only thirty research scholars a year to do work in China. This year, the committee chose Dr. Joseph Schetz, Head of the Virginia Tech Department of Aerospace and Ocean Engineering, as the only engineer to participate in the program.

Schetz will spend three months at the Qinghua University and the Beijing Research Institute doing research in liquid fuel atomization. He will leave for China June 15.

It is surprising that Dr. Schetz wants to do research in China because the country has not been noted for good engineering universities since the communist take-over. The cultural revolution has hurt Chinese engineering technology even further.

Schetz said that the "chinese general and technical education system is in pretty bad shape. However, they're now working pretty hard to fix that back up, but they're having some trouble." In spite of China's recent lack of technological advances in engineering, Schetz is optimistic about his visit. "There is sometimes quite a useful technical exchange of information from surprising sources," he said.

Schetz states that it is not necessary that he do his research in China, but many Chinese have a similar interest in liquid fuel atomization. He is already exchanging research information with them and plans to continue doing so after he leaves China.

Part of Schetz' interest in China is to help restore their technical education system. "I'm interested in doing some collaborative work with them. They're interested in upgrading their educational system; I'm going to spend some time in universities. They are interested in upgrading their capabilities for research, and I'm interested in participating in that activity."

However, Schetz is not naive about the difficulty of his endeavor. He anticipates difficulties when he crosses cultural barriers. One major difference is the sensitivity the Chinese feel towards their work. The quality of a chinese person's life depends on his job position. "The people are more closely connected to their job. Ration coupons and medical care are closely hooked to the job." This is a minor difference when compared to the political differences. However, Schetz spent three days being briefed on this problem last summer in Warrenton, Virginia. The Chinese system has many levels of bureaucracy making research difficult. Schetz has already encountered this problem in another communist country, Romania. "You have to go with the flow," he said.

In Romania, Schetz was with a technology team trying to make some negotiations. He said the team would speak for ten to fifteen minutes on a topic, and then the Romanians would spend three days clearing the proposals through various bureaucratic channels. "On top of that, the political officers must interpret everything in Marxist and Leninist thoughts. It's a very cumbersome process. So, we expect the same thing in China," Schetz said.

Schetz said that because progress is slower in a communist country, "you have to have lower horizons and expectations." But, he added, "the key ingredient is the people. Maybe there are some things that we can use to our benefit here."

Schetz' travel and stay in China is being funded by the United States government. He'll stay in hotels, dormitories, and faculty housing. The time that is not spent in universities will be spent traveling to government testing facilities.

A chinese host is arranging Schetz' travel and accommodations, because strict rules require that "everything has to be pre-arranged. You just can't check into a hotel," Schetz said.

Schetz first became interested in the project after he saw the CSCPRC announcement. He inquired at the International Programs office here at Virginia Tech about openings and qualifications, then applied.

For a research scholar to be chosen by the committee, he must be selected for the position by both countries. Schetz doesn't know exactly why China was interested particularly in him, but he thinks it may have to do with some of his technical literature that has been published in China. The chinese read a lot of technical literature, so they may have recognized his name.

Schetz, who speaks no Chinese, isn't worried about the language barrier. He said most chinese technical people speak English because most of their technical literature is published in English.

Schetz has never been to the Far East before; however, he has visited and given talks in the Soviet Union and in the Soviet Block countries of Poland, Hungary, Czechoslovakia, Yugoslavia, and Romania. He plans to take his wife for part of the stay in China because she is a speech therapist and is interested in talking to people in public schools and special education. Chinese special education "tends to be in a primitive state," Schetz said.

After his visit to China, Schetz wants to continue his foreign research endeavors.

