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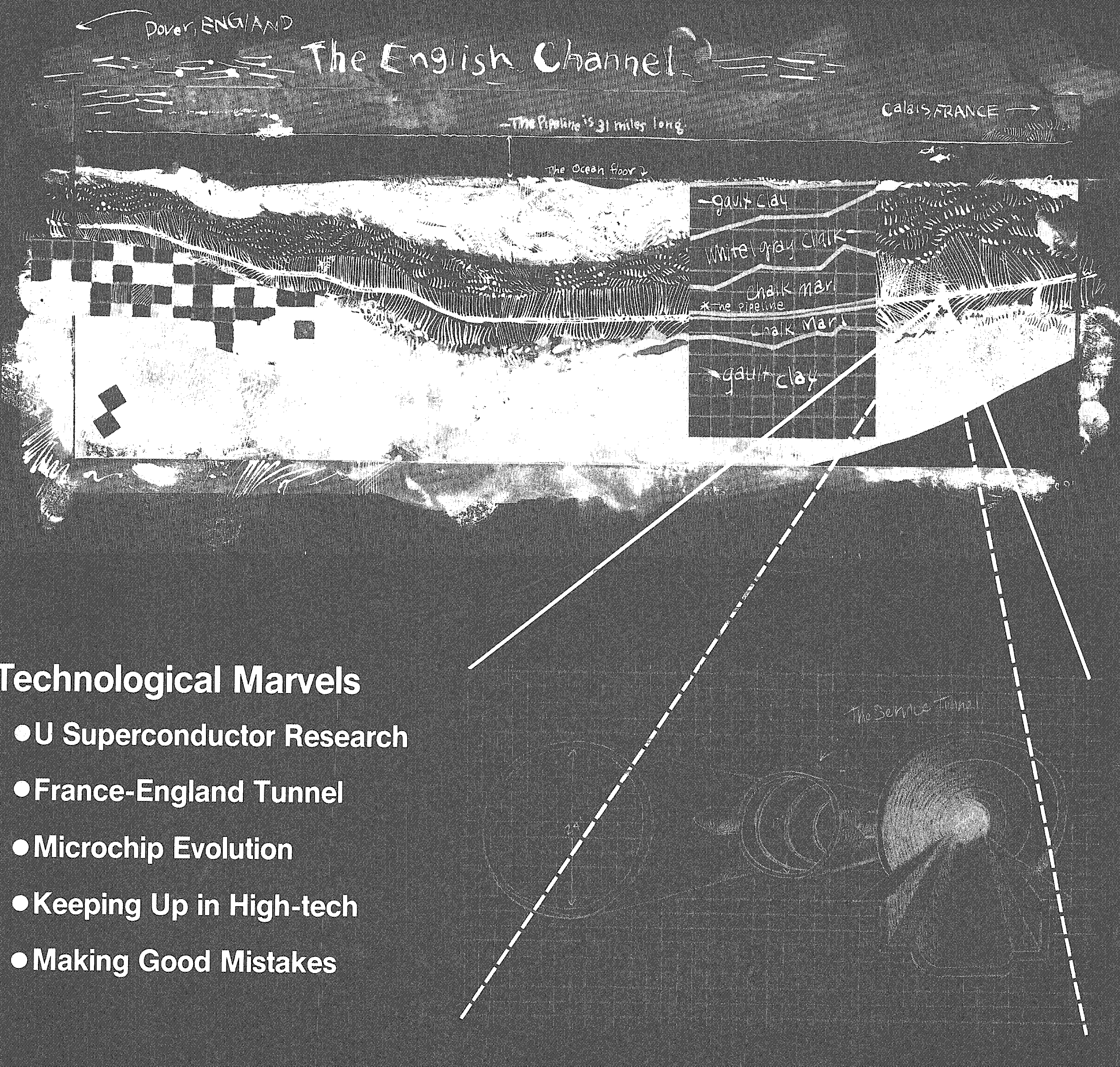
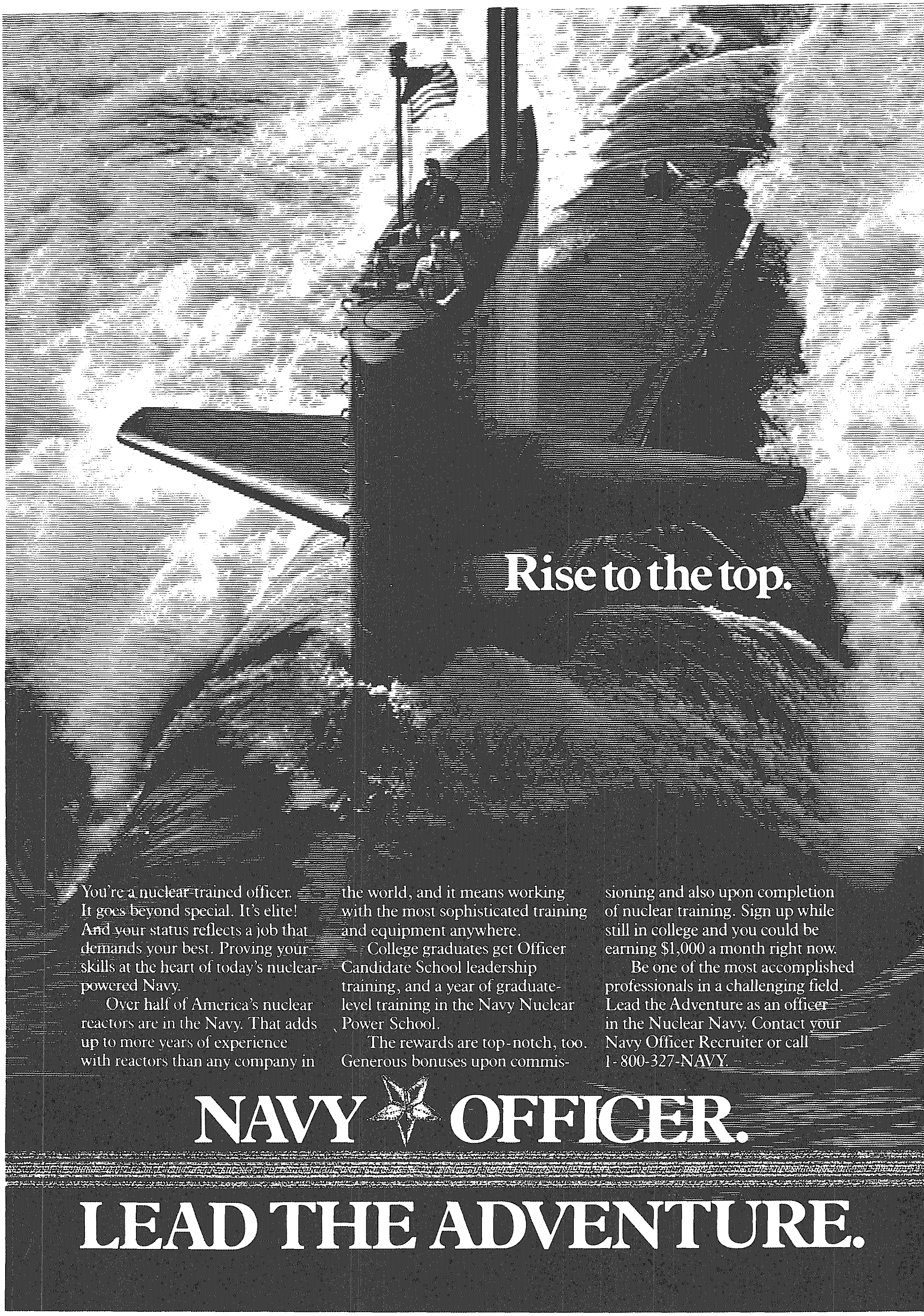
TECHNOLOG

Fall One, 1987



Technological Marvels

- U Superconductor Research
- France-England Tunnel
- Microchip Evolution
- Keeping Up in High-tech
- Making Good Mistakes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Technological Marvels

Features

Departments

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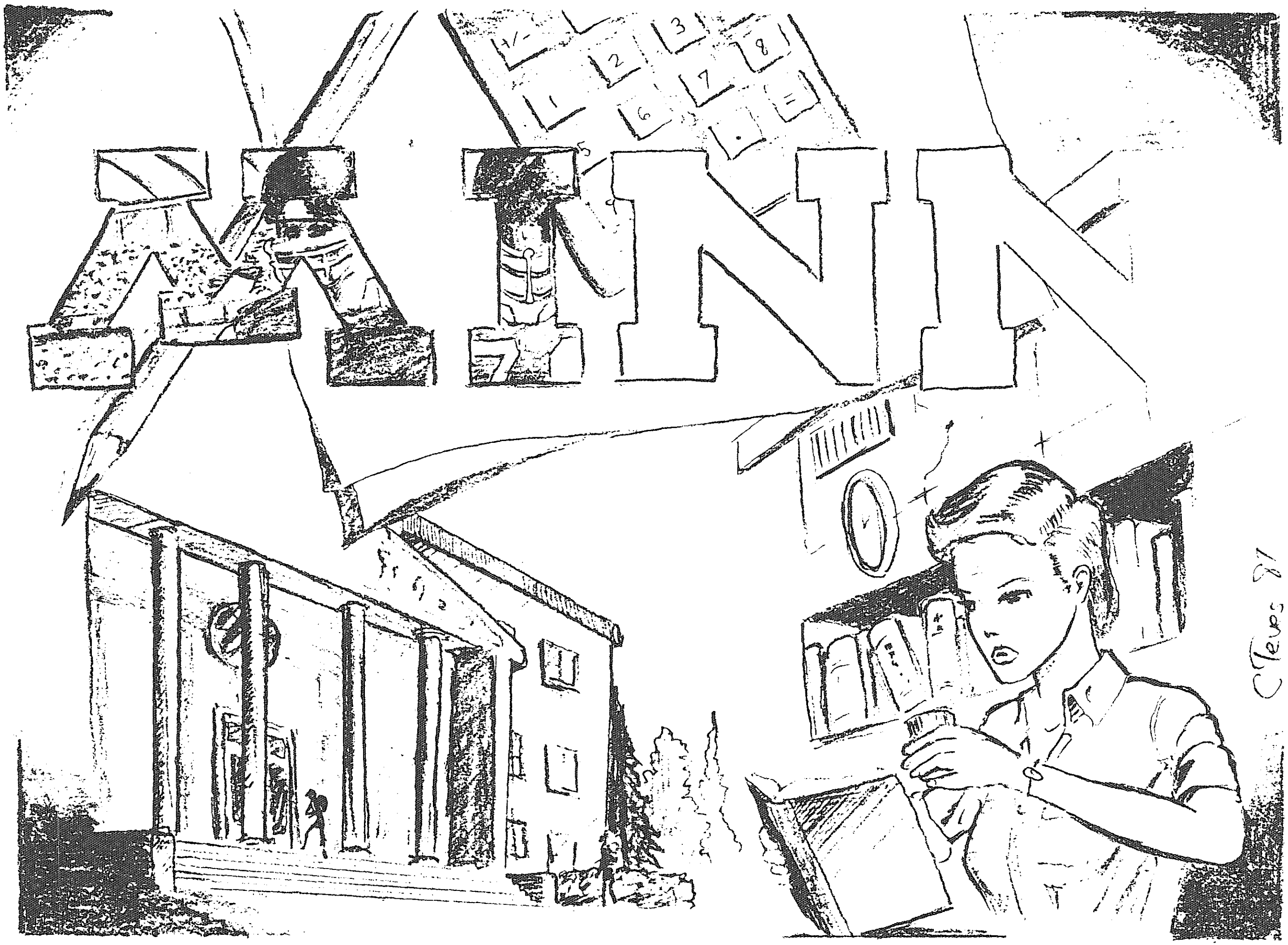


Illustration by Conrad Teves

Welcome

A new school year. Some look upon it with eager anticipation while others have dread in their minds and hearts. Whichever the case, the *Minnesota Technolog* would like to welcome you to the Institute of Technology, new students and old.

As the official undergraduate publication of the Institute of Technology, we offer you articles and news about new developments in technological areas and how they affect the University of Minnesota. David Kortenkamp's article on superconductors in this issue shows how U of M researchers are trying to understand the reasons behind the new breakthroughs in that area.

We will also feature some non-technical articles that offer looks at current issues affecting IT students, graduates and faculty. Along those lines in this issue, Susan Curran interviews an IT graduate about how engineers and scientists need to constantly keep learning to stay up-to-date with today's technological advances.

The *Minnesota Technolog* is a student-written, student-run magazine for the IT community. It is your magazine and can only improve with the help of its readers. If you have an interest in writing, illustrating or other facets of publications, stop by our office in Room 2, Mechanical Engineering (624-9816). We also welcome letters and feedback about how we are doing.

Minnesota Technolog. Your magazine. Take a good look. ▲

Editor's Log

Grading Policies — Fair and Foul

Imagine this common scenario:

> It is the first day of school and you are attending class. The professor makes a few welcoming comments and hands out a syllabus for the course, explaining some of the important details. A hand is raised in the front and the student asks, "Could you explain your grading policies?"

Up until this point, this scene probably happens the same way in every classroom during the first meeting. The similarity stops with the answer to that student's question. The difference in grading policies of University teachers is a problem that almost every student encounters. Fair and balanced grading is becoming even more important as upper-division GPA requirements increase and competition in the job market intensifies.

Fair and balanced grading is becoming even more important...

Many teachers feel that grading is one of their reserved privileges. Some think guidelines and limits would restrict their academic freedom in methods of teaching and even material presented. If everyone had a fair, non-arbitrary system that students were satisfied with, no problems would exist. But that is not the case. Inconsistencies abound.

Take the example of how two professors from the same department differ on their grading policies. One uses a statistical system that modifies each test and homework score by the performance of the other students in the class. At any time, students can punch a few numbers in their calculators and see how they stand relative to their classmates. The only area where the professor enters into the process is defining the boundaries of the grade ranges at the natural breaking points of the distribution.

The other professor grades students' performance on the basis if they would be hired by a firm at a position that uses the particular knowledge taught in the class. Does this method take into account the difficulty of the material presented? How about the other skills necessary for the position that are not taught in the class? Many excellent engineers are not the ones with the high GPA's and test scores. This system lends itself to an abundance of subjective interpretation of objective scores.

Some departments stress restrictions on the number of students per class that can receive A's, B's, etc. This across-the-board policy endorses a blind distribution curve with no regard to quality of teaching, difficulty of material or any other influencing factor. In this case, more subjective looks at these factors would yield a fair grading system.

Any answer to these problems would tread a fine line between infringing on professors' rights and students' rights. The ideal solution would not be a single, restrictive system that everyone must use, but a set of guidelines that would force the grading process to be more accountable to students. Each class would undoubtedly be different, as would each system.

Any answer to these problems would tread a fine line...

Whether this should be handled at the university, college or department level is not an issue here. Policies need to be formulated and guidelines set where teachers are allowed some freedom for their personal grading systems, but students are also protected and given the grade they deserve. ▲

Jim Willenbring
Editor

Superconductivity: Hot Research in a Cold Field

The University emphasis on fundamental superconductor research is paving the way for a better understanding of the mysterious effect.

by David Kortenkamp

Superconductors. They've made the cover of *Time* magazine. They've been the subject of presidential proclamations. Soon, we're told, they'll levitate trains, power cars and change our lives. But these wonders seem unrelated when one visits the University's superconducting laboratories. In place of engineers constructing magical devices are researchers still trying to understand the fundamental priciples of superconductors: principles that are still not fully understood even after 75 years of scientific research.

Leading the University's efforts is physics professor Allen Goldman who began studying superconductors long before they became chic. Despite the recent flurry of activity in his field, Goldman doesn't want to drop everything and enter the race to discover new superconducting materials. Instead, he and his graduate students will continue doing what they've been doing, attempting to understand just how superconductors work.

Superconductors first came to the attention of scientists in 1911 when Dutch physicist Heike Kamerlingh Onnes noted that when some metals are cooled to extremely low temperatures (~4 K), they conduct electricity with no resistance. The discovery caused quite a stir since the physical theories at the time proved that this effect was impossible.

For almost half a century the mystery remained. Then in 1957, John Bardeen, Leon Cooper and J. Robert Schrieffer developed a theory (for which they later won the Nobel Prize) that seemed to explain the phenomenon. Commonly called the Bardeen-Cooper-Schrieffer (BCS) theory, it attributes superconductivity to the collective pairing of electrons in the superconducting materials.

...the physical theories at the time proved that this effect was impossible.

In a normal conductor, electrons individually battle their way through the atomic structure of the metal, bumping into other subatomic particles along the way. With each impact, the electrons lose some of their energy which is given off as heat. In a superconductor, though, the electrons pair up. As the first electron travels through the superconductor, it leaves a positive wake behind it. The second electron is attracted to this positive wake and is virtually bound to the first electron. The bound electron pair (called a Cooper pair) is fundamentally different from an individual electron. Several Cooper pairs can occupy an identical state, where they act in a coherent manner. This collective action, or long range order, is the essence of superconductivity.

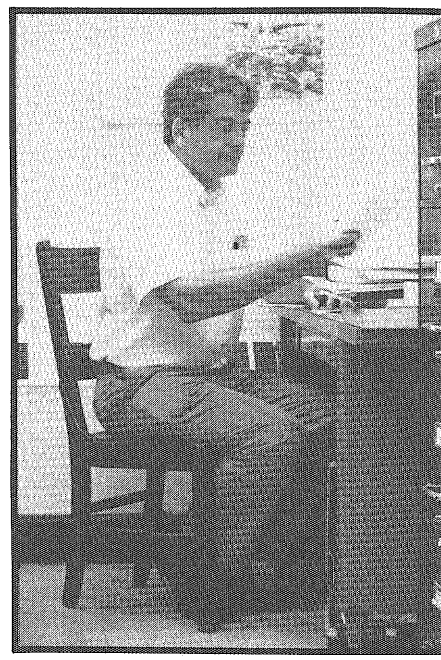


Photo by Paula Zoromski

Professor Allen Goldman heads the superconductor research here at the University.

Armed with this theory, scientists accelerated their research into superconductors but were unable to raise the minimum temperature needed to induce superconductivity more than a few degrees. It was only recently that researchers stumbled upon a new class of materials that become superconductors at higher temperatures (~90 K). The

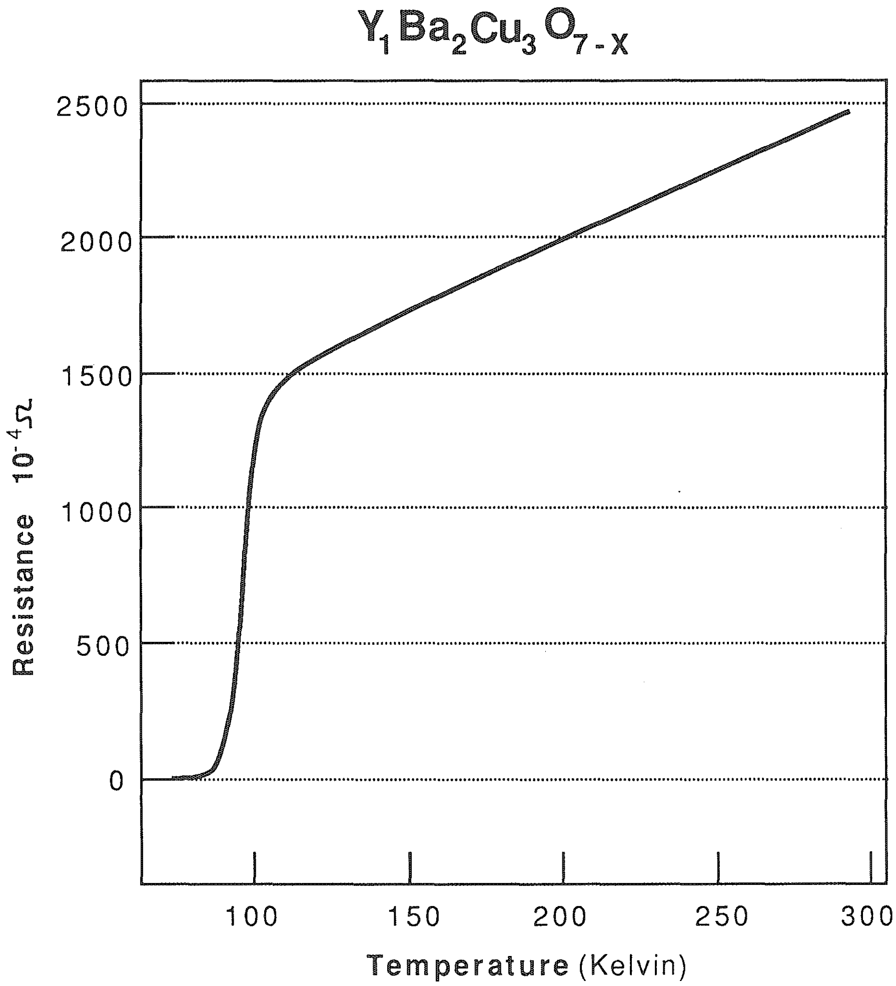


Illustration by Jerry Fiala

A graph showing the resistance drop at a high temperature of a new superconducting material, $Y_1 Ba_2 Cu_3 0_{7-x}$

significance of this discovery is partly economic, as it's much cheaper to cool something down to 90 K than 4 K. Liquid nitrogen can be used instead of rarer liquid helium. But the significance is also scientific—it reopens the mystery of superconductors since researchers aren't sure yet if the BCS theory can apply to the new class of materials.

Goldman and his students attack the mystery of superconductors on several fronts. One group deals with thin films of superconducting materials grown on substrates. Growing these thin films is not a trivial process. The films are only about 15 angstroms thick and cannot contain any impurities. Since metal oxidizes in air, the films must be grown in a vacuum. In addition, the films must be cooled to extremely low temperatures to measure superconductivity. The group uses a vapor deposition (or evaporation) technique to grow films in a high vacuum/low temperature environment.

The evaporation technique is quite simple in principle, but difficult in practice. It involves placing a chunk of metal in a furnace and heating it to its boiling point. A shutter above the furnace is then opened, allowing some of the metal vapor to escape and land on a substrate. A thickness monitor measures the depth of the deposited film. The thickness can be controlled by adjusting the temperature of the furnace and the open shutter time. This whole process is carried out in a vacuum chamber.

The evaporation technique is quite simple in principle, but difficult in practice.

A similar process called co-evaporation is used to grow films consisting of more than one element. Now instead of one furnace, there are several, each containing a different element. By varying the furnace temperatures and individual shutters, different combinations of elements can be achieved. Since the composition of the resulting film must be exact, the researchers program a computer to control the various parameters.

Gaining experience in making thin film superconduttors is a crucial step if one wants to understand the physics of the new superconductors. University researchers use the films in a variety of experiments. For example, they can grow these films and attempt to pinpoint just when superconductivity sets in. As the film grows, it evolves from a highly resistive film to a superconducting film. Detailed study of this evolution reveals much about the nature of the long range order which causes superconductivity.

Another group uses the thin films to study the atomic structure of superconductors with a scanning tunneling microscope. Electrons from the microcsope's extremely fine tip tunnel into the superconducting material. By scanning the tip back and forth and measuring the tunneling current, scientists can gain knowledge about the material's electronic states and

David Kortenkamp is a senior in Computer Science and worked for Cray Research at the University's Supercomputer Institute this summer. David is *Technolog*'s pinch hitter, having churned out four articles in the last five issues. He also had a short, but illustrious career at third base for Team *Technolog* last spring. David plans on attending graduate school after receiving his bachelor's degree.

also map the surface topology of the material. This technique is a recent development (the Nobel Prize awarded just last year to its inventors), and University researchers had to modify the microscope to operate in a high vacuum/low temperature environment.

Yet another group at the University is looking at devices made of superconducting materials. Examples of such devices are tunnel junctions and small circuits etched onto

...such devices are tunnel junctions and small circuits etched onto superconducting films...

superconducting films using an electron beam. It's hoped that this research will lead not only to a better

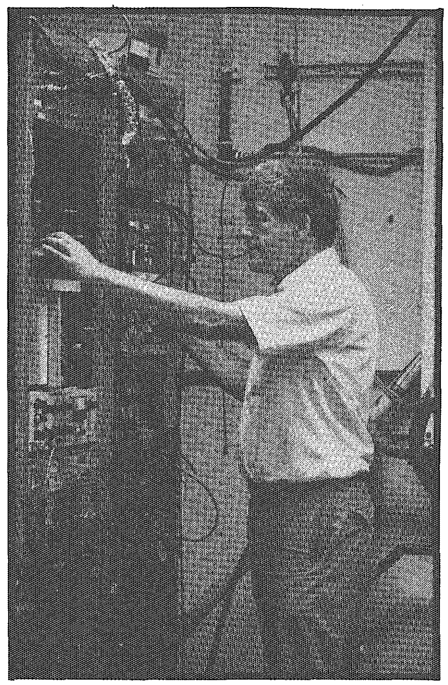


Photo by Paula Zoromski

Professor Goldman adjusts some of the equipment that controls the high vacuum/low temperature environment needed for superconductor experiments.

understanding of superconductors, but also to practical applications, especially in electronics.

Even though University researchers concentrate on uncovering the secrets of superconductors, they still have time to let their imaginations run

...they still have time to let their imaginations run wild...

wild when thinking of all the applications these new, high-temperature superconductors could be used for. According to Goldman, the most exciting applications haven't even been dreamed of yet.

One almost certain use of the new superconductors will be to create magnetic fields. Just as with ordinary

Superconductivity to 18

Log Ledger

The Centennial Accomplishment

by Sarah Hallaway

If history repeats itself, as it often does, experiments and discoveries this year will have an enormous impact on the next century of science.

In 1887 Albert A. Michelson and Edward W. Morley conducted an experiment valuable to science even today. Michelson, a physicist, and Morley, a chemist, discovered that light speed is not affected by the Earth's travel through space. Because these results contradicted 19th century absolute time theories, it is not surprising the team had been attempting to prove exactly the opposite — that light speed is influenced by the Earth's travel.

The two scientists, in agreement with other physicists of the 19th century, felt positive that light was a rare wave which passed through ether. The theory was that space occupied only ether. As ether changed in space, so did light waves. Consequently, ether and light waves were disrupted by the Earth's orbit.

To prove the speed of light would differ and that the rays were affected by ether, the experiment used an instrument, an interferometer, to divide and recombine a light beam into two, which passed at right angles to one another. With the use of mirrors, beams bounced back and forth and reunited. The union was viewed via an eyepiece. Due to a postulate of Einstein's Theory of Relativity (all motion must be defined relative to the observer's frame of reference), we know the researchers did not observe changing patterns which would have occurred if the speed of light was variable.

Case Western Reserve University scientists in Cleveland attribute many of our past century's scientific successes such as nuclear engineering, solid-state electronics, magnetic resonance imaging, and modifications in philosophy and the arts to the Michelson-Morley accomplishment. To celebrate the 1887 event, a Michelson-Morley Centennial has been planned by professors at CWRU.

Source: *Popular Mechanics*, July, 1987.

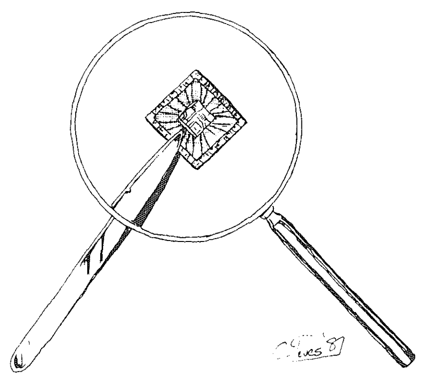


Illustration by Conrad Teves

Ultra-small Transistors

by Mark Werner

IBM scientists recently created the world's most powerful experimental silicon transistors made of features less than one-tenth of a micron, about two hundred atoms wide.

These new transistors will be able to send the strongest and clearest electronic signals ever measured in silicon transistors their size. They were designed with ultra large scale integration (ULSI) in mind.

Logic chips based on the tenth-micron technology could hold millions of logic elements which switch in as little as ten picoseconds (trillionths of a second), ten times faster than those used today.

Computer applications such as weather forecasting and continuous speech recognition might run on machines the size of today's personal computers made with such transistors.

Source: IBM News Release.

Atomic Teleportation

by Sarah Hallaway

The old adage, "Be careful what you wish for because you may get it," applies to proud t-shirt owners displaying "BEAM ME UP SCOTTIE, THERE'S NO INTELLIGENT LIFE HERE."

Researchers at Bell Laboratories have discovered a technique of taking a single atom and physically transposing it. This discovery occurred while studying a germanium crystal with a scanning-tunneling microscope. An atom of germanium was singled out of its structural position by researchers and placed in a new position. The germanium, a carbon element, had been transposed

Log Ledger to 20

Keeping Up-to-date: A High-tech Imperative

A veteran industry engineer tells of her methods for staying current, and relays some helpful hints for getting ahead.

by Susan M. Curran

All technology students know in the back of their minds that someday the knowledge they have acquired at the University will be obsolete. This realization is of greater importance to those who choose to stay in the engineering part of industry instead of pursuing a management career. A certain amount of confidence is present in most graduates who hold

...the fear of losing a job to a younger engineer or scientist is very real...

the gift of "current" knowledge, but the fear of losing a job to a younger engineer or scientist is very real if education isn't continued after graduation. Experienced engineers and scientists need to keep up-to-date to maintain their roles in industry since each year a new set of graduates holds more knowledge than the group before.

Barbara A. Clauson, senior electrical engineer at ETA Systems, is one of these experienced engineers who wanted to stay on the research side of her field. After five years in industry, she realized she had to further develop her skills and knowledge to maintain her job and become a more valuable resource for her employer. She graduated from the University of Minnesota in 1975 with a bachelor's degree in mathematics and in 1977 earned a bachelor's degree in electrical engineering. From 1977 until four years ago, she worked for Control Data Corporation. Since then, her employer has been ETA Systems.

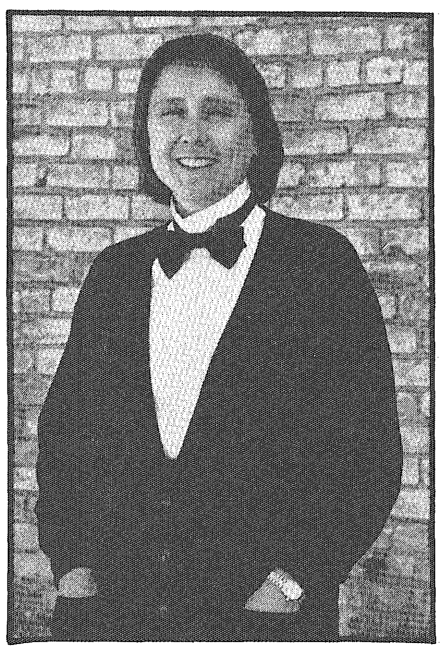


Photo by Paula Zoromski

Barbara A. Clauson, an IT graduate in math and electrical engineering.

Clauson's goal as an undergraduate was to not become a manager. She wanted to be a designer. Her fifth year in industry was significant since she had chosen to stay in research and had switched companies. She didn't see many engineers in their 30s, but did see new college graduates working for ETA Systems. This made her realize that she had to do something to gain more respect within the company. She had a good amount of experience in micro-computers and decided to expand on it. Her specialization in computers made her a valuable employee, exactly what she intended. After only six years in industry, she was involved with serious design work and had established herself at ETA

Clauson believes it is naive to think your job is ever secure.

Systems. Clauson believes it is naive to think your job is ever secure. It's a constant effort to keep up with new developments.

Susan Curran is a senior in Journalism and is *Technolog*'s ace-in-the-hole, having contributed regularly since Fall I of last year. She is also on the editorial staff this year, showing us engineers and scientists the difference between the words "that" and "which." She brings a fresh breath of professional journalism to our magazine.

Most large companies encourage continued education. If you work for a smaller company, you have to remind yourself that continued education is important. Whether or not the company you work for funds your education, you should attend seminars and conferences. "People had better be aware that they should take it upon themselves to finance their own continued education," says Clauson. Besides reading technical journals within your field, Clauson recommends attending in-house classes and conferences. They are cost-free, easily accessible, and provide valuable information. You should also read any memos, pamphlets, or books your company distributes on products or topics of interest.

Clauson also encourages engineers to attend seminars and conferences sponsored by outside groups. Professional associations often host such activities that attract individuals from various companies. Contacts you make at these events may help you develop your career or make a job switch in the future. Attending vendor-sponsored seminars is another option. If you look beyond the sales pitch, you'll find a good amount of up-to-date technological information.

It isn't necessary to wait until you enter industry to keep up with developments in your field of study, Clauson recommends that students begin reading journals now. "I suggest reading the journals to get an idea of all the hot topics and to be ready when a hot topic comes up in a class or a job," says Clauson.

"Go out there and learn as much as you can quickly. If you read the journals, you know where to look."

Clauson has seen too many engineers who don't have sufficient communication and presentation skills. If liberal arts classes don't fit into your schedule while working on your degree, she suggests taking them for your own benefit after you graduate. "I don't know if one quarter is enough (Comp 3031.. Technical Writing for Engineers)," says Clauson. "There are a lot of different kinds of writing you have to do. Even as a technical person, you can't get out of doing it. I've read so many awful reports. It's clear there isn't enough writing training. Communication and presentation skills aren't taught either. If you want to move up or make a splash as an engineer, no matter which direction you want to go in, management or engineering, you've got to eventually sell somebody on one of your ideas." To help your presentation skills in industry, you should, at the very least, practice in front of a willing group of colleagues or a supervisor who can give you constructive criticism before presenting your ideas (or possibly embarrassing yourself) before an audience.

I'm concerned that women...think that there is no more discrimination.

Clauson is concerned that women believe they will be fully accepted by industry, and she has special advice for them. "When I started, I was encouraged to subscribe to all the free technical journals," says Clauson. "There was only one I got, and I had subscribed to a bunch, but I only got one! I stupidly wrote my first name. That was my lesson, I guess. I've put B.A. ever since. On my nameplate I'm B.A. Clauson. All of my correspondence is B.A., but I still have to deal with 'Is B.A. Clauson in?' like I'm a secretary. You're speaking with her!"

Up-to-date to 18

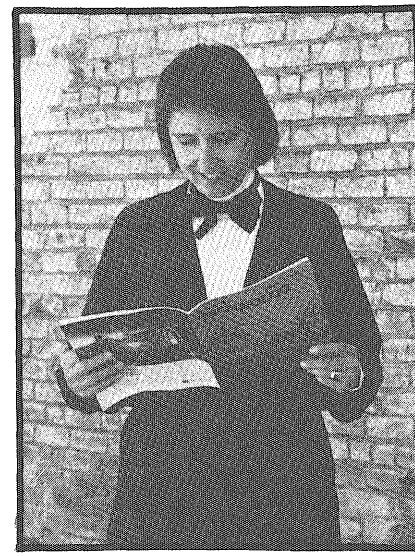


Photo by Paula Zoromski

Barbara Clauson and her favorite magazine.

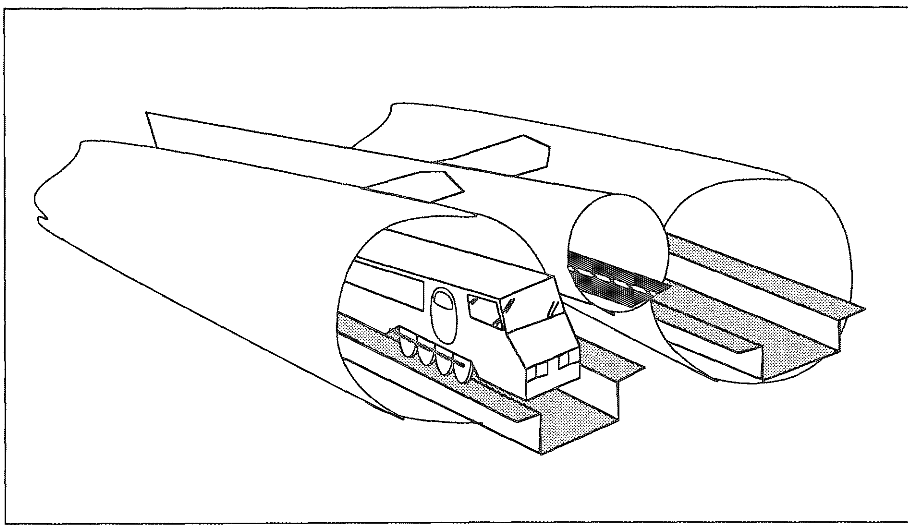
The Tunnel of Two Cities

The dream to connect the gap between England and France has been around for centuries. It has finally been realized when work started on the immense English Channel Tunnel project recently.

by Mark Werner

The United States has the St. Lawrence Seaway, Egypt has the Suez Canal, and now, Britain and France have the English Channel Tunnel.

The Channel Tunnel, a 31-mile long tunnel underneath the English Channel, will connect the two cities of Dover, England and Calais, France. Workers have begun digging two 24-foot diameter tunnels and a 15-foot diameter service tunnel set 131 feet below the floor of the channel (see figure 1). The two large tunnels will carry trains loaded with cars and trucks across the channel in 27 minutes, much faster than the two-hour ferry trip and slightly faster than the 35-minute hovercraft trip.



Source: *Science Digest*, 7/86. Illustration by Jerry Fiala

Figure 1: Three interconnected tunnels, one service and two transportation, will travel under the entire width of the English Channel. The trains will carry passengers and vehicles.

One plan for connecting the countries envisioned a 23-mile automobile bridge-tunnel with two six-lane highways encased in a concrete tube spanning the channel (see figure 2). Another related proposal called for a bridge with seven spans, each four and a half kilometers long. The most grandiose of the plans proposed called for two artificial islands in the channel connected together by a tunnel and connected to the mainland by bridges. British Prime Minister Margaret Thatcher and French President Francois Mitterand considered other proposed projects before deciding on the most inexpensive and conservative method. At $10.2 billion, the Channel Tunnel was the least expensive: it was financed wholly by private firms.

The project will be financed mainly by the Channel Tunnel Group/France Manche, a consortium of two British banks, three French banks, and ten construction companies. So far, they have raised $407.6 million. Fifteen private investors have been called upon to provide the remaining $24.4 million needed to start the project.

Part of the Channel Tunnel agreement states that the present builders of the tunnel must build a parallel highway tunnel for cars by the year 2000 or lose their monopoly. The stipulation was placed into the plan to avoid strikes by Channel Tunnel workers which would shut down cross-channel traffic.

The advantages of the Channel Tunnel are numerous. Here are a few of the future benefits:

1. The tunnel, transporting 4,000 vehicles in each direction per hour, will help alleviate some of the cross-channel traffic which is expected to double by the year 2000.

2. A businessperson may drive his or her car from London to Dover, enter the Channel Tunnel, disembark in Calais, and drive to Paris all in four and a half hours, the same time it takes to fly. Later, when France's high-speed rail system

is connected to London, that same businessperson can make the trip in three and a half hours.

3. This project will generate 40,000 jobs and will create more than one billion dollars in revenue.

4. Since the trains will be powered by overhead electricity, the environmental concerns will be small compared to the other passage designs.

The idea to tunnel under the English Channel is by no means novel. It had been proposed as long ago as 1753 and was attempted three times before. In 1875, the French dug a 2000-yard tunnel before giving up. In 1880, the British dug an exploratory tunnel hundreds of feet beyond the English shore. Most recently, in 1973, England and France signed a tunnel treaty, but British Prime Minister Harold Wilson became worried about the financial liability of Britain and ordered the British to stop after they had dug 400 yards and the French had dug 600 yards.

With improved technology and information about the ground under the seabed, the Channel Tunnel has become a feasible venture. Chalk, the most abundant soil type in the area, is an ideal substance to tunnel through. It is stable and very waterproof. The more than 80 test borings of the channel bed taken prior to 1970 reveal that the channel lies on three layers of chalk which rest on a layer of red clay. A few miles from the French shore, however, the chalk becomes fissured and gives way to shale and clay (see figure 3).

The chalk-clay structure of the ground is almost waterproof, so workers will not have to pressurize the tunnel to keep water from leaking in. The digging will be relatively easy; the workers will use tunnel boring machines with fifteen yard diameter faces. The faces contain ceramic teeth and carbon-steel disks which will rotate, pushing against the walls with up to 50,000 pounds of pressure. These mammoth machines are expected to move forward at a pace of 0.3 miles per month.

...workers will not have to pressurize the tunnel to keep water from leaking in.

The British and French machines are similar. The head of these machines turn at about four and a half revolutions per minute. They have conveyors which carry the excavated buckets of chalk from the cutter head. Behind the head, hydraulic jacks set in place preformed, reinforced concrete segments. In the weaker areas, coated cast-iron will be bolted in place to add reinforcement.

...the boring machines will be guided by lasers...

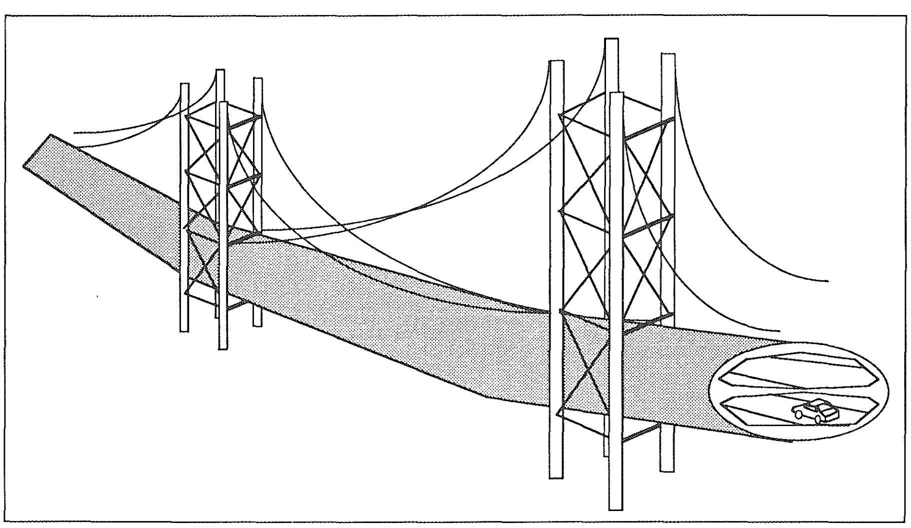
In order to insure accurate digging, the boring machines will be guided by lasers and photodiodes connected to microprocessors. The micro-processors will monitor the positions of the boring machines and will keep them on path to within inches.

The plan is to dig the fifteen foot middle tunnel several kilometers ahead of the other two. Every 100 feet, workers will stop and probe ahead another 100 feet to see if there are any faults in the strata. If some are detected, they will inject a cement-like grout into the holes to seal and strengthen the area.

Other holes will be drilled into the path of the two main tunnels as well to test the ground there.

Every 400 yards, the workers will dig access tunnels from the middle service tunnel perpendicular to the two main tunnels. These tunnels will be lined with 23-inch thick concrete sections joined by cast metal bands. The rail for the train will be continuously welded and laid on a concrete base.

Channel Tunnel to 13

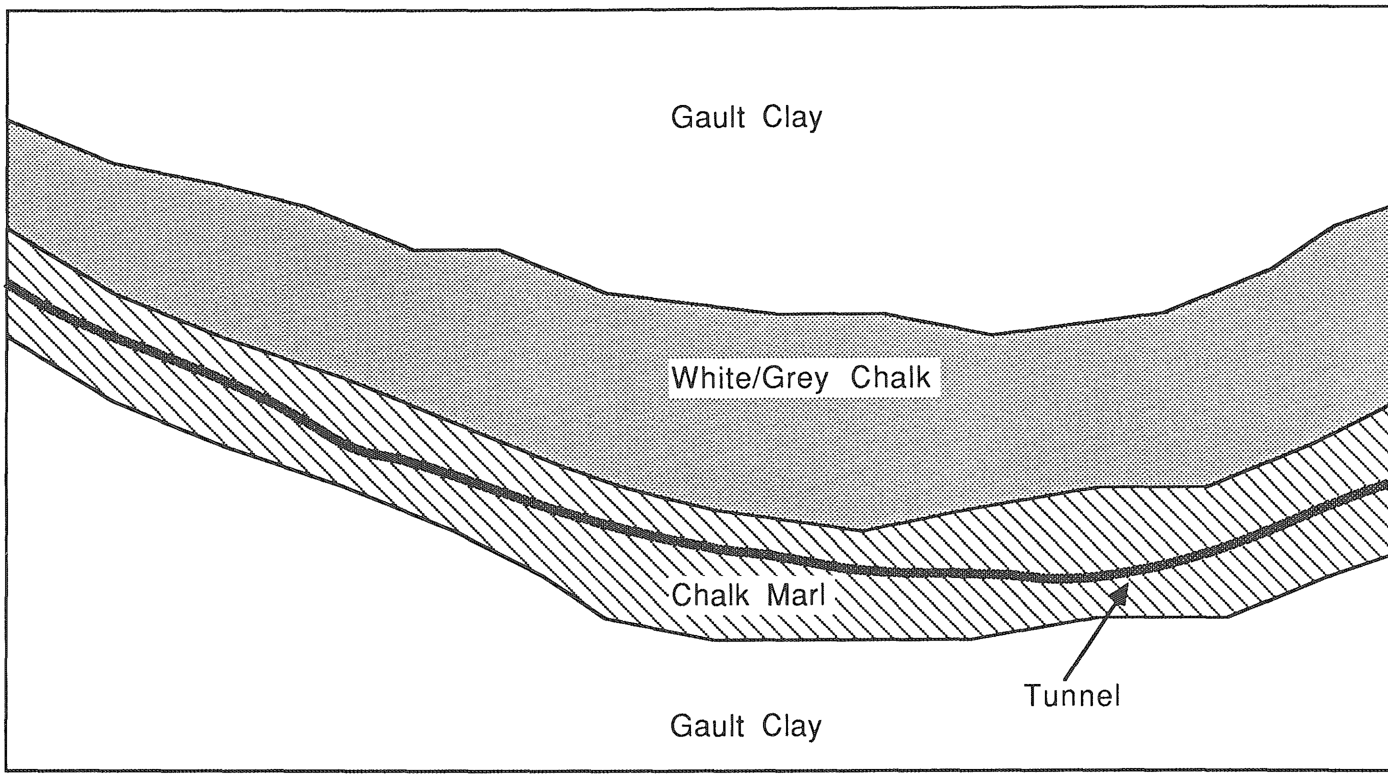


Source: *UNESCO Courier*, 3/86. Illustration by Jerry Fiala

Figure 2: This alternate design called for an above-ground tunnel suspended by bridge supports across the 21-mile channel.

Mark Werner is a junior in Technical Communication who saw the light last year and switched from IT to the College of Agriculture. Mark is living proof that you can survive after being a *Technolog* Editor. Although possibly still dazed from the experience, he enjoys bicycling and cross country skiing.

Channel Tunnel from 11



Source: *Popular Science*, 5/86.

Illustration by Jerry Fiala

Figure 3: The soil the tunnel will pass through is chalk, an ideal substance to tunnel through.

Three different kinds of cars will use the tunnel: 82-foot long double-decker cars providing storage for automobiles and a lounge area for passengers; 60-foot long cars carrying buses, trailers, and trucks; and a shuttle carrying trucks of up to 44 tons. The trains will use electric overhead lines and pantographs for propulsion. Each group of cars will have electric locomotives on the front and back that will propel them along at speeds of 80 mph.

The Channel Tunnel has not gone unnoticed by British or French citizens, and it has stirred opposition from several groups. Flexlink, a coalition of French and British port authorities opened a $3.4 million campaign against the tunnel. They are angered because they say the tunnel could destroy the ferry business between Calais and Dover along with the jobs of the 40,000 people they represent.

Local residents fear there will be a big increase in air and noise pollution at both ends of the tunnel because of the traffic coming to and going from the tunnel. Residents of Britain have also voiced concern that rabid animals from France might make their way through the tunnel and infest the rabies-free United Kingdom. Other experts complain that the trains are not much faster than the hovercraft servicing the channel. These critics wonder if people will use the tunnel enough to cover its cost.

Not everyone is complaining, though. Supporters point out that the journey from downtown London to downtown Paris through the Channel Tunnel will take less time than it does by air. There also will be no long waits or expensive fares like the airports have. Also, the tunnel is likely to increase day tourism and export trade between the two countries.

Boon or bane, the Channel Tunnel has captured the interest of the British and French. When completed, it will symbolize the recent increase in cooperation between the two countries and will help to bring England and the rest of Europe closer together. ▲

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Microelectronics History: The Birth of a Chip

A documentation and explanation of how the electronic wonders of today evolved, and the principles on which they operate.

by Chi Hum Paik

Perhaps there are as many papers written about the history of microelectonics as the number of different electronic devices currently offered. And by no means has the progress of microchip research ended. Yet, no matter how complex a material or chip design can be (or become), the basic principle behind it will not perish.

All chips, whether used in calculators or microwave ovens, are based on a simple principle: to precisely control the flow of mobile electrons in a desired direction and time. For example, even the fastest of the supercomputers operate on the simple binary logic of "ON" and "OFF." Flow of electrons in one specific direction can mean ON, in the other direction, OFF. This is why a device or material is needed to control the flow of electrons.

This need was fulfilled by an electrical engineer, Lee DeForest, who discovered in 1906 that where an electrified wire grid was placed across the path of a stream of electrons in a vacuum, the flow of electrons could be controlled (amplified, interrupted, or stopped entirely). This led to the first electronic revolution: a vacuum tube that accurately created electric and magnetic fields to control the flow. Perhaps the most well-known prize of this device was the ENIAC (Electronic Numerical Integrator And Computer), the first digital computing machine which contained 18,000 vacuum tubes and had a capability of adding 12,000 digit numbers in 200 microseconds.

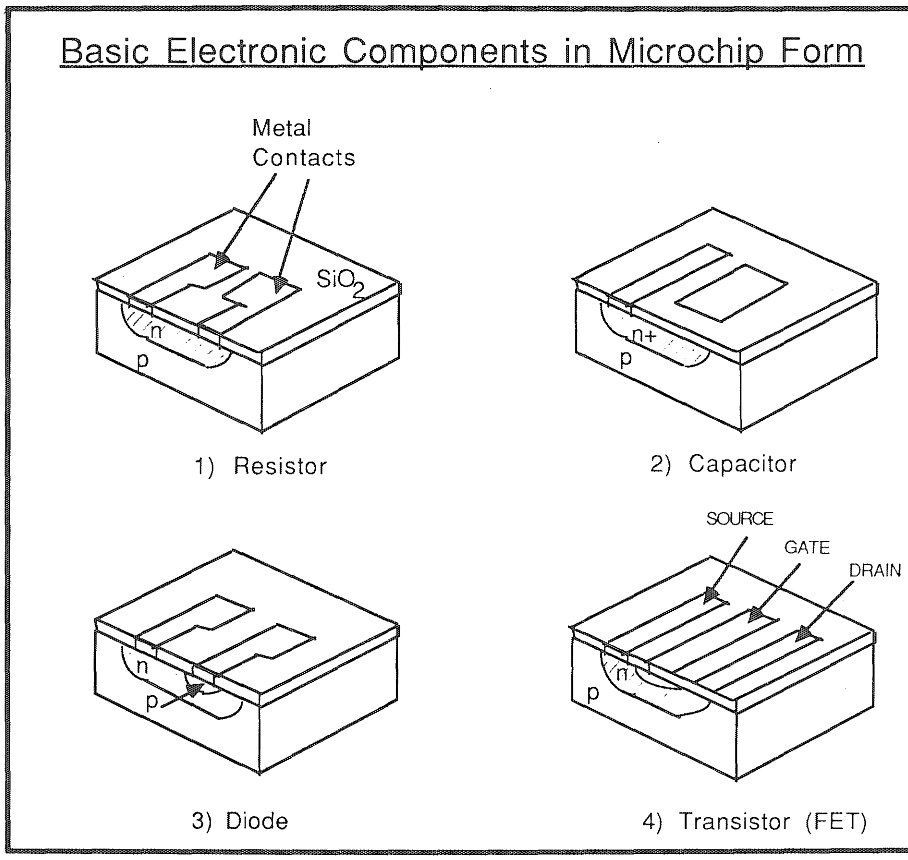

Illustration by Chi Hum Paik.

The introduction of vacuum tubes provided incredibly versatile collections of electronic equipment, from telephones to missile guiding systems. But the tubes had two disadvantages: they consumed too much power and were too bulky for practical use. Until the late 1940's, engineers and manufacturers concentrated on finding shrewd ways to build smaller electronic tubes with higher power efficiency. However, a more fundamental change was to take place where the electrons could be controlled within a material rather than a device. This material was needed to impede/insulate the electron flow in itself and at the same time be conductive when necessary. A solution to such opposing requirements was the semiconductor.

Chi Hum Paik is a senior in Chemical Engineering. This summer he was involved in the ChemE department's undergraduate research program, honing his research and presentation skills. Chi holds a position on the IT Board of Publications, which publishes the *Technolog.* He enjoys playing tennis and soccer and reading classical books.

Semiconductors, just as the name suggests, are materials more and less conductive than insulators. By supplying external energy, these semiconductors can be made conducting or not conducting (therefore going back to that same principle of allowing or disallowing the electron flow in a certain direction).

In 1947, Bardeen, Brattain, and Shockley, scientists at Bell Laboratory, developed a way to use these semiconductors for a second electronic revolution, the introduction of the transistor. Transistor (meaning transfer of electrical signal across a resistor), is an electronic switch that utilized the properties of semiconductors to control the current flowing through the device. The advantage was that the capability of controlling the current was now increased by an order of magnitude and required a much smaller amount of power.

However, the first transistors had no striking advantages over the smallest tubes (by this time remarkable engineering efforts had been put into tube designs that came in different shapes and sizes). It took a while to convince others that transistor components were indeed more reliable and longer lasting.

...the first transistors had no striking advantages over the smallest tubes...

The transistor earned real respect with the introduction of the integrated circuit. Basic circuit components (resistors and capacitors) could be fabricated in semiconductor form, greatly reduced in size compared to their original forms. Using this idea in 1958, J.S. Kilby and Robert Noyce separately fabricated a complete circuit (including the interconnections) on a single chip. This idea of reducing the dimensions and integrating the circuit components led to the third electronic revolution and the birth of the microchip. Integrated circuits led to two additional blessings. First, reduction in size meant smaller distances that electrons had to flow through. Therefore, the devices became faster (very useful in computer and information technology). Second, since the resource material needed was small and could be mass produced, the cost of manufacturing was much less.

The fourth revolution was the development of the microprocessor in 1969. We were able to have the computing power of a 30 ton ENIAC in less than the size of a wrist watch.

...the computing power of a 30 ton ENIAC in less than the size of a wrist watch.

Ted Hoff, an engineer from Intel Corporation, introduced a revolutionary approach in interconnecting three tiny chips for different operations: first, a central processing unit (CPU); second, a memory to store programs and instructions; and third, a chip to move data in and out of the CPU. This completely changed the approach in electronic design from a network of logic circuit design to a categorized way of "thinking, remembering, and telling." The capability and flexibility based on this philosophy is complex enough to allow versatile operations of electronic devices.

The progress of present research done in microelectronics covers wide areas from superconductor research to 3-D circuit designs. The University of Minnesota participates in the research race of most of these areas. Research teams from approximately six to seven departments are all channeled through the Microelectronic and Information Sciences Center (MEIS), an interdepartmental center in I.T. Established in 1982, MEIS utilizes the funding from external grants and

Semiconductors

Conduction occurs when the electron(s) in the outer shell (called valance electrons) can "wander" from one atom to another. The materials are categorized by the availability of these valence elctrons and the accomodations (called energy states) the hosting atom can provide. Three categories exist: conductor, semiconductor, or insulator. Ideal semiconductors, such as silicon or germanium atoms,, have four valence electrons that hook each other in four ways so all electrons are tightly bound in covalent bonds between the atomic lattice. Although these electrons are tightly bound, one can externally supply enough energy to free an electron from its bonding and allow it to conduct throughout the material.

The real use of semiconductors is brought into picture when these semiconductors are "doped" with impure atoms that have one more or less electron than the original tetravalent (four electron) distribution. An example is silicon doped with a phosphorus atom. The extra electron will cling loosely to the phosphorus atom. But a small energy supply to this doped material can enable this loose electron to wander around the structure, and therefore to carry current. With an extra conducting electron, this type of doped semiconductor is a negative charge carrier type, or n-type, semiconductor.

The counterpart to this type of doped semiconductor is the p-type (positive charge carrier type semiconductor). Instead of having an atom with an extra valence electron, the tetravalent atom is doped with an atom lacking an electron; i.e., having three valence electrons. Thus there exists an excess vacancy that other electrons could occupy. From participating in the bonding, with little energetic encouragement, the electron can fill the vacancy thereby leaving a "hole" of positive charge. Although this hole is not a physical entity, it can be conveniently treated as one since this hole propagates, just as an electron does, throughout the material. By having a positive charge flowing in a controlled direction, the p-type semiconductor can become useful.

contracts to support affiliated research teams. MEIS's support will help professors receive other external fundings and help the growth of MEIS.

Although specific research teams can study highly specialized fields, the general research done through MEIS is as follows [from MEIS, 1986 Executive Summary]:

1) III-V High Speed Semiconductors—Gallium Arsenide (GaAs) has recently earned its popularity by being the successor of silicon in high speed electronic devices. There are still heavy investigations to study the bulk and interface (surface) properties, GaAs processing, and circuit stimulations for GaAs and other similar high speed materials. Groups from the Departments of Electrical Engineering, Chemical Engineering and Materials Science participate in this project.

2) Three Dimensional Integrated Circuits—Teams in the Department of Electrical Engineering investigate ways of designing and fabricating 3-dimensional circuits, "to optimize the performance and reliability of [the devices]."

3) Artificial Intelligence—This project is to design the computers that reason and learn. Specific group topics are vision, programming, and computational models. Teams from computer science, electrical engineereing, statistics, and other non-IT departments (management science and child development) participate in the research.

4) Artificially Structured Materials—Having devices built "at nanometer scales" requires better understanding of physical and chemical properties of materials that other devices are built from. Groups from the Departments of Chemistry, Physics, Chemical Engineering and Materials Science investigate this problem.

The differences between academic research and industrial research is that industrial research has a shorter

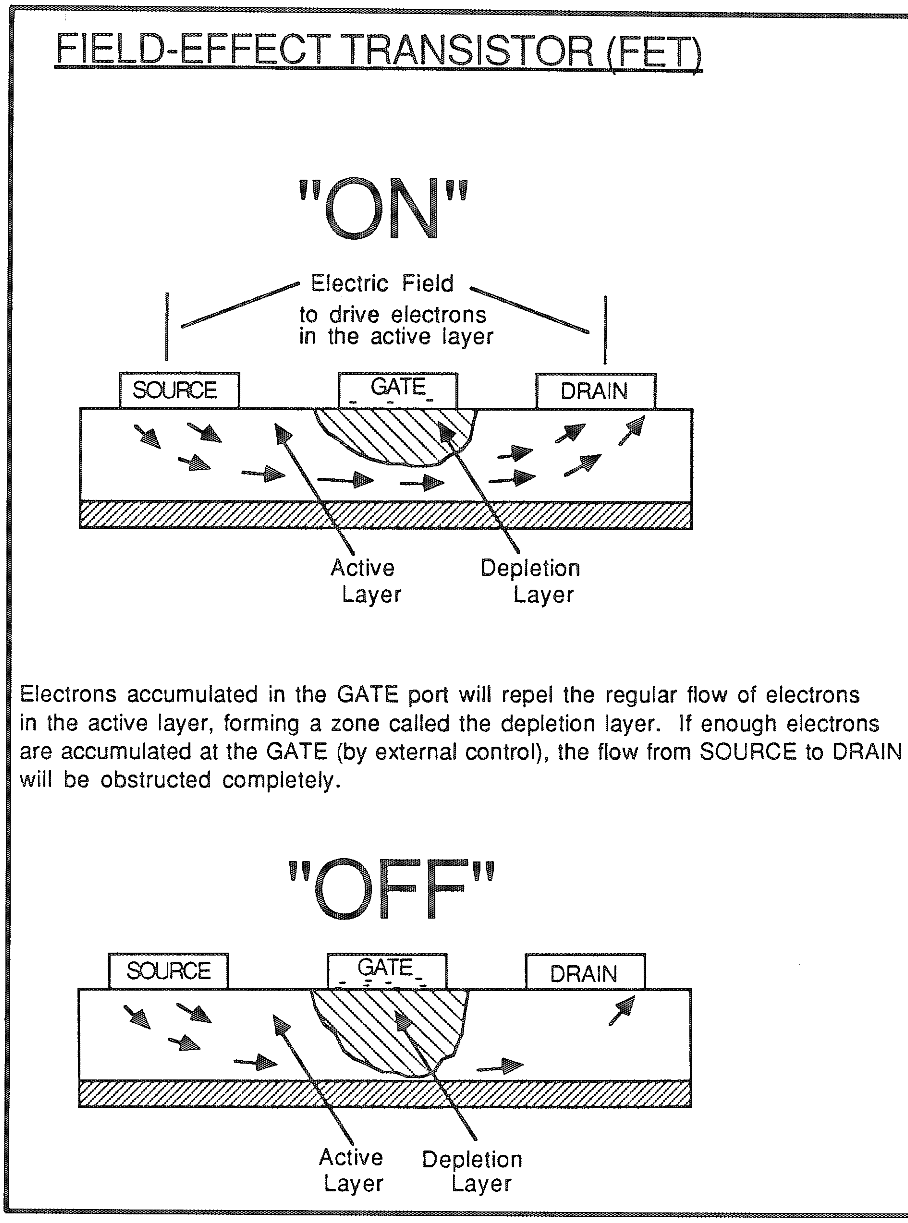

Illustration by Chi Hum Paik.

Transistor

The simplest type of transistor is the Field-Effect Transistor (FET). The FET has three external metal ports: SOURCE, DRAIN, and GATE. Just as the names suggest, the electrons flow from the SOURCE to the DRAIN, driven by the electric field externally applied between them. Between the SOURCE and the DRAIN is the GATE. All three ports are metal pieces in contact with a semiconductor layer. When a metal (conductor) is in contact with a semiconductor, an activation energy barrier is present for an electron to pass between the two materials. This barrier, called the Schottky barrier, will prevent the electron from passing from the metal to the semiconductor.

Thus, electrons accumulate on the metal piece. By externally controlling the voltage, one can let enough electrons accumulate at the GATE so that the excess negative charge in the middle port will repel the normal flow of electrons from SOURCE to DRAIN. This obstruction, called the depletion layer, acts as a gate to allow or disallow the flow of electrons in a specified direction. Again, this means the flow of electrons can be contolled in direction and magnitude.

time frame, according to John Weaver, materials science professor. Academic research can afford to participate in basic research of materials or designs not being restricted by the mentality of whether this project will bring profit to the company or not. Weaver explained that when a graduate student starts out and has funding for his PhD project, not all of the information this student acquires will be applicable to the current microelectronic industry. But the main goal is to study the fundamental science, and as long as

...as long as the student does "good science," the funding will continue.

the student does "good science," the funding will continue. "One of the benefits in academia is doing what you want to do (research)," Weaver mentioned.

The efforts put into this technology are by no means as simple and basic as the original principle behind the microelectronic devices. This allows the variety of applications offered to us. And rather than specifically thanking the names who are responsible for the four revolutions, we need to thank *all* those who participated and contributed towards the research in this area. ▲

ED TOIVALD, AN UNEMPLOYED FORESTER, WHILES AWAY THE HOURS BY OFFERING MEGABUCK JOBS TO UNSUSPECTING I.T. SENIORS.

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Weaver, Dr. John H., Professor, Department of Chemical Engineering and Materials Science, University of Minnesota; Interview: August 5, 1987.

Superconductivity from 6

metals, when superconducting wire is formed into a coil and electricity passed through it, a magnetic field forms. But since superconductors offer no resistance to electricity, there is no need to continue supplying power to the coil to maintain the magnetic field. The current flows forever when the loop is closed, creating a permanent magnetic field. This application sparks engineers to dream of making levitating trains and electric cars.

Before things get too far out of hand though, Goldman cautions that there are many problems left to solve. Several of these problems involve the new materials themselves. The new superconductors are not metals but oxides, and researchers have yet to find a way to make them into wires. The new materials are also very unstable and react quickly with water. Another obstacle is the critical current density of the new materials. If too much current is fed into a superconductor, it loses its superconductive property. What this upper limit (the critical current density) is in the new materials remains an open question.

Despite these problems, Goldman is optimistic about the future. The University has made a major commitment for multidisciplinary approach to superconductor research that involves the chemistry, materials science, electrical engineering, and physics departments. With this commitment, Goldman hopes to continue probing the fundamentals of superconductors. According to Goldman, as science begins to better understand the new superconducting materials and gain experience in working with them, things will really get interesting. ▲

Sources

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"Superconductors!," *Time*, May 11, 1987, pp. 64-75.

Up-to-date from 9

"I'm concerned that women who are coming into technical fields think that there is no more discrimination," says Clauson. "They think they have arrived and that they don't have to act professionally. I really hate to see that. We're going to lose everything we've gained. We have to look totally professional. A lot of them don't dress the part. I think professional women should dress professionally regardless of how the men dress."

From her own experience and observing those around her, Clausen knows what needs to be done to keep up-to-date and strongly encourages technology students to be aware of what could be in their future. The best advice anyone can give: never feel totally secure with your job and make every effort to continue your education. ▲

Technotrivia

by Jim Willenbring

Questions:

1) Henri de la Fuerte of France was highly regarded for his ability to undress down to his socks in six seconds flat. If you are struck by lightning, you may very well have your clothes and shoes thrown off in even less time. What causes this quick-strip?

2) How was "HAL" derived as the name for the computer in *2001: A Space Odyssey*?

3) Approximately how long does it take sunlight to reach the Earth?

4) If you ever graduate, would you invest in an exagram or a femtogram of gold?

5) According to a U.S. Department of Health, Education, and Welfare study, which occupation is least stressful: an auctioneer/huckster or a university professor?

6) According to Carl Sagan, how many galaxies are there in the universe?

7) If you plan on taking your yacht down the Mississippi before it freezes this year, you should know the following: how deep is a fathom? How deep is mark twain?

8) In 1948, three Americans by the names of Shockly, Brattain, and Bardeen invented something that would completely change our lifestyle in only 30 years. (Hint: see article in this issue.) What did they invent?

9) What was the name of the first electronic computer?

10) What do foresters think a logarithm is?

Scoring

0-1 Next time read the answers first and then see how you do.
2-4 This is the A-range for forestry majors.
5-7 You must spend weekend nights playing Trivial Pursuit.
8-10 You must spend every awake moment memorizing worthless bits of information.

Answers:

1) The quick-strip is caused by the rapid evaporation and expansion of the moisture on your skin that blows off your clothes and shoes. You could even be left unharmed, but embarrassed.

2) HAL is derived by backing up one letter in the alphabet from IBM.

3) It takes approximately eight minutes for sunlight to reach Earth's atmosphere.

4) Even with engineers' high starting salaries, a femtogram is the most realistic. In the SI system the prefix exa means 10^{18}, while femto means 10^{-15}.

5) In listing the least stressful occupations, a college or university professor finished eleventh while an auctioneer/huckster was thirteenth.

6) There are approximately one hundred billion galaxies in our universe, each of which contain an average of one hundred billion stars.

7) A fathom is six feet deep, and mark twain is two fathoms.

8) Shockly, Brattain, and Bardeen, researchers at Bell Laboratories, invented the transistor, which made possible today's computer revolution. They are mentioned in this issue in "Microelectronics History: The Birth of a Chip."

9) The first electronic computer was the Electronic Numerical Integrator and Computer (ENIAC). It was developed for the U.S. Army in 1946 and weighed over 30 tons. It contained more than 18,000 vacuum tubes and 1,500 relays.

10) Foresters think a logarithm is a song you sing while cutting wood. You get a bonus point if you got this one right.

Log Ledger from 7

from a perfect crystal to a crystal with slightly projecting atoms.

This type of scanning-tunneling microscope has the ability to detect the slightest differences in the tip-to-crystal gap width when the current changes. The microscope has an unusually fine tungsten tip which skims the crystal at a distance of several diameters of an atom. When the tungsten tip observes a weak electrical current, the current proceeds across the tip-to-crystal gap, thus detecting any amount of change.

Researchers can also chart the microscopic patterns of the current's flow, even so specifically as bumps on a single atom due to the tungsten tip.

This atomic discovery offers possibilities for more compact, quality computers because of new methods to etch the smallest circuitry on a computer chip no wider than one atom.

Russell Becker, a Bell Laboratory researcher, attributes the discovery to the tungsten tip capturing several stray atoms. Another possibility is that the microscope created the electrical field and reorganzied the crystal's structure.

Source: *Popular Mechanics*, September, 1987.

Woodstock of Physics

by Sarah Hallaway

Through research on superconductors, an exciting breakthrough has been announced. Referred to by some scientists as the "Woodstock of Physics," a special conference was held at the New York Hilton in late March to announce the discovery of materials carrying current with no loss whatsoever at temperatures as high as minus 294 degrees Fahrenheit.

Physicists from three continents and 2,200 plus participants attended the conference to hear the discoveries that will undoubtedly lead to increases of commercial applications in electricity, magnetism and electronics.

Development of a superconducting thin film for electronics was accomplished in one weekend, announced IBM's laboratory in Zurich.

Other developments include a minimum of eight materials, fairly simple to construct, which all have the ability to become superconducting at approximately minus 298 degrees Fahrenheit.

"What we're seeing here is one of the most exciting developments in decades. It's utterly remarkable, and I think there is more to come," said Neil Ashcroft, Chairperson of the American Physical Society's Division of Condensed Matter Physics. ▲

Source: *St. Paul Pioneer Press Dispatch*, March 20, 1987.

Making Good Mistakes

Julie Bratvold addressed the Institute of Technology's graduating class of 1987. The following is an edited version of that speech.

by Julie Bratvold

President Keller, distinguished guests, fellow graduates, families and friends: good evening.

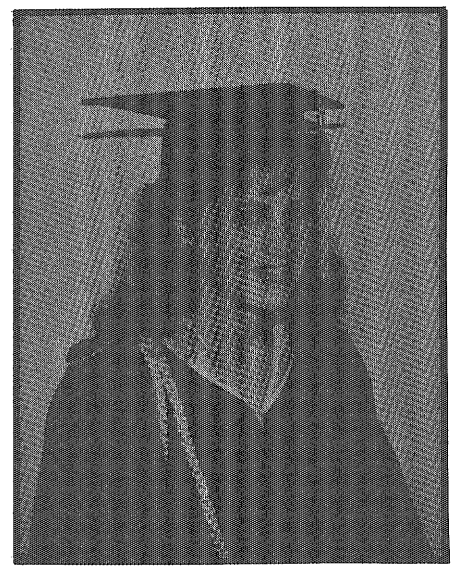
To the members of the graduating class of 1987 I offer my sincere congratulations on your achievement and I impart to you an observation by the American poet Emily Dickenson, who wrote "Sweet is the End of Grief."

This achievement of yours is something of which to be proud, for it hasn't been easy. But somehow we managed. Through our many successes and failures, accomplishments and mistakes, victories and defeats, we survived. And this in itself is quite an achievement, for there were those that didn't survive. I remember two freshmen in particular who were among those that fell by the wayside. Each night after dinner they would toss a coin to decide what they would do that evening. "O.K. If it shows up heads, we'll find some dates and see a movie. If it shows up tails, we'll go to a party. And if it stands on edge, we'll study." If nothing else, they seemed to know something about statistics.

When choosing a topic for this commencement address, I was very concerned that it be one which would allow me to commend to you in five minutes parting wisdom to last your entire lives. Needless to say, this made the choice very difficult. However, I stopped worrying when someone informed me that the topic really didn't matter since, as a prominent IBM vice president once pointed out, "Nobody listens to a commencement address, except, perhaps, a few parents engaged in one last ditch effort to get something for their money." I hope you will feel you've gotten your money's worth tonight.

A few years ago, Honeywell published an advertisement in *Spectrum* magazine which piqued my interest because of its unique message. The ad, whose only illustration was three crumpled-up pieces of paper, was entitled "On Making Mistakes" and it began by saying, "When you make a mistake, make it a good one." The ad went on to say that while this wasn't an official company slogan, it did, to some degree at least, reflect their attitude towards people they employ. At the end they added a disclaimer explaining the spirit of the ad so no one would get the erroneous idea that it was an "out-and-out solicitation for mistake-makers" to come and work at Honeywell. But I think I knew what the ad meant even without the disclaimer.

"When you make a mistake, make it a good one."



Julie Bratvold

The ad was acknowledging the fact that any situation which entails risk — be it a business venture, an innovative design concept or a final examination — carries with it by definition the potential for failure. However, this potential for failure is not sufficient cause to deter one from taking any risks or the potential for success will be surrendered as well. The ad's message was that if you hire someone to be innovative and ingenious, you must also accept the fact that some mistakes may be made along the way because the only people who never make mistakes are those who never take risks. The ad also points out that there is no justification for simply making mistakes. Rather, every mistake must be a "good" mistake. A good mistake is one from which

Julie Bratvold received a Bachelor of Electrical Engineering with high distinction in June, 1987. She was president of HKN in 1986-87 and was active in SWE and IEEE. Julie is currently attending graduate school at the Massachusetts Institute of Technology.

something can be learned. We have often heard the phrase "People learn from their mistakes." Usually what they learn is that they should have studied harder for the test. But much more than that may be learned from a mistake. A mistake can help point out errors in your logic or reasoning, it can help to clarify an ill-defined problem, and it can even help you to improve those valuable inter-personal communication skills — specifically those needed to explain the mistake to your boss.

I believe the most important message in the advertisement was that even successful people occasionally make mistakes. They don't do it all the time, of course, or they wouldn't be successful. But they have the ability to distinguish between failing in a particular instance and being a failure. The Chinese have a saying

"...failure is the first step toward a success."

"failure is the first step toward a success." The successful person is the one who realizes this and learns from each mistake so that one failure is not the first step towards more failure.

And don't ever think you are alone in making a mistake just because you may not always hear about the mistakes of others. I remember hearing a story once about two high-energy physicists who were stranded in the desert. One of them, seeing a mirage in the distance which he took to be a lake, crawled off to get some water. When he returned and told his companion that he had been unsuccessful in his search, his companion said, "Yes, I know. I tried that a few days ago." "Well, why didn't you tell me!" the first physicist wanted to know. His companion just shrugged his shoulders and said, "Who publishes negative results!"

So I hope the next time you make a mistake and crumple up that piece of paper, you will remember this commencement address, and remember too these three points:

> First — Never let the fear of failure stop you from striving for success.
>
> Second — Learn from your mistakes and the mistakes of others since no one has the time to make every mistake on their own, and
>
> Finally — Even successful people fail occasionally, but that doesn't prevent them from eventually reaching their goals.

I wish you, my friends and classmates, all the best for the future, and remember, "When you make a mistake, make it a good one." ▲

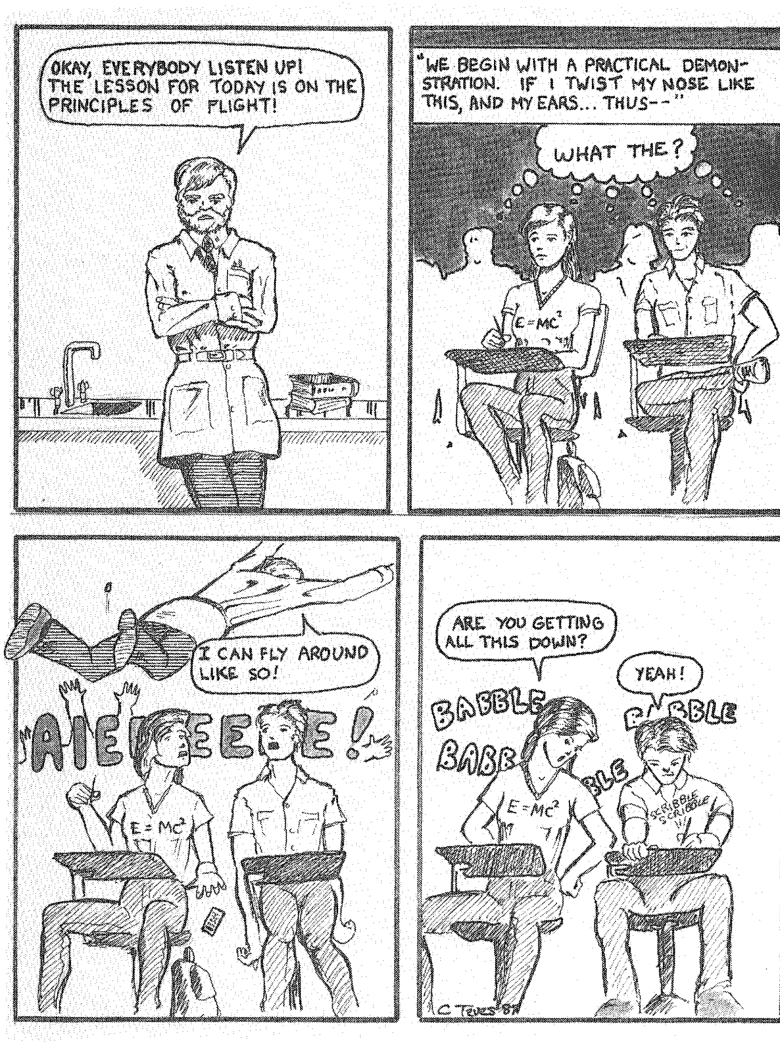
Technocomics

The Near Side
by Steve Littig and Conrad Teves

Having heard about class sizes at the "U", Paul came prepared.

Finite Loops

by Conrad Teves



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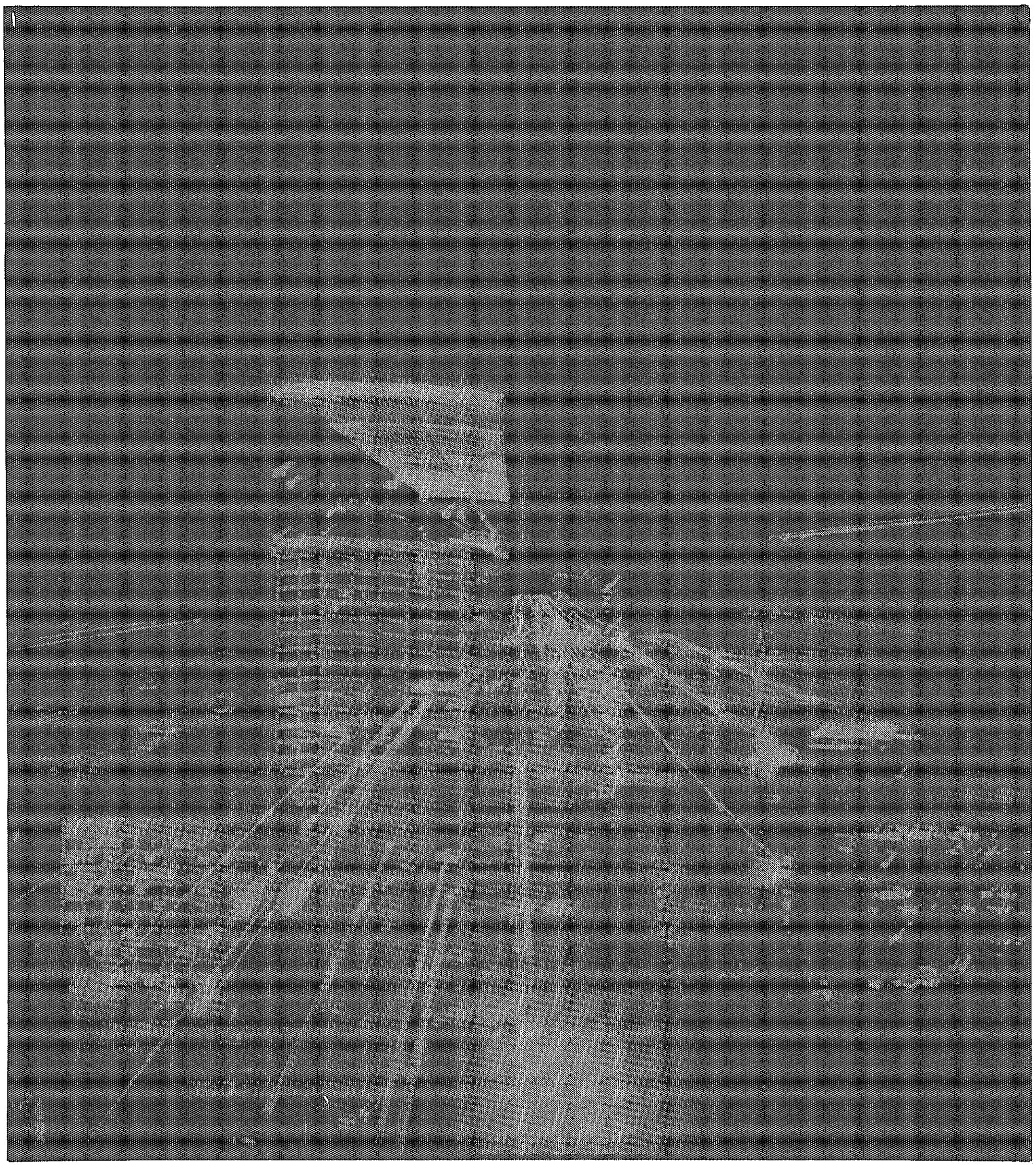
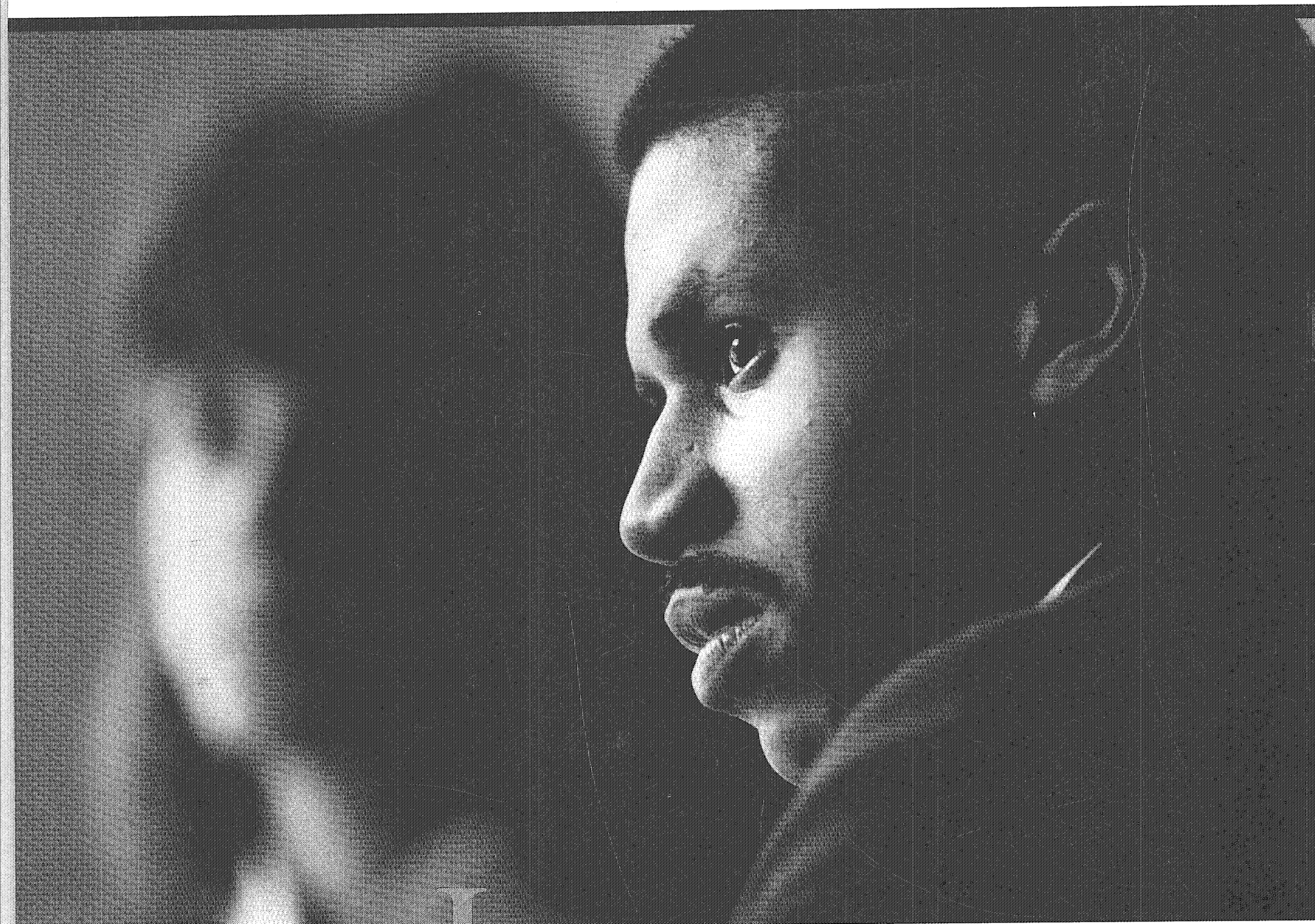


Photo by Paula Zoromski



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TECHNOLOG

Fall Two, 1987

Acoustics

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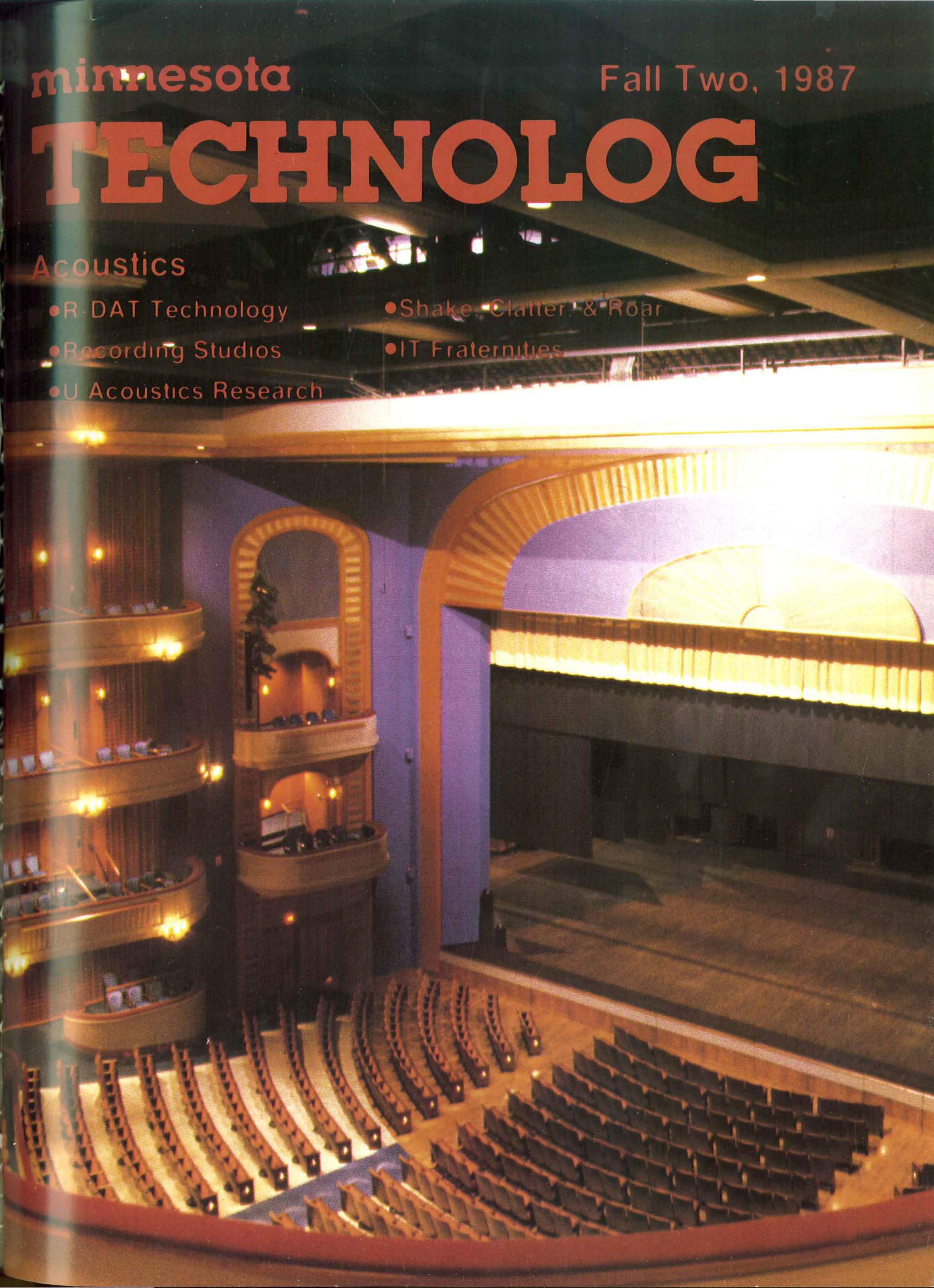
- Recording Studios
- U Acoustics Research
- Shake, Clatter & Roar
- IT Fraternities



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This photo was taken inside the Ordway Music Theater, St. Paul. The theater was specially designed to optimize acoustical properties. Special thanks to Christine Murakami from the Ordway Music Theater staff.

minnesota TECHNOLOG

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Acoustics

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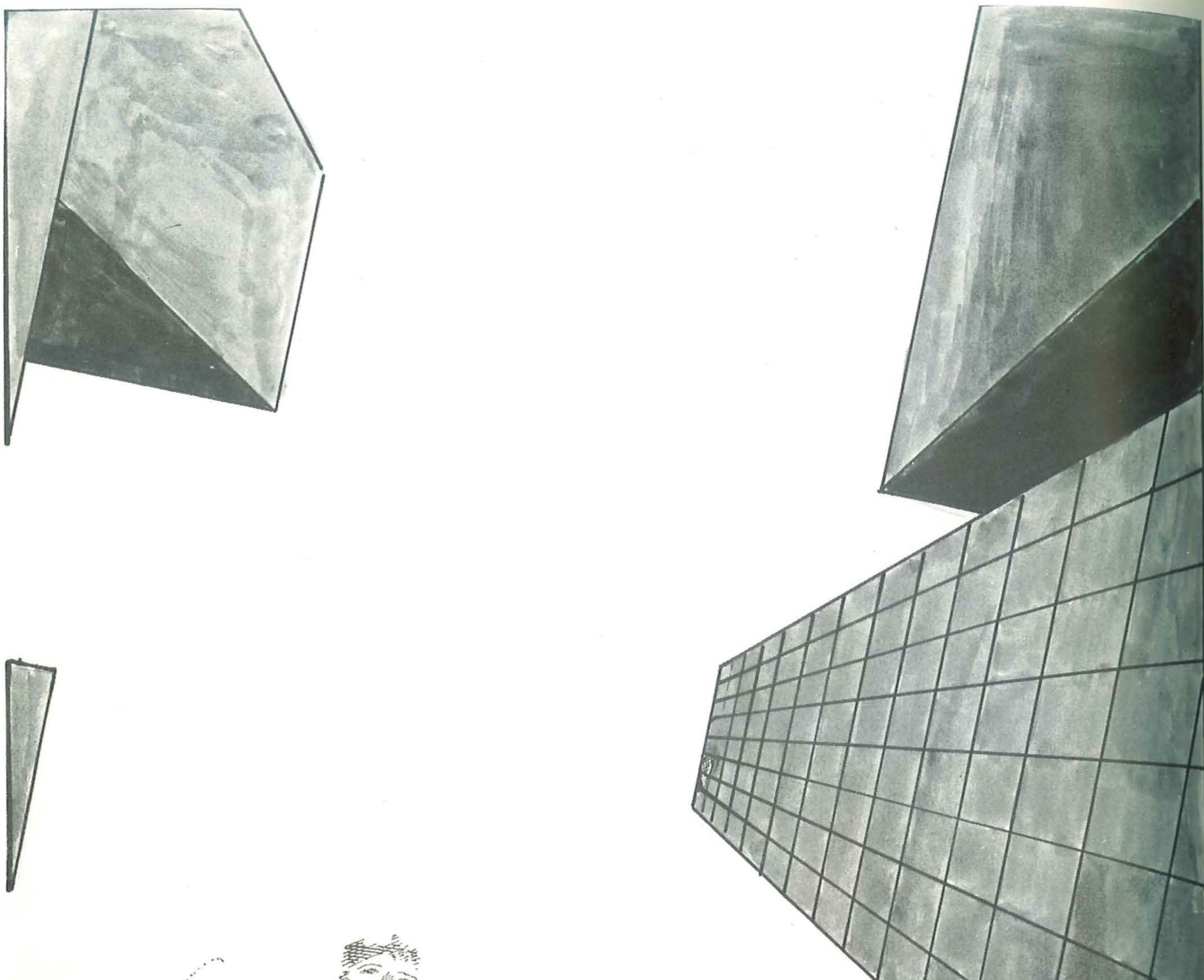


Illustration by Conrad Teves

Editor's Log

Core Curriculum Deficiencies

Roger walked into the interviewer's office, conservatively dressed, copies of his resume in hand. The ink still wet on his engineering degree, he was confident but still nervous. Roger is excited about the field he is in and his emphasis area, on which he has spent many classes and outside research opportunities. His grades have been good and he participated in the student professional society for his major.

The interviewer noted all these positive factors but was troubled by one thing. She asked, "Roger, are you involved in any activity or do you have any interest outside your field of study? Your transcript shows that you met your college liberal arts requirements, but it looks like you took mainly non-core courses, some even pass/fail." Roger responded, "Well, my main interests are in my field, so I took the easier liberal arts classes so I could concentrate on what was most important, my major."

The interviewer shook her head and said, "I'm sorry, but we are looking for a person with a more well-rounded background, varied interests, and a broader education. Thanks for coming, and could you send in the next person on your way out?"

Has this happened to anyone you know? Although not too common, the reasons behind Roger's rejection have begun appearing as policy in some companies' personnel departments. The narrowing emphasis of college degrees, especially in technical and professional areas, has become prevalent in today's higher education system. Long gone is the notion that a college degree implies the education of the "whole person," founded as an ideal in ancient Greek culture. Whose fault is this? Some of the blame rests in the individual student, but most of the responsibility for this saddening condition rests in the universities and society in general.

...the responsibility for this saddening condition rests in the universities...

Philosophy professor Allen Bloom states in his book, *The Closing of the American Mind*, that students may emerge from school as competent engineers, doctors, or lawyers, but they emerge as an "unfinished person." The once-assumed curriculum of philosophy, history, and literature, which is a major part of the foundation for the whole person, has all but disappeared. These courses are offered, but for many in the professional programs, they are in a list of electives or courses to choose from to meet the liberal arts requirements.

Here at the Institute of Technology, the student who finishes his or her degree in four years is an exception to the rule. Degree requirements are currently very demanding. As it stands now, to graduate in four years a student would have to average almost seventeen credits per quarter (three quarters), pass all the courses, and always be successful in registration! Also, most students are pulled in two directions by money concerns. They want to graduate as soon as possible so they can enter the job market and start earning money, and yet the problem of financing the cost of the education lengthens the amount of time spent pursuing the degree. Would students embroiled in these problems be concerned about the "whole person" and receiving a broad-based education?

What the University needs to do is reevaluate the Institute of Technology's degree programs. Course requirements and content should be revamped, reflecting a higher emphasis on a fundamental liberal arts education. The number of required communication courses should be increased. For example, the College of Agriculture currently requires three writing courses and one speech course for graduation. Only two writing classes are required in IT. These additional classes would be a realistic standard for which to aim. New technical classes reflecting the current advances in technology today could also be additional courses.

All of these ideal changes would place even more burden on the currently overburdened student. Consequently, the degree program lengths should be officially extended to at least five years to accommodate for the additional requirement.

The application report of University

Editorial to 11

R-DAT Technology: Potential vs. Protectionism

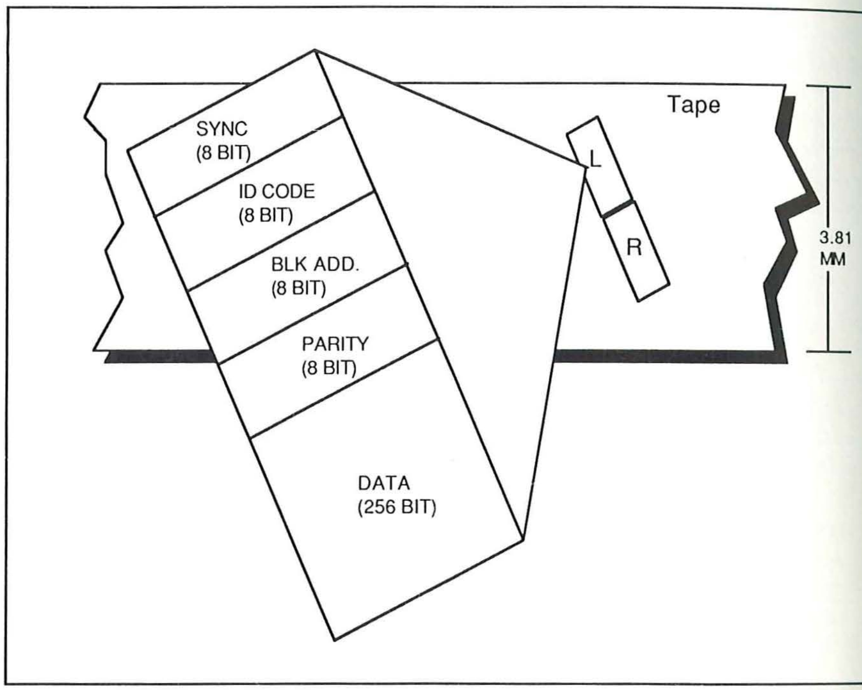
Government intervention, tariffs, and losses of 1.5 billion dollars per year surround this controversial new entry into the music recording industry.

by Kirk Nelson

Within the next year, a new type of audio deck called R-DAT (Rotary-head Digital Audio Tape) will hit the market. It combines the sound quality of a compact disc with the flexibility of an audio tape deck. The new audio deck uses digital codes much like CD's and can reproduce sound without much of the background noise associated with the conventional audio decks' analog format. The actual tapes will look much like conventional analog audio tapes but will be less than half the size. These new tapes will have the extraordinary playing time of two hours.

In late 1985 the Japan Electronic Industry Association announced standards for a new audio format called Rotary-head Digital Audio Tape (R-DAT). R-DAT uses a relatively old technology used in VCR's and 8-mm video format. A 30-mm rotating drum has a pair of tape heads to play or record two tracks on the tape. The drum rotates at approximately 2000 rpm. This allows a large amount of information to be placed on a short amount of tape.

Each track in the R-DAT format is a digital pulse-code modulation (PCM) data block. Each data block has five fields of data inside. The first three include codes for tape time, music selection, and indexing. The fourth data field contains an eight-bit parity code for error checking. The final field is a 256-bit code that contains the actual encoded audio information (see Figure 1).



Source: *Popular Mechanics*, August 1987. Illustration by Jerry Fiala

Figure 1: This illustration shows the digital pulse-code modulation (PCM) data block with the different data fields.

The tape path travels only half the rotating drum's circumference, meaning each recording head is reading the information only half the time (see Figure 2). The information from each head is put into a buffer where it can be stretched out into a continuous signal. If one head is unable to read the data from its track, the other head will read it and interpolate the missing information.

The R-DAT format has a sampling rate of 48 kHz. This means the sound is stored in intervals of about two one-hundred thousandths of a second across. This is different from a compact disc sampling rate of 44.1 kHz. This difference is mainly to stop direct digital recording of compact discs on to R-DAT tapes. The higher sampling rate actually gives the R-DAT format better recording quality.

Since R-DAT uses older technology compared to compact discs, why wasn't it the first digital format to come out? The answer is that the audio component industry had little success with new formats that could not differentiate themselves from other formats. The compact disc format has a laser pickup system and a virtually indestructible recording medium. The only difference that R-DAT offered was high quality digital sound when the merits of digital recordings were still being debated. Instead of starting with R-DAT, the industry went with CD players, which had the high-tech feel to differentiate it from other formats.

If the R-DAT format had industry standards set for it two years ago, why haven't we seen a R-DAT tape deck on the market? This may be caused by the Philips Corporation's influence on the Japanese audio industry. Distribution dates for R-DAT were rolled back when Philips' officials met with the Japanese audio industry officials. The Philips company has a vested interest in Polygram Records, which is a large compact disc maker. It seems Philips was instrumental in getting the European Economic Community to place a tariff on Japanese compact disc players. The implied threat being another such tariff placed on R-DAT decks.