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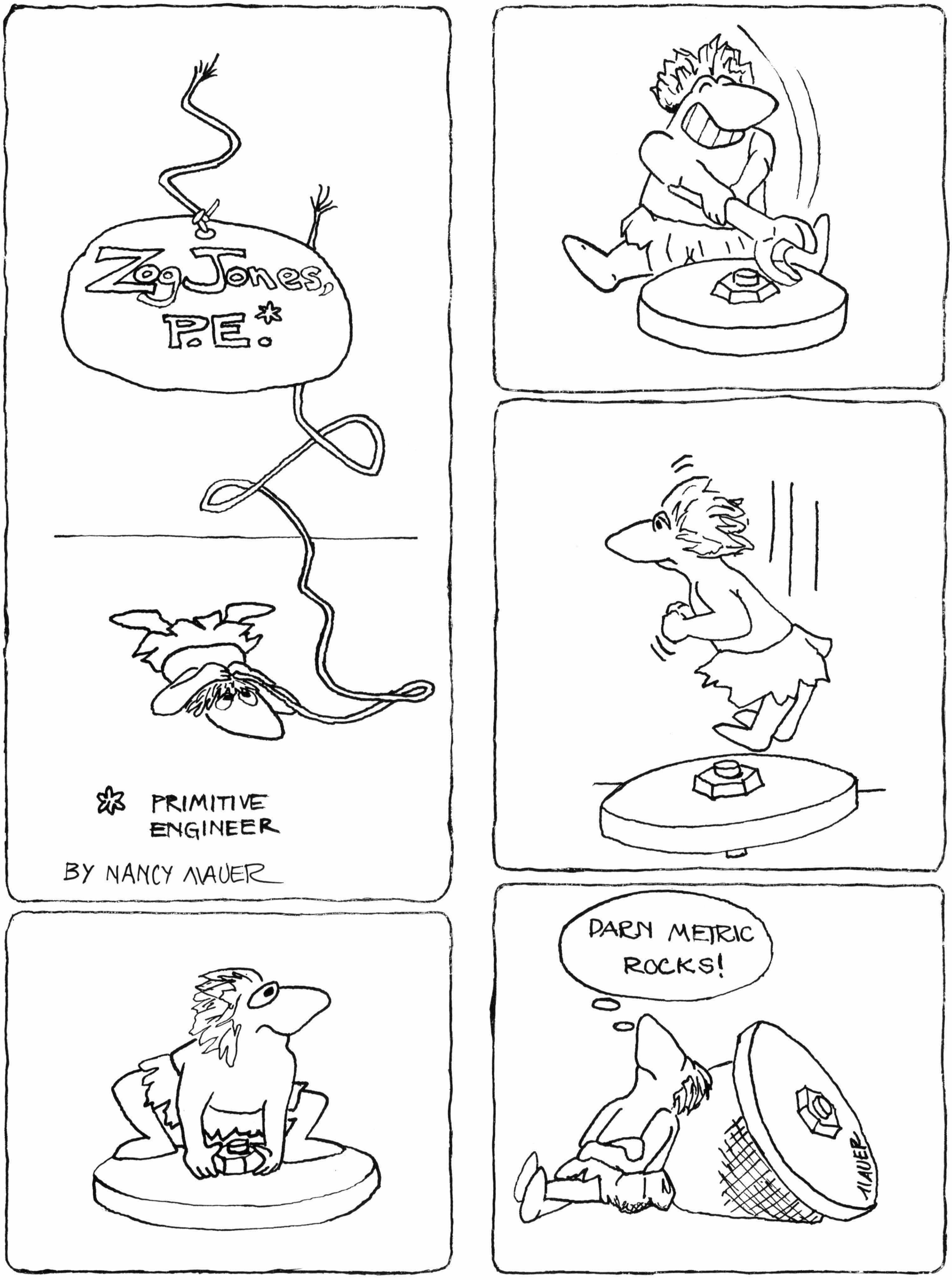
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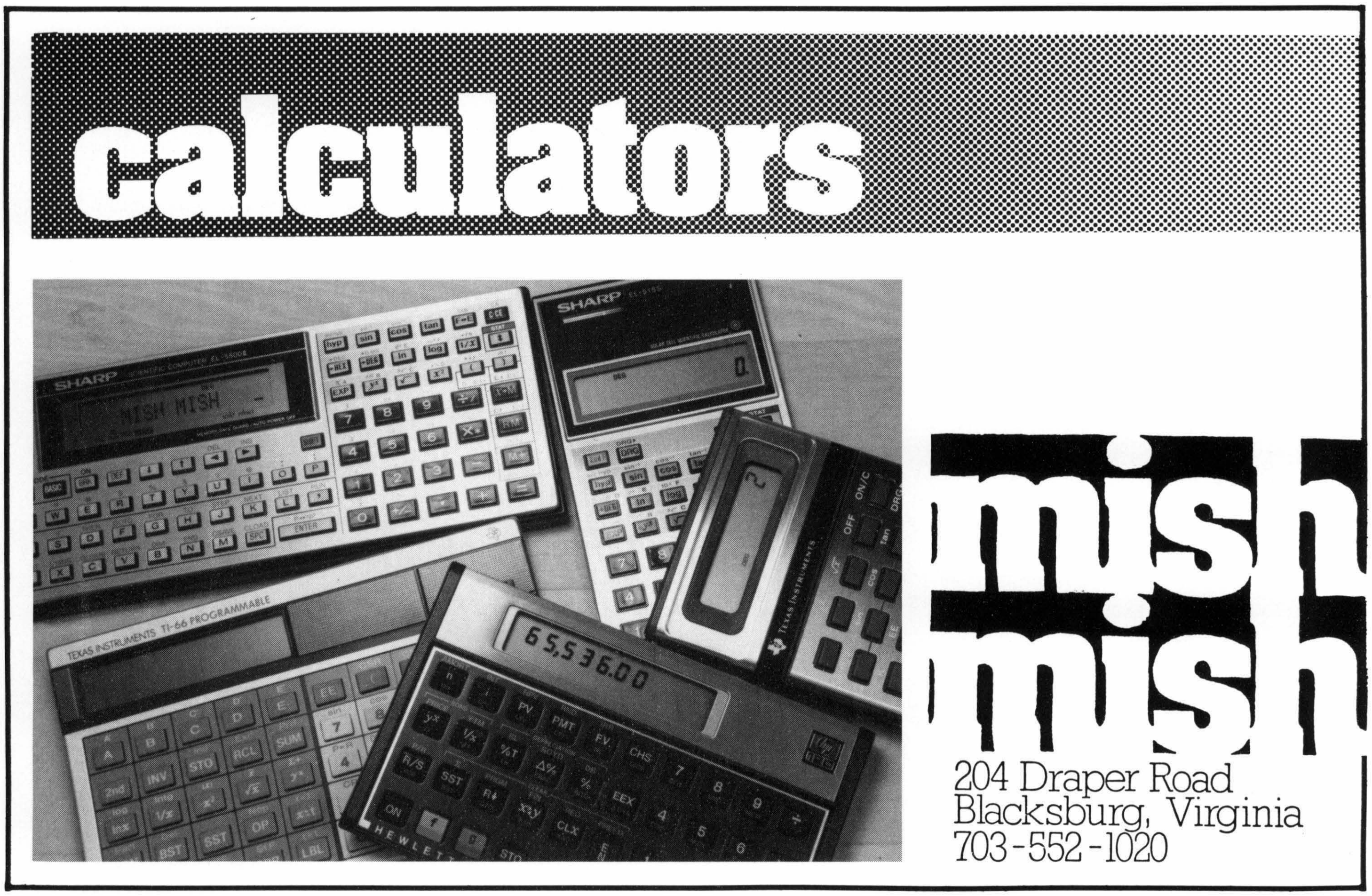