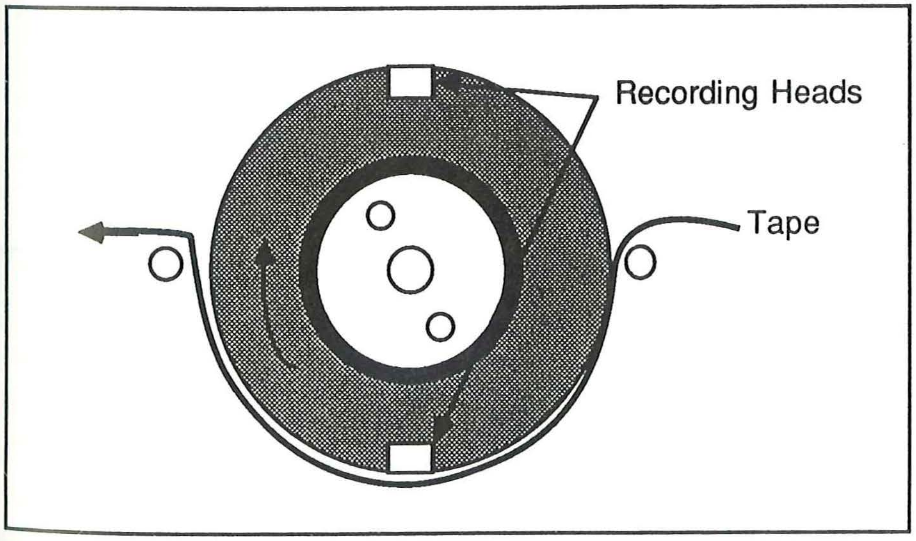
Not long ago Congress was considering a bill that would put a surtax on all digital audio tape recorders. Now Congress is considering a new form of this bill, the Digital Audio Copy Code Act of 1987. The act states that a manufacturer or individual can manufacture or sell a digital audio recording device only if it has a copy code scanner. It also makes any device that disables the copy code scanner illegal. A copy code scanner continually searches for a 'notch' in a recording. The notch will be in the audio frequency range of 3,500 and 4,100 Hz. A notch is an absence of sound resulting from the removal of sound signals at a certain frequency between 3,700 and 3,900 Hz. Once a notch is detected, the recording device will have to turn itself off for at least twenty-five seconds. This means that every prerecorded digital audio tape must have a certain frequency removed.

...every prerecorded digital audio tape must have a certain frequency removed.

To understand the Digital Audio Act of 1987 we need to know the reason behind the legislation, the copy code, and how the copy code works. In 1979 the CBS technology center was given the task of creating a way to stop unauthorized copying of records and tapes. At first they tried inaudible signals that would disrupt the recording process without any added circuitry. When no such method was found, they came up with copy code. Although this method required additional circuitry, it was their hope that a law would be passed requiring the device in analog and digital audio decks and video recorders.

...the recording industry loses 1.5 billion dollars per year because of home recording.

The major proponent of the Copy Code Act is the Recording Industry Association of America (RIAA). They did a study that found the recording industry loses 1.5 billion dollars per year because of home recording. R-DAT allows perfect recordings of prerecorded digital tapes and the RIAA believes this will mean more lost revenues. Also many members of the RIAA have large amounts of capital placed in the rapidly growing CD market and R-DAT technology may cut into it.



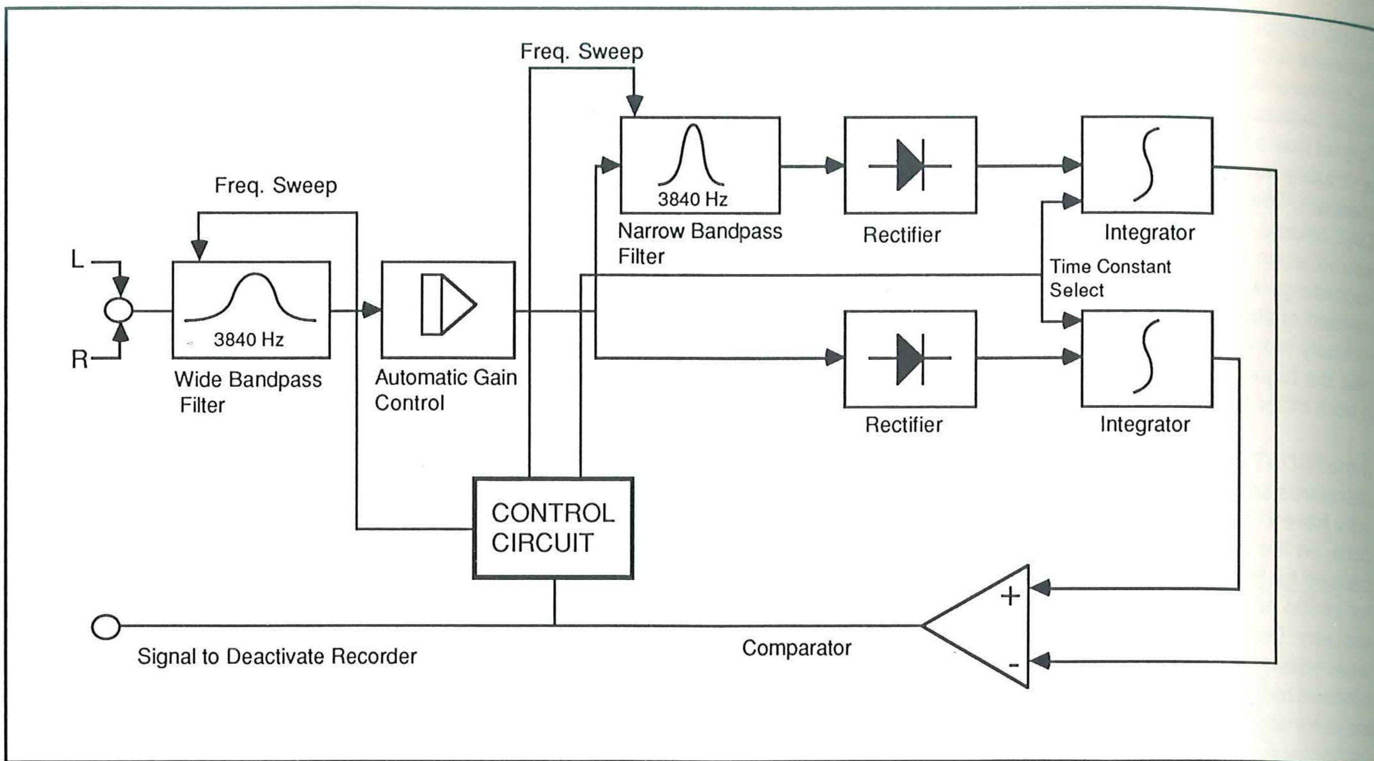
Source: *Changing Times*, January 1987. **Illustration by Jerry Fiala**

Figure 2: Each recording head reads the data only half the time. Since there are two heads, one head can cover for the other if data is missed.

A Notch Below the Rest

While the industry has removed the temptation of directly copying CD's to R-DAT decks, another issue has presented itself. R-DAT has such a high quality that an analog output of a CD would be easily taped on an R-DAT deck. The new recording would not be audibly different. The music industry has latched onto the copy code as a solution to this problem.

The copy code itself is made by filtering the audio through a narrow bandstop filter. A bandstop filter does not allow those signals near the center frequency to continue in the circuit. The center frequency for the copy code is at approximately 3,840 Hz and its -3 dB points are approximately at 3960 Hz + 120 Hz The design is reported to have a ninth-order Chebyshev response realized by cascaded biquad bandpass filter stages. The output of the design is then subtracted from the



Source: *High Fidelity*, July 1987. Illustration by Jerry Fiala

This block diagram of a copy code scanner, from a description in a CBS document, shows the dual path (upper right) the signal takes on its way to the comparator. The comparator is the device that makes the actual record/don't record decision. The circuit's provisions against false alarms make it vulnerable to jamming by several kinds of homemade circuits.

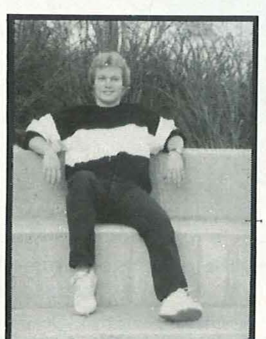
original audio signal to create the code. The maximum depth of the notch is to be -67 dB.

A ninth-order Chebyshev device contains a large number of operational amplifiers. These op-amps and the phase equalization process will add noise to the audio signal as will any other active components. Dynamic range of the signal may be reduced by substage overload. If one of the cascaded stages overloads before the final output, distortion will be added to the recording.

Even if the distortion caused by the added circuitry was inaudible to the human ear, the actual copy code may be heard as a loss of notes or harmonics. Removing the audio frequencies between 3,720 and 3,960 Hz means that any note or harmonic falling close to the notch will be reduced. Any note of harmonic falling into the gap may be totally obliterated. The notch frequency falls between the top A sharp and natural B on a piano. If the instrument being recorded is tuned to modern standard pitch and equal temperament, the copy code will not be heard as long as you don't use high-pitched vibrato. But few instruments are tuned this way, and if you are unlucky enough to like an artist who likes to tune up or down or use high vibrato, you're likely to notice the difference.

The copy code scanner must allow for a six-percent difference in recording speed so it can detect the notch in off-speed recording. It also must allow for code scanning at double speed for high-speed dubbing. The scanner device works on the input signal which is put through a wide bandpass filter. A bandpass filter is the inverse of a bandstop filter. The initial filter allows frequencies of 3,820 +/- 375 Hz through. An automatic gain control compresses the signal so the rest of the circuit sees little variation of signal level. The signal is then split up into two different paths. The first path is put through a narrow bandpass

R-DAT to 11



Kirk Nelson is a senior in electrical engineering and is thinking about triple-majoring with physics and aerospace engineering degrees also. The *Technolog* is considering nominating Kirk for the "Professional Student Award" with all the schooling he has ahead of him. This is Kirk's second year as a member of the IT Board of Publications. He enjoys skipping class to play Nerf basketball in our office.

Log Ledger

by Mike Servatius

Proton Decay

Deep below the surface of the earth in Minnesota's Iron Range, a fascinatingly complex physics experiment is taking place. The Soudan Mine in Soudan State Park is the site of a 235-feet long, 37-feet high, 45-feet wide room, 2000-feet below ground level. In this room, a group of scientists from the University of Minnesota, Argonne National Laboratory of Chicago, Tufts University in Boston, Oxford University and England's Rutherford Laboratory carrying out an experiment which will determine whether protons decay. This group of physicists is building a 1000-ton proton decay detector on the 27th level of the Soudan Mine.

The material being observed consists of taconite concrete—taconite concentrate from the Iron Range in a mixture with Portland Cement and water. Embedded in this material are 48 layers of 72, one-inch diameter, steel tubes. A very thin gold-plated tungsten wire runs through the middle of each tube. The tubes are filled with argon and carbon dioxide gases and the inner wire is charged to a high voltage.

If proton decay is actually occurring in the taconite-concrete mixture, the physicists will detect this by observing electrical pulses generated by decay products passing through the steel tubes. A computer amplifies and records any pulses that occur. This experiment is happening deep in the mine in order to protect it from cosmic radiation that would interfere with the results of the experiment.

Professor Marvin Marshak of the University of Minnesota Physics Department is one of the principal researchers on this project. According to Marshak, the Soudan Mine was chosen for this experiment because, "Most mines you can't use because they haven't been maintained and are dangerous. But because this one is maintained by the state it is ideal."

The 100-ton detector, which is expected to be completed within three to four years, is so large because in order to record the decay of even a few protons a year, an extremely large amount of protons must be observed.

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Shuttle Flights

After being put on hold since the January 1986 explosion of the space shuttle Challenger, NASA plans to resume operations by launching six shuttle flights over a one-year period beginning in June 1988. Scheduled for June 2, 1988, the first mission, STS-26, will launch a Tracking and Data Relay Satellite (TDRS)/Inertial Upper Stage payload by the shuttle Discovery. The other five missions are scheduled as follows:

—September 8, 1988; Defense Department payload by Atlantis.
—November 10, 1988; Defense Department/CIA advanced imaging reconnaissance satellite by Columbia.
—February 2, 1989; A second TDRS spacecraft.
—April 25, 1989; Magellan Venus Radar Mapper spacecraft.
—June l, 1989; Hubble Space Telescope.

Source:
"Six Shuttle Flights Planned for 1988-89," *Astronomy,* Vol. 15, No. 10, October 1987, p. 87.

Mars Exploration

The United States and Soviet Union are both launching plans for exploring Mars. The International Conference on Solar System Exploration held May 19-21 in Pasadena, California and sponsored by the American Institute of Aeronautics and Astronautics and the Jet Propulsion Laboratory, served as a forum for the two countries to introduce their exploration proposals.

According to B.G. Lee of the Jet Propulsion Laboratory, NASA is beginning a major research and development effort to find the most cost-effective way to obtain samples from Mars. A 1998 or 2000 launch date is anticipated.

Presently, two Observer spacecraft for inner solar system exploration are under construction, and the Mariner Mark II outer solar system spacecraft is being developed, though no flights have been approved yet.

Slightly more ambitious Soviet plans will start in 1992 with the launch of two identical pairs of helium-filled balloons and small solar-powered

Log Ledger to 15

Sound Engineering: From Piano to Prince

The Twin Cities has emerged as a major recording studio area in the music industry. Here is a look into two local studios and how the process works.

by Angela S. Miller

The band members play their final note and look out expectantly from the recording studio's sound booth. After a slight pause, two people in the control room look back through a window which separates the two rooms; one smiles, gives the "old thumbs up," while uttering those longed for words through a microphone, "That's a take!" The recording now over, it's time for the other person to work his magic. Seated behind a large, impressive control board with many dials and levers, the audio engineer skillfully "mixes" a good song into something spectacular.

...Movie myth, or an accurate representation of a real recording session? What exactly is the function of that person behind the "board?" And does he/she really play that large of a role in the recording process?

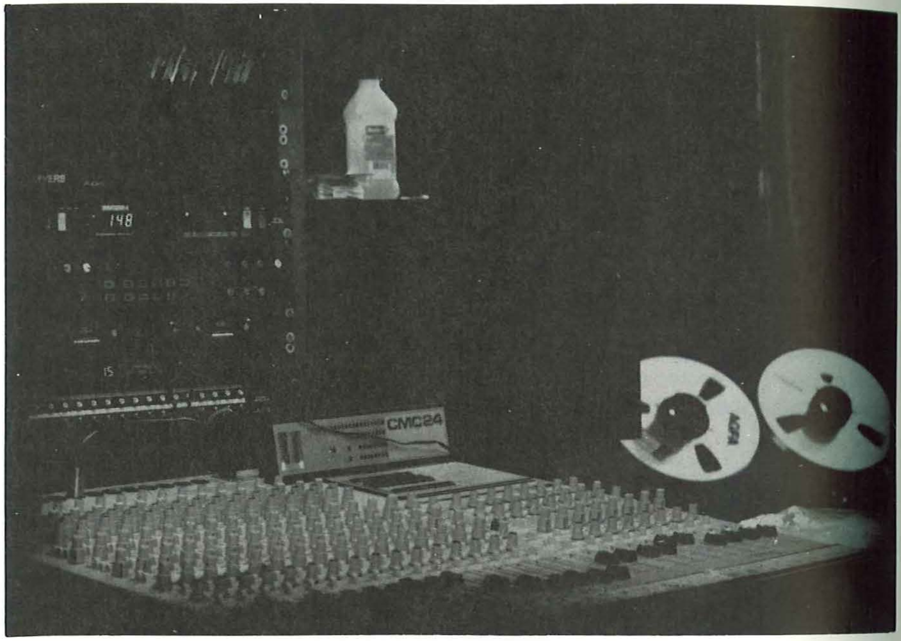

Photo by Paula Zoromski

Figure 1: The 16-track mixing counsel, or "board," at Studio D.

The main tool of an audio or sound engineer is the mixing counsel, or board. It receives the first sounds, perfects them, and allows the new sounds to be captured on tape. Other than the tape, recorder, and the musicians themselves, the board can be considered the most important element in making a recording. The original sounds go through the board to the tape.

Most first recordings — for example, a demo tape to be presented to a record company or radio station — are initially done on either 8, 16, or 24-track, reel-to-reel magnetic tape. Each element or sound occupies its own track: possibly drums on track one, bass on track two, vocals on track three, etc. The board first allows individual elements to be separated, and then is able to isolate each sound so it can be altered and improved before being mixed together again.

Mixing is basically the altered multi-track recording being combined onto a two-track tape. After many hours of recording, re-recording, and/or programming, the performers have an initial, or *dry*, recording. Next the audio engineer goes to work mixing the various elements — adding, erasing, or modifying — for the finished, or *wet*, sound which is recorded onto two tracks. This is the final sound heard on radio, records, or cassettes.

But, back to the board! The mixing counsel consists of series of rheostats (the dials and levers that regulate and adjust the flow of current) in vertical columns, one column for each track. Going from left to right across the board, each row has a specific function and can be divided horizontally into sections (see

Figure 1).

Neal J. Thorgrimson of Guitar Center Recording Studio in downtown Minneapolis described his eight-track system by horizontal sections (see Figure 2). The upper-most five rows comprise the equalization section, comparable to the treble section on a stereo. This allows for a general mixing of sound. Adjustments to frequency, pitch, and other aspects can be made that either add to or detract from the quality or quantity of sound on the recorded tracks.

Below this section is the affects area, used for adding echo and/or reverberation. Reverberation can be described as close to the actual tremor of sounds as they bounce off walls. Echo is a slowed down, more controlled repetition of specific sound. This section can do everything from reversing the sound to provide a "booming" drum or bass, to giving the illusion of a large concert hall stage recording.

The board also plays many roles during the actual dry recording. The next section is for one of these. It controls the volume of each element, or headphone mix, for the musicians as they record. This function is comparable to the monitoring systems that bands use during live performances, where each member can gauge his/her own playing to that of the other members. Thorgrimson gives an example: "Say the drummer likes to hear a lot of saxaphone when he plays. We can increase the volume for him. Then if vocalist relies on the bass or rhythm, we alter his headphone mix to increase the intensity of the drums."

...each member can gauge his/her own playing to that of the other members.

Achieving a stereo sound, or placing individual sounds left to right across the spectrum, is yet another possible function of the board. This pan-control section can give a realistic feel to a recording. For example, in a choral recording, the soprano section will be completely dominant on the left side, the altos will be right side dominant, with the tenor and bass sections blended across the middle, as they would be positioned on stage.

Photo by Paula Zoromski

Figure 2: A general overview of the Guitar Center Recording Studio control room with its 8-track mixing counsel.

Or it can give the listener the feel of an entire drum set placed right in front of them. When the drummer takes the lead on a solo, playing a riff (striking each drum, going from left to right), the listener will hear the sound move through the speakers just as it moves across the instrument.

The final row on the board consists of the levers which control the volume of each individual track. This allows a single track to be isolated for additions or modifications. Then the volume of each track is set for the final wet recording.

The Guitar Center fits well into the ideal of a traditional recording studio. This facility is a professional guitar instruction school during the day, also doing recording and mixing for musicians. Besides doing actual audio engineering, Thorgrimson also teaches his profession during the evenings at the studio.

A musician himself for about fifteen years, Thorgrimson is intent on trying to maintain and capture a true-to-life performance; he wants the sound to be as natural and as realistic as possible. He prefers to record an entire band together, instead of each musician playing his/her part separately. He also tries to use as few microphones as possible, which he believes gives the most natural blend of music. However, the musicians make the final decisions on both recording method and engineering.

The musicians may decide to give their music a more high-tech, or flawless quality. Or a lone vocalist, not wanting to put together his/her own band, may decide to do everything himself. Many modern studios are able to cater to these demands.

Studio D, a primarily Christian music recording studio in South Minneapolis, is such a facility. Operated by Scott Duand, its control room contains, among other things, a sixteen-track mixing board and reel-to-reel recorder, a drum machine, and two synthesizers.

Duand mentions a new emphasis

being placed on musicians to "do everything themselves." Synthesizers and drum machines make this possible.

The drum tracks can be programmed into the machine — the various sounds of a drum set all made with the touch of a button! Even groups that have their own drummer will choose to program their patterns on the machine, it being more accurate, consistent, and reliable. Duand estimates about 32 patterns to a four minute song, and will probably use the first five tracks for drums alone.

After drums, synthesizers can supply the remaining instrument sounds required. Studio D recently purchased a new Korg synthesizer that is more of a computer than an instrument. It comes complete with computer disks capable of producing 32 variations of each sound available on each disk. A singer can perform to anything from bass clarinets to an entire orchestra; there's even a disk to supply backing vocals. Or it is possible to do a live album simply by strategically placing programmed crowd noises and applause to a track in the final mix.

Entrance into the field of audio engineering appears to be more of a "who-you-know" rather than a "what-you-know" business, as might be expected in any entertainment profession. Both Duand and Thorgrimson stress experience — both musical and engineering — as helpful for moving into this field.

An audio/sound engineer can become certified in approximately six months at a technical institute, or can learn from another engineer such as Thorgrimson. In keeping with the desire to do everything themselves, many musicians are learning to do their own engineering. This is making a popular field even smaller, suggesting that in the long run it will be the person with the most knowledge and technical training who will ultimately advance and get ahead in the field. Thorgrimson, a University of Minnesota electrical engineering major for two years before deciding to pursue a music/audio engineering career, credits the classes he took and knowledge he gained at school in helping him in his career. Besides the expected usefulness of learning things like the speed of sound, decibels, and how electrical equipment works, the practice in basic problem solving has proved very valuable.

While problem solving can be beneficial, problem causing can also be useful. With all of the technological advances in the creation of perfect and flawless music, the human element seemed to be forgotten. People want to hear other people play real music. Unfortunately, real people make mistakes. How can a compromise between the ease and perfection of a drum machine, and the realistic, "true" but imperfect human sound be reached? Enter the computer-generated human imperfection, which allows an engineer to place timed flaws into a drum program. What will be the next step in in music production? The audio engineer will find out and can be relied on to create the best recording possible. ▲

Sources

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Angela Miller is a junior in English and is planning to study in England this spring. This is her first article for the *Technolog*. She professes a partiality for football (preferably Vikings), the color purple, and Jane Austen as an author. Music is another of Angela's specialties, choosing Elton John as her favorite (an English singer, of course). She loves to fence, the English style, I'm sure.

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R-DAT from 6

filter that is identical to the encoding filter. Both paths are rectified to make DC voltages and then sent into integrators. The signal from both paths are then sent to a comparator. If both time averaged signals are the same, then the copy code scanner has not detected a notch. If the signals differ by a set ratio or more, the device will register a notch.

To try to eliminate false positives, the copy code scanner works on a long scan period. It first scans through the six-percent speed difference every eighty milliseconds. When the first notch is detected, the scanner locks on that frequency and if a notch is still detected thirteen seconds later the device shuts recording off.

The copy code scanner is hardly a foolproof way of stopping unauthorized recordings. A small amount of distortion added to the signal at the copy codes frequency will fool the scanner without losing much in sound quality. Also by placing a bandstop filter centered at 3,820 Hz and with a rolloff of over +/- 375 Hz you will fool the scanner. This last method, although the easiest, will compromise sound quality. All these methods would be illegal under the proposed law.

If the Digital Audio Copy Code Act of 1987 (House bill HR-1384 and Senate bill S-506) is passed in Congress, the consequences may be far reaching. The introduction of R-DAT technology will be slowed or stopped completely in the United States. Few people will want to buy R-DAT decks when they cannot make backup tapes for their own personal use and know the prerecorded music for their deck has been filtered. If this legislation is passed, you can bet that similar legislation will be put forward for analog audio cassette decks and video recorders. That is what the copy code was first designed for. ▲

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Editorial from 3

President Ken Keller's "Commitment to Focus" plan, called "Strategy for Focus," recommends that an Academy of Literature, Sciences, and Arts (ALSA) be formed that would be the single entry point for all incoming freshmen. ALSA would incorporate IT, CLA, the College of Biological Sciences, and General College into one confederation for lower division students. Students would then apply to upper division to their respective colleges when their core curricula in ALSA was completed.

If approved, this restructuring would be the ideal vehicle to institute a curriculum reform. ALSA could set requirements for a more traditional liberal arts education that would apply to all lower division students. IT majors would then have at least three years to complete the technical portion of their studies after the initial two.

These ideas are just one way to address the problem of narrow, non-diverse college graduates. Other colleges around the country are also examining this growing problem. Our universities must recognize the responsibility they have to furnish future "Rogers" with a broader educational base that all businesses will expect in the future. ▲

Jim Willenbring
Editor

Phonics, Freeways, and Fillies

Sound propagation, abatement, and applications in biomedicine are just some of the topics in University acoustics research.

by Kevin Cummings

Here at the University of Minnesota there is a lot of different research going on that revolves around the study of acoustics. Work as diverse as ultrasound, acoustic microscopy, and psychoacoustics are all proceeding at this time. Two important areas that are being focussed on are the propagation of sound and also biomedical diagnostics.

Since his beginning as a graduate student in 1948, Professor Robert Lambert of the Electrical Engineering Department has been working on various applications of acoustics. He usually has more than one topic going on at the same time, and right now is no exception. Presently one of his areas of study is the propagation of sound through porous materials. This came out of another interesting project that involves the noise barriers that are along many of the Twin Cities' freeways.

In the late 1960's, the Minnesota Department of Transportation (MN/DOT) became concerned about the increased noise along urban freeways. Complaints by residents along the routes were becoming more and more frequent and MN/DOT was forced to choose from some poor alternatives. First, they could close the freeways, but that obviously would be impossible given the increased need for high speed transport. Second, they could divert trucks that seemed to account for much of the noise, but the expense involved and the pressure from the trucking lobby precluded that possibility. Finally, MN/DOT decided to find out if erecting some sound barriers would do the trick.

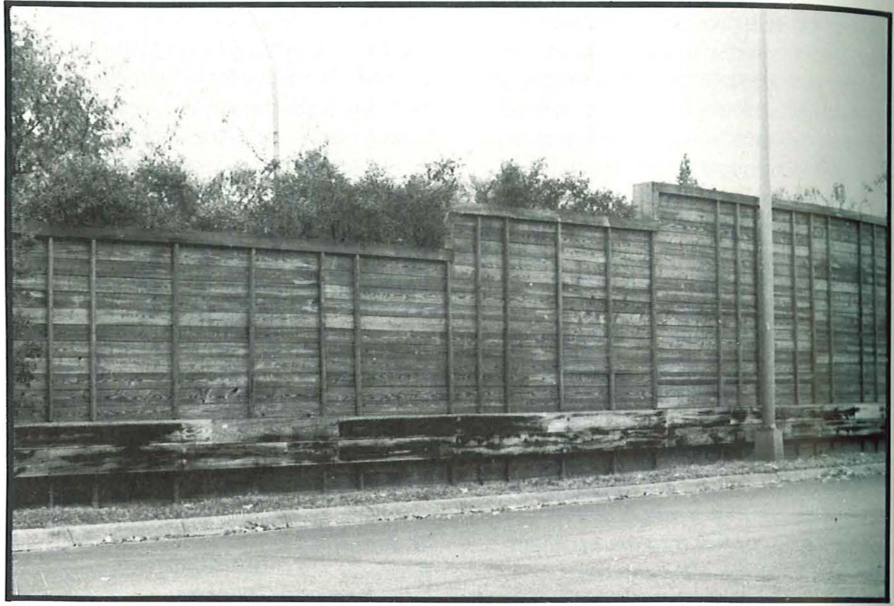


Photo by Paula Zoromski

One of the sound barrier test sites at I-35W and Minnehaha Creek.

MN/DOT hired Lambert to conduct objective sound tests in the area around a section of Interstate 35W near Minnehaha Creek. They also hired Professor Thomas Bouchard of the Psychology Department to take surveys of affected residents in that area to see if the subjective data from people coincided with objective data from Lambert.

In his initial investigation, Lambert found out that the first wall built to block traffic noise in the Twin Cities area was on the Washington Bridge by Anderson Hall. Complaints about traffic noise from Washington Avenue by people in Anderson Hall had prompted the physical plant to built a cement noise barrier. No objective studies had been done to asses the effects. The Anderson Hall residents had noticed a change, but their responses were not scientifically analyzed.

At the I-35W site, Lambert and Bouchard tested their respective fields for some pre-barrier data. In his next step Prof. Lambert conducted

Prof. Lambert conducted some research with computer simulation models...

some research with computer simulation models to determine what kind of barriers would be needed. His models used 30 to 40 variables including time of day, traffic flow, wind speed and direction, propagation of sound through the ground and air, distance from the freeway, etc. Some of the variables were unknown, for instance the propagation of sound, and this preliminary work spurred his present studies in sound propagation.

One of the non-scientific lessons Lambert learned at this time was how influential politics were. His model would have to work because as he said, "[I learned] if you don't do an effective job the first time, the public won't let you do it again."

After much analysis, Lambert determined the needed barrier. At a cost of about $100 per linear foot, the 1.6m to 5.8m-tall wall was put up. His noise measurements showed a drop in peak noise levels (usually 9-11 AM) of 10-12 decibels at homes that were about 45 meters from the centerline of the freeway. Locations farther away from the freeway had less change.

The subjective results were even more interesting. On a scale of 1

...a successful example of coordinated efforts of physics, engineering, and human behavior.

(unobjectionable noise) to 6 (intolerable noise) the people in the homes closest to the freeway rated the pre-barrier noise about 5.5 and the post-barrier noise about 3.4. This was interpreted by the two professors and MN/DOT as a successful example of coordinated efforts of physics, engineering, and human behavior.

As one example of acoustic research, the freeway noise barrier experiment is very interesting, but it is only a very visible example of work Lambert and others are working on. His present focus is sound propagation, especially in the lower atmosphere. Here his work with ground reflection and absorption, temperature gradients, and wind components can be used not only as empirical studies to further knowledge about the subject, but also can be used for projects such as airplane noise reduction.

Professor Lambert has worked throughout his lifetime for many different groups, notably the National Science Foundation, NASA, Honeywell, and the United States Navy and Air Force. He teaches engineering acoustics for seniors and graduate students in EE and other related sciences such as physics, architecture, and mechanical engineering.

Another interesting person in acoustic research is Professor Jim Holte, also of Electrical Engineering. Holte has done much work in the last 10 years on a variety of projects including using sound to detect problems in joints of the human body. This was widely reported in the news three years ago and he notes that the project has reached the testing stage. Dr. Leonard Myer, chief of oral surgery at Hennepin County Medical Center and who also has a University appointment, has been working with Holte on this work involving the jaw bones.

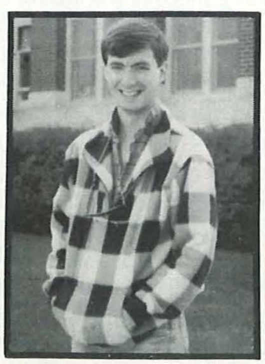
But Holte has many other interesting stories to tell. Recently one of his undergraduates, Elise Zuidema, received a UROP (Undergraduate Research Opportunities Project) to study race horses. Her work as a horse trainer led her to want to study why race horses' front legs often get hyperextended during races. With ultrasound she hopes to find some answers by comparing the transduction of sound before and after a race.

...a chance to see how their skill can be applied in a non-traditional area.

Holte also is one of the instructors in the EE senior design class, EE 5450. He was approached by an engineering instrumentation company interested in buying ultrasonic test equipment. They wanted a systematic way of checking products before they buy them. Holte hopes that his five seniors and one graduate student in the design class can come up with some ideas for the company.

As a perfect example of research opportunities, Holte would like to see more of this kind of give-and-take between business interests and the university. Especially beneficial in this case is that it allows seniors in EE a chance to see how their skill can be applied in a non-traditional area.

As seen by these two professors, acoustics is an area that encompasses many diverse and interesting topics. Professor Holte continues to take an active interest in biomedical acoustic research, and Professor Lambert is advancing his study in sound propagation. Both of them use each other's work as a resource, and in combination with their own research, help others interested in the study of acoustics. ▲



Kevin Cummings is a senior in technical communication emphasizing in aerospace technology. He is awarded this issue's "Expeditious Award" for receiving his assignment with the least amount of time to complete it. As you can see, he finished with flying colors. When not hurridly trying to meet *Technolog* deadlines, Kevin is very active in University Scholars and interns for KTCA's award-winning "Newton's Apple."

Assigned Reading

by David Kortenkamp

The Making of the Atomic Bomb

by Richard Rhodes
Simon and Schuster, 1986

The typical starting point for most books dealing with the atomic bomb is Los Alamos — after all that's where the first bomb was constructed. By contrast, Richard Rhodes in his book *The Making of the Atomic Bomb,* elects to begin in the early 1900's, when scientists first struggled to understand the atom and to unlock its secrets. Only after laying the necessary theoretical groundwork does Rhodes proceed to describe those few short years at Los Alamos when the bomb was actually engineered. In addition, Rhodes chooses to concentrate more on the people who brought the bomb into being, rather than on the bomb itself.

The cast of characters in this book is stunning—Einstein, Bohr, Fermi, Lawrence, Oppenheimer, and many others. Rhodes depicts not only their scientific sides, but delves into their personal lives, their politics, and the moral dilemmas they encountered as they made history. They alone, Rhodes points out, really understood the power of the atom and how it would change the world forever.

The emphasis of personality over science makes this a relatively easy read for someone who remembers a little of their high school chemistry or physics and has an attention to detail. In fact, the descriptions and diagrams of the atomic and hydrogen bombs leads one to believe that their construction would be a trivial process. Near the end of the book, lest anyone forget the awesome destructive power of the bomb, Rhodes uses eyewitness accounts to vividly describe the devastation of Hiroshima (he does tend to moralize a bit though). The book's most frightening moment finds Enrico Fermi in his Columbia University office looking over Manhattan, his hands cupped as if holding a ball, saying to himself, "A bomb no bigger than that and it would all disappear."

The Tomorrow Makers

by Grant Fjermedal
Macmillan Publishing Company, 1986

Many popular books have been written recently about robotics and artificial intelligence (*Into the Heart of the Mind* and *Machinery of the Mind* to name a couple), but *The Tomorrow Makers* is the most expansive and the most provocative. It touches on everything from miniature robots, which could repair defective DNA inside a human cell, to the possibility of "downloading" a human brain into a computer, giving immortality.

Award-winning science author Grant Fjermedal spent several months touring American and Japanese artificial intelligence laboratories. What he found is both frightening and fascinating; the world's top computer scientists are working day and night to give machines intelligence, and many of them feel that it's only a matter of time before it will be done. Fjermedal's book deals not only with the question can it be done, but also with the question should it be done. Fjermedal expresses particular concern about the possible military uses of the new technologies (most of the research is funded by the Defense Department.) He is also concerned about the social dilemmas we might face. He includes a chapter on theology and an interview with Arthur Harkins, a professor of cultural anthropology at the University of Minnesota and an expert on robotics and society.

This book probably has too much of a "gee whiz" feeling for serious computer scientists, and at times it seems to border on science fiction. It does, however, offer a glimpse into what some researchers believe the next century will be like.

Thursday's Universe

by Marcia Bartusiak
Times Books, 1986

If you're a novice astronomer looking for a basic introductory astronomy text, Marcia Bartusiak's *Thursday's Universe* is not for you. On the other hand, if you enjoy questions without answers, you'll be fascinated by Bartusiak's book which focuses on astronomy research in the last twenty years.

The book is a collection of eleven fairly independent chapters, each focusing on a different area of current research. The quality of the chapters varies; some are simply more interesting than others. Those dealing with stellar evolution and galaxies (roughly the first half of the book) offered little that couldn't be found elsewhere. It's when Bartusiak enters areas ignored by most astronomy texts that the book begins to fascinate.

The fun starts with a chapter exploring the mystery of the missing mass. Gravitional pertubations tell astronomers that the universe has more mass than they can see. Where is the missing mass hiding? Bartusiak presents several theories, none of which can be conclusively accepted or rejected. Another chapter entitled "The Cosmic Burp" describes how scientists explain the birth of the universe, all the way back to 10^{-35} seconds after it was created. The last chapter, "Before the Beginning," is the most interesting. As the title implies, it turns its attention to those few scientists who are attempting to explain how the universe was created out of nothing, without resorting to a supreme being.

Bartusiak uses personal interviews and historical flashbacks to bring life to many of the theories. She sometimes falls into the "isn't that awesome" syndrome (e.g. if the earth was shrunk to the size of a pea...) which plagues many popular astronomy books, but overall the writing is solid. The strength of the book lies in its presentation of the brilliant and imaginative ideas generated by today's scientists as they try to explain how the universe works and where it came from.

Pioneering the Space Frontier

National Commission on Space
Bantam Books, 1986

The National Commission on Space was created by Congress and appointed by President Reagan to prepare an agenda for America's next 50 years in space; "Pioneering the Space Frontier" is the Commission's final report. As far as writing goes the report is dry and uninspiring, but then who would expect anything else from a congressional commission? Besides, it's the agenda they propose that makes the report worth reading (not to mention the magnificent artwork).

The Commission recommends that the United States adopt a stepping stone approach to exploring space. Their timetable recommends a space station by the mid-1990's, a lunar base by 2005, an initial human outpost on Mars by 2015, and a full Martian base by the year 2030! Naturally, such recommendations have received both praise for outlining an agressive civilian space program, and criticism for being outlandish and much too costly. Which side you take depends on how much of a space buff you are.

In addition to these big ticket items, the report includes many other recommendations on which there is general agreement. They argue for more support of basic research in space science, astronomy, and biology, as well as more international cooperation. They also propose that the United States maintain separate launch vehicles for humans and for cargo.

This report was one of many released after the Challenger accident almost two years ago, although the Commission was formed before this event. Its only mention of the tragedy is in dedicating the report to the crew of flight 51-L, but the Commission obviously wants to show the President, Congress, and the American people what the next 50 years of space exploration can bring.

Explanation Patterns

by Roger Schank
Lawrence Erlbaum Associates, 1986

Explanation Patterns would make a good companion book to *The Tomorrow Makers,* which was reviewed earlier. The latter book depicts a future with intelligent machines, but glosses over the technical problems computer scientists still face. *Explanation Patterns* gives us the nuts-and-bolts approach as author Roger Schank attempts to show the underlying processes which allow us to understand and be creative.

Roger Schank is a leading artificial intelligence researcher at Yale and his book is not for the layman. Only those with a serious interest in artificial intelligence or cognitive science will want to wade through the entire book. Schank's central theme is that the key to understanding is to ask the right questions and then find the answers. Schank further theorizes that creativity arises when we answer one question by modifying (Schank calls it "tweaking") an explanation that was originally used to answer a different question. Schank argues that creativity (and understanding) is not magic, but a mechanical process which is within the grasp of computers.

No detailed knowledge of computers or computer languages is necessary to understand the book. Those interested in artificial intelligence will read it because Schank's name is on it. Others may want to read the first two and the last two chapters, which introduce and summarize his theories without going into great detail.

Log Ledger from 7

rovers supported by two orbiters. The rovers will map possible sample return areas. In 1994 a similar but larger-scale mission will be sent to gather samples. And in 1996 the rover/orbiters will rendezvous with two ascent vehicles to collect the samples and boost them into Mars orbit. The samples will be returned to a Soviet orbital space station near earth via return vehicles launched from Earth in 1996 or 1998.

Source:
Robertson, Donald F. "The Race Is On: U.S., Soviet Plans for Mars Exploration," *Astronomy*, Vol. 15, No. 10, October 1987, pp. 86-87.

Some things are so serious you can only joke about them. — Albert Einstein

Engineers are scientists who can walk and chew gum at the same time. — Gene Roddenberry

Illustration by Phillip Kiet Luu

Shake, Clatter, & Roar

A light-hearted look at the problems of regulating and reducing noise levels, as well as some creative solutions.

by Mark Werner

Take a walk down a dorm hallway on any given afternoon and you're bound to hear a high-volume, jumbled mish-mash of Led Zeppelin, Run DMC, U2, and the Nylons. Each worthy groups, but together, a nightmare of noise pulsing at an annoying crescendo. This environment can be painful to study in. Not only does noise break concentration, but it also is a contributing factor in impaired hearing, chronic fatigue, and increased blood pressure. In a University of Montreal research laboratory, a test on noise stress found that the muscle system periodically tenses and relaxes in the presence of intermittant noise. It also found that a sharp, loud sound will increase cranial pressure by as much as four times the normal level. According to a report in the *Journal of Medicine* by Dr. Forest Kennedy, constant noise excites and irritates, alters conduct, and causes loss of temper. Experiments on rabbits have shown that exposure to noise can cause atrophy of the liver, convulsions, and even testicular degeneration in males.

Everyone knows that the last thing a male dorm resident wants is testicular degeneration, so what's a guy to do?

Well, you could go around to each individual door, pound on it with a ball-peen hammer, and politely ask the residents to turn their music down. Only a few minutes of this activity will convince you that it will make you extremely unpopular and get you no closer to your desired objective.

You could then go to your friendly R.A.'s and discuss the problem with them. After they have finished their convulsive laughter, you will again realize that your action has made you very unpopular with your R.A. and, because your R.A. has tried to quiet people before and has gotten nowhere, you will have gotten no further toward your desired goal.

Since you have signed a contract with the university student housing office, and dorm contracts for sale in midquarter gather more dust than *Minnesota Dailys* on Ken Keller's desk, you are left with an alternative; defend yourself.

...dorm contracts... gather more dust than *Minnesota Dailys* on Ken Keller's desk...

First, invest in a good pair of earplugs, the kind that are advertised to make a George Thorogood concert sound like the public library.

Second, sign up for EE 5120, Acoustics for Architects, and learn how to rennovate your room so that if George Thorogood had a concert in the hall, it would sound like the public library in your room.

Since EE 5120 is not offered this quarter, and it's a little late to register for it any way, I have some helpful hints for abating sound that, according to research, are supposed to help absorb or interfere with acoustical noise:

1) Seal up cracks. In a dorm, this in nearly impossible, but there is one large crack that you can seal: the one between your door and the threshold. Stuff some old socks in there, or your roommates 501s, or any old heavy cloth. This will block some of the noise that is amplified and carried through hallways.

2) Install carpet if you don't have any. Carpet is a heavy resillient surface which dampens sound, especially high frequencies. If your parents don't have any, ask a carpet store for remnants or scraps. You can then piece them together to form neat collages (great for a conversation piece).

3) Hang heavy cloth tapestries on your wall. Heavy tapestries are also resillient. If you do not own any tapestries, go to a Grateful Dead concert and buy one from a deadhead vendor. If the Dead are

Dorm Noise to 22

Mark Werner is a junior in technical communication emphasizing in electronics and computer software. This is Mark's fourth year being involved with the *Technolog*. In writing this article, Mark drew on his own experiences with noisy dorm neighbors. His collection of Grateful Dead tapestries and velvet Elvis portraits is unparalleled.

IT Fraternities

Helping make the University a smaller, more friendly place to go to school.

by Sarah Hallaway

No doubt you hear the stories, the horror stories. We all hear them, and unfortunately and unnecessarily some University of Minnesota students experience them. The scenario goes something like this: Upon deciding to attend the University of Minnesota, you muddle through sarcastic comments such as: "You are going to that HUGE, IMPERSONAL college?! You do know you'll just be a number, don't you? No one cares about you there, all they want is your money!" After questioning yourself and your decision due to those inappropriate comments, you finally make it to the first day of classes, only to discover the people with "U ASK ME" stickers plastered on their chests only know how to refer you to another building, and they don't know any of the buildings on IT row. However, the challenge has not yet started. Three IT classes later, your head is spinning with thoughts of "How can I compete? Did my high school classes mean anything other than studying?" The questions are endless... and so are the answers, in a variety of forms.

One way to find answers to these intimidating problems is to check into IT fraternities and organizations. Although you may be thinking, "I barely have time to study, let alone commit time to something else," you may be surprised. IT fraternities focus on academics as well as social aspects, attempting to provide a balance between the two. These organizations want to help students by creating a more personalized college environment. All the fraternities have study groups, files of old IT exams and notes, catalogs of materials, and opportunities for leadership outside the classroom, such as positions within the fraternity and positions to chair events.

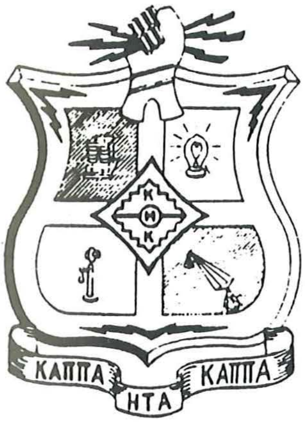
Alpha Chi Sigma

You may recognize this fraternity as the sponsor of the Forester Joke Contest during IT week. Alpha Chi Sigma is a chemical sciences professional fraternity. This fraternity is unlike most other fraternities because it is co-ed. Alpha Chi Sigma accepts both men and women into their present group of 40 members. Fourteen members live in their house located at 613 Oak Street SE. Students of chemistry, chemical engineering, materials science, biochemistry, and other chemistry related fields belong to Alpha Chi Sigma. They accept sophomores, juniors, and seniors and are comprised of mainly juniors. According to Frank Stifter, an Alpha Chi Sigma member and chemical engineering senior, Alpha Chi Sigma's main attraction is their alumni support. Presently, their alumni are employed by a broad base of companies, allowing easier access to interviews and getting a foot in the door. Intra-fraternity committees provide contacts and leadership opportunities for the students. For more information about Alpha Chi Sigma, call 378-9907 and ask for Paula Rybak.

Alpha Rho Chi

"Being in a fraternity has given me terrific exposure. It has helped me to deal with responsibilities and organization. I've had the opportunity to take trips to Dallas, Los Angeles, and Chicago for national fraternity conventions—an invaluable experience. Individually, I couldn't have done it myself," commented Chad Omon, vice-president of Alpha Rho Chi. Omon is a senior majoring in architecture. Located at 605 Ontario Street SE, Alpha Rho Chi is an architecture fraternity accepting students majoring in architecture, landscape architecture, interior design, and related fields.

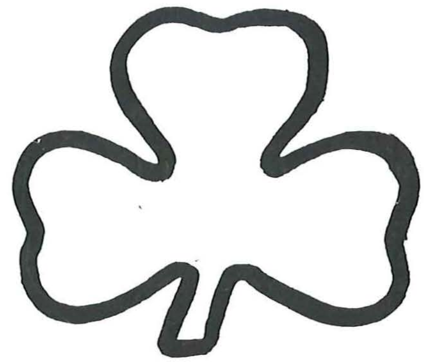
A feature that sets Alpha Rho Chi apart from many other fraternities is their acceptance of CLA students. According to Omon, most students in their twelve-member fraternity graduate from the Institute of Technology, even if they entered as a CLA student. Alpha Rho Chi is known for their informal and casual atmosphere. They are planning a tour of the downtown Northwest building for the near future. They stress touring and meeting other companies because as Chad Omon said, "It's very hard to compete in the world without having worked with people in the related fields." For further information call 331-7961.



Kappa Eta Kappa

Kappa Eta Kappa is a professional co-ed fraternity. Although this fraternity accepts all IT concentrations, it is primarily composed of electrical engineering students. Presently, Kappa Eta Kappa has ten members. Membership is down due to a large graduating class last spring. According to Kevin Lu, Kappa Eta Kappa president, and a senior in electrical engineering, the fraternity's focus is to help freshmen and sophomores with academics and adapting to the University. The fraternity has a strong alumni association, which in turn provides corporate contacts for members. The fraternity sponsors monthly guest speakers on Monday evenings. Presentations include topics regarding electrical engineering opportunities and how an electrical engineering degree can adapt to other careers. The guest speaker presentations are open to all IT students.

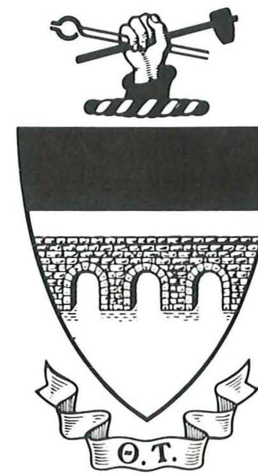
Kappa Eta Kappa also sponsors periodic plant tours. The last plant tour was to Marcom, a plant initiated by a Kappa Eta Kappa alumni. Marcom is a plant which produces CRT monitering stations for hospitals. Kappa Eta Kappa occasionally hosts happy hours on Friday afternoons, inviting professors, alumni, and all IT students. Watch *The Daily* for their next happy hour. Kappa Eta Kappa offers a $1,500 scholarship each year to a qualified member. Applications are accepted each spring. You must have completed your junior year to apply. Lu commented, "A benefit of being a member of Kappa Eta Kappa is being in an exedutive office. I'm learning a lot about responsibilities." Kappa Eta Kappa is located at 1100 4th Street SE. For further information call 331-2133.



Plumb Bob

Plumb Bob is a senior honorary leadership and service fraternity. Plumb Bob's purpose is to plan the infamous IT Week held the first week of May. Plumb Bob accepts applications from IT students. The main criteria for acceptance is leadership skills. Maintaining a 2.5 GPA is also a requirement. Plumb Bob is open to juniors and seniors and you need not be a member of a fraternity to apply. The acceptance committee goal is to seek the most qualified person while maintaining a balance of engineering/science representation.

The benefits to members of Plumb Bob are numerous. The experience offers the opportunity to meet many potential employers. IBM and UNISYS are two major sponsors of IT week. Consequently, meeting with representatives from these companies provides valuable contacts for students. Also, members meet many faculty members and the Dean. Members enjoy the luxury of using the computer in the Plumb Bob office, located at 169 Fraser Hall. Naturally, the most important benefit is the self-satisfaction of knowing you are capable to organize and be an integral part of a huge affair, IT Week. Leon Keat Cheah, known as Keat and vice-president of Plumb Bob, says a goal of Plumb Bob this year is to diversify from IT Week and concentrate more on academic areas, such as the "Career Fair." If you have any ideas concerning Plumb Bob's direction, or want more information about Plumb Bob, contact Keat at 626-1552.



Theta Tau

Theta Tau is a national professional engineering fraternity. This chapter has 36 members. Plant tours are Theta Tau's main attraction. Sponsoring two to three tours each quarter, they provide an opportunity to meet and talk with people in the industry. Mike Siegfried, Theta Tau's rush chairperson and electrical engineering junior, commented, "A plant tour is worth ten to fifteen classes at the U." Siegfried's actions prove his opinion. He and four other classmates have started their own small company, Systems Software Engineering, Inc., as a direct result of talking to people in the industry via plant tours. "I never would have even thought of starting my own company if I hadn't gone on a plant tour," he added.