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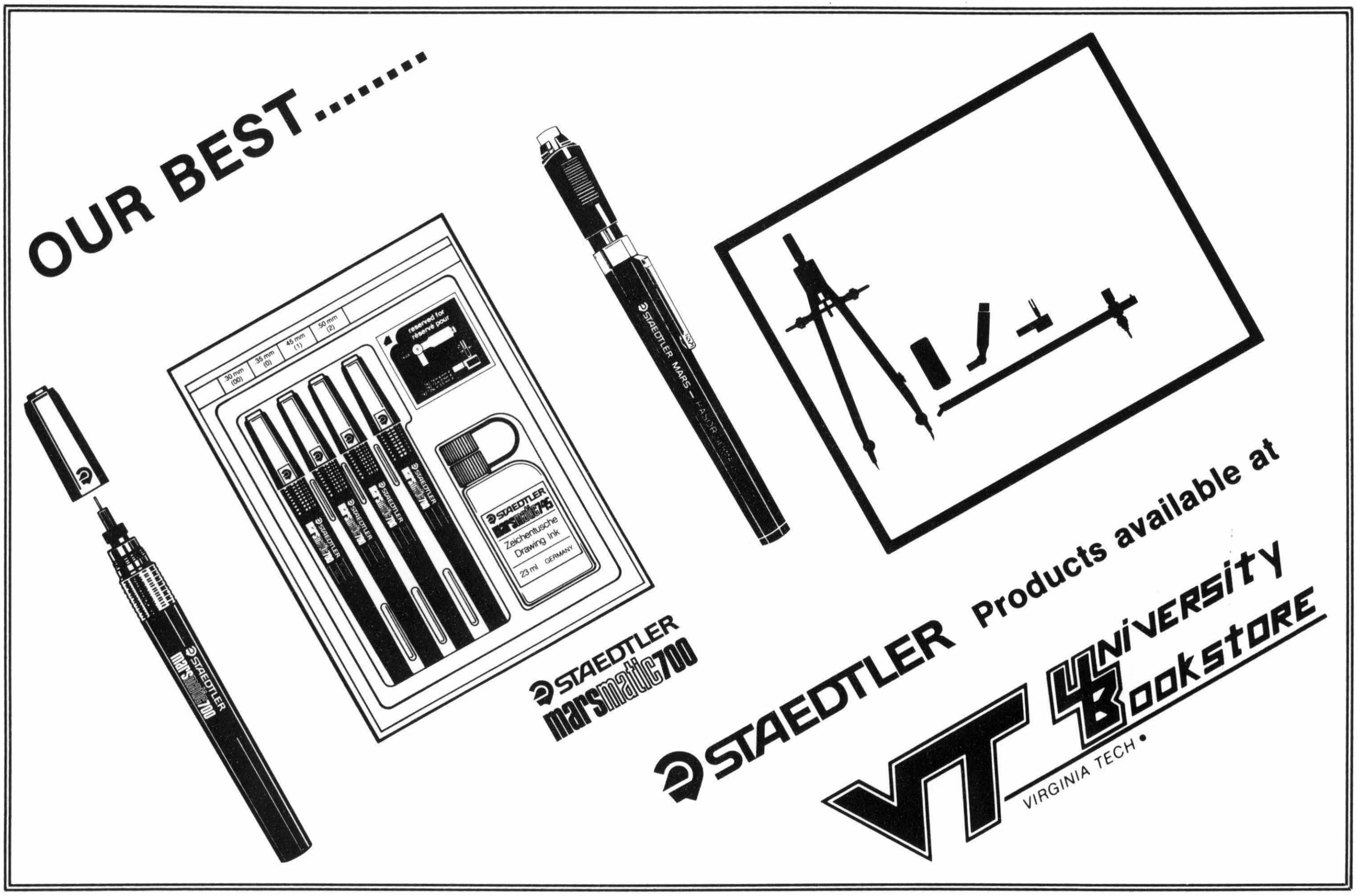

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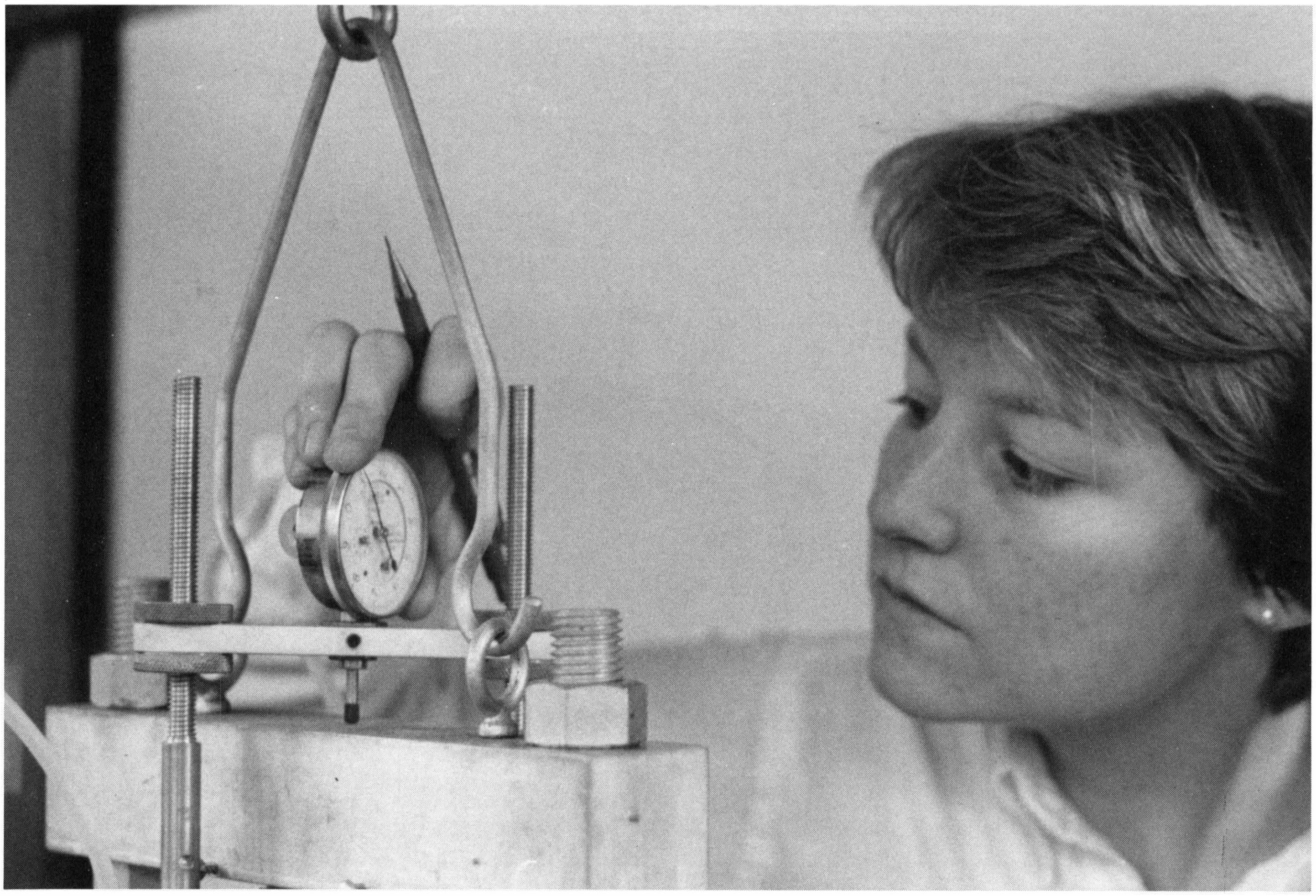

B. Robertson

The Geotechnical Engineering Project Center

by David P. Hernson

How do engineering students become involved in engineering practice while still in school? The geotechnical department of Civil Engineering here at Virginia Tech has a solution to this problem. The Geotechnical Engineering Project Center* was initiated in November 1984 in order to help bridge the gap between practicing engineers' need for information and academic engineers' ability to supply it. The project center provides its industrial subscribers with completely researched, state-of-the-art technical information that is collected, compiled and presented by students working for credit towards their engineering degrees.

In the performance of the job at hand, a practicing engineer often realizes that he does not have the data, or the computer program, or the chart solutions he needs to solve his problem efficiently. Within the constraints of the job, there is not time to develop the needed materials, so he does without them. Although he knows information is available he does not have time to locate it or put it in the best form for general use.

For example, in the course of an engineering job, a civil engineer realizes that using geotextiles might be a good idea that could save his client some money and lead to a better job. He knows that variety geotextiles are available and a wealth of information (alas, too much) is available, but he does not have time to collect and digest it.