Theta Tau is planning an upcoming tour to UNISYS and the U of M's new supercomputer facility. Last year a tour to the very automated company, Ford, was conducted. Guest speakers are being planned as well. The speakers include company, private, and consulting engineers. Last year one of the speakers was the man who invented "Post It" notes. Topics include engineering opportunities and leadership development. It is important to note anyone may attend Theta Tau's plant tours, guest speaker seminars, and study sessions. You need not be a member to participate. "I'm still in IT because of this fraternity. I credit my success to them and surrounding myself in IT." I know what's out there and I know what to expect," concluded Siegfried. Theta Tau is located at 515 10th Avenue SE. For further information, call 331-7931.

Triangle

Triangle is a fraternity for students in engineering, architecture, and science. Support for underclassmen is stressed in Triangle. With an abundance of juniors and seniors, assistance is always ready. A computer center in their attic is tied in with the University system and can be used for programming and word processing. A Little Sisters program is a component of triangle. Little Sisters need not be in IT. Triangle accepts CLA students as well.

One of Triangle's main attractions is their advisor, Ben Sharpe. Sharpe, who frequents Trangle's location at 521 12th Avenue SE, is the Director of IT Admissions. He is available to help plan curriculums and talk with students. Other benefits include off-street parking and participation in intramural sports. They will enter the broomball season as defending champs. Triangle has 55 members and is a member of the Inter-Fraternity Council. Jon Linser, an electrical engineering Triangle senior, said, "I've made tons of friends who will be people I will know the rest of my life. Academically, it has been helpful. I've benefited a lot by helping underclassmen." Dave Rys, Triangle president and senior majoring in chemistry and chemical engineering, adds, "Triangle has provided me with a good study and social environment. I'm more involved in the U system because of it."

Overall, 28 IT student organizations exist on campus. The important factor, stressed by many fraternity representatives, is that you check out a variety of organizations and select the one best-suited for your needs. The other IT organizations can be found listed in the *IT Student Guide*. Many opportunities are waiting for you to explore. ▲

Sarah Hallaway is a junior in journalism and is looking to go into public relations and advertising as her emphasis. She has quickly learned about IT and technology in general through writing Log Ledger in Fall I, working as a technician for UNITE, and learning about IT fraternities. Sarah's interpretation of technical information has given *Technolog* editors a chuckle or two at times. Oh, how we wish we still had her point of view.

Technotrivia

by Kirk Nelson

Questions:

1) This physician thought he cured ailments by rubbing the afflicted person with magnets. He actually was one of the first doctors to "mesmerize" his patients using hypnosis. Who was he?

2) Hyman L. Lipman patented this useful writing device in 1858. He later sold the patent for 100,000 dollars. What did he invent?

3) In 1781 William Hershel discovered this planet that was first named the Georgian, after King George III, until renamed in 1856. What planet did he discover?

4) Fibrous serpentine is better known as?

5) In 1882, this Englishman designed the Valveless Water Waste Preventer (a predecessor of modern toilet design) and was knighted for it. Who was he?

6) If you belong to the Catapillar Club in aviation, what do you have in common with the other members?

7) James A. McConnel conducted experiments on planarian flatworms to test learned responses and inherited memory. He publishes a journal which is a parody of other scientific journals. What is the name of this journal?

8) Who awards the Nobel Prize for physics and chemistry?

9) Cheops pyramid in Egypt is built of blocks whose average weight is 2.5 tons. How many blocks are in the pyramid (approximately)?

10) Peter Goldman invented this analog recording format in 1948. What is this format called?

Scoring

0-1 Remind me to have you in my next class that is graded on a curve.
2-3 Burn any good books lately?
4-7 You have nothing on Cliffy the postman.
8-9 You must be one hell of a conversationalist.
10 Honesty is a virtue you do not possess.

Answers:

1) Franz A Mesmer (1734-1815). His cure worked so well he was elected to the Bavarian Academy of Sciences. He also introduced the term "animal magnetism" to the world.

2) Pencil with Eraser, not Chapstick.

3) Uranus. To save embarrassment, remember that the accepted pronunciation has changed from yoo-ra-nes to yoo're-nes.

4) Asbestos. Now you won't be fooled by cheap imitations.

5) Sir Thomas Crapper. His name has been immortalized in American toilet slang.

6) Your life has been saved by a parachute.

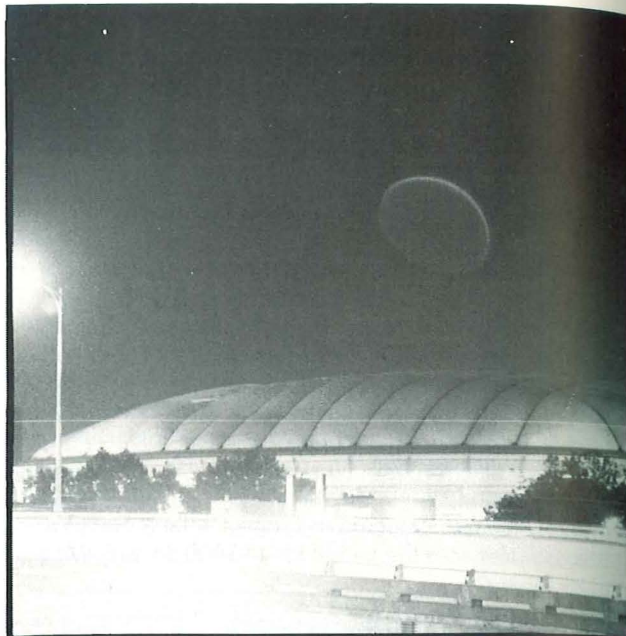
7) The *Worm Runners Digest*. The title is a parody of expriments with rats in mazes.

8) The Swedish Academy of Science. Don't worry if you got this one wrong. I doubt you will ever win this award.

9) 2,300,000. If your close, give yourself the credit You didn't have to build it.

10) LP record. He recieved no royalties but did get a copy of all the LP's Columbia produced.

Could This Be A Pop Fly Off Kirby's Bat... Or Just Another Spaceship From Planet X?



Don't tell us. We don't even want to know the real story. But we do want your photos.

Got a couple of supernatural, unexplainable, possibly doctored, or just plain wierd snapshots? Then submit them to *Minnesota Technolog's* first annual science fiction photo contest.

For details, check the Winter I issue of *Technolog*. And stay tuned to this space.

Dorm Noise from 17

not coming to a stadium near you soon, buy a tapestry from the deadhead vendor by Jones Hall. If he is gone for the winter, run to a starving artist sale and buy old velvet Elvis portraits.

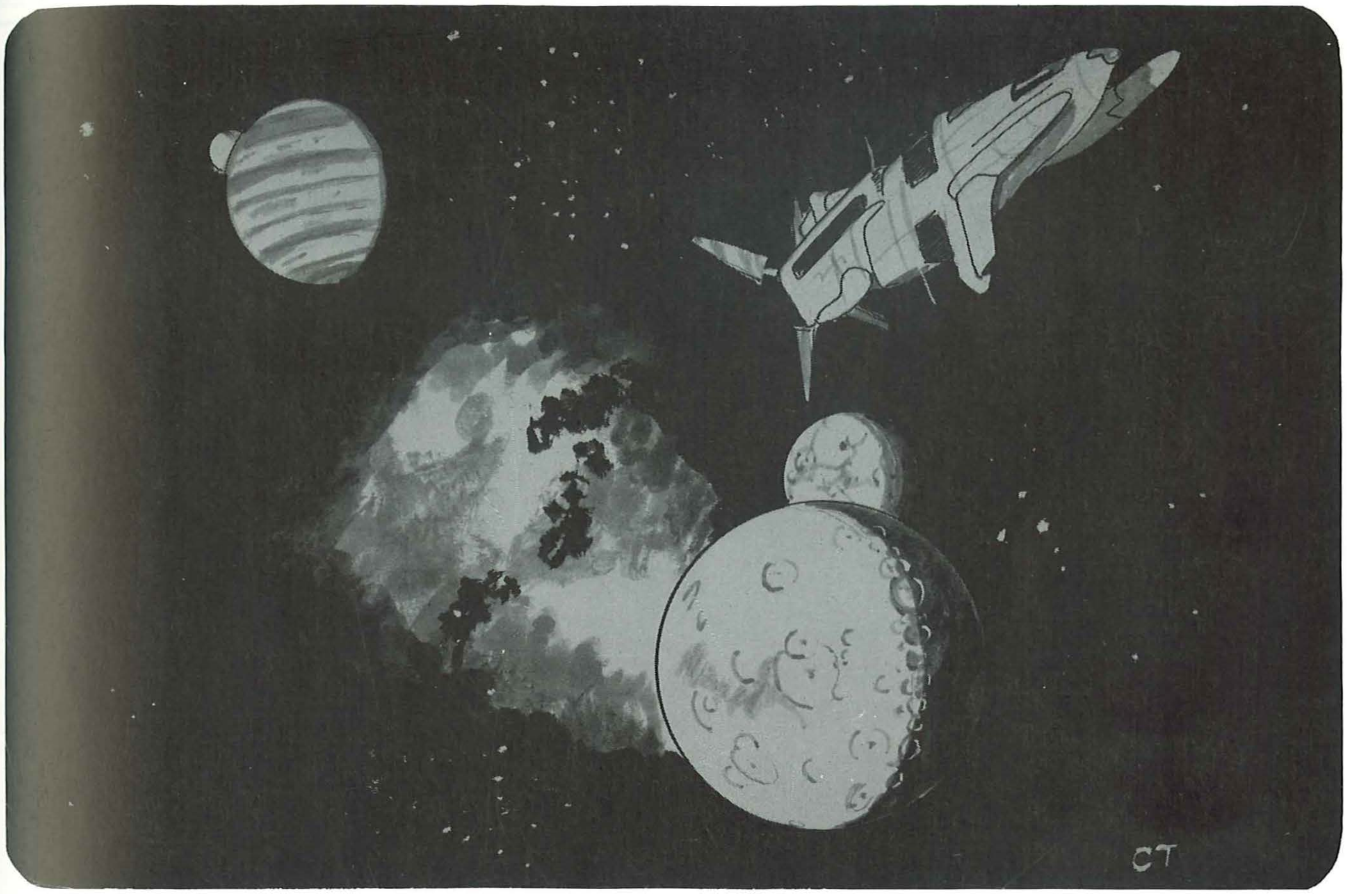
While the last steps I mentioned might not entirely stop the decibels from penetrating your abode, they will help reduce the noise. The earplugs, though, should do as good of a job as anything.

Dampening and amplifying sound in structures have been attempted for centuries, but from reading reports of research it seems that Charles Garnier, architect of the Paris Opera House, best described the existing knowledge about acoustical architecture when he said, "I must explain that I have adopted no principle, that my plan has been based on no theory, and that I leave success or failure to chance alone."

Maybe you should just study in the library. ▲

Source:
***Sound control and Thermal Insulation of Buildings*, Close, Reinhold Publishing Corp., 1966, p.36.**

It's Stranger Than Fiction. It's Wierder Than Science. It's *Minnesota Technolog*'s Annual Science Fiction Contest.



Rules: The rules are simple. This contest, open to registered U of M students, is for you, the budding, unpublished author. *Technolog* staff and IT Board of Publication members past or present are not eligible. Type and double-space your entry with a one-inch margin on 8½ x 11 inch paper. Keep your entry to 3500 words maximum. Make three copies with an attached cover page stating your name, address, and phone number (please don't put your name anywhere else on the manuscript). *Minnesota Technolog* retains the first publication rights to your winning manuscript. Deadline is February 12, 1988. Questions? Call 624-9816. Oh, and there are prizes:

1st Prize: $75.00
2nd Prize: $50.00
3rd Prize: $25.00

So fictionalize your science. Or be scientific about your fiction. But don't space out on this opportunity.

A Thousand Words

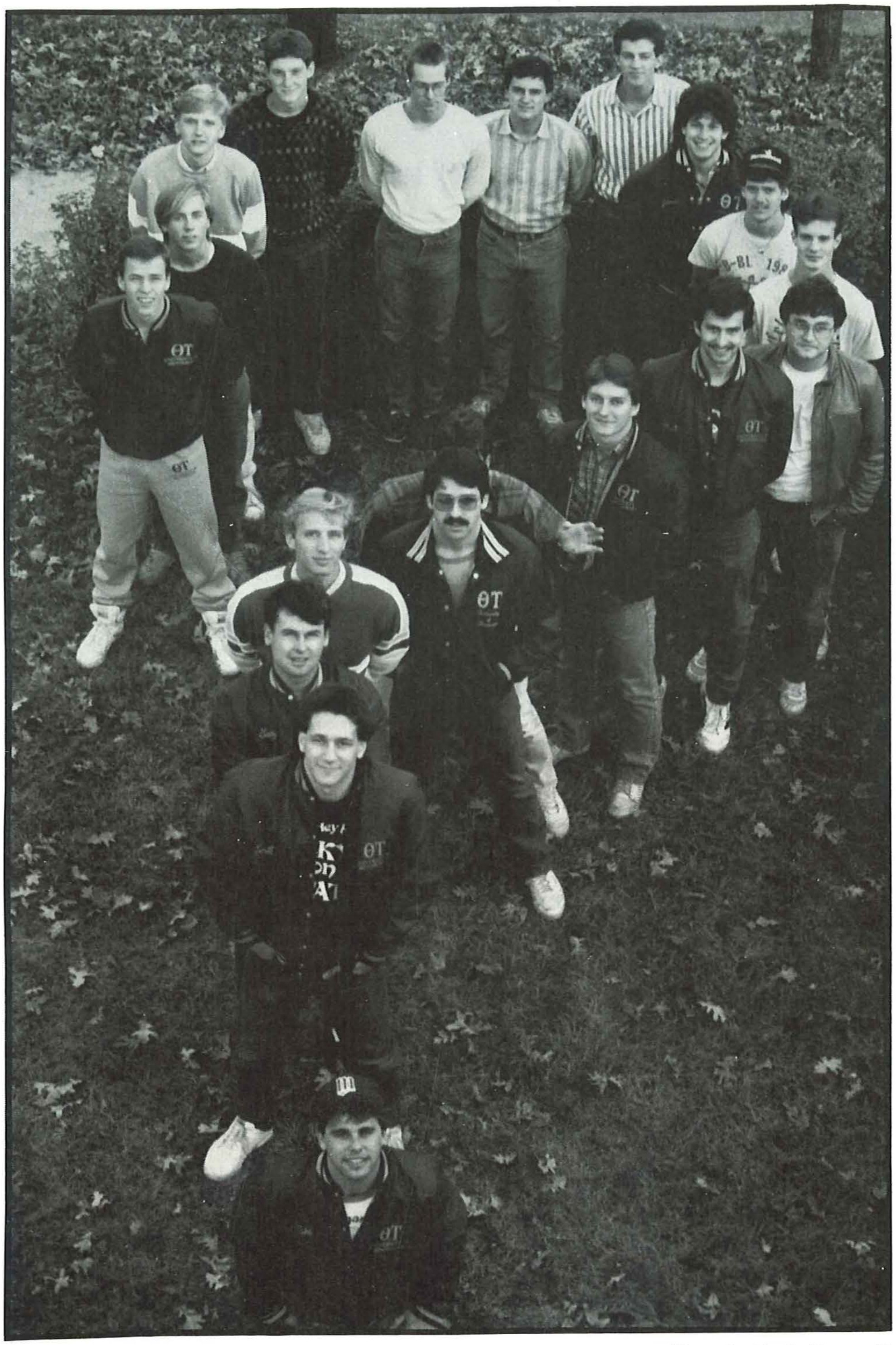
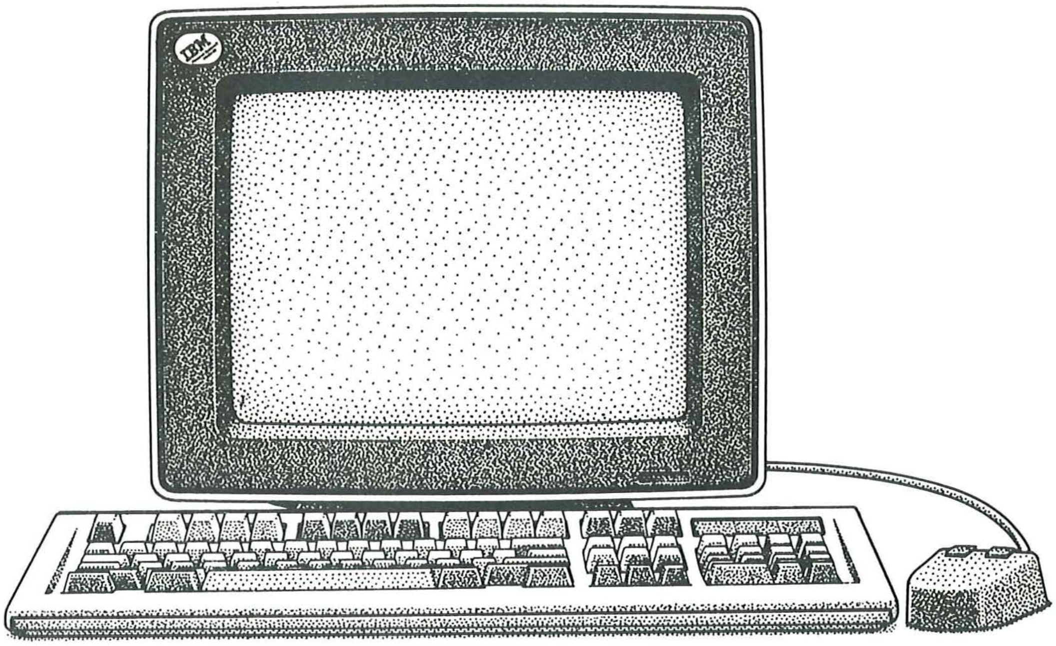
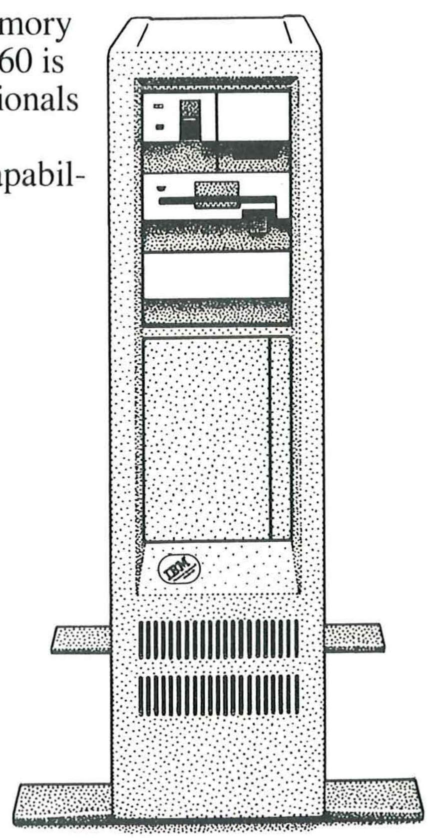


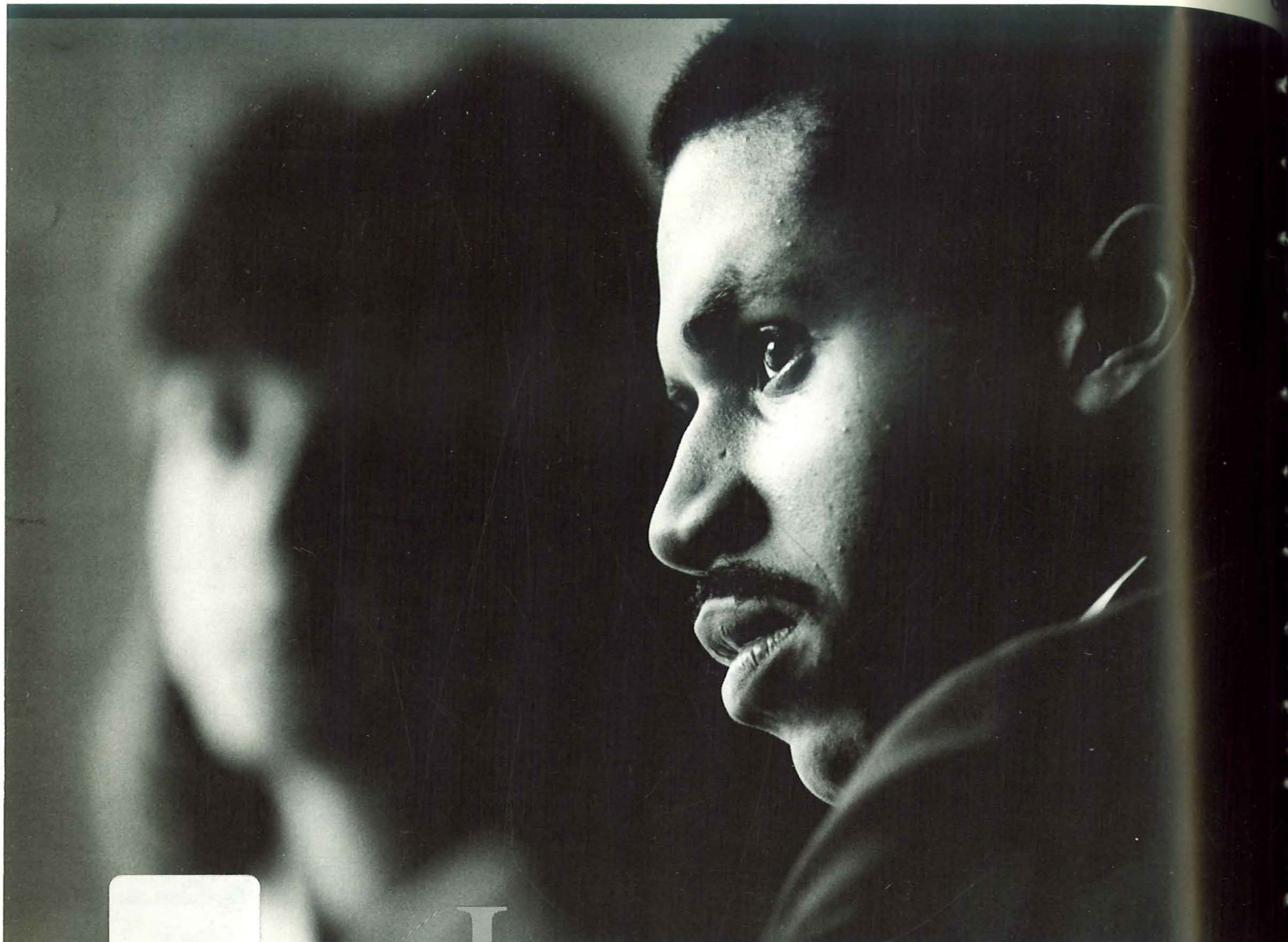
Photo by Paula Zoromski

Questioning Theta Tau

Thanks for the memory.







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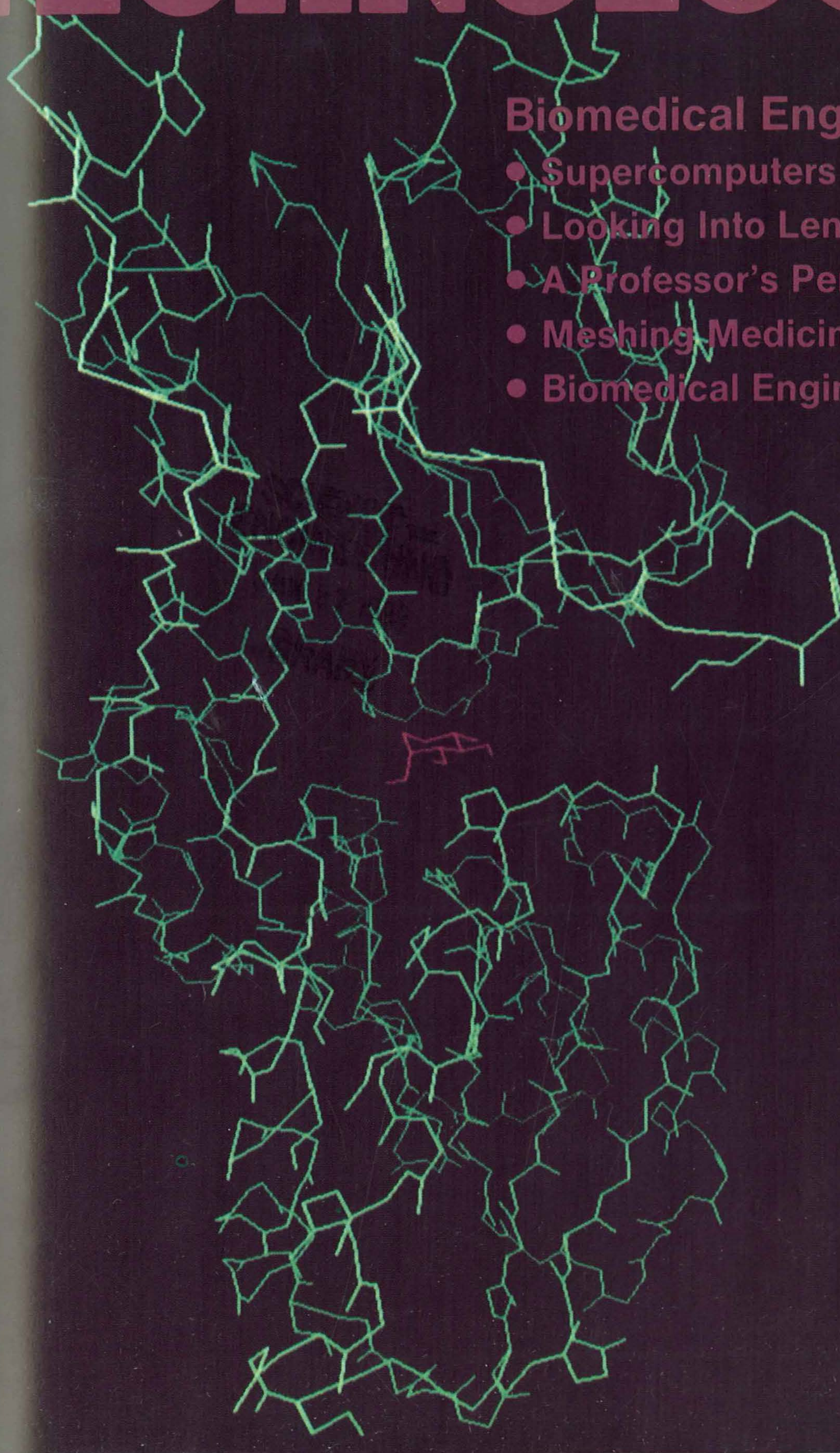

Biomedical Engineering

- Supercomputers and Medicine
- Looking Into Lenses
- A Professor's Perspective
- Meshing Medicine & Mechanics
- Biomedical Engineering Programs

Cover photo by Paula Zoromski

About the cover:
The photo is a single frame from a dynamic simulation of an arabinose binding protein. The red in the center is arabinose, with the rest of the picture showing its position in the protein structure. The simulation was run from the Supercomputer Center's Cray-2 and was displayed on a Silicon Graphics Iris workstation. Special thanks to Professor Florante Quiocho of the Baylor College of Medicine/Howard Hughes Research Institute for performing the simulation.

minnesota TECHNOLOG

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Biomedical Engineering

Features

Departments

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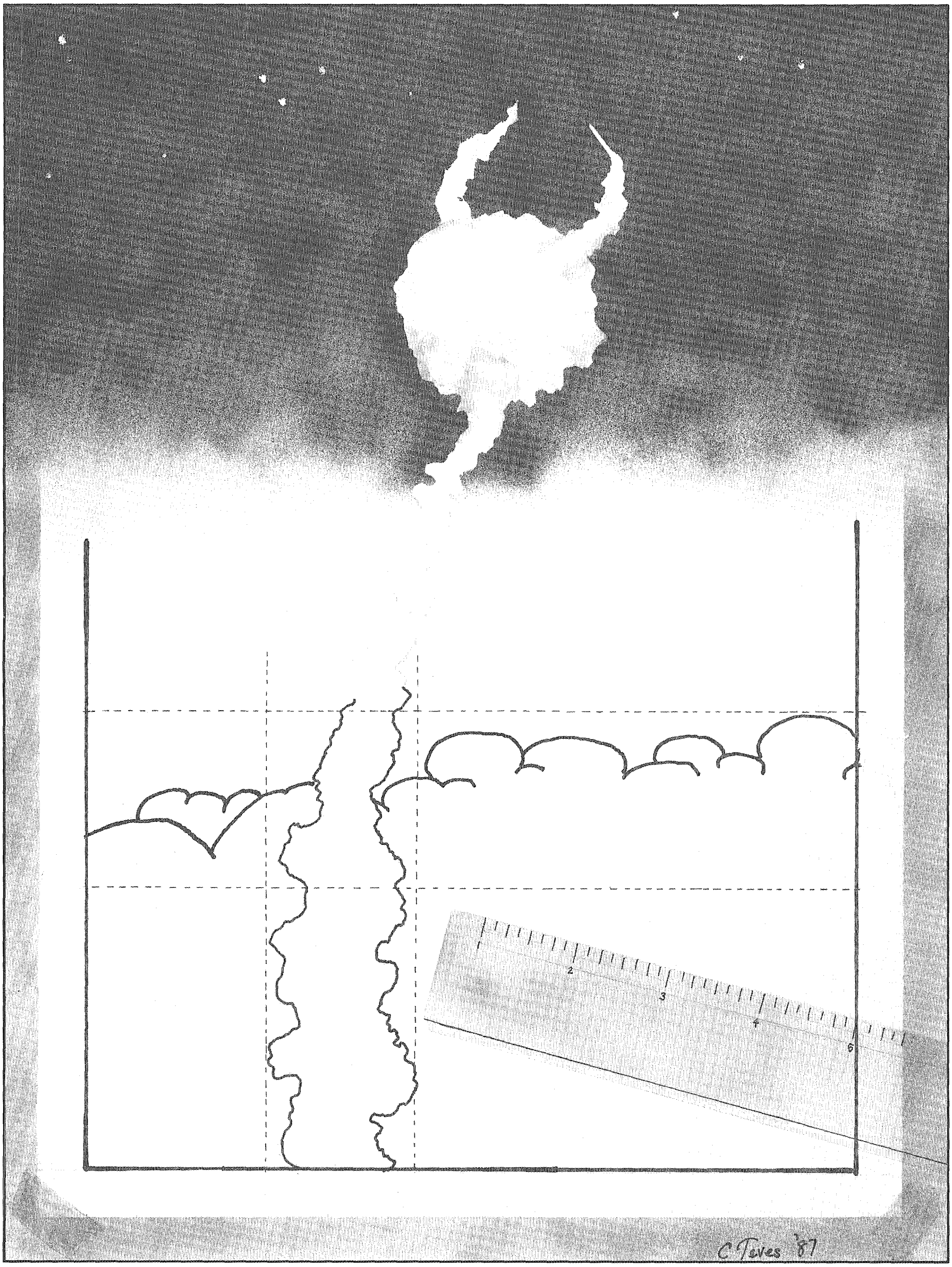


Illustration by Conrad Teves

Editor's Log

Protection of Public Safety

Engineering and ethics. In our world of tiny microchips, streamlined manufacturing, and plans for an orbiting space station, the relationship between these two words seems non-existent. However, rapid technological advances in our society are making grey areas out of areas that have been traditionally black and white. To many engineering students, the word "ethics" implies lofty ideals. In reality, these ideals appear in everyday situations. Engineers will have to apply personal and professional ethics to crucial situations in society during their first years out of college.

Ethics are important in any profession, but they take on a special importance in engineering since many decisions affect the lives and safety of others. The introduction to the National Society of Professional Engineers (NSPE) Code of Ethics says, "...the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of public health, safety, and welfare." This overriding concern for public safety is best illustrated by a recent example.

On January 28, 1986, the space shuttle Challenger was destroyed and its seven crew members killed in an explosion 73 seconds after liftoff. The cause of the explosion, failure of the rocket booster 0-ring seals due to cold weather, was determined after an exhaustive investigation by a presidential commission.

The tragic part revealed by the investigation was that Allen McDonald and Roger Boisjoly, two engineers at the company that made the rocket boosters, recommended the day *before* the launch that the take-off be postponed because of the cold weather. They felt they could not guarantee proper function of the 0-ring seals since the launch was taking place in weather outside of the standard operating temperature range. The engineers' objections were overruled by a company management team, one of whom told the representing engineer to take off his engineering hat and put on his management hat.

> **...engineers...must be dedicated to the protection of public welfare.**

These facts became public when McDonald and Boisjoly testified at the commission hearings. As a result of their testimony, Morton Thiokol demoted both engineers. McDonald was later reinstated because of pressure by the presidential commission. He was actually promoted to be in charge of design modifications and the company's press representation. Boisjoly's position has not been as favorably resolved.

McDonald and Boisjoly saw the problem with the operating temperature and objected to the launch, showing their concern for the safety and welfare of the shuttle crew members and for the shuttle program as a whole. Tragically, their recommendations were overruled, and the news of the Challenger explosion stunned the United States and the rest of the world. The disaster set back our country's shuttle program at least two and a half years, since it will be mid-1988 before another shuttle mission is scheduled. The confidence and image of NASA were struck a blow and are only now starting to recover.

As this example illustrates, ethics play a very important role in engineers' decision-making. In some cases, the engineers have had to place their job or reputation in jeopardy in order to protect the public health, safety, and welfare. It may seem to be an abstract concept, but public welfare must be an ever-present thought on engineers' minds.

It is very difficult to think of ethical choices when working out problems in circuit design, fluid flow, or polymer structure. Students should take time to examine areas in their field where ethical problems might exist. The Institute of Technology recommends additional courses be taken that examine the effect of technology on society, since it is the engineers and scientists that will discover and introduce new and existing technologies.

These additional courses would provide a good basis on which students could base ethical decisions that they will face in the future. Loyalty to companies is a very worthwhile attribute, but it should not obscure an engineer's overall view of practicing engineering for the public good. Everyone must remember that an engineer's hat should stay on. It can be added to, but should never be set aside. ▲

Jim Willenbring
Editor

Supercomputers and Medicine

The use of supercomputers is not staying in traditional high-tech areas. Medical research is now taking advantage of its many benefits.

by David Kortenkamp

Physical scientists regularly use computer simulations as research tools. Aerospace engineers fly mathematical planes through mathematical air. Physicists bounce mathematical particles off each other. Astronomers blow up mathematical stars. It's only recently though, that biologists have begun to use computer simulations in their research.

A growing number of University scientists now take advantage of the Supercomputer Center's Cray-2 to conduct research in biology. One of them is Assistant Professor Terry Lybrand of the medicinal chemistry department. Lybrand uses the Cray-2 to do molecular simulations of drug molecules binding to protein DNA molecules.

Lybrand begins by entering into the computer initial relationships between atoms in the drug and protein molecules. The initial atomic relationships, usually involving some 15,000 to 20,000 atoms, are determined experimentally using a process called X-ray crystallography. He then enters mathematical equations that determine the interaction between these atoms. For example, bonds between atoms act something like springs and can be represented as harmonic spring functions. There are also electrostatic interactions between atoms as well as many other forces. Although many of the forces in atomic interactions are inherently quantum mechanical, in general they can be adequately modeled using classical Newtonian mechanics.

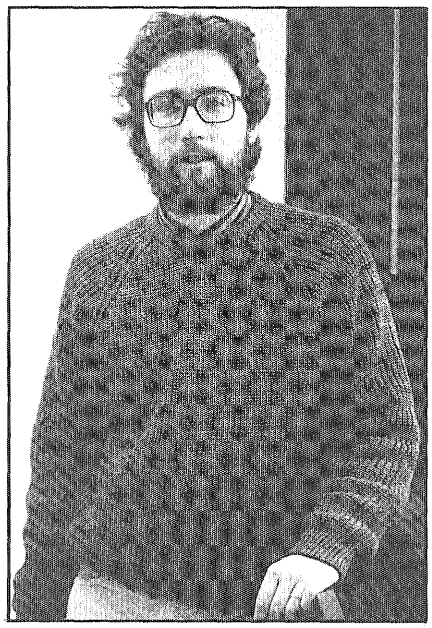


Photo by Paula Zoromski

Professor Terry Lybrand uses a supercomputer to simulate drug/protein molecule relationships.

After the initial conditions have been set up, Lybrand can sit back and let the Cray go to work. The computer simulates the actions of the atoms over a period of a few hundred picoseconds by solving Newton's equations of motion for all the atoms. This requires several hundred thousand to several million iterations on the computer. Then using a graphics display, Lybrand can analyze the results and formulate ideas to explain what's happening. Experiments are then carried out to evaluate how well the computer model works. Lybrand calls computer simulations the "ultimate microscope offering perfect atomic resolution."

Lybrand also uses supercomputers to perform free-energy calculations. The free energy of a molecule is a function of the bonds between its atoms. While free energy itself cannot be measured, changes in free energy can be. When a molecule (a drug for example) binds to another molecule (like a protein) there is a change in free energy. Binding different drugs to the same protein will cause different free-energy changes. By examining changes in free energy, researchers can tell how tightly different drugs will bind to a protein.

...requires several hundred thousand to several million iterations on the computer.

Laboratory methods to determine changes in free energy are very time consuming and sometimes impossible, which is why Lybrand has begun to look at ways of determining free-energy changes on a supercomputer. As before, Lybrand will begin by entering the atomic structure of the drug and protein along with the free-energy equations. He will then gradually change the original drug molecule into a different one and look at how the free energy changes. From this data he tries to understand how and why some drugs bind more

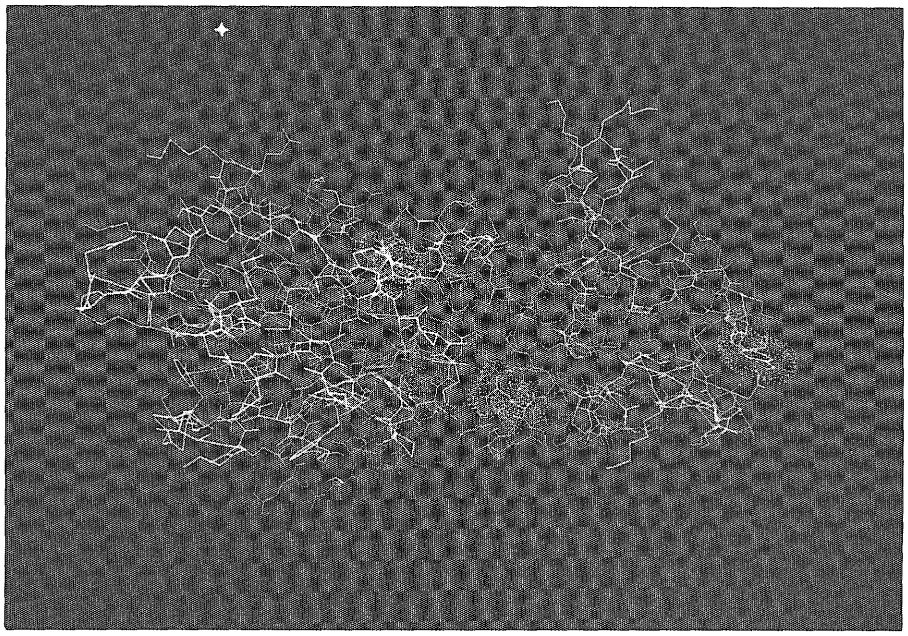


Photo by Paula Zoromski

A different view (from the cover) of an arabinose binding protein.

Neural Networks

An artificial neural network is a computer's attempt to mimic the physical structure of the human brain. Our brain contains approximately 10^{10} neurons; each of these neurons may be connected with thousands of other neurons. The connections carry chemical and electrical signals which activate the neurons along their path. In an artificial neural network, small microprocessors take the place of a neuron and the connections are the data paths between processors. Compare this structure to that of a traditional computer (often called a Von Neumann computer after the Hungarian mathematician who originated the idea) that has a single processor that performs all of the calculations.

The idea of artificial neural networks has been around as long as the computer. However, only recently have advances in microprocessor technology made the actual construction of artificial neural networks possible. One of the most ambitious projects is The Connection Machine designed by Dennis Hillis that has 64,000 interconnected processors. Many researchers believe that artificial neural network computers may be able to perform tasks such as pattern recognition, which humans do with ease, but traditional computers find very difficult.

tightly than others. This work has a great deal of practical significance in drug design —simulation results can often guide researchers toward the most promising drugs.

Simulations of the type Lybrand does aren't the only applications of supercomputers to biology. According to Associate Professor George Wilcox of the pharmacology department, University researchers are also using the incredible power of the Cray-2 to solve problems involving many diverse areas of biology.

...researchers try to discover how a disease (such as AIDS) spreads...

For example, Wilcox uses some of his Cray-2 time to simulate neural networks (see corresponding box). He hopes to teach the simulated network such things as object recognition, speech, and language understanding. This work might shed some light on how biological networks, like our brain, function. Since a typical network may have almost 200 million connections, a supercomputer is the only practical way of simulating them.

...a typical network may have almost 200 million connections...

A related area, at least conceptually, is the simulation of population dynamics. Using a supercomputer, researchers try to discover how a disease (such as AIDS) spreads through the population. They simulate contact between different parts of the population and then look at how the disease varies according to changes in the behavior of the population.

Another group using the Cray-2 is the University's Biomedical Image Processing Lab. They use it to construct three-dimensional representations from two-dimensional X-rays produced by a CAT scan. A CAT scan will take hundreds of two-dimensional pictures, each representing a slice of the entire object. The slices must be put together to make a three-dimensional representation that can be displayed and manipulated by the computer. Only a supercomputer has the power and memory to easily deal with constructions of this type.

Wilcox sees yet another area of biology where supercomputers will definitely be needed — cataloging the human genome. The genome is made up of an "alphabet" of four chemicals; about 3 billion of these "letters" make up about 10,000 to 100,000 individual genes. Each gene is then responsible for a different function in the human body.

Researchers have already cataloged (or sequenced) about 12 million of the

3 billion chemical bases. As they discover new chemical bases, they will need to compare them with those already found, a job only a supercomputer with its enormous memory and speed can perform adequately. If researchers ever do sequence the entire genome, it may help them discover the causes of genetically produced diseases.

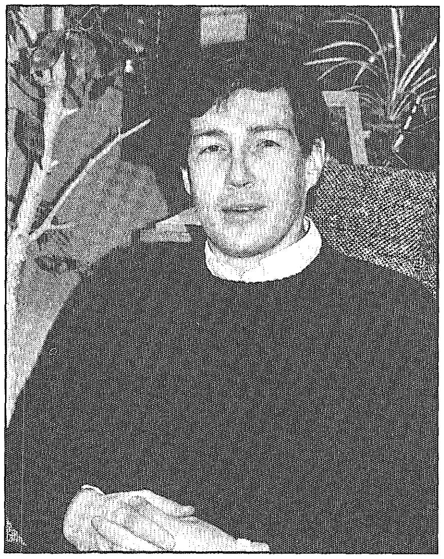


Photo by Paula Zoromski

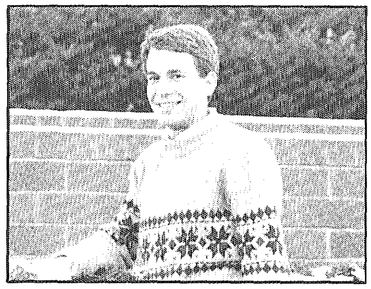
Professor George Wilcox researches neural networks with the help of supercomputer simulations.

Whether it be sequencing the human genome or simulating the spread of AIDS through the population — supercomputers have become an indispensable research tool for biologists in the last ten years. Scientists are only now beginning to develop and refine the computational methods needed to apply the power of supercomputers like the University's Cray-2 to the many unanswered questions in biology. ▲

Sources:

Karplus, Martin and McCammon, J. Andrew, "The dynamics of Proteins," *Scientific American,* April, 1986, pp. 42-51.

"The Genome Initiative," *Newsweek,* August 31, 1987, pp. 58-60.



David Kortenkamp is planning on attending graduate school after receiving a degree in computer science this spring. Long-distance running is something David excels at. He can now add completing the Twin Cities Marathon as one of his accomplishments. David helps out in production and layout for the *Technolog* also.

Log Ledger

Letter to the Editor

Dear Sirs:

The interesting article on microelectronics history in your Fall I issue was a good summary of a complex history and technology. Unfortunately, it contained a factual error regarding the history of the MEIS Center. The article states that the MEIS Center was established in 1982. In fact, the impetus for the center was provided by William Norris of Control Data, who persuaded Control Data Corporation to contribute $2,000,000 to the University to start a new University center, as yet unnamed.

The gift was presented during a meeting on December 14, 1979. The meeting at Control Data included the following people: C. Peter Magrath, then President of the University, Roger Staehle, then Dean of IT, J. Ben Rosen, then head of the Computer Science Department, William R. Franta, then professor in Computer Science, Robert Hexter, a Chemistry professor, Richard Meyer, then with the University Foundation, and myself, a professor of Electrical Engineering. The condition on the gift stated that it could be used to fund a center, provided that the University raise an additional $3,000,000 for the center within twelve months. This challenge was met through fundraising efforts by a team consisting of Walter Bruning, a Vice President of Control Data, Prof. Franta, Prof. Kain, and Dean Staehle. Major contributions to the center were made by Honeywell, 3M, and Sperry, in addition to the original Control Data gift. The base funding in excess of $5,500,000 provided support for the four large projects mentioned in the article and many smaller projects. Professor Franta and I served as the Acting Co-Directors of the Center during its first phase.

I appreciate this chance to set the record straight and publicly acknowledge the enormous impetus provided by Mr. Norris.

Sincerely,
Richard Y. Kain, Professor

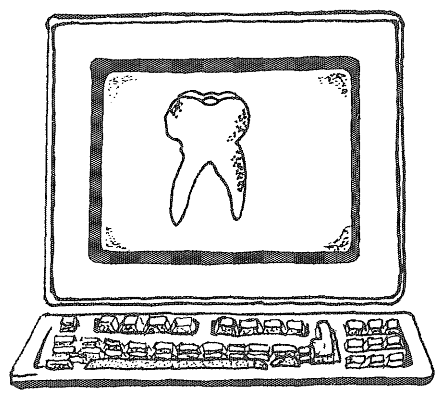


Illustration by Thomas J. Rucci

CAD/CAM Dentistry

by Kevin Cummings

A University of Minnesota researcher has developed a system to make inexpensive dental crowns using computer aided design and manufacturing (CAD/CAM) systems that have previously found applications in the business sector.

Dr. Diane Rekow, who has degrees in mechanical engineering and dentistry, uses image-processing software to digitize the image of a tooth and then instruct another machine to cut the crown out of metal or ceramic. The restoration has an accuracy of 20 microns (0.02 millimeters), which is the requirement of the Minnesota State Dental Board. With 6,000 data points in a three-dimensional image, the system can also take into acçount jaw motion and the position of nearby teeth.

Rekow expects that a dentist could have the image collecting system (about $5,000) in their office and have the manufacturing system (valued at $150,000 to $200,000) owned by a laboratory.

Although the start-up costs are high, Rekow notes that savings would come from the use of cheaper materials for the crowns instead of the gold or precast stainless steel and ceramic that is now used. Also, the new crown would be better suited to the patient and would eliminate the need for temporary crowns.

Source: ASME News Release

Brain Scanning With Light

by Kevin Cummings

Scientists in England have discovered a non-intrusive method for examining the brains of premature babies. Using a scanning device and an infrared light source, doctors can make sure that the baby's brain is receiving enough oxygen. Premature infants are especially susceptible to low brain-oxygen levels, and this method can determine if surgery is necessary instead of waiting until other symptoms appear.

Log Ledger to 21

Looking Into Lenses

The current popularity of contact lenses has led to greater research efforts in that area. 3M Company has two fascinating projects that promise many advantages over current lenses.

by Chadburn A. Blomquist

Eyeglasses possibly date back as far as the 10th century. However, the Chinese used magnifying glasses placed in wooden frames even earlier than this. According to historians, portraits from the Middle Ages depict eyeglasses being used in Italy and in other countries throughout Europe. But because the great majority of people were illiterate before the invention of the printing press in the 15th century, eyeglasses were not in high demand. With the circulation of the printed word, the demand increased, and by 1629 the guild of spectacle makers in England had been granted a charter to produce eyeglasses.

The scientific world has been interested in eyeglasses and optical correction since English philosopher Roger Bacon (1214?-1294) scientifically recorded the earliest statements about the use of lenses in 1268. Since then many great men of science have devoted years of study to optical properties and laws. Sir Isaac Newton (1643-1727), for example, published a work entitled *Optics* in 1704 in which he discussed the heterogeneity of light and the optical properties of lenses. Even Benjamin Franklin made a contribution by designing the first pair of bifocal eyeglasses in 1760.

Since wearing optical correction devices is common today, engineers and scientists are developing new techniques to help ease the use of these products and reduce the risks involved.

At 3M Company, two such projects have been underway. Mr. David H. Schlagel, Certified Manufacturing Engineer, and Mr. Paul T. Ihn, Biomedical Engineer, of 3M's Vision Care Division in St. Paul, are currently developing two different types of lenses for optical correction. The first project, under the direction of Ihn, is a contact lens made of flourocarbon (organic compounds with all hydrogen atoms replaced by fluorine atoms). The second project, under the direction of Schlagel, is a lens implant developed to actually replace a damaged or diseased human lens.

...present soft-contact lenses and extended-wear contacts can be damaging...

Ihn's contact lens was developed because present soft-contact lenses and extended-wear contacts can be damaging to the human eye by not letting oxygen get to the cornea. Deterioration of the outer-eye cell layer as well as corneal ulcers can be the result of poor oxygen flow. Even some of the best extended-wear contacts can only be safely worn up to two weeks without removal.

One of the main concerns with the lenses on the market is corneal swelling. Swelling of the cornea prevents the contact lens from moving around on the eye. This increases the possibility of getting foreign particles under the lens thereby damaging the cornea itself. Swell studies on patients wearing different types of lenses have been conducted to determine what types of materials best suit contact lenses for oxygen transfer to the eye. The tests have shown that with no lens at all, the human eye's cornea swells about four percent during an average eight-hour sleep period. Most of the lenses on the market today can make the cornea swell as much as twenty percent in one night's sleep. Some lenses can actually make the cornea swell so much that they become stuck to it.

The 3M fluorocarbon lens allows oxygen to flow through it so well that laboratory mice can live in an aquarium full of fluorocarbon, swimming around like fish. This lens provides much better corneal health. The average swelling in an overnight period for the fluorocarbon lens is around six percent. Amazingly enough, a silicone contact lens can prevent corneal swelling enough so that only three-percent swelling

...laboratory mice can live in an aquarium full of fluorocarbon, swimming around like fish.

occurs, which is better than no lens at all. However, silicone lenses are difficult to work with because they cloud up and inhibit vision.

There is still a large percentage of people who need visual correction that will not wear contact lenses. But according to Ihn, more people will start to wear them when the lenses are easier to use, safer, and above all, more comfortable. This fluorocarbon lens is a step in that direction. Market research has estimated that 50 percent of all contact wearers in the United States today would switch from their soft contacts if there was something available that provided safe extended-wear functionality. The 3M lens, since it is made of nearly 80-percent fluorocarbon, can be worn comfortably but, more importantly, safely for about fourteen days without removal.

Contact lenses are made in three ways. One process is to lathe-cut it. This process requires taking a button of the material to be used, putting it on a lathe, and "swinging" different surfaces on the lens. The different surfaces are required since a contact lens is made up of different radii. This change in curvature fits the lens to the cornea and reconstructs the eye's shape to improve its optical ability. The second way is called spin casting. A liquid material is put in a plastic mold of the lens to be made. The mold is spun until a surface forms. The material then solidifies and becomes a pliable, soft, but adequately durable contact lens. Cast molding, the third option, places two plastic casts together and a liquid material is compressed between them. The cast is removed and the lens is complete. The 3M fluorocarbon lens is manufactured in this fashion.

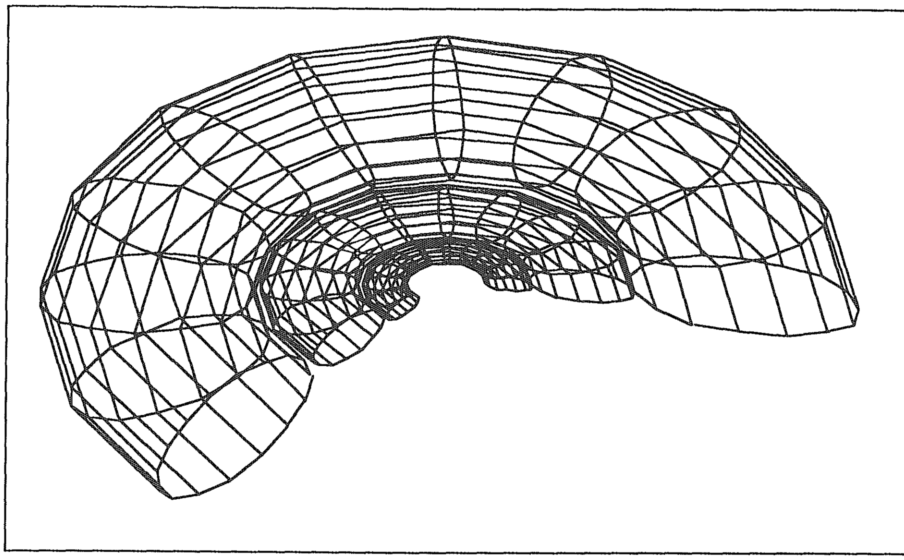


Illustration by Jerry Fiala

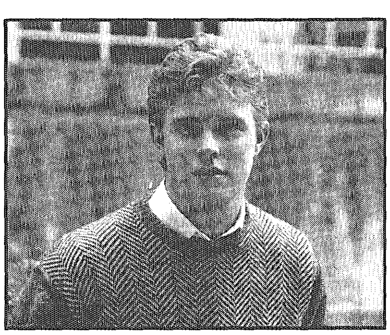
A wire-frame model of the human eye.

In addition to all three manufacturing processes, the 3M lens can be tinted to highlight the natural color of the wearer's eyes.

...people in the future may be able to see perfectly throughout their lives.

But a person's optical correction sometimes goes beyond the need for glasses or contact lenses. If the lens in the eye is damaged or becomes defective, contacts may no longer provide the proper type of treatment. Since about 1978 3M has developed about sixteen different lenses for replacement of human lenses. They are called intraocular lenses and are made to actually fit inside the eye. Under the direction of Schlagel, about twelve of these have been developed and produced within the past few years. But the history of the intraocular lens goes back much farther than one would first suspect. In the 1950's the first intraocular lenses were implanted and tested for reliability. Since that time, materials have improved, surgery has become much less complicated, and overall performance of the lens has increased dramatically.

This lens is implanted in place of the human lens that has either been damaged or has been exposed to some disease. It can be placed in three locations within the eye: the anterior chamber (forward of the iris), the posterior chamber (between the iris and the lens chamber), or in the lens chamber itself. Since the human eye focuses by contracting muscles within the eye that actually change the shape of the lens, focusing may present a problem with the solid, implanted lens. According to Schlagel, 90-percent of the patients who receive this fifteen-minute surgery will regain 20/40 vision or better, with slight focus ability. The new lens attaches itself to the eye with long, curved wire-like structures (see figure 1) that act as "shock absorbers" against sudden movements or disruptions.



Chadburn Blomquist is a junior in mechanical engineering who plans to attend graduate school, possibly in management. Chad enjoys his job as systems programmer for MinCAD Systems. This is his first article for the *Technolog*. He likes writing, programming, and is involved in Toastmasters.

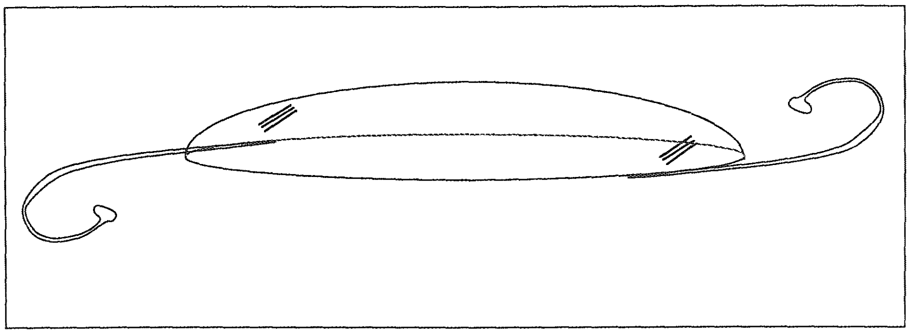


Illustration by Jerry Fiala

Figure 1: The intraocular lens is attached to the eye with long, curved wire-like structures.

The intraocular lens is manufactured by the injection-molding process, and the lathe-cut process, both described earlier. One major difference between the intraocular lens construction and the contact lens is that the intraocular lens is a double-convex lens while the contact lens is more of a convex-meniscus design.

Although the intraocluar lens is considered as a "permanent" lens, it is not totally permanent. According to Schagel, this lens is "semi-permanent in the sense that it could be removed and replaced if a problem occurred, but is permanent as far as everyday use is concerned." From the patient's standpoint, this is one more positive reason to consider lens replacement surgery.

Sometimes, after a patient has had the implant, the bag behind the iris within the eye will become fogged and the patient's vision will be hindered. The surgeon will then have to carefully "pop" the bag like a balloon with a laser, allowing the patient to see clearly again. No matter how safe these lens implants are to wear, some risk will always be involved with surgery on the human eye. However, future products and new technologies are making eye surgery and lens implants safer and more commonplace everyday.

Through contact lenses and lens implants, biomedical engineering is helping to improve the quality of our lives. By making strides toward better optical correction, people in the future may be able to see perfectly throughout their lives. With the technology being developed at 3M and other medical-research facilities, eye disorders and eye diseases are becoming less of a threat to everyone. ▲

Sources:

"Eyeglasses," ***Funk & Wagnalls New Encyclopedia*****. Vol. 10 (1986), pp. 64-65**

Interview of Mr. David H. Schlagel, Cmfg.E., and Mr. Paul T. Ihn, Biom.E., Nov. 3, 1987

Wanted:

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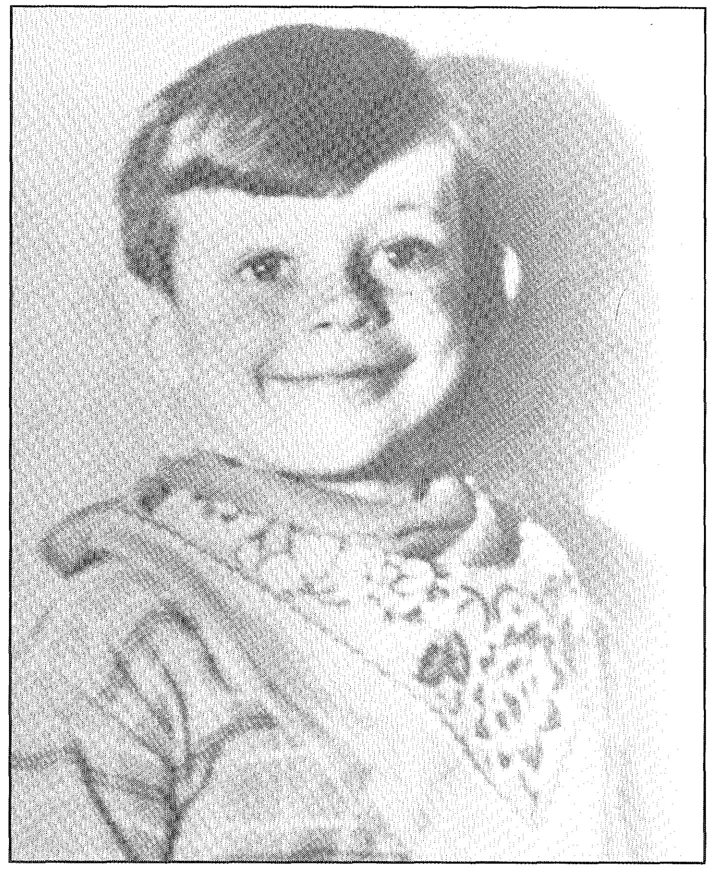

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DEADLINE: FEBRUARY 24, 1988

Applying Research to People

A biomedical engineering professor tells of his many research interests and how they can improve everyday life.

by Susan Curran

Associate Professor James Holte is a name dropper. He mentions every key person involved in his projects, and he does it with a smile. Over and over again he stresses people. "I don't think of myself as a hero worshipper," Holte says. "I get into things, obviously we all do, because of people and the associations we make. We like to pretend afterwards in some sort of self-determining destiny, but it isn't so."

Holte's first ambitions as a student at Minneapolis South High School were to be a physician or a nuclear physicist. He wanted to go to Cal Tech, but didn't know where it was. When it came time to pick a university, he chose Minnesota because it was in the Twin Cities and a friend's brother was in the electrical engineering program at the time. Holte knew he wouldn't go into nuclear physics and saw electrical engineering as a comparable field. It also served as a graceful exit from his previous plans. Once he got to the university, he discovered that the electrical engineering program concentrated on basic activities such as foundary and drafting for all engineers. The curriculum wasn't what he had in mind for himself, and he planned on changing colleges but the lines at registration were too long. "It became a procrastination thing," Holte says. "I kept telling myself I'd change colleges next quarter. It never happened."

The Institute of Technology must not have been too bad of a place since Holte received his bachelor's and master's degree in electrical engineering from the University. He worked with Professor Robert Lambert after receiving his master's degree in 1960. Until 1964 Holte and Lambert worked together on Lambert's ongoing research in acoustics and low microwave applications. In 1964 Holte became Director of Continuing Education for Engineers and Scientists. He helped plan courses for professional

...he planned on changing colleges but the lines at registration were too long.

engineers and scientists who needed to keep up with their fields of study. He held this position until 1973 when he returned to the electrical engineering department. The years he spent in continuing education are now helping him in his current project with Psychology Professor Rene Dawis and the Institute of Electrical and Electronic Engineers (IEEE). Holte is a regional director for IEEE so he is involved with the institute's efforts on helping professionals maintain their job skills. On the local level, Holte and Dawis are doing their own research on evaluating job skills necessary to attain short-term career goals. "In IEEE we're looking hard at what kinds of services we can offer to people to assist them in keeping up," Holte says. "I learned a great deal in the CEE (Continuing Education and Extension) structure on how people after college develop and maintain technical subject matter in people skills and managerial skills—it's all

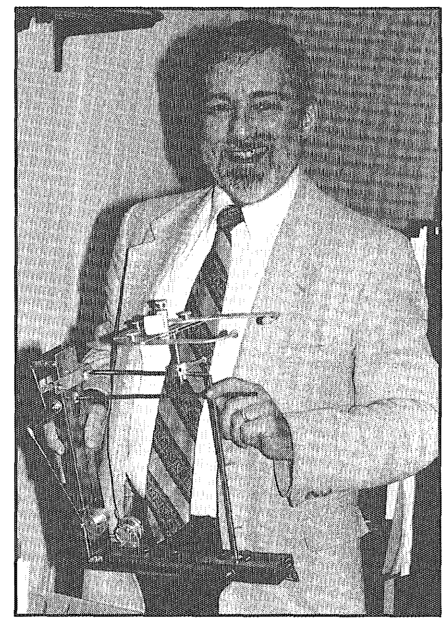


Photo by Paula Zoromski

Professor Holte with a gonimeter, a device that measures the position of the lower jaw. It is useful in the study of lower jaw movement.

mixed together. It's artificial to talk about divisions of skills. Hopefully we can have the local study supplement the IEEE's $150,000 national pilot study."

This would be the first study to form job descriptions for higher-level professions. Job descriptions have been completed for entry-level positions such as manual labor and clerical jobs, but haven't been developed for specific occupations in engineering and science. Both the IEEE and the Holte/Dawis study are trying to identify job skill requirements for a microwave circuit engineer. "We need to determine what skills are needed to functionally perform on-the-job," Holte says. "Then a test can be taken to find where their competencies are and diagnose further schooling or training necessary to attain a particular career goal."

Holte has been involved with several research projects with various people inside and outside the University. He can attach each project to a previous project or a person who was working with him. The first research project that got him interested in biomedical engineering was on urinary incontinence. Holte helped Jerry Timm and William Bradley develop an implant cuff that fit over the urethra to prohibit urination when undesired. Timm's implant is now on the market and has a dual function. The cuff can be replaced with a cylinder to help in male impotency. Through this research experience Holte discovered that his interest in medicine had a deeper meaning than he originally thought. As Holte says, "Wonderful results from humble origins."

Because of this research, Holte is currently working with Urologist Carl Smith from Hennepin County Medical Center (HCMC) on the functions of urinary bladder control mechanisms, both normal and diseased. They are studying how the conscious decision of whether to void or retain urine is made by the neural messages sent from the brain, down the spinal cord to the bladder, and then back to the brain.

Another research project of Holte's was influenced by his own cracking jaw. About four years ago Meyer Leonard, a maxillo-facial surgeon from HCMC, asked Holte if he could record the click his jaw made when it cracked. A cracking jaw is a malfunction of the temporo-mantibular joint (TMJ), one of the body's most complex joints. The TMJ is like a ball-and-socket joint since the lower jaw rotates and moves down and forward all at the same time. The cracking sound is caused by the tissue between the upper and lower jaw bunching up when the lower jaw moves. Leonard was interested in measuring the sound wave that resulted from the click. He could then infer the progression of the TMJ condition. This use of acoustics led to arthritis research using the same method.

Since arthritic joints don't make their own sound, a sine wave of 1000 hertz is introduced on one side of the joint. A recording device manufactured by Starkey Laboratories placed on the other side of the joint receives the sound wave. A clinician can then look at the information on a graph and understand the progression of the arthritis.

An extension of the fingers could optimize the mechanic's dexterity.

A more futuristic project of Holte's is on human functionality. Holte and Darrell Frohbib are trying to go beyond the conventional ways of improving functionality (i.e., speaking, hearing, walking, etc.). They are working on maximizing the dexterity and strength needed for specific job activities. For example, a mechanic needs a special wrench to reach in and twist a screw in a hard to reach place. Using a wrench is usually cumbersome because the mechanic can't "feel" what he's doing. An extension of the fingers could optimize the mechanic's dexterity. A similar device could be invented to improve the hearing of a person working in a noisy environment, like at an airport. A mechanism could be implanted to allow the person to hear despite high noise levels.

Holte strongly believes in allowing undergraduate and graduate students to explore their research interests in the biomedical instrumentation course and biological system modeling and analysis course he teaches. He disagrees with IEEE's attempts to get away from student membership. "We're all in this mess together," Holte says. Students should be allowed to be part of the organization. He compares research to fixing a leaky faucet. Everyone needs to find their own way through problems, and learn the process of finding solutions.

One weakness Holte finds in student researchers is that they don't like to document their work. "They want to get results, but don't realize they need to leave their tracks," Holte says. "Students don't seem to understand that 33 to 50 percent of their time should be spent proposing and reporting their results. No one will be able to use the information found if it isn't documented." Holte recommends that students always remember who their audience is. They need to write for their audience, not themselves.

In the classroom and in his research, Holte stresses the role people play in his work. As he pointed out, the contacts he has formed over the years enabled him to complete the projects he has been involved with. They have also given him leads and ideas about where to head next. Holte does biomedical research that he's interested in and encourages students to do the same. ▲

Susan Curran is a senior in journalism who is looking forward to graduating this spring and is hoping for a job in public relations. She has enjoyed writing and editing for the *Technolog* since Fall I, 1986. After graduation, Susan wants to buy some of the simpler things in life: a condo, a Saab 900, and a remote-control television.

Meshing Medicine & Mechanics

One of the first master's degree recipients in biomedical engineering tells us of his recent job assignments, as well as shares some advice with those considering the field.

by Steven Subera

Biomedical engineering requires not only knowledge in traditional engineering fields, such as electrical and mechanical engineering, but also study in the life sciences. These diverse qualifications attracted Paul DeGroot who works as a staff research scientist for the biomedical firm Medtronic, Inc.

DeGroot completed his undergraduate studies in biomedical engineering at Marquette University in 1984. Marquette's biomedical program was a subdepartment of electrical engineering, which constituted much of his early course work. Dim prospects in the biomedical job market swayed him toward graduate school. After searching for graduate programs the choice was narrowed to Marquette University, University of Wisconsin-Madison, and University of Minnesota-Twin Cities. DeGroot chose Minnesota because of its versatile facilities and size that allowed access to a greater number of faculty.

DeGroot entered the University's graduate program with the intent of obtaining a master's degree in biomedical engineering. At the time only a doctorate was offered, but he was assured a master's program would materialize. After his first year, the master's program was implemented. Since the program was new, the course requirements were not clear. DeGroot had to keep his own goals in mind and follow a few basic rules to meet requirements. Having an electrical engineering background, he enrolled in mechanical engineering courses and many natural science courses in an attempt to obtain a broad background. In the spring of 1986, DeGroot and another student became the University of Minnesota's first master's degree recipients in biomedical engineering.

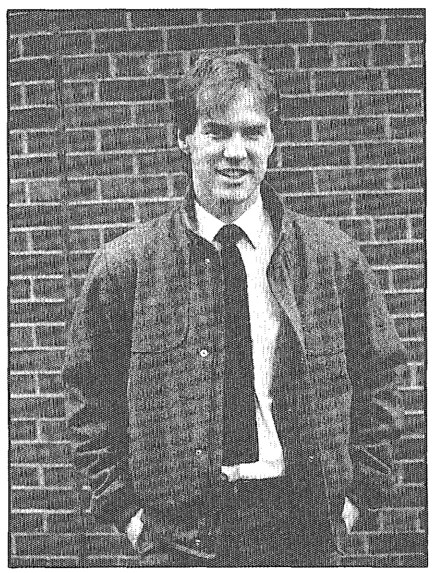


Photo by Paula Zoromski

Paul DeGroot, a master's degree graduate in biomedical engineering.

Two plans for obtaining the master's degree were available. One involved a thesis and concentrated research. DeGroot opted to work on a number of smaller projects and took more classes instead of writing the traditional thesis. One project involved work with a visiting Chinese scholar on a system for determining the pulse-wave velocity of an artery. The Chinese scholar researched the clinical aspects of the project and DeGroot was the engineer. "The Chinese are really interested in determining blood pressure non-invasively," DeGroot says. "This particular Chinese scholar was also interested with the sympathetic nervous system, which is an integral part of the cardiac system." The procedure involved placing three block-shaped transducers on a patient's arm. One transducer was placed above elbow level on the artery, one on the front side of the wrist, and a third over the end of a finger. The initial pulse due to the injection of the blood into the artery was determined at each transducer position using a light emitting diode and a photo transistor. The light intensity of the photo transistor was proportional to the blood-pressure wave. DeGroot used this proportionality to 'observe' the blood-pressure wave and find the time of the initial pulse for each transducer. The speed of the pulse travelling through the artery was measured by dividing the distance travelled by the time elapsed.

> **"...you sit down on your first day and it's almost like starting over."**

As a recent graduate, DeGroot has pertinent information for young engineers. He doesn't believe salary should be emphasized. Engineering and technology positions already have higher salaries than many other areas. "Whatever type of job you get, there will be much learning involved," DeGroot says. "You get a good foundation when you're in school, but you sit down on your first day and it's almost like starting over." DeGroot remembers his first couple weeks at Medtronic being spent familiarizing himself with his project. He had to read literature on the subject and old lab notes from his supervisor.

"The first six months are just going to be getting yourself into a normal daily routine and trying to figure out how to get yourself through the day," DeGroot says. "You must learn how to handle yourself within the business. After that you start to get yourself established in the company and feel comfortable with offering ideas instead of just being told what to do."

Medtronic was only hiring summer interns when DeGroot finished graduate school, but he wanted to

DeGroot's work illustrates the necessity of being knowledgeable in both life sciences and engineering.

work for them. He took an internship with the hope of becoming a full-time employee and it paid off when Medtronic retained him. DeGroot's initial project, an implantable defibrillator, is also his current concern. Medtronic markets pacemakers and cardiac products. Pacemakers are used to control a person's heart when it is beating too slowly. The next generation of products concerns the opposite case. Fibrillation occurs when the heart beats too fast. It loses all rhythm and becomes non-functional. The only way to rectify the problem is to deliver a high-energy shock causing the tissue to depolarize all at once. The procedure is a fairly new idea. DeGroot's work illustrates the necessity of being knowledgeable in both life sciences and engineering.

DeGroot has a varied work week. At least one day a week is spent at Medtronic's lab facility doing research. The rest of the week is divided equally into performing data analysis and theoretical calculations. He also spends a small amount of time in meetings.

Currently, attention in the biomedical field has focused on sensor research. "The one thing you have to do with any living system is get data from it,"

...his main challenge will be to complete his dissertation.

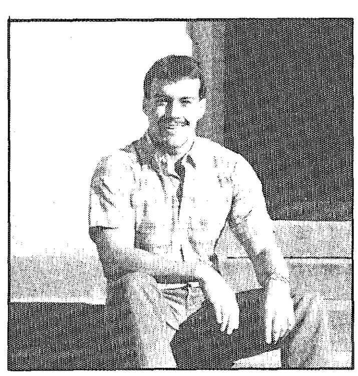
DeGroot says. A transducer that relays electrical pressure or other body signals is needed. Ultrasound and catscans are familiar sensor devices. DeGroot's area of research, cardiac products, has received heightened attention due to the first implantation of the Jarvik-7 artificial heart.

DeGroot's future plans involve further schooling. He has doctoral work in mind that he would complete at the University of Minnesota. His master's program involved taking many of the classes he needs for a doctorate, so his main challenge will be to complete his dissertation. DeGroot is still in the processes of establishing himself at Medtronic and he doesn't have any specific goals. He believes he's headed in the right direction with the company.

"I get to practice true engineering and problem solving."

DeGroot completed a master's degree program before entering the biomedical profession. "A master's degree isn't necessary, but you have to spend some extra time taking extra credits and you have to get some background in biology and chemistry," DeGroot says. "Otherwise you would end up doing a job that could be accomplished by any other traditional engineer."

Overall, DeGroot is extremely satisfied with his biomedical position. Early in college he considered medical school, but decided against it. However, he wanted to stay close to the medical field. "I get to practice true engineering and problem solving, yet I am very closely related to medical problems," DeGroot says. ▲



Steven Subera is a junior in electrical engineering and is very eager to finish school and work in the world that he writes about in his article. He enjoys working with computers, reading, and football, having been a die-hard Chicago Bears fan since third grade. Steve wrote for the *Technolog* because he believes engineers need to have good communication skills.

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Log Ledger from 8

The infrared light is directed toward the skull, and a minute amount is not blocked. Ultrasensitive sensors pick up the traces that get through the head and analyze them to check for oxygen quantity in the brain. The scanner can be used continuously because, unlike X-rays or other medical imaging devices, it doesn't damage the infant's tissues.

Although the device is not yet used commonly, its further applications have already been predicted. Correcting ailments involving muscles, kidneys, and hearts is most promising because these organs involve the dissemination and use of oxygen.

Source: ***Popular Science***

Astronomy and the US Constitution

by Kevin Cummings

In this, the bicentennial anniversary of the U.S. Constitution, it's nice to know that technology can help save the original document. The original parchment is aging, and the National Archives (NA) system wants to be able to detect changes in the Constitution and the other documents that they keep. Astronomy to the rescue! Using a charged coupling device (CCD), an electronic camera system that will go on planetary probes, the NA can take images of the documents in precise fashion at five to ten times the resolution of the human eye.

The CCD system uses a monitoring system to make sure the illumination, position, and temperature of the documents are the same every time an image is taken. Then it electronically compares images over time to detect if preventive measures are needed before the documents deteriorates any further. The system, designed at the Jet Propulsion Laboratory, will monitor the Constitution, the Declaration of Independence, and the Bill of Rights.

Source: ***Astronomy***

Superconducting Transmissions

by Jim Willenbring

New research from Cornell University and the Ultrafast Science Center at the University of Rochester has produced a device that is the front-runner of transmission lines that could send data at speeds up to 100 times faster than today's optical fiber networks. Incorporating superconducting materials, scientists passed extremely short electrical pulses through the device without any detectable distortion.

A single superconducting transmission line could carry one-trillion bits per second. This would be enough to support fifteen-million simultaneous telephone conversations or send the complete contents of the Library of Congress in two minutes. This has advantages over the optical-fiber networks in speed and simplicity. Optical fibers must transfer a signal from electricity to light and then back again at the opposite end of the line. With the superconducting line, the transfer is not necessary, resulting in the faster transmission time and simpler structure.

However, the threshold temperature at which materials become superconductors is still low (around 90 K), and liquid nitrogen is needed to maintain that temperature. This restriction prohibits the use of superconductors as wires used in today's communication networks, some of which span hundreds or thousands of miles. Widespread use in transmission lines would require further breakthroughs in raising the threshold temperature. ▲

Source: ***St. Paul Pioneer Press Dispatch***

Programs in Biomedical Engineering

Biomedical engineering is a compilation of many different disciplines. Here is a look into that diverse field.

by Gregory Ley

The human body can be viewed as a very complex machine made up of mechanisms, sensors, pumps, circuits, and controls. Most known physical and biological phenomena are manifested in each unique representative of the four-billion people currently inhabiting the planet. Each model has an intricate circuitry consisting of over twelve-billion neurons with an almost infinite number of inter-connections communicating with sensors and controls via electrical or chemical stimulation. There are hundreds of thousands of miles of pipes, ducts, and pumps in the form of veins, arteries, intestines, and various organs networking a massive array of fluid systems. Over six-hundred muscles expand and contract, acting like cables to control lever arms, rotary motion and various other mechanisms among the 206 bones in the human body; all of which are constantly experiencing tensile, compressive, and shearing forces. These vast electro-magnetic networks provide ample opportunities to use both the engineering and medical sciences to repair, assist, enhance and improve the human body and its lifestyle.

There are many different routes one can take to become a biomedical engineer. Each route depends on when a biomedical engineering career is chosen before, during, or after the academic career, and what area(s) of interest is (are) selected. Some enter the field, for example, with a bachelor's or an advanced degree in one of the traditional engineering programs: chemical, electrical, or mechanical engineering. Others obtain a masters or doctorate in a formal biomedical engineering program offered at one of the colleges or universities around the country.

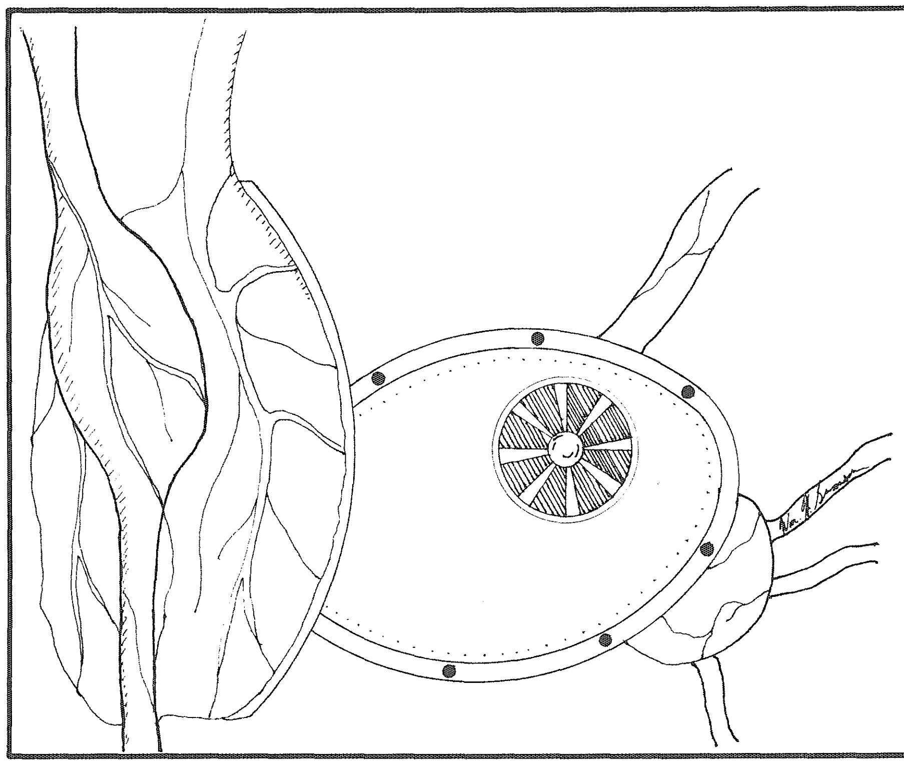

Illustration by Bill Swanson

Upon graduation from college with a bachelor's degree in engineering, the engineer has many different opportunities. Some of the job functions engineers might find themselves in include: applications, field service, design, development, manufacturing and production, research, sales, or systems analysis. These functions fit the needs of the biomedical industry just as they would the needs of the automobile or computer industry.

According to Professor Perry L. Blackshear Jr., director of graduate studies in biomedical engineering at the University of Minnesota, many biomedical engineers in the field today have started in the traditional engineering route since biomedical engineering programs are relatively new, and in the past only a few degrees were offered on the graduate level. Graduate programs are increasing throughout the United States as biomedical engineering is becoming more recognized by health-care industries and health-care professionals. With this increase in biomedical engineering degree programs, certain positions in research, design, and sales are often requiring graduate degrees in biomedical engineering. One important reason for this is to make biomedical engineers more capable of communicating with the health-care professionals.

There are many colleges and universities in the United States which offer undergraduate programs but not necessarily formal degrees in biomedical engineering for undergraduate majors. According to *Peterson's Handbook for Engineering/High-Tech Students,* there are approximately twenty institutions that offer bachelor's degrees in biomedical engineering accredited by ABET (Accredation Board for Engineering and Technology). Professors and faculty from the University of Minnesota's Biomedical Engineering graduate school believe a solid foundation in the fundamentals of engineering, natural sciences, and mathematics is much more important than studying a specialized area such as biomedical engineering on the undergraduate level.

...a solid foundation in the fundamentals of engineering, natural sciences, and mathematics is much more important than studying a specialized area...

The Institute of Technology offers special programs in the aerospace, chemical, electrical, and mechanical engineering departments for students interested in biomedical engineering. The mechanical engineering (M.E.) department, for example, requires students to take a pre-engineering program during their first two years of school, like other departments. The third year is devoted to topics traditionally related to mechanical engineering. In their senior year, students choose coherent electives in a particular area of interest. These electives comprise approximately one-sixth of their total credits. Coherent engineering elective programs in M.E. at the U of M are as follows:

Power and Propulsion
Environmental Engineering
Design and Controls
Thermal Engineering
Manufacturing Engineering
Industrial Engineering
Bio-engineering
Electro-Mechanical Engineering

Students in the bio-engineering coherent program choose the pre-med option or the biomedical engineering option. The pre-med option is designed for students interested in obtaining a mechanical engineering degree and to qualify for entrance into medical school.

The biomedical engineering option offers many diverse courses (many outside the M.E. department) exposing students to four general areas: artificial internal organs, instrumentation, orthopedics and robotics. The M.E. and many other departments offer courses tailored for these areas.

Peterson's Handbook for Engineering/High-Tech Students questions the need for graduate studies in engineering. The handbook takes the view that the practical working experience in any type of engineering is much more valuable than specializing in one particular area, since today's engineering jobs are constantly changing and the engineer must be able to acclimate him/herself to the many different technologies, applications and situations encountered in various high-tech industries.

Many entry-level jobs in biomedical industries take engineers with traditional degrees...

Many entry-level jobs in biomedical industries take engineers with traditional degrees since many of the positions require only undergraduate education in a particular area of engineering. For example, a corporation that makes hearing aids needed a position filled in its manufacturing department. It was not so important that the engineer knew the anatomy of the ear; more importantly, the engineer needed to know efficient methods of manufacturing, production, and packaging of small electro-mechanical products. However, the engineer designing the hearing aid must have some knowledge of the human body and how the ear functions to work effectively with health-care professionals to create a device that will safely and comfortably help someone hear better, without being cosmetically annoying. If a student is interested in a specific biomedical engineering position, especially in design, research, and development, a graduate degree is more than likely desired. A graduate degree in biomedical engineering not

Greg Ley is a senior in mechanical engineering and was an IT Board of Publications member for two years. He is involved in the ME co-op program and believes that practical experience is very valuable for engineering students. Greg has also done some illustrations for the *Technolog.*

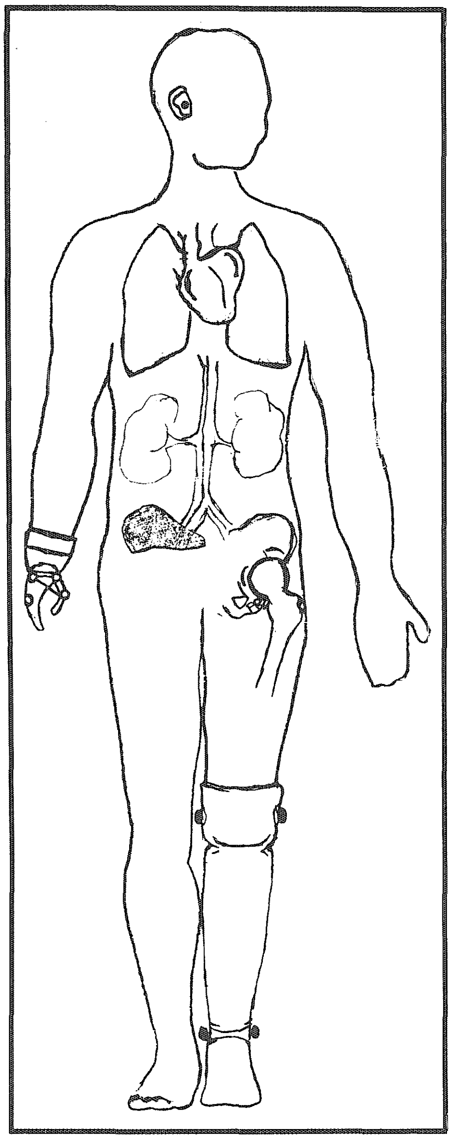

Illustration by Patsy Ruff

only exposes the students to a more in-depth study of the biomedical and life sciences, but it also helps the student to "speak the language" of the health-care professionals, according to Blackshear. An understanding of medical terminology and proper use of it is of utmost importance when working with the health-care professionals and industry.

A focus for a student's training is provided by thesis research topics chosen from among the following areas of biomedical engineering research:blood fluid mechanics and its applications to cardiovascular problems and the design of artificial internal organs; organ preservation; chemotaxis; modeling of lung dynamics and study of pathological pulmonary conditions; bone and joint mechanics and the design of bone joint prosthesis; microbial population dynamics; intestinal mass transfer; development of instrumentation and control devices to correct neurological defects; human factors engineering; health effects to design of tools and workplace; application of computer science to a wide variety of problems in physiological simulation, diagnosis, and medical data recording.

Applicants for the University of Minnesota biomedical engineering program must have a bachelor's degree in engineering, physical, or biological science and demonstrate a proficiency in French, German or Russian. A biomedical engineering graduate program is planned with the aid of an adviser, a three-member subcommittee selected jointly by the candidate, and Blackshear.

Blackshear described the routes of a few students who graduated with a master's degree in biomedical engineering:

One student became employed by a corporation that made surgical stapling machines. These machines staple a patient's skin together at the site where an incision was made during surgery. Part of this biomedical engineer's job was to sell the staple guns to different health-care institutions. This involved meeting with surgeons and discussing their specific needs. If he had an idea that would improve the effectiveness of the staple gun, he would report this to his supervisor who, in turn, gave him the time and facilities to set up lab to work on his idea or modification. When his lab work and/or product was complete, he would work with the surgeons so they knew exactly how to use it. This person was in effect the applications, design, research, and sales engineer for that company's surgical staple gun.

In another situation, a graduated student went into dialysis work. He is currently in charge of research at the regional Kidney Disease Center as a biomedical engineer, and is now a world authority on the technical aspects of kidney dialysis. He is also a member of the graduate faculty at the University of Minnesota, and teaches a course in artificial internal organs and advises students. One interesting point about this biomedical engineer career is that he actually works with the patients. It's rare for this to happen since the health-care profession has a tight grip on working directly with the patient, especially when it comes to breaking the skin, mainly because they are the ones that are covered by and paying malpractice insurance.

Blackshear spoke of another biomedical engineer who works directly with patients at Fairview Hospital. He designs braces for people who have scoleosis and has extensive contact with patients. This type of biomedical engineering concerns itself mostly with mechanical design.

Most biomedical engineering activity has been focused on the needs of sick people, resulting in the development of diagnostic and treatment equipment, surgical implants, and rehabilitative technology. Recently, biomedical engineers have become interested in the healthy body, both to protect it from injury and to enhance performance and well-being.

...the health care profession has a tight grip on working directly with the patient...

Professor Otto Schmitt, of the University of Minnesota, says that biomedical engineers are now "...making well people feel even better..." Biomedical engineers are helping professional and after-hours athletes perform better and work out more effectively, efficiently, and safely.

Professor Arthur Erdman, of the University of Minnesota, has develop a rowing ergometer that accurately measures work expenditure and conveys instant feedback to the rowing athlete in the form of plots power, force, and other stroke variables by computer. This ergometer can be adapted to machines that previously could only give rough approximated values of physical and physiological quantities. With these ergometers, rowers can train throughout the year just as other athletes are starting to train with technology.

Other biomedical engineering endeavors for sports include development of digital ski bindings for safer releases in alpine skiing, sports cinematography and computerized analysis of professional football punter kicks, and developing a standard rating for measure of how well foot shock is dissipated in running.

Biomedical engineering is an adolescent profession that combines engineering technology with medical and life-science technology to adapt, assist, enhance, and improve the quality of life. Education medical and life sciences is just as important as education in engineering to better communicate with health-care professionals and to understand or see where problems exist. Biomedical engineers cab be found performing similar tasks as traditional engineers, or those involving health-care professionals and their patients. Biomedical engineers are influencing the lives of not only the sick and crippled, but also the lives of people who lead physically normal lives. ▲

Sources:

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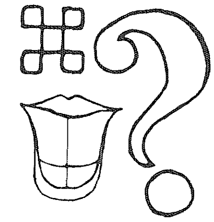
Technotrivia



by Kirk Nelson

Questions:

1) What group of people first began the art of traffic engineering?

2) This day of the week gets its name from the Norse goddess of love.

3) A foot is equal to sixteen digits in the ancient Greek system. How was a digit defined in this time?

4) Who designed the periodic table for elements in 1869?

5) How many feet are there in a nautical mile?

6) On December 3, 1973 an unmanned probe flew near Jupiter and discovered that the planet's magnetic field is upsidedown and ten times stronger than expected. What was the probe's name?

7) Immanuel Velikovsky wrote a book that was found open on Albert Einstien's desk when Einstien died. The book predicted the Van Allen radiation belt, radio emissions from Venus, and the electromagnetic nature of solar flares. What is the name of this extraordinary book?

8) Apollo mission 11 and 12 landed in what two lunar basins?

9) Parvo Nakachecker of Finland invented this useful containing device. What is it?

10) Blaise Pascal invented a device commonly found in Las Vegas. What did he invent?

Answers:

1) The Romans, circa 100 B.C. They had everything we have today (stopsigns, yields, and opposing street parking) except streetlights. MN/DOT has really been on the cutting edge of technological innovation lately, hasn't it?

2) Friday (Frig's Day). This is certainly a well loved day.

3) A digit was the breath of a finger. Makes you wonder if there was an incentive to starve during this period. "Let's see...you say I owe four digits of gold chain for tuition..."

4) Dmitri Mendeleev. Remember your freshman year...? Good.

5) 6076.115 feet. Didn't expect to have to know the answer to a third digit accuracy, did you?

6) Pioneer 10.

7) *Worlds in Collision*. If you said the Tipler physics book, you weren't even close.

8) Sea of Tranquility and the Sea of Storms respectively. If you are a professor and failed to get this one right, take away credit for a correct answer if you have one.

9) The athletic supporter. Just threw this one in to break the monotony.

10) The roulette wheel. It was developed as a by-product of his perpetual motion experiments.

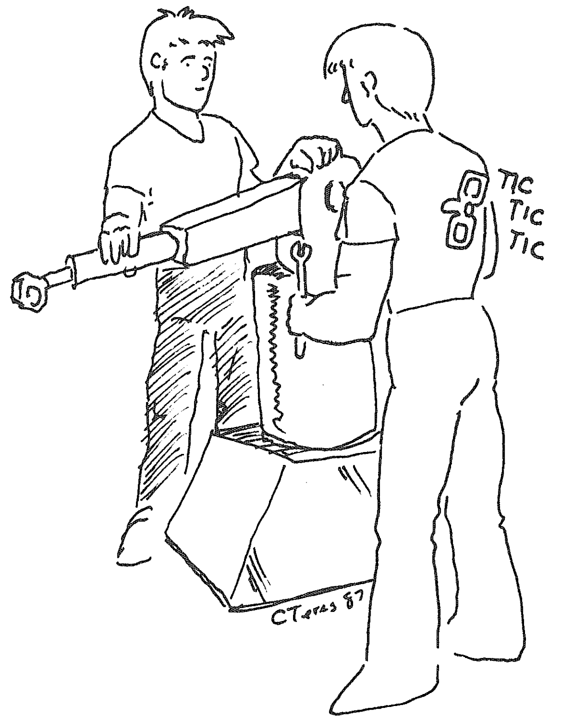
Scoring:

0-1 Newborn babies have done better than you.
2-3 Are you on an athletic scholarship?
3-7 You're tolerably normal.
8-9 Reward yourself by not getting a Tammy Baker album.
10 The objective was to answer the questions, not to connect the matching numbers.

Technocomics

The Near Side

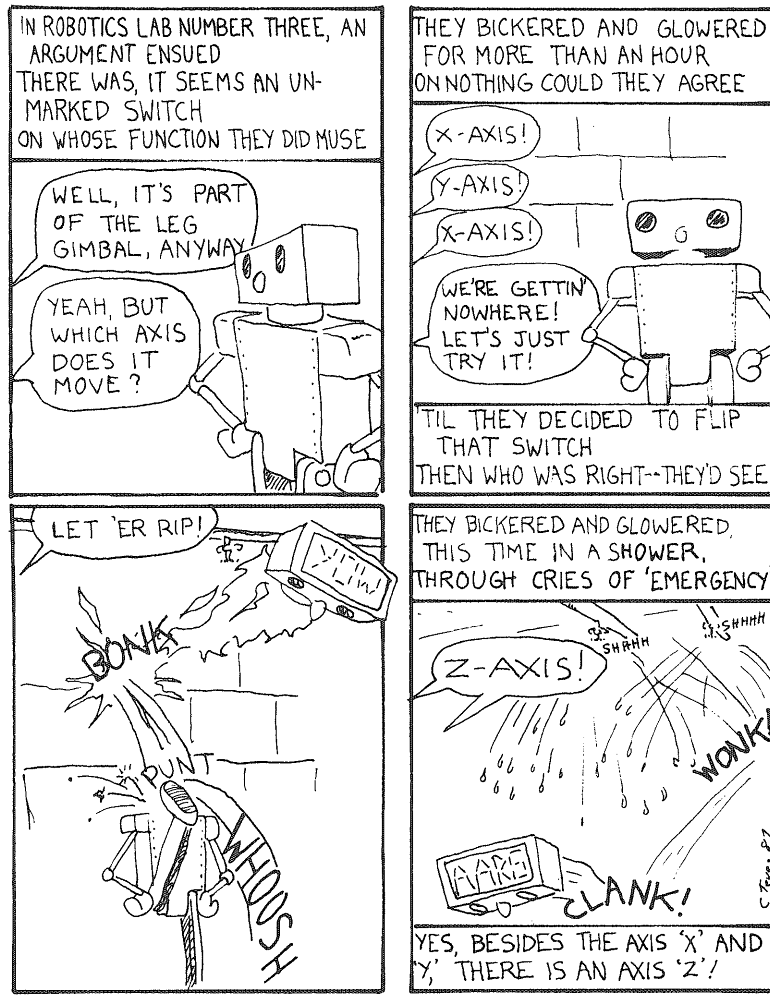
by Steve Littig and Conrad Teves



When asked why he was a robotics major, Tom simply stated, "It's in my blood."

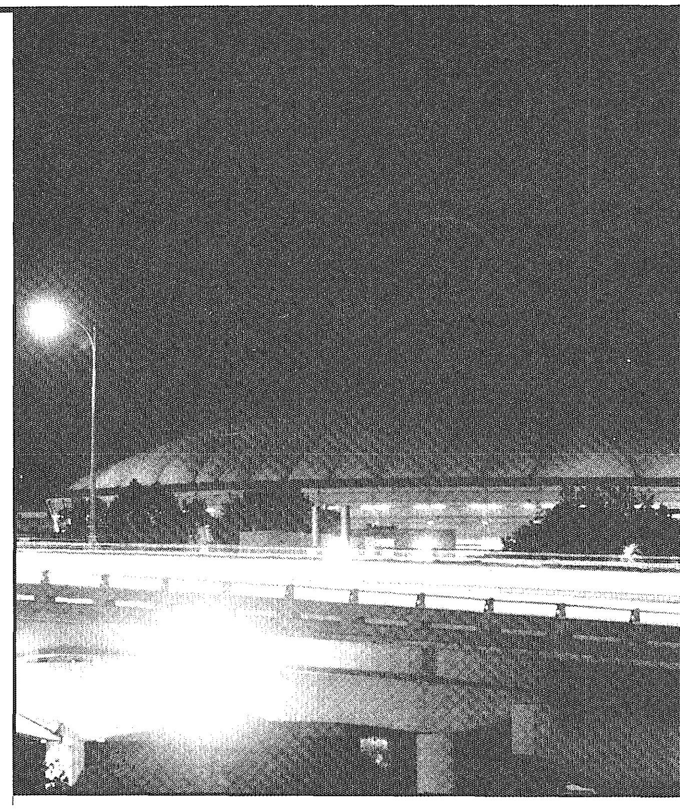
Finite Loops

by Conrad Teves



COULD THIS BE A HAIL MARY PASS FROM WADE WILSON TO ANTHONY CARTER...

OR IS IT SIMPLY THE SPACE FAMILY ROBINSON HOMEWARD BOUND?



What ever it is, we'll never know. But we do know we need your photos.

Have some old snapshots floating around to rival or (we hope) eclipse this one? Then submit them to the *Minnesota Technolog*'s first annual science fiction photo contest. The rules are simple.

Rules: The contest is open to both students and non-students. Technolog staff and IT Board of Publications members are not eligible. Photos must be in black and white. There is no limit to the number of entries you may submit. Just be sure to include your name, address, and phone number on the back of your photos. The deadline for submissions is Tuesday, March 15th. Questions? Call 624-9816. And, oh yes, there are prizes:

1st Prize: $40.00
2nd Prize: $25.00
3rd Prize: $15.00

So whether your photo is supernatural, celestial, surgically-altered, or just plain spacy, give this contest a shot and enter soon.