Meanwhile, in one of her courses a Civil Engineering student learns about geotextiles, is

◀
The time rate of consolidation is the subject of Master's student Sybil Goessling's research. She is compiling a comprehensive engineering manual that brings under one cover the plethora of existing theoretical and empirical literature on this topic. The manual includes charts, graphs, tables, correlations and an extensive bibliography to serve not only as a design aid but also as a teaching tool.

In an effort to predict the effects of cementation on the liquifaction potential of naturally deposited soils, PhD candidate Barry Millstone works under a grant from the Earthquake Hazards Mitigation Program (NSF). Laboratory samples are tested in a dynamic triaxial apparatus to measure liquification with respect to the number of cyclical loads.

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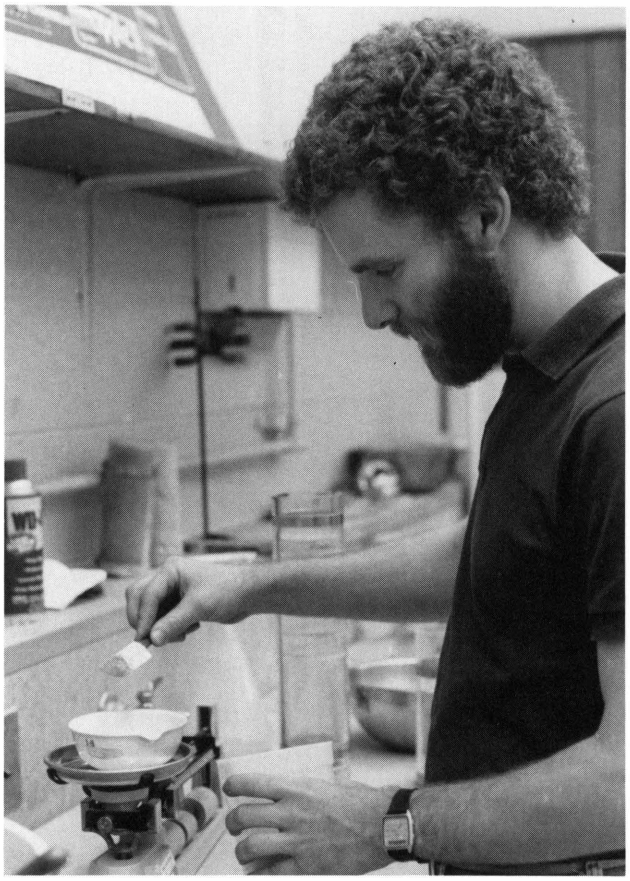

fascinated by their potential and would like to know more about them. Unfortunately, none of the courses offered consider the topic in enough detail to satisfy her.

The project center was established to bring these two engineers together. Faced with his problem of insufficient time to collect and organize information on geotextiles, the civil engineering member of the project center can call any member of the geotechnical faculty at Virginia Tech to find out if they know of any ready source of the information he wants. Assuming this information does not already exist, the project of developing it is added to the project center's list and the practicing civil engineer is made professional adviser for the project (assuming he wishes to be). The student interested in the project can sign up for academic credit to undertake this project, working with a faculty adviser and a professional adviser.

In this way, the project center provides benefits to the professional and the student engineer:

1. Practicing engineers have access to faculty members' knowledge of the state-of-theart in their field, and an efficient mechanism for suggesting improvements in the state-ofthe-art.
2. Students have opportunities to work on development of engineering tools (i.e. summaries of information, computer programs, design charts, etc.) of direct and immediate use in engineering practice. In the process they have a chance to meet professional engineers and to learn first-hand about what is important in engineering practice.
3. Finally, the educational program is enriched through greater involvement with practicing professionals and use of the Project Center products in courses.

Typical projects include the development of micro and mainframe computer programs (with complete documentation), the compilation of experimental data, theoretical results, engineering manuals and bibliographies for use in engineering practice. Some of the products currently available from the center include microcomputer programs with user's guides and example problem data. These include:

- Analysis of slope stability
- Consolidation settlement
- Seepage
- Lateral loads on piles
- Evaluation of soil properties from triaxial tests

Mainframe computer programs with complete user's guides are available on the following subjects:

- Analysis of slope stability
- Consolidation settlement
- Seepage
- Lateral loads on piles
- Wave equation analysis of pile driving
- Finite element analyses of excavations, embankment construction, soil structure interation and consolidation

In addition to these software package, the project center has available printed materials including:

- Engineering manuals for slope stability studies and settlement studies

* Reprints of professional papers
* Reprints of research reports

Underway now is the development of a microcomputer program (BASIC) for soil classification and a compilation of available charts and table for calculating time rates of consolidation settlement.

In addition to the Project Center's utilization of the entire engineering student body, civil engineering graduate students are involved in practically oriented research, including a number of large industrially and governmentally funded projects. Current projects include innovations in testing methods and analysis, dynamic triaxial test of cemented soils, penetrometer tests of confined granual soils and a computer software package designed to quickly and accurately classify soil samples based on standard lab tests, to cite only a few examples.

The Cofferdam project, sponsored by Army Corps of Engineers and under the direction of Professors Clough, Kuppesamy and Barker, is an extensive study of the interactions of materials used in cofferdams under a variety of loading conditions. This project incorporates engineering expertise from geotechnical, structural and hydraulic engineering fields of study working in coordination towards the design of a project to be constructed on the Mississippi River.