A Thousand Words

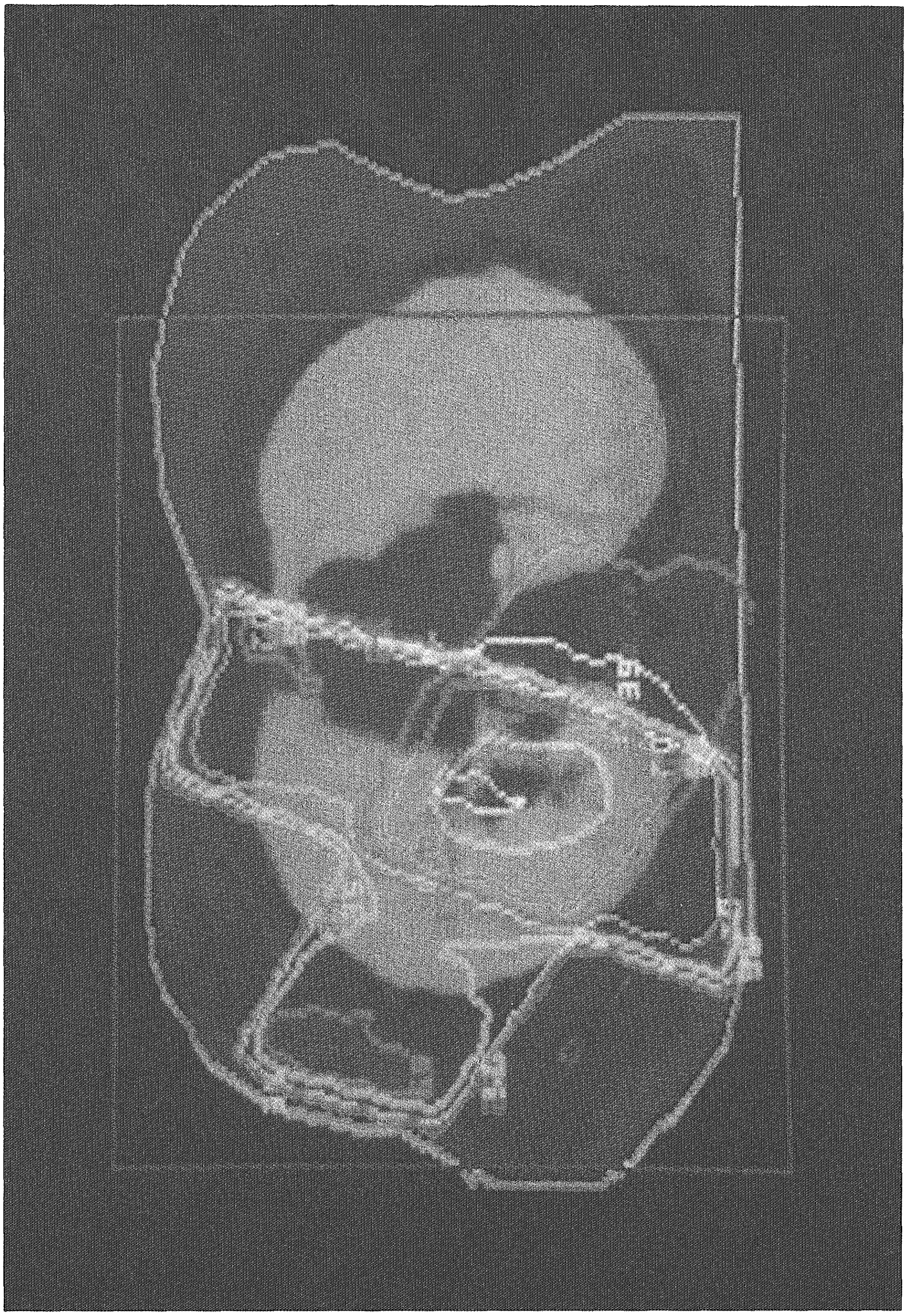


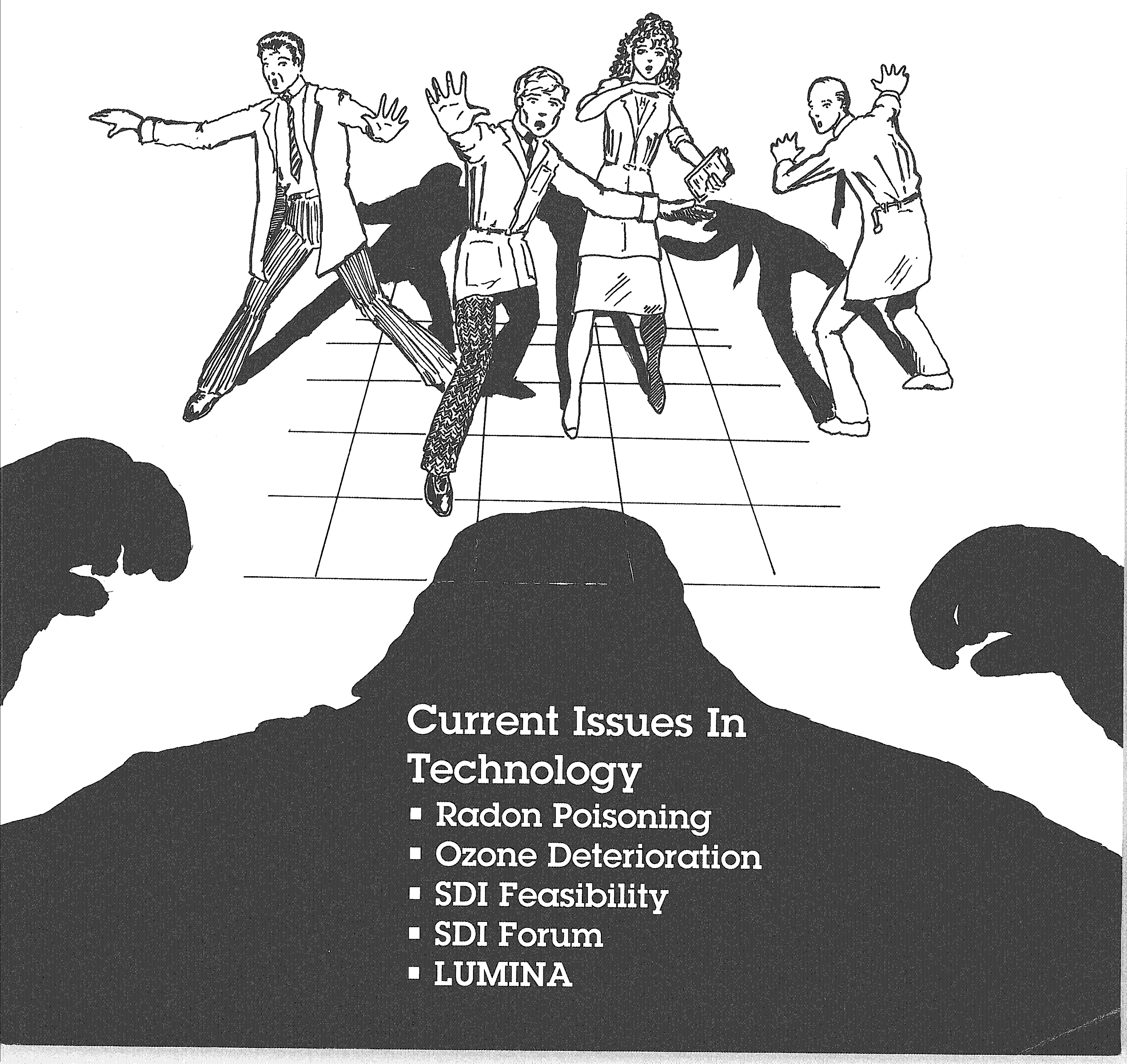
Photo by Paula Zoromski

This photo is a computerized, external beam treatment plan showing the distribution of dose superimposed on a computerized tomographic (CT) scan. The distribution was generated in the Therapeutic Radiology Department of the University of Minnesota.

minnesota

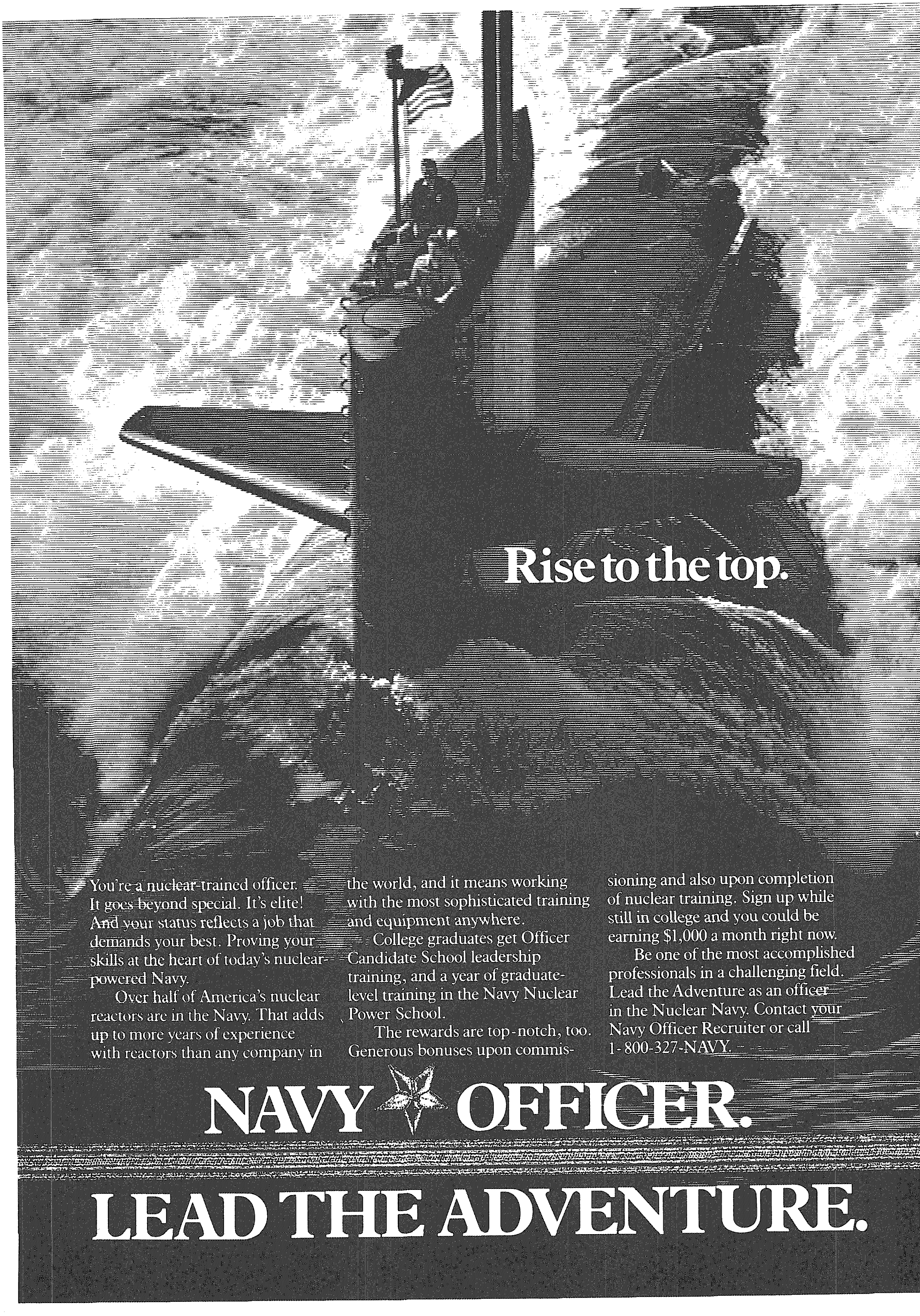
Winter Two, 1988

TECHNOLOG



Current Issues In Technology

- Radon Poisoning
- Ozone Deterioration
- SDI Feasibility
- SDI Forum
- LUMINA


Rise to the top.
You're a nuclear-trained officer. It goes beyond special. It's elite! And your status reflects a job that demands your best. Proving your skills at the heart of today's nuclear-powered Navy.
Over half of America's nuclear reactors are in the Navy. That adds up to more years of experience with reactors than any company in the world, and it means working with the most sophisticated training and equipment anywhere.
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The rewards are top-notch, too. Generous bonuses upon commissioning and also upon completion of nuclear training. Sign up while still in college and you could be earning $1,000 a month right now.
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Cover Illustration by Conrad Teves

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Winter Two, 1988 **Volume 68, No. 4**

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Current Issues in Technology

Features

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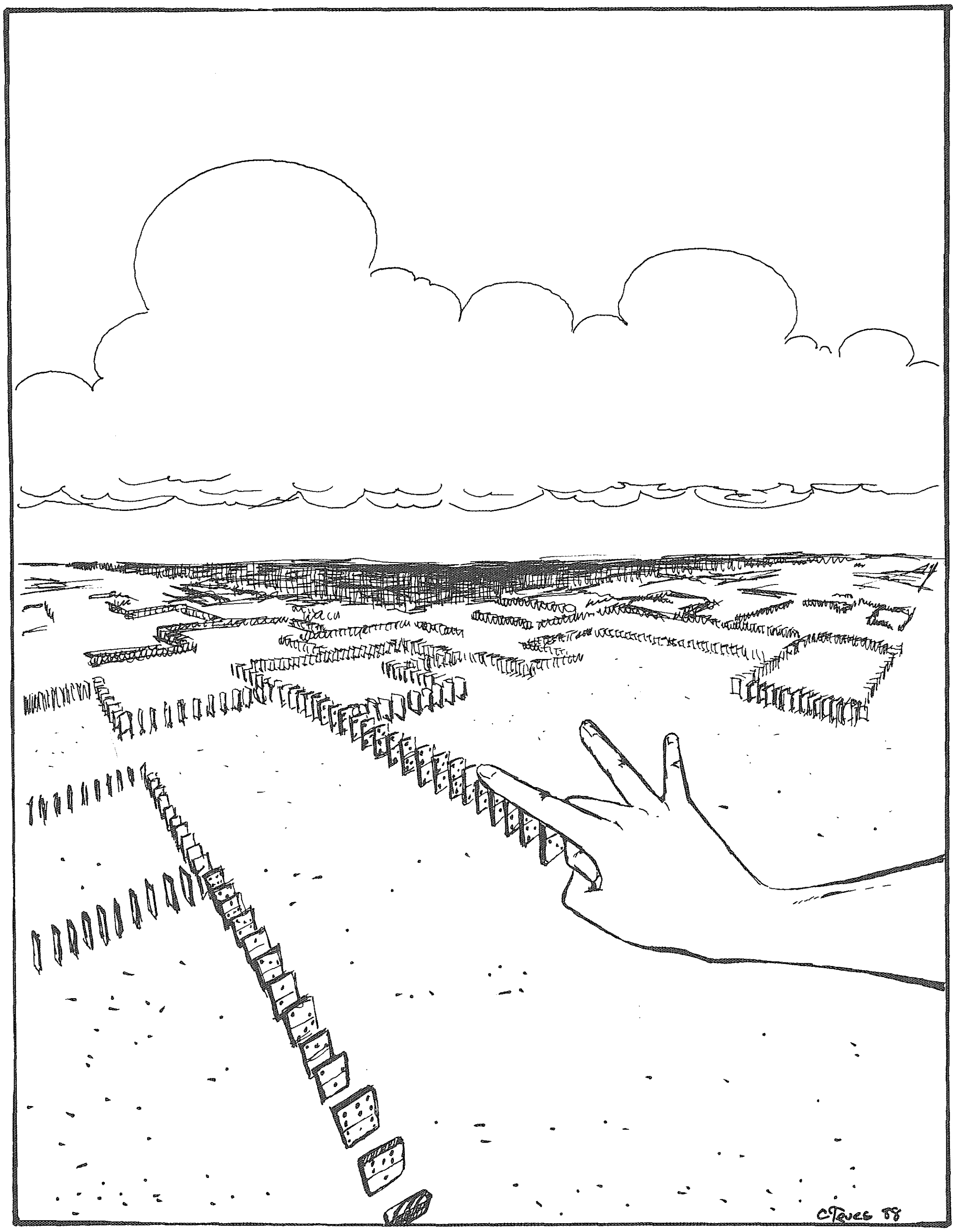


Illustration by Conrad Teves

Current Issues

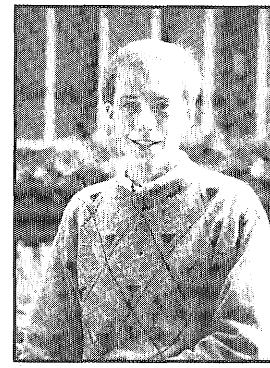
As our cover illustrates, technology in certain cases can seem like it is closing in on people, causing more harm than good. In this issue of the *Minnesota Technolog*, we take a good look into a few of the technological problems that are facing us today.

Two articles discuss radioactive radon getting trapped in our homes and the ozone layer deteriorating at the South Pole. Both are environmental concerns that have a basis in technology. SDI research brings up a whole plethora of topics, including feasibility, ethics, academic freedom and many others. Some of these are addressed in the summary of the SDI forum that occurred here at the University in October and in Mitchell Skiba's article on SDI feasibility. An article on LUMINA, the University's computer catalog system, rounds out our slate.

If you look closely, you'll notice that the *Technolog* is a little different. We've subscribed to what our name implies and gone to a computer desktop publishing system for production. The result is (hopefully) a crisper, cleaner look with a few format changes. This system is a part of our continuing goal to keep the *Minnesota Technolog* one of the best undergraduate college magazines in the country. MT

Editor's Log

The Big Picture



The ozone layer is deteriorating in our upper atmosphere, threatening increases in skin cancer from harmful ultraviolet rays. Radon, a colorless, odorless gas, has been slowly seeping into homes across America. An estimated ten million homes may have radon levels above what is considered hazardous by the Environmental Protection Agency. Industries are generating hazardous waste at ever-increasing rates. Many old spills and unauthorized dumps are being discovered now after they have affected our land and water resources. Precious reserves of non-renewable resources, like oil, coal, and natural gas, are being wasted through inefficient systems.

You wonder if the grim direction society is heading to can be altered. The ability of those in charge to look at *the big picture*, not just their own narrow environment, is crucial in correcting harmful situations like those mentioned above. Engineers and scientists especially need to look at the big picture since they can have profound effect on many people. They need to realize that their actions (or inactions) apply not only to their current project, but can be part of larger social, ethical considerations.

Let's say, for example, you are an engineer who is helping design and manufacture a custom integrated circuit. The application for this project is for the booster control system of an Intercontinental Ballistic Missile (ICBM). Even though your specialty is complex circuit design of this type, do you have any qualms about where this circuit will be used after it is completed? The dichotomy of contributing to the escalating arms race as opposed to working to help protect your country must be examined.

Other examples include scientists' research on lasers. A controversial application of this research would be for SDI laser weapons. Architects and engineers designing power plants have to consider many important factors, one of which is what type of plant it should be. Coal power plants use up a non-renewable natural resource. Nuclear power plants generate extremely hazardous waste and may have catastrophic consequences if an accident occurs. Hydroelectric power plants seem to use nature the best, but they also radically change the environment around the plant.

The ability of those in charge to look at *the big picture* . . . is crucial.

Context is the key to trying to understand these situations. The existence of the *true* good choice over the bad choice doesn't exist in real life. Cost-benefit analysis is used to determine the best alternative, but the question is who determines the value of a rare species of fish whose survival is threatened by the construction of a hydroelectric dam, or the price of increased skin cancer due to chlorofluorocarbons depleting the ozone layer? The trade-off between positive and negative parts of projects will always be present, and engineers and scientists as students need to realize that calculating the projectile motion of a particle will not have the black and white effects out in practice as it does in school.

All of these examples illustrate the point that decisions have far-reaching effects. Successful managers and executives have the ability to see the big picture, the effects of decisions that face them. People in technical fields are paid to ask questions, and the first question on their mind should be, "What would happen if . . . ."

Examine and work with the details, but step back and take a good look at who you are affecting, how you are affecting them, and what consequences may come of the action. A little clear-headed thinking and foresight can help avoid the hindsight that says, "We should have thought of that." MT

Jim Willenbring

Jim Willenbring
Editor

Illustration by Steve Winters

Radon Poisoning: Health Hazards in the Home

This newly recognized environmental threat has been traced as a cause of lung cancer. Testing and simple preventive measures can correct harmful exposure to this radioactive gas.

by Heidi Berg

What radioactive gas is poisoning a startling number of homes across the nation? What is this natural substance that increases a person's chance of getting lung cancer, and is equivalent to smoking 130 to 200 packs of cigarettes a day? It's name is radon-222. It is endangering people's lives, and may even be present in your home. But because radon is a colorless, odorless, and tasteless gas, it is impossible to detect if it is poisoning a home without specifically testing for it.

Growing concern over radon poisoning has resulted from studies by the U.S. Environmental Protection Agency (EPA) stating that indoor radon is the second leading cause of lung cancer in the United States. Other studies by the American Lung Association estimate that between five and thirty thousand deaths from lung cancer are caused by pollutants in the home. Radon has always been present in the atmosphere; the danger comes when it is enclosed in a home.

Radon is produced through the radioactive decay of radium, which occurs indirectly through the decay of uranium. While radium and uranium are found in almost all types of soil, radon is a gas that is continually being evaporated into the atmosphere as it finds its way to the earth's surface through fractures in the bedrock. In the outside air there is a very low ratio of radon to air, posing no real threat to humans. The problem occurs when someone places an enclosed structure on these high radon evaporation areas, trapping the gas.

Radon poisoning was eventually brought to the public's attention in the early 1980's. At one time radon was believed to be a man-made pollutant. Then in the late 1970's, several uranium miners found they were developing lung cancer from the radon they were exposed to on the job. The widespread awareness to radon poisoning came when a man who worked in a nuclear plant in Pennsylvania set off radiation alarms as he entered the building. His home was found to be so contaminated with radon that living in it was as deadly as smoking 150 packs of cigarettes a day. In the one year spent in their seven-year-old home, the family had increased their chances of getting lung cancer by thirteen to fourteen percent; living there had been equivalent to having 455,000 x-rays taken. To date, this is a *worst case* situation; however, it is estimated that as many as eight million homes probably have radon levels above EPA standards.

. . . EPA studies [state] that indoor radon is the second leading cause of lung cancer.

^{222}Rn

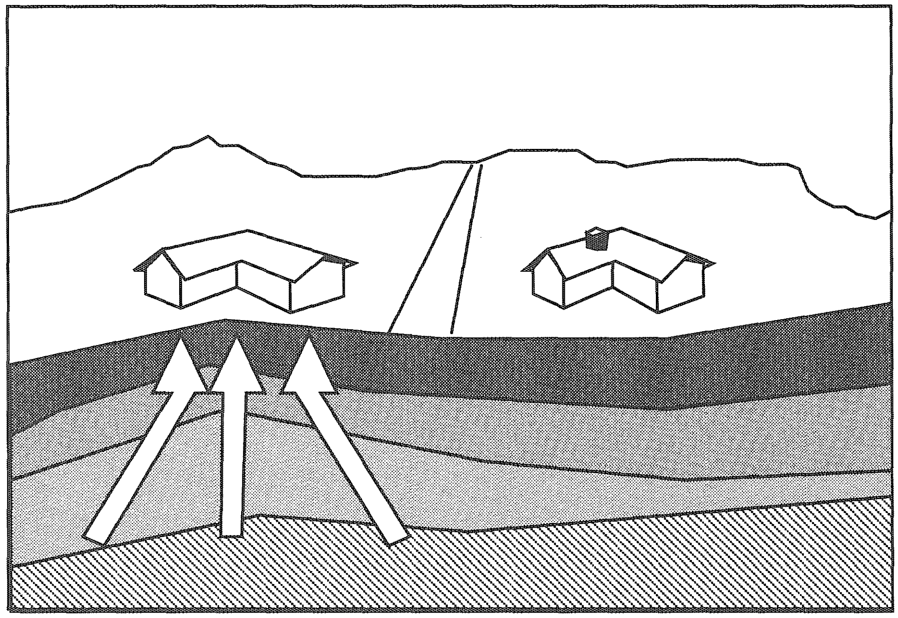
Radon enters a home through crawl spaces, basement floors, loosely fitted pipes, drains, and sump pumps. It can even diffuse through solid concrete walls. The foundation for the poisoned home in Pennsylvania was poured over low-grade uranium ore. Some white residue that had been scraped from their basement walls contained radium that has penetrated the concrete.

Other ways in which radon can enter and contaminate a home is through the water supply. If the water is brought in from a municipal water supply, families are usually safe because any radon would disperse before the water would reach the home. However, well water is another matter. When the rock underneath the well has a high radon content, the gas will dissolve into the water. Drinking the water will not cause lung cancer (although there is some speculation about its connection with stomach cancer), but the water which is splashed out of faucets, showers, and washing machines will release radon into the air.

Once radon gas enters a home, it will continue to decay into radioactive particles of polonium, bismuth, and lead, which are elements that have been connected to lung cancer. The half-life of radon is only 3.8 days, and as a consequence, it will decay very quickly into these other elements. These *radon daughters* are highly mobile, will attach themselves to smoke and dust, and will inevitably be inhaled by those living in the home. As these particles are lodged in the upper respiratory tract, they will emit alpha radiation. This cancer time-bomb shows almost no warning signs. Short-term exposure will not cause much damage; it is those who live in even a small amount of radon-poisoned air for twenty years or more who are most at risk.

Oddly enough, the radon problem was aggravated when people became highly energy conscious in the 1960's. As they began to tighten up their homes, this reduced air infiltration kept the radon in the house longer and at higher concentrations. Simple caulking and weather-stripping can increase radon levels by twenty percent. Earth-sheltered homes are now under close scrutiny because scientists suspect that the more contact a house has with the soil, the higher the chance of allowing radon to enter.

Radon levels are measured, both in the air and water, in picocuries per liter (pCi/l): a decay rate of approximately two atoms per minute for each liter of the substance. A typical outdoor radon level would be between 0.1 and 0.4 pCi/l in the air. However, indoor levels can range from 1.0 to 30 pCi/l, with most not reading above 10 pCi/l. There is much disagreement between the major government agencies as to what level should be the safety threshold in your home. The National Council on Radiation Protection says that after a reading of anything greater that 8 pCi/l, action should be taken. The U.S. EPA recommends that the threshold be set at 4 pCi/l. The EPA has also concluded that living in a home with a level of 10 pCi/l of radon



Source: Terradex Corp. "Understanding Radon", CB-1-387. **Illustration by Jerry Fiala**

The variability of soil and rock strata beneath foundations can cause neighboring houses to have differing radon levels, as this illustration shows.

carries the same lung cancer risk as smoking one pack of cigarettes a day.

Recent testing has found the highest radon levels on the East Coast; there are areas in Minnesota that are similar in geology to the East Coast. Since granite is a rock that is relatively high in uranium, maps have been drawn up by the EPA to show the granite formations throughout the state. Other radon-bearing minerals targeted as possible trouble spots include granite, phosphate, and shale. There is now said to be a *high probability* of radon in areas of Minnesota rich in these elements, but this is only speculation. Only individual testing of each home will give the proof of radon contamination. Soon the EPA is planning to test 1,000 homes in Minnesota.

Since radon is invisible, special equipment is needed in order to detect it. Currently there are only two ways for someone to test their home. Both of these use devices known as passive monitors, which are exposed to the air for a period of time and sent to a special laboratory where a computer analysis is performed. A confidential printout is then sent to the home.

Preliminary testing is usually performed by the more inexpensive device, a charcoal canister that collects radiation particles present in the air. Charcoal canisters cost from ten to twenty-five dollars each and have a test period from about three to seven days. There has been some criticism of these devices because levels of radon can fluctuate over time due to changes in weather, opening and

Recent testing has found the highest radon levels on the East Coast. . . .

closing of doors, and the types of air conditioning/heating systems being used. The most accurate way to determine an average level of radon is over a longer testing period.

The other passive monitor, alpha track detectors, cost from twenty to fifty dollars each and stay in the home for anywhere from three to twelve months. These are recommended by the Minnesota Indoor Air Quality Task Force as the most effective and efficient way for a private party to detect radon poisoning. The alpha track detector is made of a container with a small opening covered by a filter, which holds a small piece of plastic inside. When the alpha particles are given off by the nucleus of the atom during the radioactive element decay, the particles will produce tiny *damage tracks* on the plastic.

You must keep in mind that even though your next-door neighbors may have tested their homes and found high levels of radon, this does not mean you will or will not find radon in your own. Factors such as soil permeability, proximity of radon to the surface, and construction of your home all enter into the possibility of radon poisoning your home. There are some criteria, though, that have shown what many homes high in radon have in common:

- airtightness of the home
- well water
- homes without basements and crawl spaces
- single-level homes
- sandy soil under the home

No one knows yet how many cancer-producing homes are out there. Although federal officials have known for almost a decade of the health threat that radon poses, no one group has been willing to take on the responsibility of controlling an indoor air pollutant. Luckily though, several firms — including Terradex, an independent testing laboratory; the EPA; and the American Lung Association — have begun to compile research collectively. They intend to help educate the public and have testing devices made available at a low cost. Still, many people have not yet even heard of all of the dangers connected with this radioactive gas.

You may think that it couldn't happen to your home. But you will not know if this colorless, odorless, and tasteless gas is poisoning your health until you take the time to test for it. If you find radon poisoning your home, repairs can be relatively inexpensive. There are even some preventative steps you can take with your home until you finish testing your home:

- Seal loose pipes
- Increase air flow through ventilation systems
- Seal cracks in foundation, basement walls
- Vent sump pumps
- Paint basement floor and walls

For years, no one understood the significance of this naturally occurring radiation that attacks the lining of your lungs. Many families are only recently discovering that they have been living in an atmosphere of such high radiation levels that they have been needlessly exposing themselves to a cancer-causing pollutant. Radon gas can easily be taken care of. Call the Minnesota Department of Health for further information. MT

Heidi Berg is a senior in technical communication with an emphasis in law. She hopes to intern in Washington D.C. this summer as a legislator's aide. Heidi enjoys waterskiing, swimming, flying, travelling, and belonging to a fraternity. She wishes to thank her father for the inspiration and help with this article.

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Fast Tans in the Future?

The detection of a hole in the ozone layer was ignored as a computer error from 1977 until 1985. The possibility of chlorofluorocarbons as a cause for the hole has many people debating the merits of this useful substance.

by Steven Subera

Remember the ozone layer? How about chlorofluorocarbons (CFC's)? Until recently, little had been mentioned about these topics since the United States banned CFC's in propellents in 1978. Scientists have detected an extreme decrease in the ozone layer above the Antarctic. The discovery of this 'hole' in the ozone has renewed interest in the protective layer and has sparked debate.

The hole dates back to 1977, but it wasn't prominent enough to notice until 1981 by members of the British Antarctic Survey. They eventually published their findings in 1985, noting that the hole contained less ozone each year. However, the paper did not stir interest until a NASA satellite provided confirmation of an ozone hole three months later. A NASA mistake had prevented an earlier satellite report. NASA had programmed their computers to disregard the extremely low ozone level readings because they didn't believe such low readings were possible. Evidence suggesting a global depletion of ozone was also released by NASA at the same time.

Ozone resides in the stratosphere (approximately 12 to 50 km in altitude) and is composed of three oxygen atoms. Despite composing only a few parts per million (ppm) of the stratosphere, it absorbs a significant amount of ultraviolet (UV) radiation. UV radiation induces the skin to produce the pigment melanin, and it is this increase in melanin that turns the skin darker, i.e. gives you a tan. However, overexposure to ultraviolet radiation has been linked to skin cancer.

Ozone is produced when an ultraviolet photon collides with an oxygen molecule (O_2), releasing the oxygen atoms. These atoms combine with other oxygen molecules to form ozone. The cycle continues as more ultraviolet light is absorbed by ozone, freeing oxygen atoms for continued recombination. The cycle halts when an oxygen atom strikes an ozone molecule, producing two oxygen molecules. Conversely, ozone below the stratosphere is a pollutant and is produced by sunlight and automobile exhaust.

The exact cause of the ozone hole is unknown and has produced two conflicting theories. Scientists supporting the dynamic view feel the lack of ozone is caused by natural phenomena. Others argue chemicals, specifically CFC's, are responsible for the hole. Ka-Kit Tung of Clarkson University, in Potsdam, N.Y. explained the ozone hole dynamically. Tung used the fact that the highest levels of ozone are found near the poles. Springtime heating in the Antarctic causes ozone-poor air in the lower regions of the hole to rise, forcing out ozone-rich air into the lower latitudes. This results in a perceived drop in the ozone vortex (hole). However, scientists supporting the dynamic theory still agree that chlorine is harmful to the ozone and reduction of CFC's should proceed.

The chemical theory contends that polar conditions produce a chlorine sensitive area. It is the chlorine in the CFC's that produced the hole. CFC's are extremely inert materials. This allows them to rise into the stratosphere unimpeded. Once in the

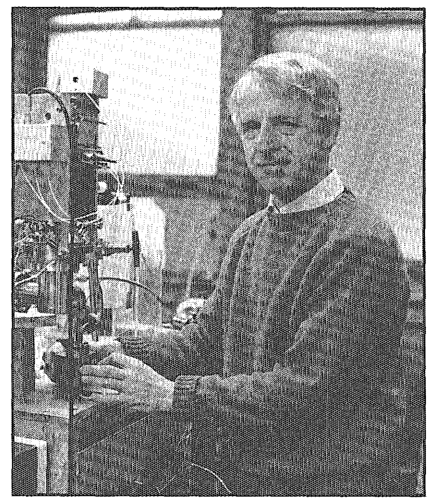


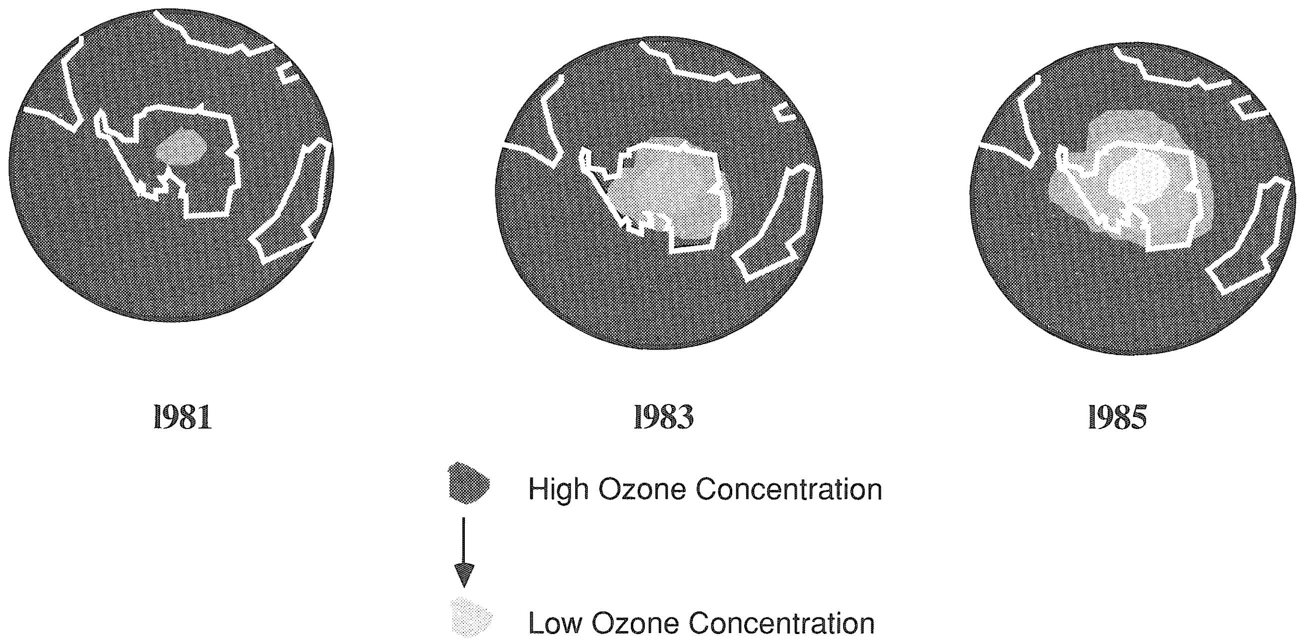
Photo by Paula Zoromski

Professor Konrad Mauersberger uses a mass spectrometer to measure oxygen isotopes in the ozone layer. Most of the data comes from instruments travelling in extremely high-atmosphere balloons.

stratosphere, ultraviolet light breaks down the CFC's and releases the chlorine. Chemists argue that the sensitivity to chlorine in the polar region is due to the unique conditions present. With no sunshine from April through mid-August, temperatures drop to -120° F. These conditions somehow convert chlorine from inactive to active molecules that release the chlorine when the springtime sun reappears.

Locally, physics Professor Konrad

Deterioration of the Ozone Layer Over Antarctica



Source: ***Scientific American*** **, January, 1988.** **Illustration by Chi Hum Paik**

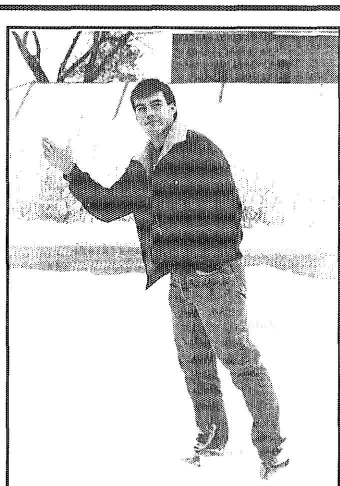
The current ozone-depleted region covers a larger area than the Antarctic continent itself. The region is surrounded by an ozone-rich crescent.

Mauersberger of the University of Minnesota has been conducting experiments on ozone since 1980. He has seen the importance of ozone to the earth's atmosphere and his available instrumentation can make precise measurements of ozone in the atmosphere and the laboratory. Mauersberger's experiments mainly consist of flying balloons into the stratosphere to measure ozone. They are equipped with a mass spectrometer, which that analyzes the gases.

Laboratory testing is also necessary to gain an understanding of ozone properties. Mauersberger's main interest is in the physical properties of ozone. His study of ozone isotopes is unique. In nature, there exists three isotopes of oxygen with molecular weights of 16, 17 and 18. Most ozone is composed of three atoms of oxygen-16. However, heavy ozone can also occur with two oxygen-16 atoms and a single oxygen-17 or oxygen-18. By studying heavy ozone, Mauersberger hopes to understand how the isotopic molecule is formed and how it will behave in the atmosphere.

Mauersberger believes one must note the ozone hole's location to help explain its presence. "First of all, it is a very isolated area in the atmosphere with little air from the outside. Then you have very low temperatures and then you come out of the winter when the sun is on the other side of the globe," he comments. He also said the North Polehas holes, but they were less pronounced with less fluctuation. He believes a mix of the two theories, dynamic and chemical, is correct.

Regarding the status of global ozone Mauersberger says, "It appears there is a small decrease. This would be attributed to the chlorines which attack the ozone high in the atmosphere, but



Steve Subera is a junior in electrical engineering. This is his second article for the *Technolog* . Hailing from the world-famous Colby, Wisconsin, Steve enjoys the normal Wisconsinite pursuits of hating the Minnesota Vikings, eating cheese, and swilling beer. Steve is still trying to find an airline that flies to Antarctica so he can work on his tan down there during spring break.

you have to be careful how well your instruments work. If I send up and measure once in a while it means nothing. Ozone is fluctuating. You have to separate nature's fluctuations from decreases or increases," he says.

Mauersberger's future experiments involve sampling ozone in the stratosphere for the first time and bringing it to earth for testing. "More precise measurements can be made in the laboratory," says Mauersberger. "In flight you are always limited by weight and power." He is currently developing an ozone collector.

The proposed CFC ban has caused controversy because of its many practical applications. In September, the U.S. and 22 other nations signed an agreement to reduce CFC use. If at least 11 nations ratify the accord, CFC consumption would be lowered to 1986 levels by 1990. Usage would be halved by 1999. Despite an aerosol ban, production in the U.S. has reached approximately 770,000 tons a year. CFC's are used in refrigerators, and in the production of egg cartons and fast-food containers. At $1 a pound, they are not only extremely useful, but inexpensive. Finding a suitable substitute has been difficult. There are many different types of CFC's. Most are harmless, but the few that pose a threat are the most useful. Cost is the main obstacle involved in switching from the ozone-destroying CFC's. Manufacturers and consumers will have have to decide if the ozone threat is severe enough to spend more money on replacements. MT

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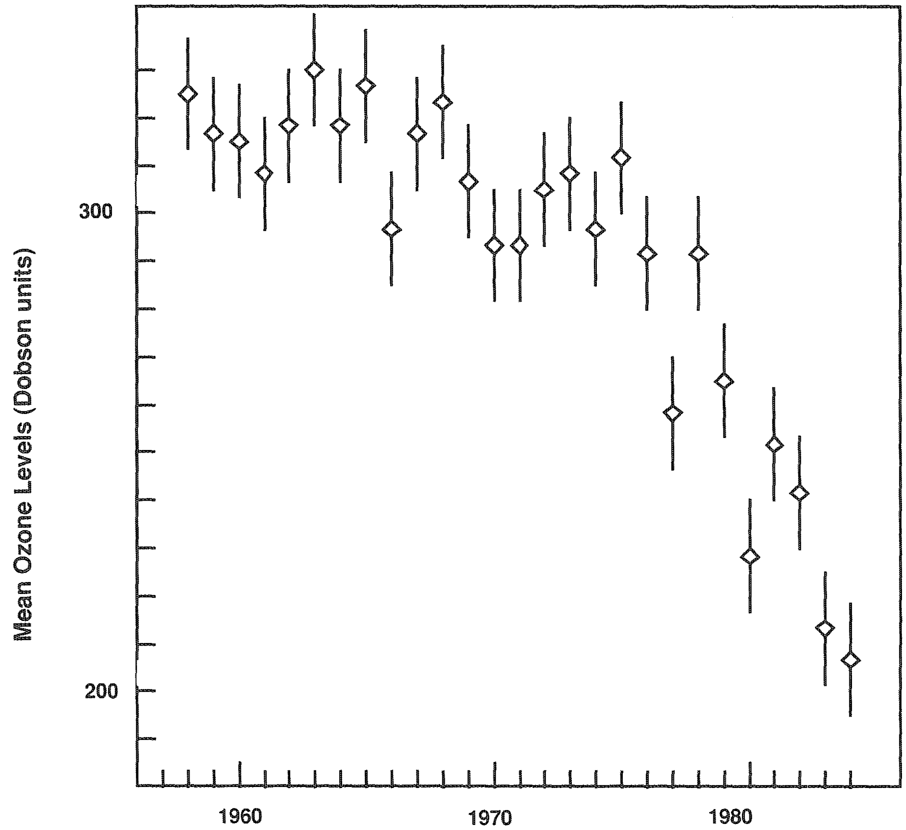

Source: NASA Reference Publication 1162, May 1986.   Illustration by Jerry Fiala

This graph shows the mean October ozone decline for Halley Bay, Antarctica, from 1957 through 1984.

Chlorofluorocarbons and the Ozone Layer

Chlorofluorocarbon gases have been in production for approximately 60 years. Initially, they were hailed as ideal industrial compounds and gained widespread use as aerosol spray propellents, refrigerator coolants, cleansers for electronic parts and foaming agents. Their extreme stability and inertness made them non-toxic, a desirable quality for industrial use. Unfortunately, this property allows the gases to rise through the troposphere (earth's surface to 12km) and enter the stratosphere. Ultraviolet radiation in the stratosphere is strong enough to decompose the CFC molecules, freeing chlorine to affect the ozone.

Chlorine participates in ozone depletion as a catalytic agent, remaining unchanged through the chemical process. A single chlorine atom may break down 100,000 ozone molecules before it is neutralized or returns to the troposphere. When a chlorine atom collides with an ozone molecule (O_3), the chlorine combines with an oxygen atom, resulting in an oxygen molecule (O_2) and chlorine monoxide (ClO). The catalytic effect occurs when the chlorine monoxide collides with another oxygen atom. The oxygen atoms combine, forming an oxygen molecule, releasing the chlorine for renewed interaction.

Log Ledger

by Steve Kosier

SDI Power Sources

In order to implement the Strategic Defense Initiative, many significant and unique problems need to be solved. Not least among these is the power source and energy conversion method that will be used. The requirements for an effective SDI power supply include very high power output for short durations, as well as rapid start and restart capabilities. In addition, the space based power system must be able to survive in space with minimal maintenance.

Among the most promising candidates to fulfill these stringent specifications are two thermal power sources, nuclear and chemical. One proposal for utilizing the power generated from these sources is to have them drive gas turbine engines. According to Robert V. Boyle and Dr. James C. Riple, engineers for the Garret Corporation, "The gas turbine offers the greatest opportunity to exploit the high temperature potential of nuclear and chemical combustion thermal energy sources." The engineers presented their ideas to the 32nd International Gas Turbine Conference and Exhibit last spring.

In the proposed nuclear system, a high temperature gas-cooled reactor would supply the heat. The gas that would be heated and passed through the turbine is hydrogen, cryogenically stored as a liquid. The hydrogen can also be used to cool the reactor, which would eliminate the need for heat exchangers.

The chemical system would utilize cryogenically stored liquid hydrogen and liquid oxygen, and it would burn hydrogen in an oxygen atmosphere. Although the chemical system is unable to generate the power the nuclear system can, its only by-product is water.

Source: ASME News Release

Human Powered Hydrofoil

A world speed record is in the sights of professor Arthur G. Erdman, mechanical engineering professor here at the University of Minnesota. The device is human powered, looks like a bicycle, and moves on water. It is a propeller driven, hydrofoil supported watercraft, and it is being designed to challenge the record of 13.68 mph over 2000 meters. Erdman is the faculty adviser for the project.

The vehicle looks like a bicycle on top, with two floats on each side to keep it up. Pedaling the bike turns the computer designed propellor, which in turn propels the vehicle through the water. The main purpose of the project is to develop the principles of engineering design, as well as computer design principles and manufacturing processes.

Aside from the technical problems, which Erdman thinks are solvable, an excellent bicycle rider will be needed in the quest for the record.

Source: ASME News Release

Pluto's Orbit Draws Near

Pluto will pass within 2.8 billion miles of the earth in 1988 and 1989, its closest visit since 1740. During this time, Pluto and its only known moon Charon will eclipse each other. The nearness of the planet coupled with the eclipse will provide astronomers with the chance to confirm the sizes of Pluto and Charon, learn more about their composition and perhaps gather more data about their surface composition.

Pluto, the smallest planet in the solar system, is covered with a methane snow. This snow is melting, however, as Pluto nears the sun. As a result, Pluto's thin methane atmosphere is expanding because the planet's diminutive mass cannot retain the more energetic methane molecules. The mass of Pluto and Charon together amounts to only 20 percent of the mass of Earth's moon, which precludes the retention of a dense atmosphere, and also makes it difficult for Pluto to retain its atmosphere as it is heated.

Source: ***Minneapolis StarTribune***

NASA's Heavy Launcher

NASA, in an effort to facilitate building the Space Station, is considering a heavy-lift launch vehicle (HLLV). This vehicle would complement the Space

Shuttle, taking over the more menial tasks of building a space-based platform. NASA believes the reusable HLLV will permit increased payloads per trip, be highly reliable, and save more money than would currently be possible using only the Shuttle.

The design criteria for the HLLV are less stringent than for the space shuttle, as the HLLV will have no crew. Less thermal protection will be necessary, and since no costly life support system is required, more cargo space will be available. In addition, the HLLV, by doing most of the heavy hauling, would free the Space Shuttle to do more scientific work that usually requires human supervision.

NASA believes the HLLV could use some of the existing Space Shuttle technologies, such as solid rocket boosters, engines, external fuel tank and existing launch facilities. These already developed systems, NASA says, should cut research and overall costs.

Source: ***Popular Mechanics***

Science Museum

The Science Museum of Minnesota offers many interesting, informative exhibits and programs to the general public. In March, a superconductivity program which will explain what superconductivity is, recent scientific breakthroughs, and potential practical applications will be offered. University Professor Allen Goldman will be conducting the program.

Also in March, the Science Museum's Skywatch Series program takes a final look at the winter skies and its prominent constellations and formations.

Among the March exhibits at the museum is one explaining how television and movie special effects are created, complete with Oscar winning props loaned by special effects artists and studios. As always, Technology Hall has many games which provide insight into the functioning of modern technology.

Beginning Tuesday, March 22, a new Omnitheater film will be at the Science Museum. *Niagara: Miracles, Myths & Magic* captures the breathtaking scenery and fascinating history of the Falls area.

For further information on these or other events, write or call the Science Museum of Minnesota.

"An important scientific innovation rarely makes its way by gradually winning over and converting its opponents: it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out and that the growing generation is familiarized with the idea from the beginning.'

— Max Planck

Wanted:

Rough and Tumble Individuals To Serve As the *Minnesota Technolog* Editor And Business Manager For The 1988-89 School Year.

Candidate Quiz:

1) Are you tough as nails?
2) Do you smoke bad cigars?
3) Have you ever eaten lunch out of a vending machine?

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To apply, simply submit a resume, transcript, writing samples (if applying for the editor position), and cover letter stating the position for which you are applying to the IT Board of Publications, Room 2, Mechanical Engineering, 111 Church Street SE, Minneapolis, MN 55455. For more information, contact Jim Willenbring or Steve Littig at 624-9816. Interviews will be the week of February 29, 1987.

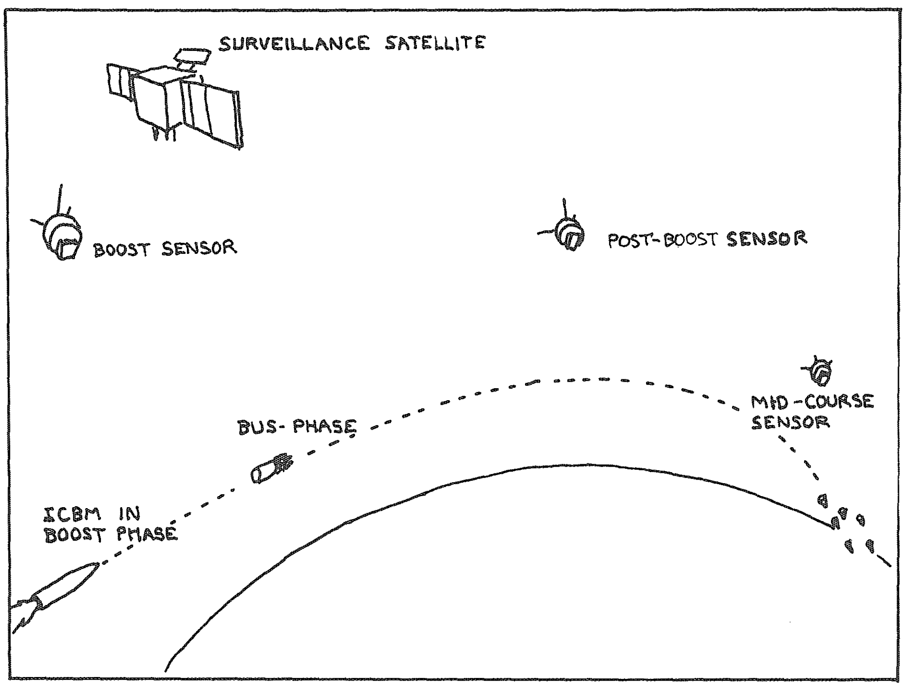
Oh, and about the candidate quiz—even if you "failed" it, that's OK. We encourage you to apply anyway.

DEADLINE: FEBRUARY 24, 1988

SDI Pitfalls and Possibilities

From power systems to software, SDI poses dilemmas not recognized previously. The realization of a defense shield will require advances in many areas, including existing technologies.

by Mitchell Skiba



Source: ***Scientific American*** **Illustration by Conrad Teves**

Figure 1: In the boost phase of the ICBM, the targets are fewer and easier to identify because their booster trail can be detected by infrared sensors on the satellites.

Recently the SDI proposal has been the topic of much debate and study. Everything from moral-ethical implications to technological problems have been discussed. The technological problems are of particular interest to engineers because they may spend some portion of their careers working directly or indirectly on this technology. It is out of this interest that these problems and possible solutions are presented.