Thus, the geotechnic department of Civil Engineering, especially now with the creation of the project center, strives to contribute to the profession not only by preparing students but also by supplying current, completely researched and documented technical information. To participate in the work of the project center, students or professionals may contact Professor Mike Duncan in the Civil Engineering department at Virginia Tech.

*The Geotechnical Engineering Project Center is founded under the auspices of Virginia Tech Foundations, Inc.

Using unsaturated samples of the slope wash from the San Luis Dam, PhD candidate Tim Stark works in cooperation with the California Bureau of Reclamation, in attempting to recreate the chain of events that caused the failure of the dam's foundation material.

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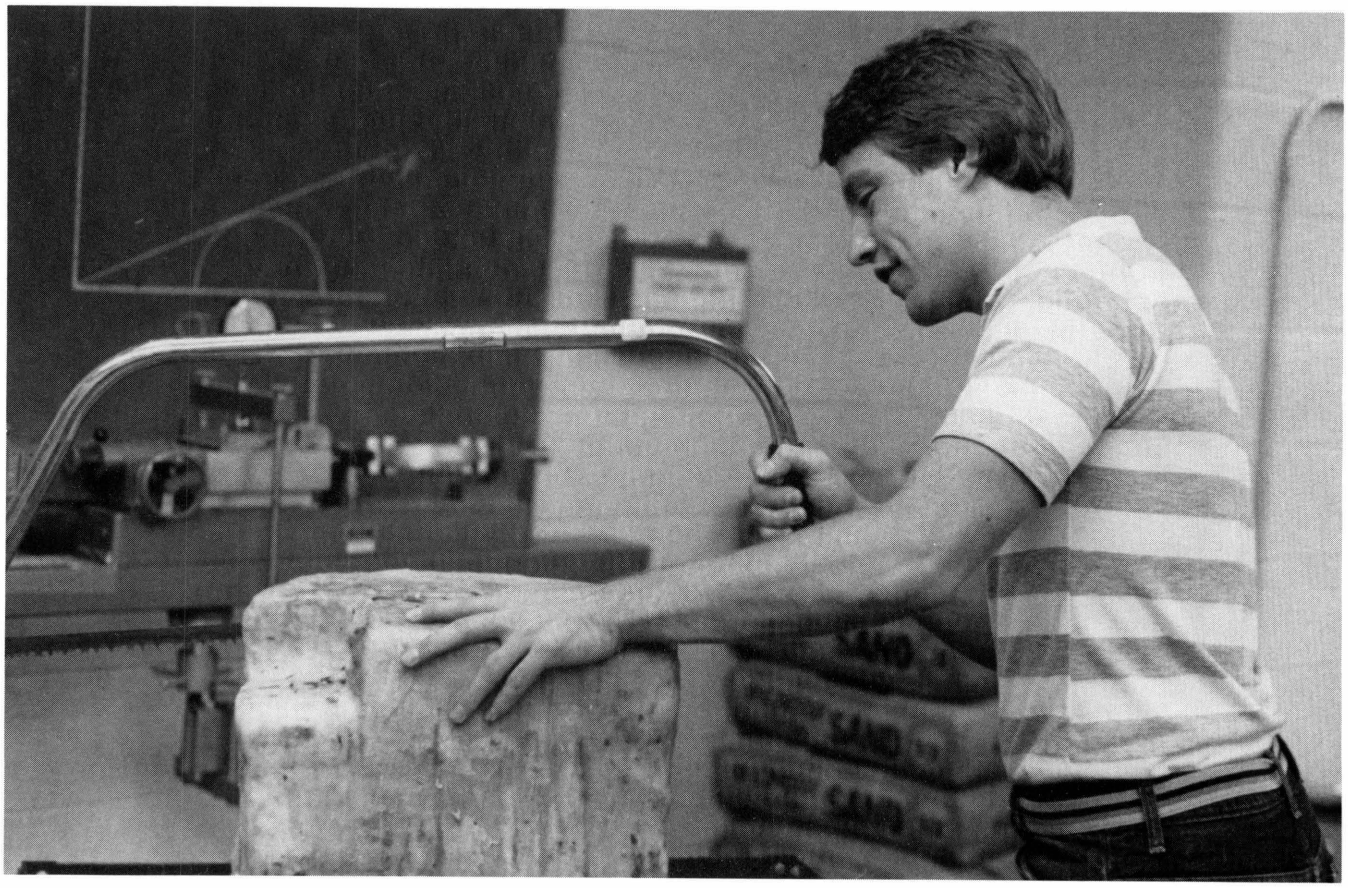