The primary goal of a space based defense is to eliminate in-bound enemy Intercontinental Ballistic Missiles (ICBM's). For many reasons the best time to shoot the missile is during the boost phase as opposed to mid-course or reentry. The two primary reasons for this are that the boost rockets are much easier to *see* because of their bright flame, and there are a relatively small number of targets to shoot (see Figure 1). Once the missile reaches mid-course, the booster rockets fall away, and the MIRV's (Multiple Independently targetable Reentry Vehicles) and decoy warheads are allowed to coast to their targets. The number of targets at this stage has grown from hundreds to many thousands. Distinguishing between warheads and decoys would use much of the valuable time needed to target and destroy the actual threat. Additionally, the warheads and decoys are relatively invisible in space because they do not leave much (if any) of an infrared signature.

The main problem of targeting warheads during the reentry phase is that the warhead is armed and can explode in the atmosphere when it is hit. This isn't much of a problem for hardened military sites like missile silos and protected bunkers that can withstand all but a direct hit by a nuclear missile. The problem lies in protecting cities and people. A nuclear explosion in the atmosphere can do as much damage to civilians as an impact explosion.

Most experts working on SDI proposals estimate that approximately 96 percent of the rockets need to be eliminated during the boost phase in order to successfully provide an adequate defense. The remaining four percent could conceivably be shot down during mid-course or reentry. Since the boost phase lasts from 40 to 300 seconds, this time constraint is a major factor in building the defensive shield. In order to catch the rockets, part or all of the defensive mechanism must be in space. There are two major proposals for the space-based system: regular satellites and pop-up satellites.

Regular SDI satellites would be placed

in orbit long before there was threat of a nuclear attack. They would be placed in either geosynchronous orbits, lower orbits, or a combination of the two., The advantage of geosynchronous orbits is that each satellite would always be positioned to cover a specific area; therefore, fewer would be required to be put into orbit. The disadvantage is that they would be sitting ducks for anti-satellite weapons (ASAT's). The enemy would know the location of the SDI satellites and could easily launch an offensive strike at them shortly before making a nuclear attack. Lower orbiting satellites, which would orbit the earth at the speed of the Earth's rotation, would be less vulnerable, but their orbits only allow them to spend a fraction of their orbit over Soviet territory. This means there would need to be more satellites in place to insure that a significant number of satellites would be in a certain area when needed. At over a billion dollars each, the decision to deploy SDI could be adversely affected if a disproportionate number of satellites are needed to be deployed in lower orbits. Moreover, these satellites are not totally free from an ASAT threat either.

Pop-up satellites provide a favorable alternative to orbiting satellites because they are less vulnerable. If based on submarines, they could be hurled into orbit after launched ICBM's are detected. Since the submarines are difficult to detect and routinely patrol the coast of the Soviet Union and neighboring countries, the satellites, once launched, would be in the necessary location to provide a defense.

The primary drawback of pop-ups is that they might not reach orbit in time to destroy the missile before it has launched its MIRV's. Currently, most Soviet rockets use liquid fuel and are known as slow-burn boosters. This means that it takes 100 or more seconds for the missile to complete its boost phase. This provides adequate time for the pop-up to be placed. The concern, however, lies with fast-burn boosters that take 40 to 60 seconds to reach mid-course. The pop-up wouldn't reach orbit until after the critical boost phase of a fast-burn booster. Most of the Soviet arsenal, however, consists of the SS-18 rocket, which takes approximately 300 seconds to finish boost. Many say that it would just be a matter of time before the Soviets develop and implement fast-burn boosters. Rod Hyde, a weapons designer working at Lawrence Livermore National Laboratory, said,

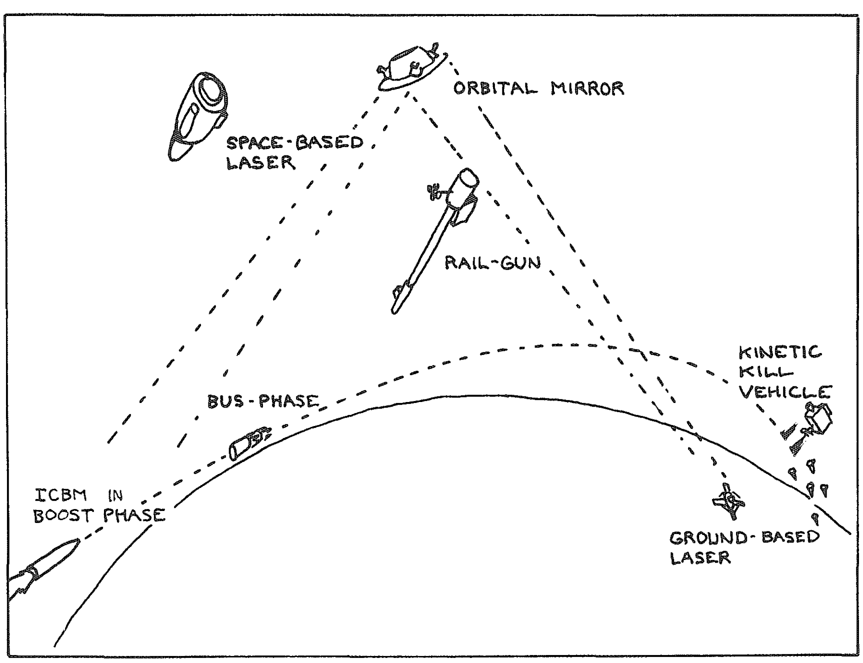
Pop-up satellites . . . can be hurled into orbit after detection of launched ICBM's.

. . . it would take six to ten million lines of computer code to drive the entire SDI system.

> We've had two generations of solid-fuel boosters, and our next one. . .i s only marginally fast burn, something on the order of 170 seconds. It's going to take them a while to come up with a fast burn thing, even with their stealing or knowing that it can be done.

The decision to use orbiting or pop-up satellites is overshadowed by yet another problem: the current inability to target a rocket through the atmosphere where it spends all or most of the boost phase. With current technology we have two weapon-system choices, with a third looming on the horizon. They are kinetic kill vehicles (KKV's), lasers, and particle weapons (see Figure 2). And currently, all have problems entering the atmosphere.

KKV's are basically *smart rocks*. They have a built-in guidance system that would allow them to track, follow, and impact into a booster rocket, rupturing its fuel tank. Once the fuel tank ruptures, the rocket falls harmlessly back into the Soviet Union or Arctic waters. The major difficulty for KKV's in the atmosphere is that they become blind during reentry. The heat generated on their skin, temporarily blinding their infrared sensors, causes them to miss their targets. Accurate course



Source: *Scientific American* Illustration by Conrad Teves

Figure 2: Three possible weapon alternatives for SDI exist: lasers (space and ground-based), kinetic kill vehicles, and particle weapons. Combinations of the different types of weapons may be used to provide maximum protection.

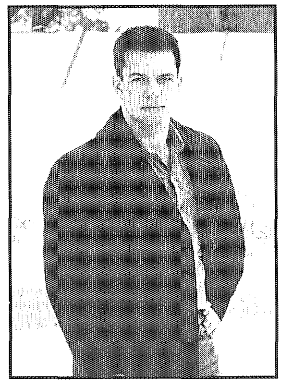
predictions could allow the KKV to intercept the ICBM along its projected path, but it would be difficult to do considering the time, size, and spatial constraints. It is analogous to trying to intercept one bullet with another.

Lasers, on the other hand, would be aimed either by the satellite containing it or from a ground control station. However, as lasers penetrate the atmosphere, clouds and atmospheric disturbances tend to scatter the laser, causing it to lose brightness. Brightness and wavelength determine its ability to rupture fuel tanks or destroy guidance systems. Research is being done to develop smaller wavelength lasers such as X-ray lasers that may provide an amply potent weapon in the future.

Particle weapons are currently in their infancy of development and have their share of atmospheric problems. In particle weapons, a stream of atoms or sub-atomic particles is accelerated to nearly the speed of light and are directed at the target. These weapons would be particularly effective because the beam could penetrate the rocket and destroy the inner guidance system, forcing it off course. The problem is that most particle accelerators accelerate charged particles. These charged particles would be pulled off course by the magnetic field of the earth as they approached their target. Neutral particle accelerators would counter this effect initially, but the advantage would be nullified as the beam entered the atmosphere because a charge would be imparted to the beam by atmospheric gases as the beam collided with them. Once again, the charged beam would not be able to follow its intended course because of the magnetic fields.

After all the technological viability problems have been resolved, the most important factor is whether or not the system will be reliable. Reliability is mainly a function of survivability and ability to function as planned.

In terms of survivability, the system must be able to survive through various levels of degradation; it must not be destroyed all at once. The system needs to be designed in such a manner that, when attacked, it will still be able to function and provide a defensive layer proportional to the damage it has suffered. Additionally, a defense system would not need to be 100 percent effective at stopping inbound missiles to create a useful shield. According to Robert Jastrow, founder of NASA's Institute for Space Studies, a perfect shield is unreasonable, and a 60 to 80 percent effective shield would provide a large enough deterrent.



Mitchell Skiba is a freshman in electrical engineering in the IT integrated honors program. He jumped into college life head first by joining the University men's alpine ski team and the Institute of Technology Board of Publications. Mitchell's home town is Bemidji, Minnesota and he is interested in computer design.

. . . no totally reliable way to debug the program short of a nuclear war. . . .

Looking at SDI feasibility from a purely business point of view, we note that survivability and percent effectiveness play a major role in the cost effectiveness ratio of the potential SDI system. For instance, if several ten million dollar missiles can completely wipe out a trillion-dollar satellite system, the exchange is not equitable. If, on the other hand, several missiles are destroyed attempting to defeat the system and several more are used to degrade the defense system by ten percent, then the exchange would be cost effective: a billion dollars of offensive to counter a billion dollars of defense. The best case would be where it cost more offensively that it does defensively, since this would make it economically unfeasible to pursue an offense.

The most significant problem both viability and reliability have to overcome is the software aspect of the SDI program. The Fletcher report estimated that it would take six to ten million lines of computer code to drive the entire SDI system. With current technology, one million lines is an incredibly complex, risky undertaking. Charles Zracket, vice president of the Mitre Corporation, said,

> If we make a linear extrapolation from our past experience, the overall effort needed . . . would be several tens of thousands of man-years. Extrapolation may be misleading, however. . . it is possible that a team of a few thousands professionals working for up to twenty years might be needed to accomplish this feat.

Assuming the program could be written in a time frame necessary to implement it, there would be no totally reliable way to debug the program short of a nuclear war, at which time it's a moot point. There would of course be rigorous testing and computer simulations, but these would not necessarily represent what would actually happen in a full-scale nuclear attack. Lowell Wood, research director at Lawrence Livermore National Laboratory, makes an interesting point when he stated,

> If it can be believed that offen-

> sive ICBM's — which have never flown over the pole, or over Soviet, U.S., or Canadian territory, or out of a real U.S. operational silo, or in any type of nuclear war environment — are going to throw warheads. . . then surely the same people can readily believe the validity of the defense. . . .

Quite understandably there is much debate and discussion over the reality of a defensive shield. The potential benefits preclude a hasty decision to scrap the idea simply because we do not currently possess sufficient technology to make it work. That is not to say, however, that the plan may not be feasible; it is just too early to come to a conclusion based on incomplete data. There are too many conflicts over projections and data to conclusively say whether or not an SDI system is possible without further research, development, and testing. MT

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> *"Science is emphatically an important part of culture today, as scientific knowledge and its applications continue to transform the world, and condition every aspect of the relations between men and nations."*
>
> **— Vannevar Bush, *Science Is Not Enough***

Assigned Reading

by David Kortenkamp

The River That Flows Uphill

by William Calvin
MacMillan Publishing Co., 1986

Cleverly interweaving notes from a raft ride through the Grand Canyon with musings about evolution, William Calvin has produced a thoroughly entertaining book. While reading Calvin's book, we get both a first person tour through the beauty of the Grand Canyon and a tour through the evolution of man. A neurobiologist by profession, Calvin touches on many different areas in his book including geology, astronomy, physics and computer science, yet he always comes back to a single theme — why are humans so intelligent?

The River That Flows Uphill is written in diary fashion, chronicling a two week rafting expedition down the Colorado River. On the trip, Calvin is accompanied by several other scientists, some lay persons, and a few guides; the conversations between them invariably end up centering around evolution (Calvin freely admits he made some of the dialog up). Following a conversation, Calvin will usually examine some of the points raised in more detail. This type of format provides a welcome respite from the usual third person narration of text books.

Another thing that makes the book so enjoyable is that Calvin isn't afraid to speak his mind. He raises many interesting ideas about evolution which certainly aren't mainstream, at least not yet. He is particularly fascinated by the size of the human brain — why is it so big? He wonders aloud about human's enjoyment of music and art as these certainly don't seem to be traits necessary for our survival. He also has strong opinions about ecology, abortion, Catholicism, and artificial intelligence.

You'll learn a lot reading *The River That Flows Uphill*, and enjoy it too. Peppered throughout the book are many quotations, each making a point that the author felt was best expressed by someone else (Loren Eiseley is his favorite). Calvin subtitled his book "A Journey from the Big Bang to the Big Brain," and a journey it is, with the meandering Colorado River serving as the perfect metaphor for the meandering journey of evolution.

Wilbur and Orville

by Fred Howard
Alfred A. Knopf, Inc. 1987

Frank Howard's biography of the Wright brothers can be divided into two parts — before the first flight at Kitty Hawk and after. Budding engineers will love the first part, as Howard describes how Orville and Wilbur tinker their way into history. They could find no body of scientific knowledge about mechanical flight, so they had to do their own basic research using a home-made wind tunnel to test their theories. Howard shows us the genius of the two bicycle mechanics , each of them possessing the rare combination of scientist and engineer. Howard also shows us the incredible affection these two inseparable brothers had for each other.

The second part of the book merely examines the consequences of the Wright brothers first flight, which is not nearly as interesting. The brothers essentially stop inventing and try to make a buck off their plane. They first attempt to sell it to the United States government, which turns them down, so off they go to Britain and France. The brothers also patent their idea of a vertical rudder and wing warping (the forerunner of ailerons). Since most airplanes, even to this day, use a vertical rudder and ailerons, the Wright brothers, in essence, patented the airplane. The ensuing legal battles occupied much of the Wright brother's time, and Howard often wades too deeply into legal issues.

Wilbur and Orville is presumably a very accurate biography, as Howard was the aeronautical librarian in the Library of Congress and an editor of the Wilbur and Orville Wright papers. He uses excerpts of the Wright brother's correspondence very well. Engineering types will find the first quarter of this book riveting, and the remainder (after the flight at Kitty Hawk), anticlimactic.

The Media Lab

by Stewart Brand
Viking Penguin Inc. 1987

The Media Lab is a book that will catch your eye — literally. The white light hologram on the cover is captivating; even if there was nothing else to the book, the cover is almost worth the $20 price tag. Fortunately, in the case of author Stewart Brand's book, we *can* judge a book by it's cover, as Brand takes us on an interesting and informative tour of MIT's Media Lab.

The Media Lab is where the three areas of broadcasting, publishing, and computers come together as one. The lab is involved in holography, movies, television, education, robots, artificial intelligence — anything that has to do with communication and information. Here's some of the various groups working at The Media Lab — Movies of the Future, Advanced Television Research Program, Computers and Entertainment, and School of the Future. If only a fraction of the projects described by Brand become practical, we're in for a revolution. Imagine, for example, your own personal newspaper compiled by your computer from thousands of other newspapers, news casts, and radio programs from around the world, and containing only articles of interest to you. Making information more accessible is what the Media Lab is about.

Brand, who you might remember as the founder, editor, and publisher of the *Whole Earth Catalog*, explains it all very well; he isn't overcome with awe at what he sees and he asks the right people the right questions . The book does drag a little at the end when Brand discusses the economic consequences of the imminent "information society," but for the most part *The Media Lab* reads as well as it looks.

Pioneering Space

by James Oberg and Alcestis Oberg
McGraw - Hill, 1986

Did you ever wonder what it would be like to live in space? James Oberg and Alcestis Oberg give us a glimpse with their book *Pioneering Space.* They use eyewitness accounts and diary entries from American astronauts and Russian cosmonauts to show us life in space. They discuss the physical and psychological problems humans face as we venture further and further into space, for longer and longer periods of time. Newer editions of the book contain a personal epilogue which has Oberg's thoughts on the Challenger tragedy.

Pioneering Space is an easy read since much of the time the book doesn't really take itself very seriously. For example, there's a chapter entitled "Bathrooms and other places of the heart," where the authors discuss problems we'll have going to the bathroom, taking a shower and making love in a weightless environment. In a more serious vein the book does a good job of describing the psychological effects of long space flight. Recall that some Russian cosmonauts have stayed in orbit for nearly a year — living with the same people in a space smaller than your dorm room. It's a wonder they don't go crazy.

You can't help but notice when reading *Pioneering Space,* that most of the data is from Russian cosmonauts, showing once again the huge advantage they have in long duration space flight research. You also can't help but envy those few who've had a chance to go into space — weightlessness sounds like a lot of fun. Just listen to Don Lind, a scientist on Spacelab 3, describe his return to earth, "This is how the guy must feel when he wakes up from anesthesia and discovers they've amputated his legs . . . I'm going to feel crippled for the rest of my life!"

Was Einstein Right?

by Clifford M. Will
Basic Books, Inc. 1986

Many young scientists are attracted to science by its openness and vitality. Theorems are constantly being created, modified, or rejected in favor of better ones. Nowhere is this more evident than in the transition from Newton's Theory of Gravitation to Einstein's General Theory of Relativity. When Newton first proposed his theorem many thought that physics would become a dead field — all of the questions, they felt, had been answered. Indeed, Newton's theory reigned supreme or more than 200 years. Eventually, though, cracks began to appear in the theorem, prompting Einstein to formulate his theory. How do we know if it's right? Physicist Clifford Will looks at that question in his book *Was Einstein Right?*

Will's book discusses various experiments which have been done to test Einstein's theory. The three most famous tests were outlined by Einstein himself when he proposed his theory. The first dealt with an perturbations of Mercury's orbit which Newton's theory couldn't account for. The second concerns the bending of light, and the last dealt with the slowing down of time. Will describes how the experiments were conducted, and what the results were (I won't give away the ending). Will's book also looks at newer, more exacting tests being proposed, as well as applications of relativity to astronomy.

Was Einstein Right? is difficult to read, not because Will does a bad job, but because relativity is such a difficult subject to grasp. This is not a book to skim through (unless you're an upper division physics major), a careful reading though, will let you understand relativity in a non-mathematical way. The idea of the book, however, is not to explain Einstein's theories but to show the scientific process at work. As great as Einstein may have been, relativity is still a theory, and as Will says, "a theory stands or falls on the basis of its agreement with experimentation." MT

"Success. Four flights Thursday morning. All against twenty-one-mile wind. Started from level with engine power alone. Average speed through air thirty-one miles. Longest fifty-nine seconds. Inform press. Home Christmas."

—Wilbur and Orville Wright in a telegram to their father from Kitty Hawk, N.C., December 17, 1903.

"I do not believe that civilization will be wiped out in a war fought with the atomic bomb. Perhaps two thirds of the people of the earth might be killed, but enough men capable of thinking, and enough books, would be left to start again, and civilization could be restored."

— Albert Einstein, *Einstein on the Atomic Bomb.*

Illuminating LUMINA

The University Libraries' computerized catalog LUMINA provides easy access to many of the libraries' holdings. Here's a look at this system and its future possibilities.

by Mark Werner

Back when today's senior class was filling out their first one-year plans, the University's librarians were looking at their five-year plan and decided something had to be done about the card catalog system.

They realized the successful library of the future will use computers to make their operations more efficient. By 1985, they had found four on-line systems to consider. Eventually, they decided to purchase the Northwestern On-line Total Integrated System (NOTIS) from Northwestern University. "We've taken their software and tailored it to the needs of the University Libraries," says Kathleen Gorman, Assistant to the University Librarian. The University's system has been dubbed LUMINA, Libraries of the University of Minnesota Integrated Network Access.

To date, LUMINA is an on-line catalog that is accessible from approximately 80 terminals in 18 locations around the university. Currently, LUMINA's database includes over one million volumes. By spring of 1989, LUMINA will have grown to include over four million volumes as older card catalog records are converted to machine-readable format.

By spring of 1989, LUMINA will have grown to include over four million volumes. . . .

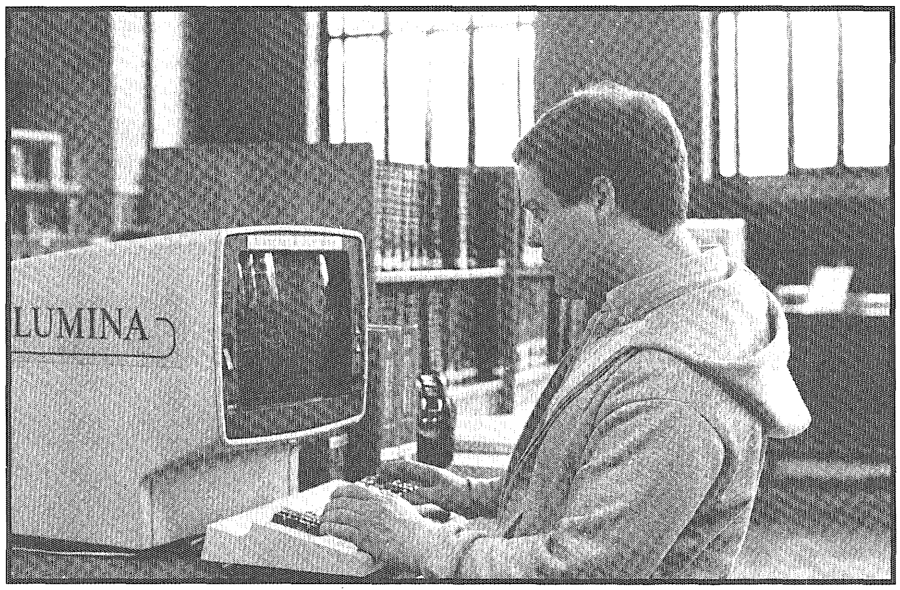


Photo by Paula Zoromski

A student at one of the approximately 80 LUMINA terminals that are found in 18 locations around campus.

Presently, LUMINA allows you to search through many of the holdings of the University Libraries and the Law Library. You must specify a standardized heading found in the Library of Congress Subject Headings . LUMINA offers the choice of searching by subject, author, or title. In seconds, it can produce a card catalog type listing of the holdings in the University Libraries and the Law Library pertaining to that topic. "LUMINA is going to be more than just catalog searching," says Gorman. In the future, LUMINA will boast the following features:

- Cataloging and acquisition

  This feature will allow library staff to catalog new materials on-line. LUMINA will be able to tell if an item is on order or is being cataloged. Cataloging and acquisition will be implemented this quarter.

- Serials control

  This feature will enable library staff to check in on-line individual issues of serials. This will allow library staff to determine which issues are available for the libraries' users. Serials control will be phased in over the next 12 to 24 months.

- Circulation information

Automated circulation will be available by fall quarter of 1989. This feature will allow libraries users to find out if an item is checked out, or at the bindery. The library staff will be able to use this feature to place or remove holds on a student's borrowing privileges, if necessary.

- Key word and boolean search

Users will not be restricted to searching with the Library of Congress Subject Headings once this is implemented. They will be able to search the data base with key words or strings of key words. For instance, users will be able to link words like computer, technical, and writing to see if there are holdings about writing computer software. This option should appear on LUMINA in spring quarter of 1988.

- Remote access

Soon the university's computer labs will be able to link to LUMINA. The computer labs will have access to LUMINA beginning this quarter and other regional libraries will have dial-up access in spring quarter of 1988.

- Gateway access to commercial data bases

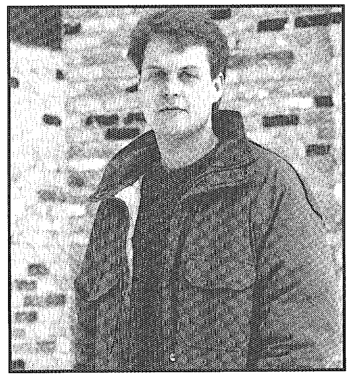
Users will be able to dial-up commercial data bases from a menu within LUMINA. This feature is still in the planning stages with no date set for its implementation.

- Accounting system

Libraries staff will use this feature to keep track of their expenditures for library materials on-line. They will enter the cost of new acquisitions, such as books or periodicals, as they order them, and the system will then provide an up-to-date record of expenditures.

What has started as a simple on-line catalog will grow to become a comprehensive data base not just limited to library information. Says Gorman, "It is nice because we have a decentralized system. . . . [LUMINA] already lessens those restrictions [of the spread out libraries] and will continue to do so as the database expands . . . people are now able to access the union catalog from any library."

With LUMINA at our fingertips, we will be able to cut out a significant portion of the research process and spend the saved time on better quality research. This advancement in technology can only enhance the University's prestige among scholars. MT



Mark Werner is a regular contributor to the Technolog, having been the Editor last year. Mark just started a job as a research assistant for the Rhetoric Department researching managerial communications, so using LUMINA is a familiar area. When he has spare time, Mark enjoys running, downhill and cross country skiing, and playing racketball.

Strategic Defense Initiative Forum

At the end of last October, a unique forum took place here at the University of Minnesota. During the previous school year, many student organizations expressed concern about SDI funded research on campus. Through cooperation with student organizations, faculty, and administration, a forum was organized to encourage all members of the university community to become involved in the following discussions: SDI research here at the U of M, university research policy in general, and academic freedom.

Minnesota Technolog **sent four writers to cover this event that drew nationally known experts in these areas. What follows is a synopsis of the four major presentations.**

SDI Policy and Technology

by Mitchell Skiba

The forum's speakers were Robert Bowman, President of the Institute for Space and Security Issues; and Colonel George Hess, Director of Survivability, Lethality, and Key Technologies, SDIO, Department of Defense. Hess opened by discussing the basic tasks that are required of a ballistic missile defense: detection, tracking, threat-cloud identification, interception and detection, damage assessment, and battle management. After a brief description of each requirement, the rest of the presentation mainly centered around interception and destruction.

The methods of eliminating incoming missiles fall into two categories—kinetic kill vehicles (KKV) and directed energy weapons. KKV's are basically shaped metal projectiles designed to rupture the fuel tanks of a booster rocket. Hess said that at this point in time our directed energy weapons, such as lasers and particle beam weapons, are not advanced enough to do the job. He did, however, indicate that much research was being done to increase the output of the lasers. He said that the goal was to get a multi-megawatt laser, and the SP-100 Project should have a 100 to 1000 kW laser by the mid-1990's.

Hess gave some insights on the Soviet's strategy. He stated that they believe force by itself is not a vice. "Force in the hands of imperialism is the source of military danger," (for the Soviets), according to Hess. The basic conception of Mutually Assured Destruction (MAD) is not the prevalent thought in the USSR either. Hess did not mean to suggest the Soviets thought they could win a nuclear war, but that they did not accept MAD as a long-term alternative to nuclear war.

Robert Bowman began his presentation by discussing the major flaws with the technology and the premise of a space-based defense. The main technological problems dealt with threat-cloud indentification and interception and destruction. In threat-cloud identification it becomes significantly more difficult after the boost phase, when the missile launches its multiple warheads and decoys, to identify possible threats. Additionally, he had some concern over the systems ability to distinguish between ICBM's and peaceful space launches. A whole host of problems exist with the aspects of interception and destruction, including atmospheric penetration, the ability to upgrade, cost effectiveness of the system, and software bugs.

Bowman also dealt with the strategy in terms of politics. He said that the most dangerous time to have the system is when it is half completed. At that time the Soviets might be forced to make a first strike out of fear that we could initiate a first strike once the system is completed, safe in the knowledge that any retaliation would be eliminated by our defensive system. He also indicated that the system could be used for offense as well as defense and that the powerful lasers needed to shoot down ICBM's could just as easily be used to incinerate ground targets.

Overall, both presentations were well-argued and supported. Unfortunately, Bowman played on emotional issues at times rather than directly addressing the topics. He made allusions to the *academic freedom* in Nazi Germany to perform experiments on humans and said that scientists were allowed to decide what to research, but didn't receive funding if it wasn't along government lines. These and similar statements tended to distract from an otherwise well-grounded seminar.

Responsibility in Research

by Kirk Nelson

The first speaker was Dr. Alvin Compaan, a professor in the Department of Physics and Astronomy at the University of Toledo. Compaan began his presentation with a historical overview of the SDI program. He sees SDI as a "program conceived in naivete, driven by political considerations, but supported to the [extent of] religious fervor which borders in some cases on madness." He contends that support for SDI comes mostly from the preconception of lasers as a magical death ray. He believes it is the duty of scientists and professors to correct this and other scientific misconceptions. Although he does not approve of "a mechanical, legalistic description for accepting or rejecting SDI money," he thinks he has a responsibility to warn his colleagues about the pitfalls of SDI research money: the possible unstable funding levels, classification of results, lack of peer review, and most importantly, the ethical concerns of accepting money for a project that is "scientific nonsense."

The second presentation was given by Ettore F. Infante, Dean of the Institute of Technology and professor of Mathematics here at the University of Minnesota. Infante believes that the allocation of research funds is a political decision: a decision that each individual is responsible for changing at the political level. His personal sentiment is that researchers "signing the 'no SDI research' statement should be protected for making a political statement, because that is what it is." He pointed out that the Department of Defense (DOD) accounts for only 2.9 percent of basic research funding at the University of Minnesota. Of this, only two grants totalling $230,000 (less than 0.5 percent of the total government funding) come from SDI. He concludes that the DOD has little effect on total university research.

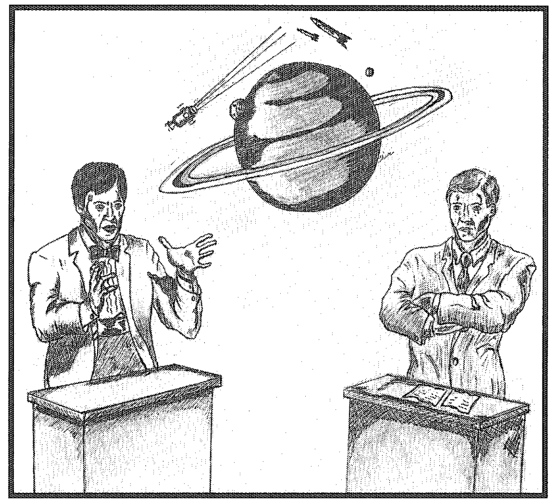


Illustration by Thomas J. Rucci

The third viewpoint was presented by Vera Kistiakowsky, professor of Physics at the Massachusetts Institute of Technology. Kistiakowsky spoke about the differing missions of the universities and the DOD. She stated that the aim of military basic research is to demonstrate a concept, while university research is information oriented. She found these differences incompatible because of the choking of the transmission of information to colleagues and the public, which is inherent in DOD research. Kistiakowsky also has a problem with a university policy of no SDI research. She said you must "do what you can on your own turf." She also would like to see a change in the way university administrations ask for more research money. "University presidents are going to congress and asking for more DOD funding, but they should be asking for more National Science Foundation money and stop asking for DOD money."

The final speaker was Ian H. Maitland, an associate professor in the Carlson School of Management who holds a doctorate in sociology. Maitland's topic was "SDI and the universities obligation to political neutrality." He stated that the public sees "sometimes more clear than others, that there is some value to making the university safe for heretical views, because today's heresy may be tomorrow's conventional wisdom. . . ." Maitland also believes that to allow full diversity in views, the university must let researchers decide for themselves whether to accept or reject research funds. If universities imposed a political stance on SDI research, then the public may demand that the stance be that of the public's, which would override the political neutrality of the universities.

The session ended with short comments from each speaker. Kistiakowsky and Compaan agreed that matching non-SDI funds should be made available in SDI dominated fields so researchers would have government funding alternatives. My opinion is that this is an unrealistic solution. It would be better to lobby for the stop of SDI funding if that is the goal. All of the speakers at this session did agree that a policy for a university administration to limit SDI research was unwarranted.

SDI and Arms Control

by Kevin Cummings

This first session of the Strategic Defense Initiative forum addressed the problems of arms control in space. In it, Dr. Keith Payne and Dr. Kosta Tsipis debated the broad issues involved in SDI.

Payne, Vice President of the National Institute for Public Policy, began with an outline of what he saw as two competing views of SDI. First was the desire to restrict space-based SDI, in order to get arms control successes.

In the second view, Payne saw that SDI is compatible, if not essential, to the reduction of nuclear threats. He saw these two goals as mutually incompatible and advocated the second approach.

Payne believed that previous arms control policies such as SALT I and II (Strategic Arms Limitations Treaties) were based on an action/reaction policy of a spiraling arms race. In other words, as the U.S. builds up arms, the USSR does also, and vice versa. To control this, SALT I and II also assumed an inaction/inaction policy, Payne said. He described this as when the U.S. doesn't build an Anti-Ballistic-Missile Defense (ABM), the USSR will not build any more missiles.

Therefore, it is the opinion of Dr. Payne that if we design and deploy a system capable of destroying ICBM's, based either in space or on the ground, it will make the ICBM's useless and as a consequence, reduce the number through further arms control agreements.

Tsipis, Director of the Massachusetts Institute of Technology's Program in Science and Technology for International Security takes the opposing view of Payne. Tsipis first noted that although the U.S. has begun SDI research, we have also been working on anti-satellite weapons. Tsipis sees this as a great danger to an SDI system because before the anti-missile system could be put up, there would be weapons capable of shooting down those satellites. This would begin a space race to protect each country's satellites weapons and anti-weapons, and the arms race would continue.

Tsipis also brought up the difference between research and development. He said some pro-SDI groups have said that research into SDI would produce spin-offs into non-weapon technologies. Tsipis feels that this would not happen because most of the money being spent by the Department of Defense goes to development and deployment instead of research.

Finally, Tsipis pointed out that since the administration wants both sides to have SDI (something he says he doesn't think the military will like) there will be more problems. For instance, if we limit missiles to 500 for each side, and the Soviets manage to hide 1000 more, their SDI system will not be able to stop all of our missiles especially since we use the triad system of ICBM's, bombers, and submarines to deliver our warheads. This means the Soviets will still be worried about penetration, so they will increase their warheads to keep up the deterrence.

I was left with unanswered questions after the discussion. I would have liked Payne to explain why an arms race wouldn't develop to try to make the anti-missile system and the missiles safe from attack. And why would the two sides allow the missile quantity to drop to the 200 to 300 level, the level at which Payne projects would be defensible using an SDI system? I also wanted to ask Tsipis what would prevent a reduced number of missiles, without anti-missile systems, from being used anyway in a nuclear war?

Academic Freedom and U of M Research Policy

by Marty Koshiol

The remarks of University President Ken Keller opened the session. He answered the question of how University research policy should be affected by the advent of SDI research funding. He began by stating examples of the University's current research policy. The University, for instance, doesn't engage in any secret research (which has the incidental consequence of keeping the University out of weapons research) because it conflicts with the University's commitment to academic freedom. Research done on humans and animals is also limited by University policy. The University won't allow research that results in the misuse of animals, nor in research on humans that is inconsistent with the way we normally treat them. Although the University can't be said to have complete academic freedom because of these restrictions, the compromises made are reasonable in light of ethical considerations.

Should such considerations prevent us from participating in SDI research? President Keller asked a number of questions that he said needed to be considered before we decide how we could, or if we should, develop a constraining policy for studying SDI. Among these questions were whether or not we have the right to suppress any kind of knowledge by prohibiting a specific type of research, and at what point do we begin suppressing knowledge (that is, what reasonable prohibitions should be allowed, such as animal abuse). Research can't be clearly divided into *good* and *bad.*

Keller covered many concerns regarding how the University research policy should respond to SDI, but failed to offer answers or even suggest his own inclinations. Perhaps his administrative position requires him to be politically neutral, but his position as a member of the forum seemed to require the opposite. Though he was the convener, it would have been enlightening to hear his suggestions.

Harlan Cleveland, professor and former dean of the Humphrey Institute of Public Affairs, offered his perspective as an educator of policy planning in the public sector. He began by summarizing the points on which all speakers that day agreed. Primary among these was the point that universities are institutions that seeks truth, but as institutions don't hold a view on any political issue. Although universities, as institutions, don't have a point of view, the people that comprise the universities are free to offer their opinions. As a result of this commonly shared view, Cleveland stated that no speaker nor institution present has stated that banning SDI research is a good idea. In the same way, he's heard no objection to the idea of individual professors refusing to accept SDI funding for their research.

Cleveland finished with a summary of his own conclusions regarding to whom the issue of SDI research belongs. He agreed with Keller that we must carefully consider who should make the decision of University research policy. However, he added that the public, through the legislators, should definitely have a part in that decision. He mentioned previously that this is very much an issue for each scholar, and that the question of whether or not to research SDI was a complete *non-issue* for the University. Cleveland also mentioned the importance of faculty members to not unconditionally refuse all research in areas (such as laser technology) that happened to be involved in SDI research also, even if those faculty find SDI morally repugnant. Cleveland made intelligent, although quite brief, remarks on behalf of the public sector. He concluded by saying that it was not the place of the University to attempt to halt SDI in a broader sense, but that it is the responsibility of citizens to think hard about the issue and to have a view on it.

Kosta Tsipis, Director of the Massachusetts Institute of Technology's Program in Science and Technology Policy for International Security, was the last of the main speakers. He stressed the importance of academic freedom, stating that failure to protest it vehemently would be "fatal to research in this country." Interference to this freedom could stem from either external political pressures or internal censorship. Paradoxically, the pressures that government imposes by fund allocation are, in a way, necessary. Tsipis said the government tries to convince the universities to engage in certain (worthy) kinds of research—like superconductivity, cancer, or AIDS—through appropriate allocations to various research funds. Since maintaining academic freedom is an imperative, there must be some balance struck between absolute academic freedom and government control.

Tsipis also expressed his belief that both scientific and nonscientific people find the idea of *Star Wars* fraudulent. It creates an arms race and damages national security by removing manpower, skill and technology from the marketplace, and by distorting research that must be internally coherent.

Tsipis concluded his statements by saying that since academic freedom must be protected, any far reaching policy that could prohibit SDI research must be accomplished by working actively against SDI at the political level (since the university making rules would restrict academic freedom). Tsipis' remarks were most convincing—well-argued, well-supported, and well-acquainted with the relevant information.

In deciding what should be done regarding SDI research at the university level, the forum's final speakers concluded with similar answers. Keller offered several concerns. Cleveland noted that it was a concern for faculty or research members only, that a policy shouldn't be developed on a university level, and that the public should somehow play a role in determining whatever policy is developed (though he never clearly explained what kind of policy this could be). Tsipis argued that maintaining academic freedom is our most important concern, and that it must resist pressures from both universities and the government to thrive. However, he recognized that the government needs to play some role through the way they allocate money for research, and that some balance must be reached. MT

Technotrivia

by Jim Willenbring

Questions:

1) It was once believed that a substance called the "ether" permeated all space and was the medium of electromagnetic waves. A crucial experiment was performed to detect the presence of the ether and its results were very enlightening. Who were the two men who performed this experiment?

2) A famous suspension bridge in the state of Washing ton tore itself to pieces when the wind happened to hit its resonant frequency (this is a standard intro ductory physics film). What was its name?

3) Who said, "The most beautiful we can experience is the mysterious. It is the source of all true art and science?"

4) What do the radio terms AM and FM stand for?

5) What *personal* computer currently in the planning stage will have the computing power of one the first supercomputers, the Cray-1?

6) Who said, "Houston, Tranquility Base here. The Eagle has landed?"

7) When does the twenty-first century officially begin, on January 1, 2000, or on January 1, 2001?

8) What is the voltage of a heavy-duty bolt of lightning?

9) While on the topic of lightning, are men or women more likely to be struck by lightning?

10) When a computer program has errors, we say it has "bugs." Where did this term originate?

Scoring:

0-1	So you must have slept during those lectures, huh?
2-5	Average. But we all know being average in IT will not get you good grades.
6-8	You're David Letterman's top ten list writer, aren't you?
9-10	Yeah, right.

Answers:

1) Albert A. Michelson and Edward W. Morley were the famous scientists who conducted that experiment. In fact, last year was the one-hundredth anniversary of the experiment.

2) The bridge's name was the Tacoma Narrows Bridge.

3) Albert Einstein, in *What I Believe*.

4) AM stands for Amplitude Modulation while FM stands for Frequency Modulation. Take two points off if you are in electrical engineering and you missed that.

5) The Apple Macintosh III.

6) Neil Alden Armstrong, on the Apollo 11 mission.

7) Bonus question. Both answers are correct. Since there was never a year 0 on our calender, it presumably started in the year 1. Adding 2000 to this would give us the year 2001 as the beginning of the twenty-first century. However, in the nineteenth century, the changeover was celebrated both years, so you can assume that people will use this precedent to do the same.

8) 100 million volts. Give yourself credit if you were within 1 volt.

9) According to a University of Michigan study, men are *six* times more likely to be struck by lightning than women. That must be the reason that women want men to bring the car around when it is raining.

10) According to one version of the story, the term "bug" was coined when the first computer, the ENIAC, crashed without warning. Technicians later discovered that a moth had been caught and fried in one of its electrical relays, causing the ENIAC to come to a grinding halt.

Technocomics

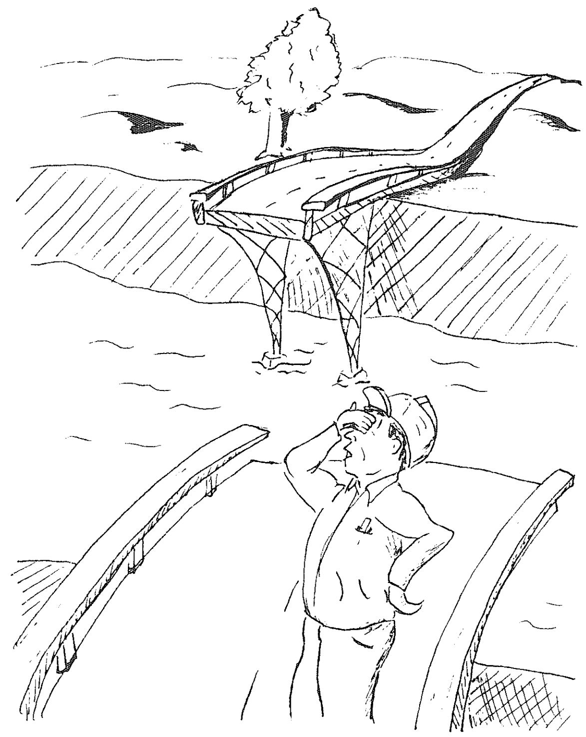
The Near Side

by Steve Littig and Conrad Teves

After calculating the fluid flow for the system, the viscosity of the water, and the thermal conductivity of his shoes, Roger determined that yes, indeed his feet were getting wet.

The Flip Side

by Jim Willenbring and Tom Rucci



Harold now realizes why there was no partial credit in many of his engineering classes.

A Thousand Words

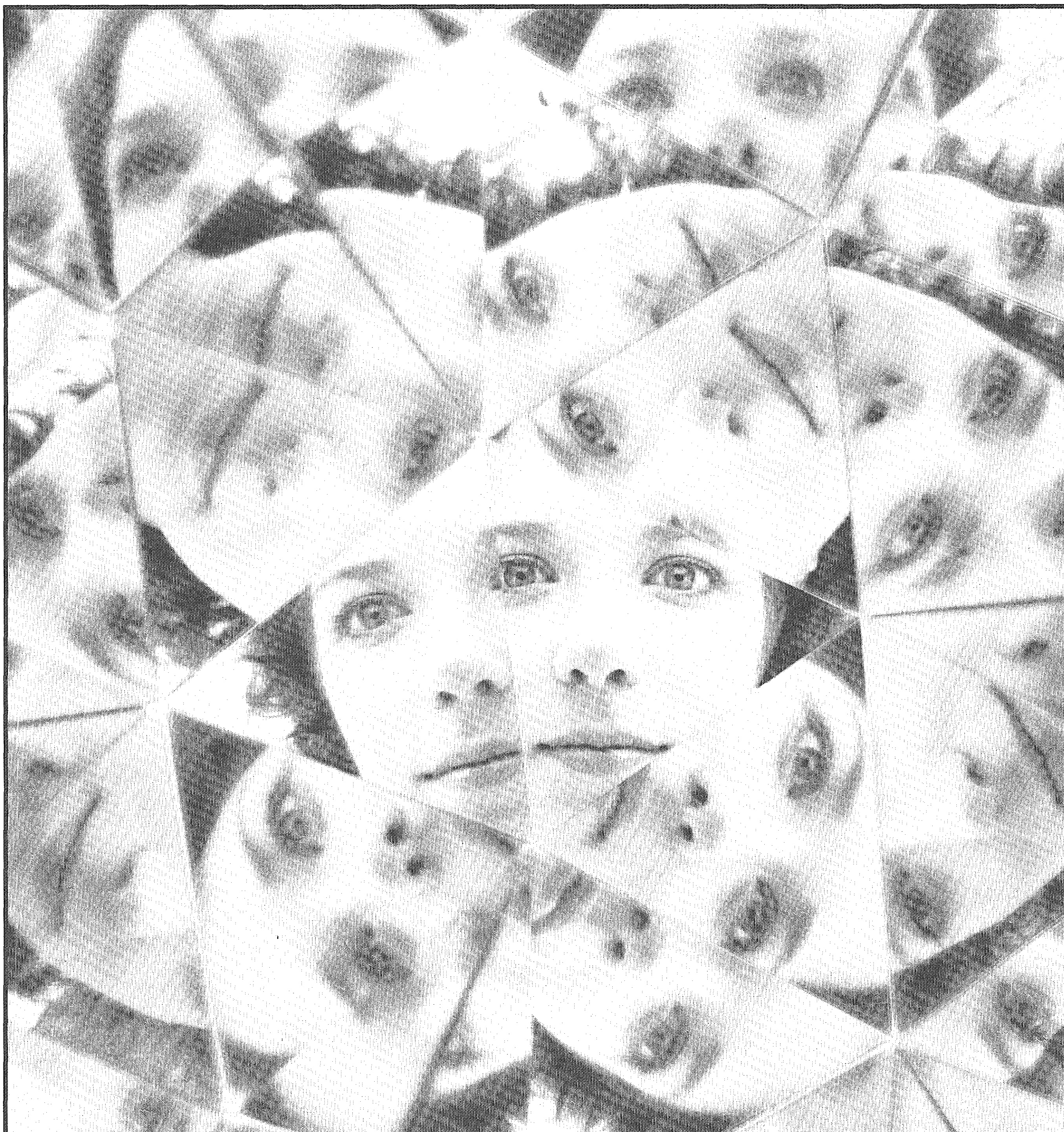
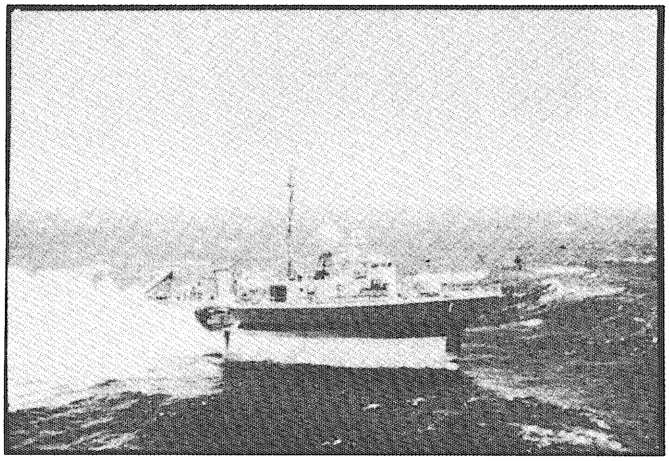
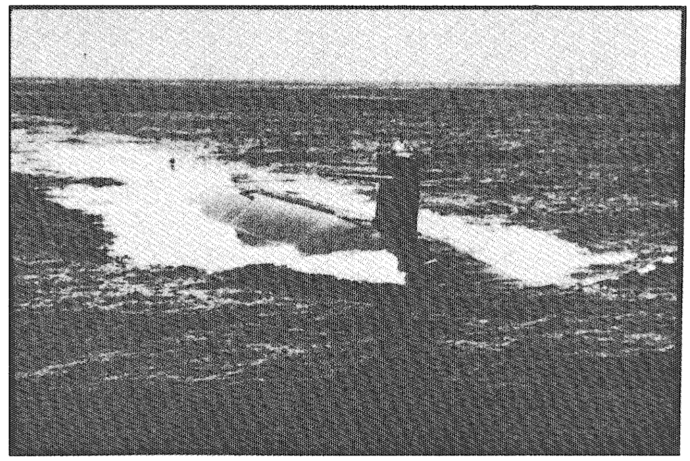
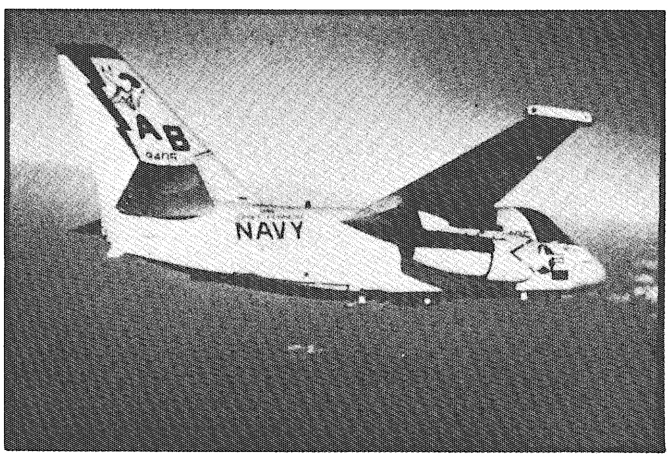


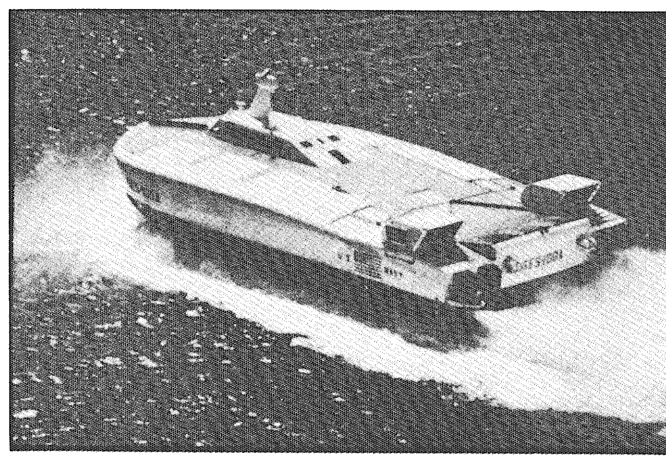
Photo by Paula Zoromski

LEADERSHIP AND MANAGEMENT EXPERIENCE UNEQUALED BY INDUSTRY.... WHERE?