B. Robertson

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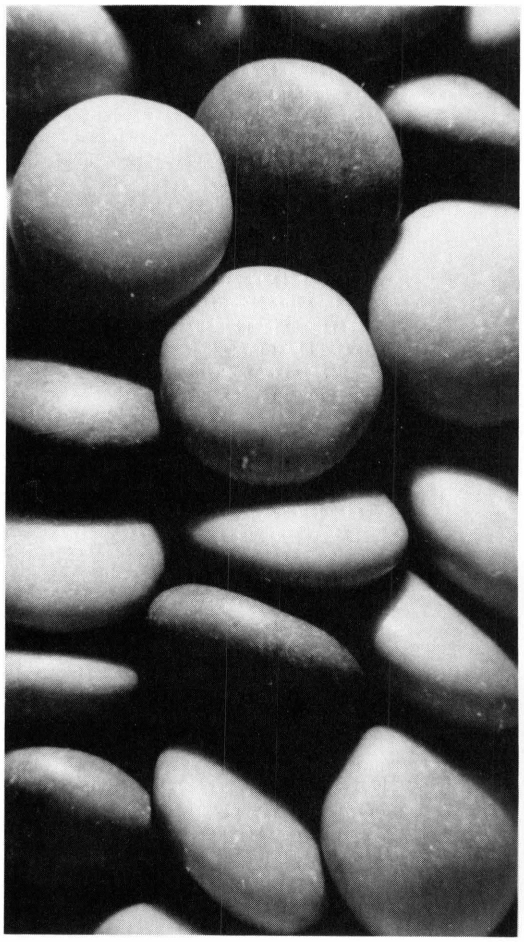

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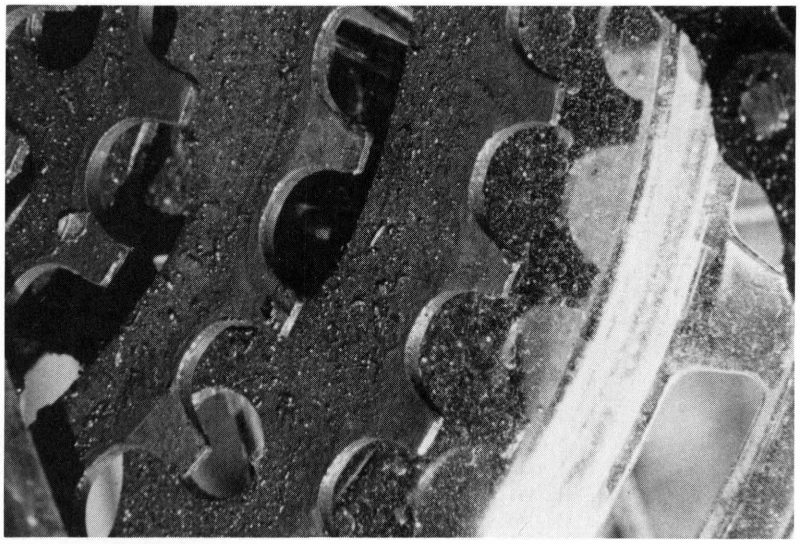

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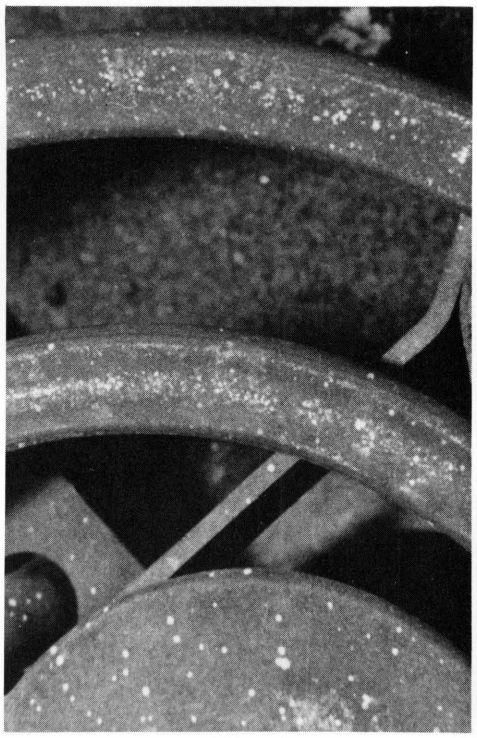

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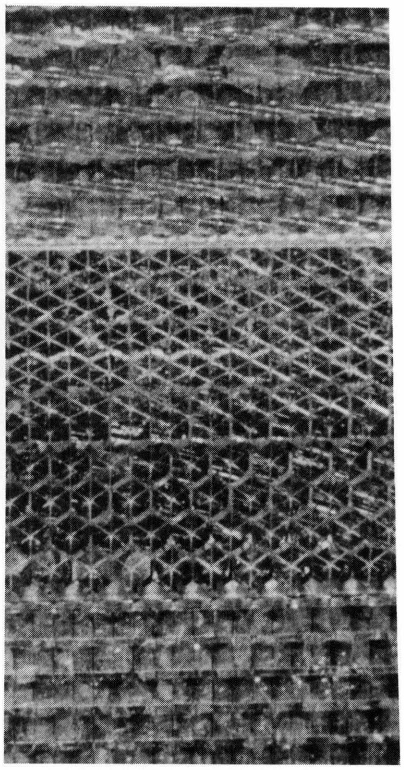

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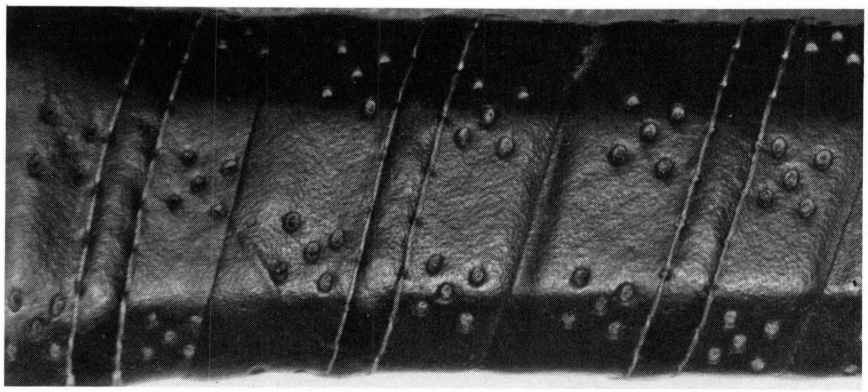

Answers: 1, M&M's; 2, bicycle freewheel; 3, stove element; 4, safety reflector; 5, racket handle

by *B. Robertson*
M. Hill

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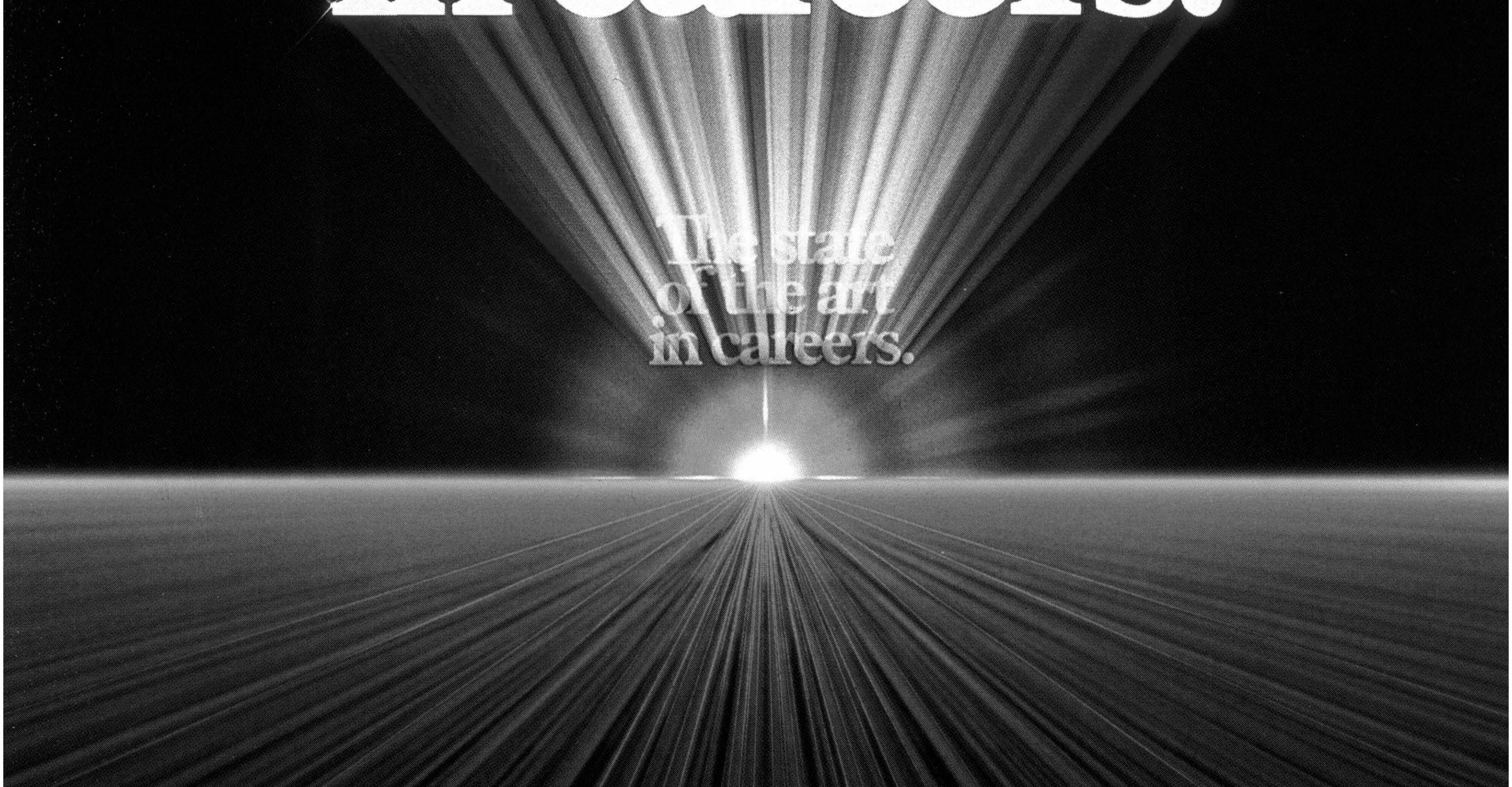

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