Current technology and its influence on the United States Navy is creating a demand within the fleet for technically qualified line officers. Because of this demand, the Navy is offering a two-year scholarship program through Naval ROTC designed for college sophomores and juniors pursuing engineering and hard science curriculums. This program allows qualified students to obtain a commission in the United States Navy and continue on in surface line, aviation, or nuclear power. Let your last two years of college prepare you to be someone special! If you are interested in applying for this opportunity please call

LT Clay Sellers
NROTC Unit/Department of Naval Science
203 Armory Bldg.
15 Church Street S.E.
University of Minnesota
Minneapolis, Minnesota 55455-0108

(612) 625-1030 or 6677

THE NAVY

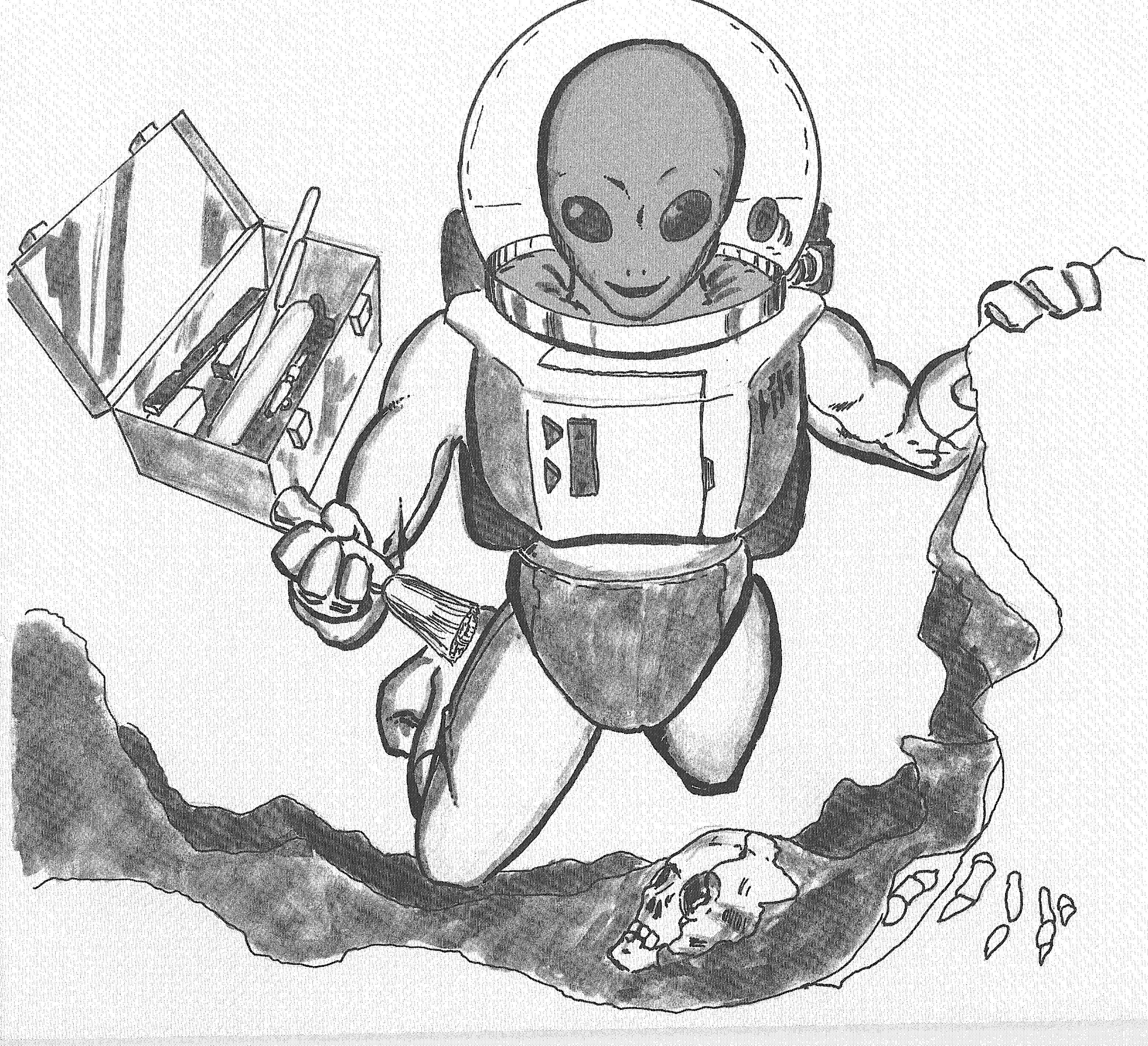
minnesota

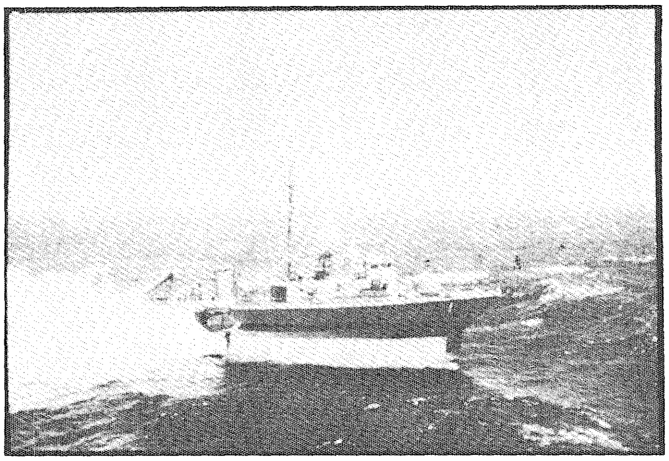
Spring One, 1988

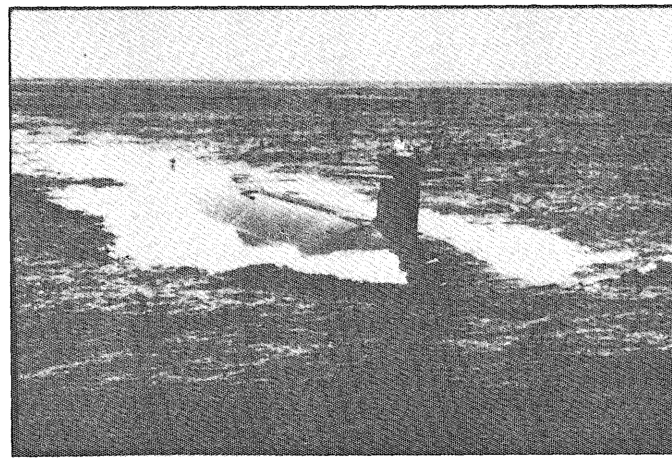
TECHNOLOG

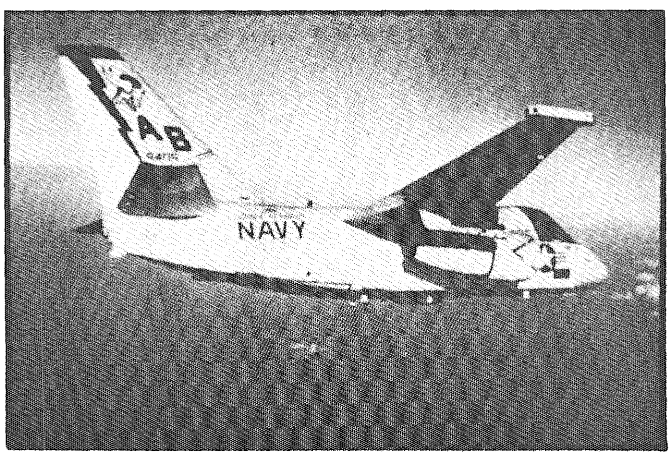
Future

- Harkins Interview
- Sci-Fi Winners
- Sci-Fi History
- Year 2000 Computer





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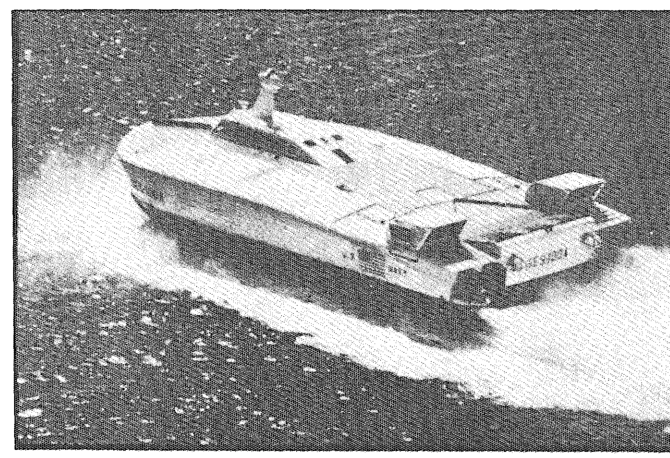

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minnesota
TECHNOLOG

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Future

Features

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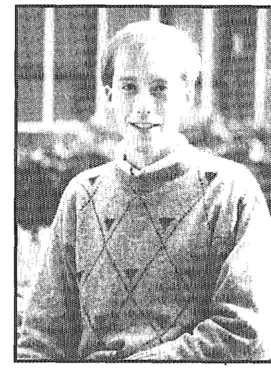
Illustration by Conrad Teves

Editor's Log

Messenger of Tomorrow



1) What name does James T. Kirk's middle initial stand for?

2) What is the name of the ship's computer in the movie *2001: A Space Odyssey*?

3) What is the registration number printed on the hull of the starship Enterprise?

I bet at least half of all Institute of Technology students would be able to correctly answer these three science fiction trivia questions. I even know a few who could answer 99 out of 100 obscure *Star Trek* questions right. Along the same lines, *Minnesota Technolog* sponsors a science fiction contest every year. Although the response has not been overwhelming some years, the contest and the winning entries are looked forward to by many. Why does science fiction appeal so much to science and engineering students?

An obvious, outward reason is that students studying science and preparing to use it in their careers later would naturally be interested in fiction that involves science. However, I think there is more to it than that. Science fiction tickles the imagination, giving people a glimpse of the glorious and the horrifying things that may exist in the future. Engineering and science disciplines naturally strive toward the future, discovering new technologies and finding out how to better describe and predict the phenomena that happen around us.

Science fiction offers a way for engineers and scientists to dream what their profession could do and be in the far future. It is something that few other professions can say about themselves. Who knows what art, music, accounting, or interior design will be like in ten, fifteen, or twenty-five years. Actually, if you think about it, what many professions will be like in the future depends largely on advancements in technology. But technology we do have an idea about, or at least an inkling. And through this inkling,

. . . a glimpse of the glorious and horrifying things existing in the future.

science fiction writers dream and scientists and engineers create to keep up with this dream. Vannevar Bush best said it in the title of one of his books: *Science: The Endless Frontier*.

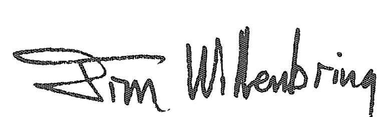
The genre is reaching an age now where some of the early science fiction was written about our current time. Some authors have exhibited eerie precognitive ability by predicting discoveries and developments that happen many years after they have written. Thankfully, only a small percentage of science fiction is correct about what may happen in the future, but enough writers have played the role of harbinger to show that science fiction and the actual future of technology are intertwined.

George Orwell's Big Brother never truly appeared in our 1984, although if you look hard enough, social and technical traces of the novel *1984* are around in our society today. Jules Verne was sending submarines around the oceans of the world long before the idea of submersibles was even thought to be feasible. A more high-tech example is Arthur C. Clarke's prediction of communication satellites circling the globe in geosynchronous orbits. H. G. Wells ominously once said in *The World Set Free*,

> Nothing could have been more obvious to the people of the early twentieth century than the rapidity with which war was becoming impossible. And as certainly they did not see it. They did not see it until the atomic bombs burst in their fumbling hands.

The uncanny thing about it is that he wrote this in *1914*. Science fiction doesn't just predict the good events, unfortunately.

Doom or glory, science fiction can be seen as the messenger of tomorrow, a forerunner of what today's technology inspires in writers. Who knows? Maybe the warp drive will be invented, hyperspace will be discovered, and robots will become more intelligent than humans. **MT**



Jim Willenbring
Editor

Arthur Harkins and Anticipatory Science

Required science fiction courses, anticipatory education, cultural revolutions, and even relationships with robots are just some of the events University Professor Arthur Harkins sees in the future for students and society in general.

by Susan Curran

Who else but a futurist would own five television sets, three answering machines, and would be going on his third satellite dish because he "wore out" the technology? Assistant Professor Arthur Harkins believes America needs to push itself into the future. He's doing his part by teaching graduate-level anticipatory studies and consulting for Visionary Management.

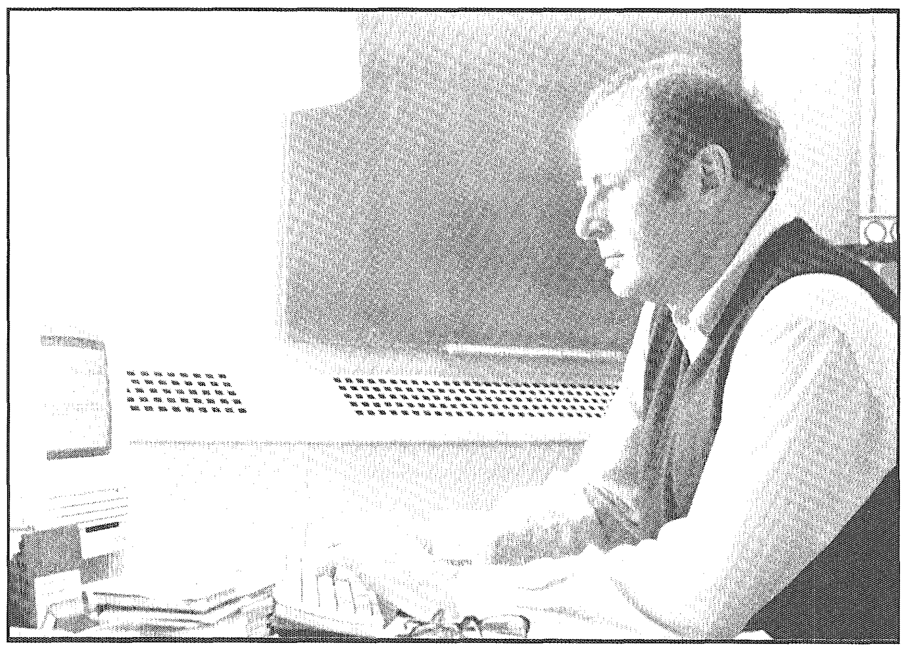


Photo by Paula Zoromski

Professor Arthur Harkins teaches graduate concentration courses in anticipatory science in the College of Education.

Harkins' interest in the future began in high school. He was an avid science fiction reader and constantly spoke of the future. A grade average of C- proved deceiving when he took an IQ test while in the armed forces and received a score of almost 170. He earned his bachelor's degree in psychology and sociology at the University of Kansas, his master's degree in sociology at the University of Massachusetts, and his doctorate in sociology at the University of Kansas. While an undergraduate he worked for Radiation Incorporated on a classified Air Force project. He didn't know what he was working on exactly, but whatever he did must have been impressive because after graduation he found himself part of a think tank in Orlando, Florida with a radiation biophysicist, an anthropomortrist, and an electrical engineer. They were developing a foam habitat to be placed on the Moon so a three-man Air Force team could work there for a six-month period.

"I knew what it was like to work in my fields of anthropology and sociology with a long-term frame of reference—five, ten, fifteen years into the future," Harkins says. "I knew there were grave difficulties and great opportunities involved in associating new ways the hard sciences and soft sciences and the human systems approach."

Harkins has been teaching at the University for more than twenty years. Currently he is a professor for the graduate concentration in anticipatory anthropology and education offered through the Social and Philosophical Foundations Department in the College of Education. Students in this program "re-invent" themselves by learning new ways of thinking about the world that will help them in their future jobs.

"There is no place for them to be hired as anticipatory anthropologists when they leave here, so they are going into consulting or going back to their existing job and doing it differently or to a different location within their existing company," Harkins says. "Our graduate students are a lot different because they know more than one paradigm of science. They know several paradigms, and they are able to work with these as tools rather than simply being zealots, advocates, or brainwashed within that original science framework or some other alternative scientific framework. We teach people here to look at science as just another tool, it's a macro tool. There are many subsets of science, smaller tools. Let's just call science a toolbox. These tools are really different paradigms of science itself. The students have to be willing to take the guff and gaff from orthodox positivists who knee jerk their way through a statistics class and a conventionally taught methods class and think they understand science."

Harkins believes the University doesn't supply enough support for anticipatory studies. "It's a trial-by-fire because the University of Minnesota is not a very adventuresome university when it comes to alternative paradigms of science," Harkins says. To help remedy this Harkins has several suggestions. First a science fiction literature course should be required course work for technology students.

"Surely we can clone humans now that we can clone cattle."

"Maybe it should be called Speculative Fiction and Its Relationship to the Emerging Professions," Harkins says. "It's perfectly legitimate; there are so many professions in quality science fiction literature that don't exist yet but are logical extrapolations of existing innovations or even existing professions. We live in such a rapidly changing world that probably in the next twelve years we'll invent more knowledge than that's been invented in the past 2,000 years. When I look around at the number of industries, not to mention curricula to be developed in what I call the interface sciences areas, it's not just speculative fiction where you're interfacing. It's alternative paradigms of science. It's overwhelming. It calls for either a renovation of much of what universities do, or it calls for the institutions to which people will go as alternative choices and spend their developmental time. I think the main driver to make that happen will be the privatization of education so that people can vote with their feet and their tuition money when it comes to such things as courses in speculative fiction that interface with the idea of new professions or altered professions."

The University is the logical place to discuss the future, according to Harkins. Science fiction could be used to culturally prep society for the future by by visualizing how we might handle similar situations that occur in fictional stories. "Science fiction fuels connective intuitions in the same way that a story line fuels connective intuitions throughout the history of humanity, " Harkins says. "We used to use stories as the primary way to be able to learn because we didn't have any literacy to speak of. Science-fiction allegories are miraculously able to knit together some pretty unusual extrapolations of science and technology changes as well as sociological and other changes with some identifiable human or alien culture base."

Harkins believes that the inevitable future should be understood by every human being. Technology won't wait for acceptance. "It's necessary, not just useful, to translate something such as sentience in a robots and sapience in an advanced robot to Joe Six-Pack," Harkins says. "You have to use metaphoric examples from the world you understand and then make the extrapolation to the concept. I don't think the world will wait for campuses, and I don't think the world is going to wait for religions. We're inventing a bunch of new institutions that are becoming tomorrow-maker institutions or pathfinder institutions that are leading the way for the slower, more 19th, 18th, and 17th century-oriented institutions such as the universities. The future of robotics, of machine intelligence, of androids and so on, is in an advanced stage of development. My God, just a few years we were told we'd never be able to clone a human being; it's too complex. Well, we just cloned a bunch of cattle. Surely we can clone humans now that we can clone cattle. We've probably already have done it. It's absolutely unbelievable. We now have the capacity to clone ourselves and make spare body parts for ourselves, but of course the ethics are incredibly difficult. What's so fascinating about humanity is that we are inventing our new disciplines, professions, industries, and our new needs for expanded educational services and training services all the time."

". . . to alter the way we see ourselves and what we do . . . will mean a cultural revolution."

Preparing society for the future needs to happen now. Most of these changes need to be made at the collegiate level. Professionals in the technological field as well as in the social sciences need to diversify their interests and talents to meet the needs of the future. "Much of what we now do in classrooms ought to be automated to disc or tape. There would be huge amounts of resultant time to convert those classrooms into think tanks where not only a master's degree student in a new biomedical program can invent his own thesis or own program," Harkins says. "Everybody can create their own program, but under contract with the agency providing the educational service. There is that much diversity potential out there and there is that much need for diverse people right now. We at the University only value two kinds of intelligence at this point: cognitive intelligence where you pass tests and you write essays and you please your mentor or professor by doing orthodox and athletic intelligence, and I might add artistic forms of intelligence that are low on the scale of importance. There are probably twenty-five or more different types of intelligence, not just three or four. The future of the United States and of our species depends on finding out what these forms of intelligence are and amplifying their use and exploding the application of that amplified intelligence in new industries, new lifestyles, new arts, new sciences, new technologies, new forms of cooperation within our own species as well as with those new

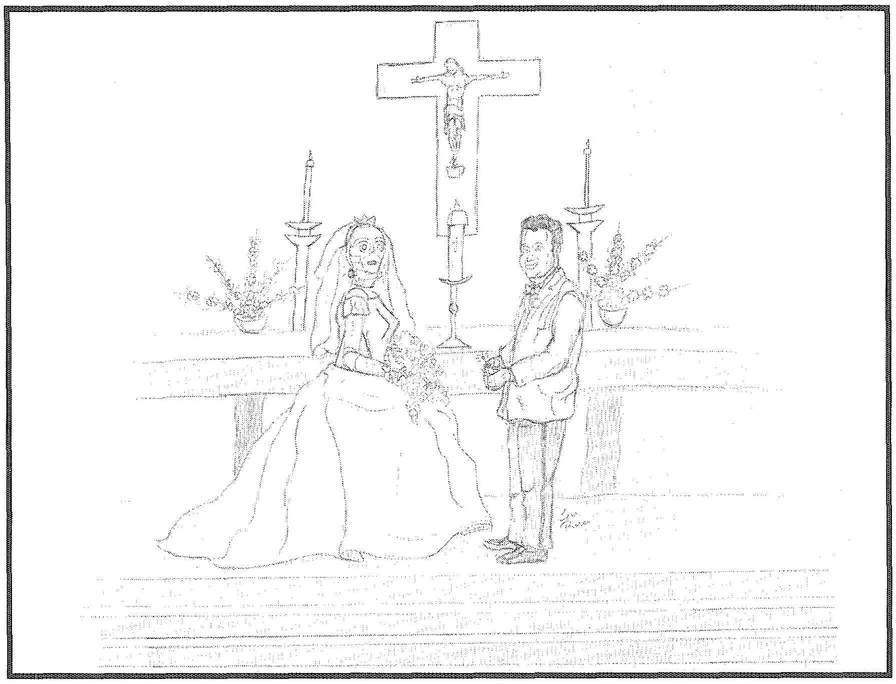


Illustration by Thomas J. Rucci

forms of intelligence we invent and as they go to re-invent themselves. "

Harkins believes top management should consist of people willing to take the risk of welcoming futuristic approaches instead of conforming to an obsolete set of performance expectations. "We need the ones with applied imagination," Harkins says, "the ones with vision, the ones with the courage to experiment with their lives, the ones who think horizontally with respect to others, the ones who openly display their ideas and know the shelf-life of a new industry is going to be shorter and shorter as the industry is first developed because competition will come in and take the industry through different step functions within months, and soon within weeks, as artificial intelligence comes in to help us.

"We now have a need to prepare people for entrance into some step-functioning future professional technology. It has to be anticipatory education. It can't be just, 'this is what we know and these seem to be the next steps in our knowledge.' Intuitions are developed in certain logical or likely directions, at the same time we leave a large amount of space for serendipity. This is called strategic education or anticipatory education. It's part of the up-scaling of the American work force. We have a tendency to call the variety that most people generate error or misbehavior, immoral or amoral, or otherwise wrong behavior. Human variety is simply a way of establishing a new foothold into the future.

"America's got to realize that it has to intellectualize itself in an applied way. I think there are major of opportunities for us to alter the way we see ourselves and what we do. This will mean a cultural revolution; it will not simply be tinkering with this school, or that business, or that church. It will be a major cultural revolution that's gotta come. And who knows who will lead it. It might be lead by black intellectuals, Asian Americans, Caucasian intellectuals, Caucasian technical professionals who've had enough of their jobs being threatened by the loss of technology and the loss of production overseas."

Robotics, cloning, and the capacity to build cyborgs creates a great number of ethical concerns. Citizenship rights for robots have been considered in the past and seem perfectly logical to futurists. "The idea of citizen-level roles, protected by the Constitution and the Bill of Rights and other amendments is not a new idea," Harkins says. "The stage has already been set through the provision for full-citizenship status of blacks, Indians, and women."

The possibility of marriage between a human and a robot also seems logical to futurists. Harkins drew a great amount of attention with his early 1980s prediction that the first human-robot marriage would occur by the year 2000. Harkins defends his statement about wanting to marry a robot and the general possibility of this kind of marriage. "We say that a Downs Syndrome children are citizens and we allow people who have other severe intellectual, mental deficiencies to marry," Harkins says. "I think it would be on those grounds that we take serious the possibility of matrimonial union of a machine system and a human system. We know people marry people who are in prison whom they can never, ever consummate that marriage. We know there are people who marry others they never see, they just correspond. We know people that are gay marry lesbians. These are intellectual, emotional things. They don't have a physical component. There is no reason on those grounds why a human and a machine cannot have a very rewarding, long-term marriage. We haven't built to my knowledge this hardware/soft combination that would

Harkins to 19

Susan Curran is a journalism senior who has us all green with envy, as she will be graduating this spring. This is her final article for the *Technolog*, having been a regular contributor since the Fall I, 1986 issue. The *Technolog* will miss her writing and editing skills, and we wish her the best of luck in the future.

Student Space Week

When the world's first spacecraft was placed in orbit over thirty years ago, mankind began what would become its greatest adventure. Student Space Week '88, hosted by the Students for the Exploration and Development of Space (SEDS)/University of Minnesota Chapter, is an effort to spotlight international expansion in modern space exploration. The primary focus of the program is to design a stimulating educational forum for the technically-oriented and general audience on current and future issues of space technologies.

Student Space Week '88 (SSW '88), to be held April 25-28 on the U of M Minneapolis campus, will present an exciting array of dynamic space experts and professionals who are actually making the next space generation happen. The program will feature a lecture series on space-related topics, a Soviet/American conference, and an International Space Symposium which will emphasize International Cooperation in Space Policy and Development. Speakers will include University of Minnesota faculty, representatives in corporate space research, NASA administrators, a Soviet cosmonaut, an American astronaut, and delegates from space agencies around the world including Japan, France, and the Soviet Union.

Organized and governed by the student membership, SSW '88 will hopefully encourage student involvement in the promotion of space development and educate the community on important space issues. Much support towards the efforts of SEDS has been offered by the US and Soviet governments, particularly in the advocation of collaborative missions in outer space on an international scale. Participants of SSW are invited to attend a complimentary showing of Seasons at the Omnitheater and a reception following the International Space Symposium on April 28.

For more information call 331-6423 or stop by the SEDS desk in room 235, Coffman Memorial Union.

Math Supercomputing Project

by David Kortenkamp

Does using a supercomputer to draw knots sound a little strange? It doesn't to researchers in the Geometry Supercomputing Project. They hope to use the University of Minnesota's Cray-2 supercomputers to analyze very complex mathematical structures. According to University of Minnesota Mathematics Professor Al Marden, who organized the group, the "work will involve both research in mathematics itself and the development of algorithms required to compute and display mathematical objects."

The project is funded by a three-year, $1.5 million National Science Foundation (NSF) grant. The University is donating 600 hours of Cray-2 time, as well as office space, and is sponsoring the visiting scientists. Thirteen mathematicians from across the country and Europe will participate in the project, the first of its kind. Says Marden, the "project involves the exploration of uncharted mathematical structures that have never been seen before."

One-size-fits-all Space Suit

by David Kortenkamp

The space suits currently worn by NASA astronauts are custom designed, non-reusable, and cost hundreds of thousands of dollars. Since NASA envisions more and more astronauts going into space, they are looking for ways to reduce the cost of space suits. Enter Hubert Vykukal, a scientist at NASA's Ames Research Center. He has invented a one-size-fits-all space suit which can accommodate people of heights ranging from 5 - ft. 2-in to taller than six-feet.

The suit, made of aluminum and weighing about 185 pounds, has one or more expansion rings coupled between the upper and lower portions of the suit. By adding or removing the expansion rings the suit can be made to fit different sized people. The suit has a large opening in the rear where the astronaut enters, the hole is then covered by a backpack containing life support and communications equipment. The same design could also be used for deep-sea diving suits.

Source: Popular Mechanics, March 1988

Energy from the Arctic Ocean

by David Kortenkamp

The Arctic Ocean may soon be producing electricity for research stations and

Log Ledger to 24

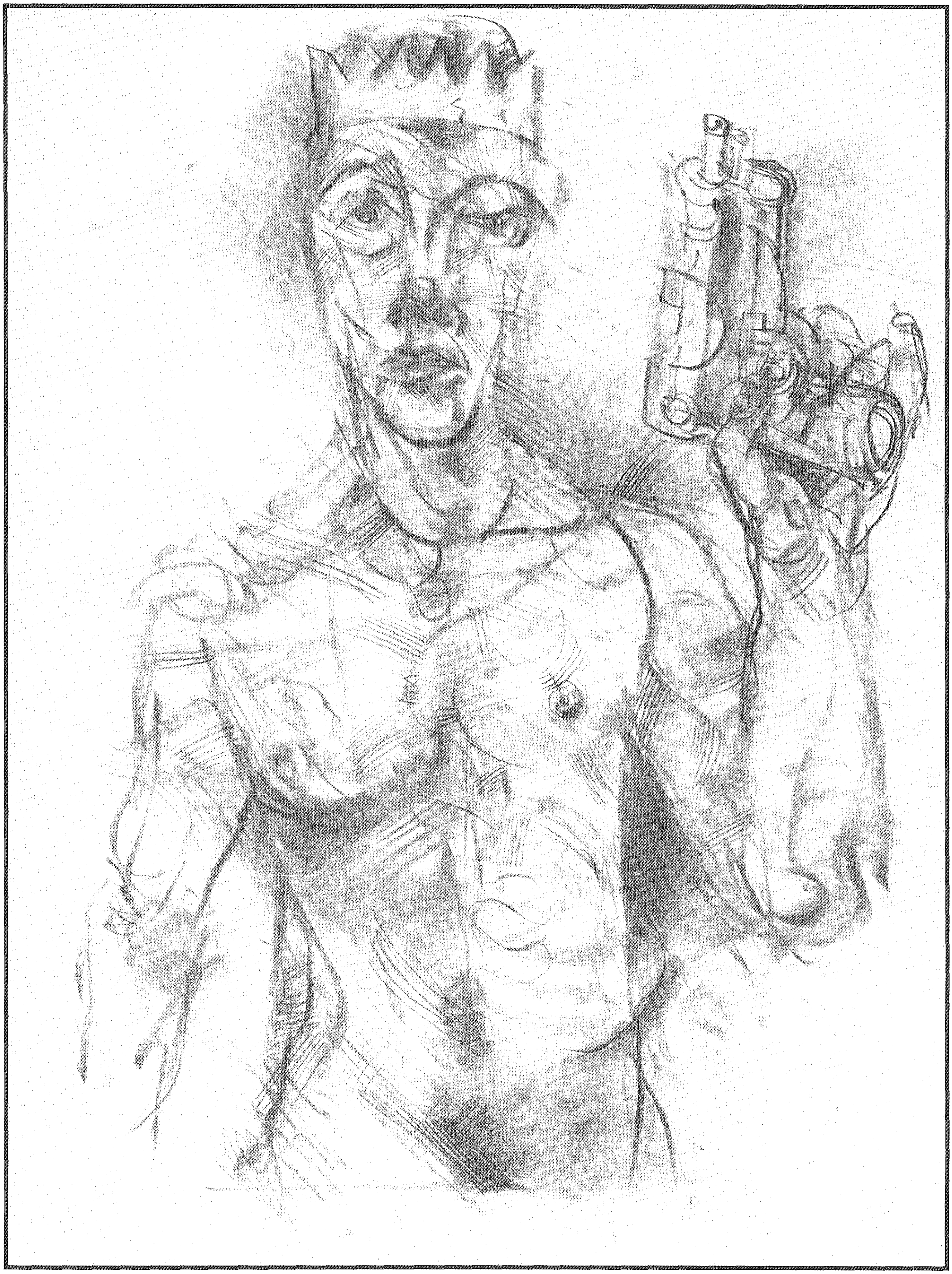


Illustration by Steve Winters

Dux Bellorum

First Place

by C. Ray Coleman

The raid had gone well. Almost perfectly in fact. If Scott hadn't brought in that damn Russ woman and her brat everything would have been damned near fine.

Sean kicked at the fire with irritated distraction and rose from his seated position on the ground. Around him the commando was settling in for a comfortable warm camp, the men and women of the party hobbling the horses, setting the guards, and assigning foraging duties.

Looking for some activity, Sean headed for the sound of a deep braying voice giving foul-mouthed commands near a copse of trees a short distance from the fire, and found there the raiding party's second in command, Alex Chauvin. Sean leaned quietly against a tree and watched the sun set on the prairie horizon as Chauvin harshly deflated the confidence of two young fighters who in overeagerness had declined to follow the battle plan in the afternoon's engagement. When the dressing down was complete, and the two soldiers sent shame-facedly about their duties, Chauvin joined Sean in looking out over the darkening plain.

Sean intended to be an American Arthur, even to the point of using Arthur's final solution.

"Scott really screwed up this time, Sean," Chauvin began without preamble.

"No shit. It's a rotten mess, and now I have to deal with it."

Alex shifted against the tree and grunted. "Hey buddy, any time you want to give command of this chicken outfit to a real man, you just say so."

Sean laughed quietly to himself. Alex was his closest friend in this screwed up world, but the French-Canadian chemist-cum-night raider made no bones about the fact that he felt himself better qualified to lead expeditions against the Russki invaders. Ignoring Chauvin's last remark, Sean reached down for a sprig of prairie grass and stuck it in his mouth. Talking around the sprig he asked, "Who's with the witch now? I hope you set somebody other than Scott to guard her."

Alex spat at the dusty ground. "Right now I wouldn't trust that Red-loving bastard to guard his own . . ."

"Okay, so who?" Sean interrupted.

"Taylor."

Sean nodded. "Good choice."

Chauvin stirred. "I'm gonna go get some coffee. Want any?"

"How about some tea? I'll drink it here."

"Tea. Jesus." Alex walked off toward the fire, shaking his head.

Sean leaned more comfortably into the tree, sucking on his piece of grass, and listened to the dwindling grumbling of his friend. What the hell, maybe Alex was right. Maybe you needed more than an ex-history professor to fight this damned war.

Still, like Arthur in ancient Britain holding back the Saxons and the dark, Sean and his commando were doing what they could to stop the eastward migrations of Asian peoples who had invaded North America after the mutual destruction of the Soviet Union and China.

Like Arthur and his revolutionary British cavalry, Sean, Chauvin, and the rest were seeking to forestall the advance of the invaders, trying to dislodge them from the American plains before they dug in permanent roots, and displaced the rightful American and Canadian occupants.

"Bring me my sword, Anne, that I may pass judgment on them both."

With a sigh Sean came to his feet. Like the Britons and the barbarous Saxons, the North Americans and the Russ were now engaged in a struggle to see who would dominate the continent in the new age. Whatever savagery it took, Sean intended to be an American Arthur, even to the point of using Arthur's final solution. "Even to the point of genocide, if it damn well comes to that," he thought grimly to himself. Spitting his sprig from his mouth, Sean turned away from the open plain, and headed back to camp.

"Verus, bring me the Caledonian with the Saxon woman."

Chauvin looked at Sean with poorly concealed irritation. "Verus my ass. And who the hell is the Caledonian?"

Sean looked up from the fire with bright eyes, his camouflage shirt soaked with sweat. The other members of the commando glanced about, looking for anything to attend to rather than the familiar scene about to be played before them.

"What, Verus? Bring to me the barbarian woman, and Scott, her captor." Sean turned to the raider next to him and said, "And bring me my sword, Anne, that I may pass judgment on them both."

"We don't take any prisoners: men, women, or children."

"Cut the bullshit Sean. There's no Verus here, it's just me." Chauvin stood and looked at his friend and commander.

Sean gazed at Chauvin for a moment in bewilderment, and then shook his head as if to clear it. "Alex?" he asked, sounding puzzled. "Would you bring Scott and the Russki woman here? I need to speak to them both in front of the troops."

Chauvin appeared embarrassed, as he stood in front of the fire shuffling his feet. "Yeah, okay Sean," he replied as he walked into the night. Around the fire, conversation began again as the raiders realized that a confrontation had once again been narrowly averted.

When Alex Chauvin returned, he was followed by two adults and a child. One, Scott Erlandsson, was clearly recognizable as a member of the commando. The woman and the child were just as clearly Russ: the remains of the woman's clothing carrying two red stars on the collar, and the Cyrillic lettering on her battered hat proclaiming her to be part of the Central Kansas Agricultural Commune Number IV. The gathered North Americans hissed and muttered as they passed.

The woman and her captor, the hapless Erlandsson, stood before Sean and the assembled troops of the commando. Sean, from his seated position addressed Erlandsson: "So Scott, what do you have to say for yourself?"

Erlandsson, his Nordic features moving in obvious agitation, nervously cleared his throat. "Uh, what do you mean Sean?" he asked.

Sean stood, and moved closer to the fire. The night raiders sat straighter in anticipation of the scene to come.

"You know what I mean. We are here for a reason, and that reason is the extermination of the Russkies. You know that we don't take any prisoners: men, women, or children. So why did you do it?"

Erlandsson took a step back from his accusing commander and cleared his throat again. "Uh," he began, "Uh, we cleaned out the commune, just like you said, and we, you know, killed all the Russkies we found, and well, I just couldn't take it no more. I mean, all the blood and the screaming, the little kids and the old men. Well, I found this woman and her baby hiding in one of them silos the Russ always build, and I just couldn't kill them, you know? I just couldn't do it. I didn't mean any harm, you know that."

Sean watched Scott Erlandsson as the man spoke brokenly in his own defense. As he listened to the man's story that strange light returned to his eyes, and his usually casual posture took on a more formal, even regal appearance. Chauvin, who was standing behind Erlandsson and the captive Russki woman stiffened, noticing these signs with alarm.

"Scott," Sean began, "What is our policy regarding these people who have invaded our land?"

Erlandsson moved closer to the Russ woman before replying to the commando leader. "You keep telling us that we got to kill them all, that any Russkies left in America will be our enemies forever, and maybe even push us off our land like we did to the Indians. But I don't believe that! I never believed that!"

Gesturing wildly at the captive woman and her child, he shouted, "Look at that baby! Who is he going to hurt? I'm not the only one here who feels this way!" Quiet stirrings among the troop indicated that Erlandsson was right.

Warming to his plea, Erlandsson took a step toward Sean, looking at his leader over the fire. "Why is killing all we do? Don't give me any of that college bullshit about King Arthur and barbarians and all that stuff. These are real people we're killing, not characters in some goddamned fairy tale!"

At this the wild light in Sean's eyes took on an even more alarming intensity. Stepping perilously close to the fire, its flickering reds and yellows highlighting his face in shifting patterns, Sean turned and addressed the members of his command.

"An enemy who lives in your own home comes to think of it as his, and will fight as desperately for it as you will."

"Fairy tales? Who else of you believes this calumny? Arthur and his Britons were more than just the stories you read about in school. They were real men, faced with the same problem we are faced with now.

"Vortigern, that archtraitor, invited the Saxon barbarians into Britain to live and protect his rule, but the Saxons turned out to be dubious allies, more intent on dispossessing the Britons of their lands and homes than protecting anyone.

"When Arthur took the throne, the Saxons ruled half of his kingdom, and greedily sought the other half."

Sean turned about again to face Erlandsson over the fire. Behind

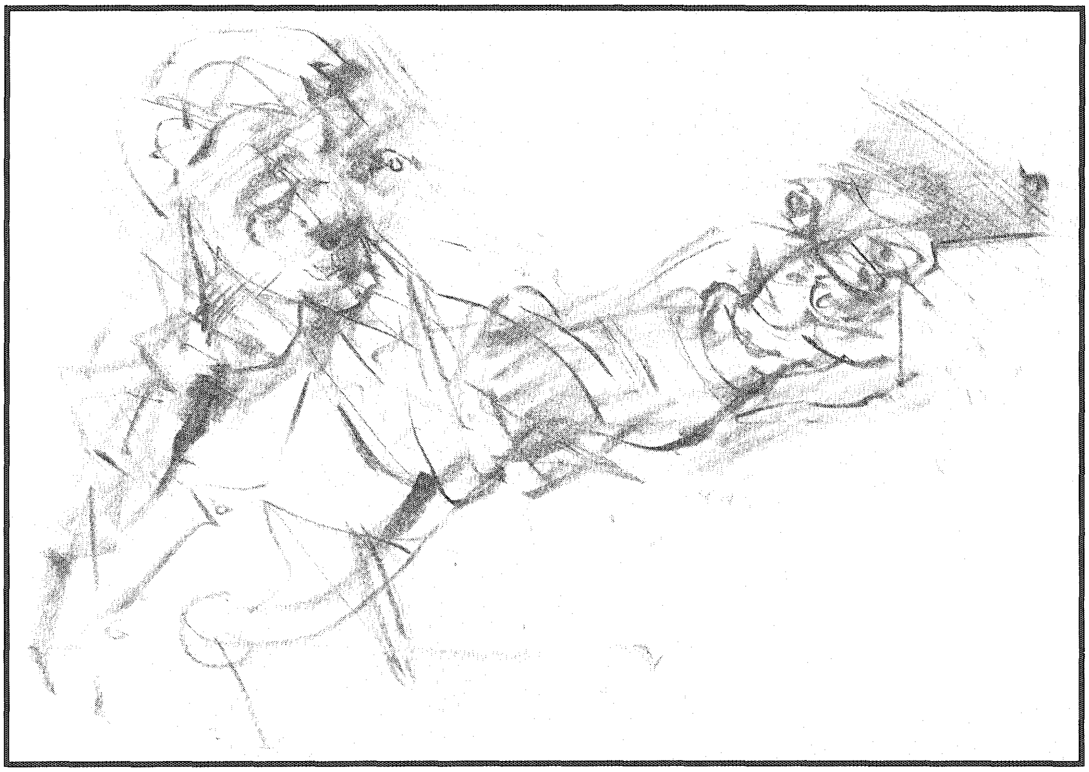


Illustration by Steve Winters

Erlandsson, Alex Chauvin tried in vain to gain the attention of his friend.

"Fool," Sean growled at Erlandsson, "An enemy who lives in another country can always be defeated or held at bay. An enemy who lives in your own home comes to think of it as his, and will fight as desperately for it as you will. Arthur knew this, and that's why he ordered the destruction of the Saxons — men, women, and children — because each invader who lives and multiplies on our soil raises a new generation of enemies to fight against our children. That baby there who you fiercely want to save may be the murderer of your own son, or the raper of your daughter. "

"Verus, Bedivere," Sean called to Chauvin. "You know whereof I speak. Didst not once bring to me a woman and child, who in my ignorance I set free? And did not that same child grow to manhood as a Saxon chief who made war on our poor, oppressed people? Tell these doubters the dangers we face here!"

Motioning to two soldiers, Chauvin quietly ordered that the captives be removed from the council fire. Erlandsson too he gestured into the background before crossing around the fire to stand at Sean's side.

"Bedivere?" Sean asked in bewilderment.

"No, it's Alex, Sean. You need to rest for a while. The raid wore you out."

"Yeah, I think you're right Verus . . . Alex. Yeah, I'm tired."

Chauvin, leading his friend to his bedroll away from the fire, dismissed the troops with a rough wave of his hand.

Much later that night, as the fire wore down and the sentries went about their monotonous rounds, Alex Chauvin strode around the camp, listening to the whispered conversations of the men and women who were his responsibility. What he heard disturbed him, but didn't surprise him at all. Sean was losing his grip. That much was obvious to everyone. There were differences of opinion as to how bad things were becoming, but none as to the fact that their leader wasn't well.

There was also grumbling about Sean's "no prisoners" policy. This had always existed among the troops from unoccupied areas, but now seemed to have spread to even those whose homes were held by the invaders, and whose families, if they still lived, worked on the Russ's collective farms. It seemed the general consensus that it was the pressure of all the killing which was driving Sean, a tactical master on the field, to loose himself in his fantasies of British history.

As he was making is rounds of the camp, Chauvin noticed that Sean was awake, and sitting on his bedroll with his back to his saddle. Alex walked over to him and sat beside him. For a while neither one spoke.

Finally, it was Sean who broke the silence. "Was it bad tonight?" he asked, not turning his head to look at his friend.

"No worse than it's been for a while. This business with Erlandsson and the woman seems to have brought it on again."

"Yeah." Sean sat up straighter. His voice became agitated as he spoke, "Everybody seems to think we're doing this because we like it. Can't they see that if we let the Russ live and grow here in North America that they'll spread like a cancer, and that we'd be dooming our children to generations of war and fighting?"

Chauvin put a hand on Sean's shoulder and said in a relaxing tone of voice, "Hey, take it easy. Most of the troops understand. The ones who don't are the ones who have never been deep into the occupied zone. If they could see what the Russkies have done to Denver or Calgary, they'd feel differently."

Sean shook his head. "They'll have to find out about that some day. Either we have to eventually bring this war to the heart of the occupied area, or we are going to go the way of the civilized peoples of Europe in the Dark Ages. Some day we'll end these hit and run raids on isolated Russ communities, and go for their rotten throats!"

Standing suddenly, Sean looked down at Chauvin intently. "The woman," he began, "Where is she?"

Alex gazed at Sean for a moment, searching for signs of another loss of control. Seeing none, he replied, "By the horses, near the trees. Schiller and Moss are guarding her."
"I'm going to go talk to her. She needs to know what is going to happen to her." With that, Sean turned and disappeared into the night.

Chauvin, still seated, listened as the sound of Sean's angry tread diminished away to nothing. Staring out into

". . . the American people are engaged in a struggle for their survival as a free people."

the empty dark, he mused on the grim crisis of leadership now confronting them.

"If Sean is really losing his mind, and I think he really is, what the hell am I supposed to do?" he thought. "Do I take over? Can I take over; what would Sean do if I tried? Shit, I don't even know if the commando would follow me. Sean's gotten us out of some really rotten messes, like that balls-up at Winnipeg. He may be going crazy, but he knows his business." For a moment Alex's thoughts returned to those days of horror on the Canadian plains where Sean had first made his reputation as a commander. Since then, Sean had repeatedly demonstrated his ability to succeed in encounters with the enemy. He not only seemed to win against the odds, he did so with an intense concern for the well-being of his troops.

Still, these attacks of instability . . . , "Shit, let's be honest, he's losing his mind!" Alex thought with a mixture of anguish and disgust.

Alex shifted uncomfortably, and then settled back as he watched a shooting star pass over the vault of the sky. "That's Sean," he said to himself. "I'll wait till he burns out completely, then I'll pick up the pieces. I owe him that much, he's my friend."

Sean found the Russ woman and her baby just as Alex had described them. Moss was sleeping sitting up against a tree, while Schiller sat before a small fire, opposite the woman who was awake and nursing her baby.

Sean gave Moss a small kick, starting him into wakefulness, and ordered the two guards to stand off a bit while he spoke to the captive. He reminded the two to remain within earshot in case he needed them.

When Moss and Schiller had gone, Sean seated himself across the fire from the woman, who watched him closely, but without fear.

"Good evening," Sean said in passable Russian.

"The same to you, Sean the Butcher," she replied.

"Is that what your people call me now?" he asked with a small smile on his face.

"Is that not what your own people call you?" the woman asked.

Sean's smile froze on his face. He thought for a moment and then replied simply, "Yes."

After this, both were quiet for a time. Then Sean, breaking the silence, looked at the woman and said, "Madame, you have me at a disadvantage. You know my name, and even one of my titles, but I don't know you. What's your name, and your son's?"

"I am called Nadya, and my son is Constantin. My husband, Petr Petrovich, was killed in your raid on our commune. I suppose you will kill us now as well." Nadya stared defiantly at Sean and shifted her baby in her arms. She gave him an insolent look as she closed her coarsely woven blouse over one pale breast.

Sean thought over Nadya's comments for a moment before responding. Finally, in a heavy but determined

. . . Sean took up the guilt of his people, dooming himself that they might live.

voice he spoke: "Yes Nadya, now we'll kill you too. It doesn't bother me much to tell you that. This is our home, and that commune you mentioned probably belonged to some poor American family that you and your husband killed or drove off."

For the first time the Russ woman showed a trace of fear. Not because of what her captor had said, that was only what she expected from the bloodthirsty Americans, but from the look of growing instability on Sean's face.

Having nothing to lose, she went on the offensive: "Do not try to sound noble with me! You are no better then we — no, far worse! What we did we did to survive! When the war was over, and the clouds of terrible chemicals and nuclear waste had passed what else were we to do?

"We appealed to you, you fat, rich capitalists here in America for help, but you just laughed, said, 'Die, you Red pigs!' Then we did as we had to; we took our weapons and our herds, and our children, and fought to stay alive. All this blood could have been avoided if you had not hated us so much!"

Now it was Sean's turn speak, a slight quaver entering his voice. "Before the war," he began, "I was a college professor, specializing in military history. I was there, fighting, in Alaska and British Columbia trying to turn your people back. I thought I'd puke the first time I killed a man, but I didn't. I kept thinking I'd seen all this before, in the history of the collapse of the Roman Empire."

Sean leaned toward Nadya, betraying through his posture the depth of his inner conflict: "We can't both live on this continent, there isn't room. Like Arthur in Britain, the American people are engaged in a struggle for their survival as a free people."

Now Sean got to his feet. Nadya could see sweat break out on his forehead. "You call me a butcher, but if by God you people had stayed where you belong, none of this would have happened! Your blood is on your own hands, not mine! Not mine! Not mine!"

As Sean stalked back and forth in front of the fire, Nadya felt a kind of surrealistic fear. The American fascist leader looked positively crazed as he rubbed his hands on his camouflage pants, apparently trying to cleanse them of some kind of unseen filth. Nadya watched on, mesmerized.

Slowly, Sean's speech and manner changed as he harangued Nadya and her child. His Russian, not overly fluent to begin with, degenerated into a combination of muttered English, and non-grammatical Russian statements. In order to spare herself any more of this, Nadya threw away a major advantage and addressed the commando leader in almost unaccented English.

"What are you saying?" she asked. "I do not understand you."

Sean stopped pacing in surprise. He composed his features again and said, "I was telling you about Arthur of Britain. Have you heard of him?"

"No. What has he to do with me?"

Sean shook his head gently. "With you and me, not much. He was a civilized king of ancient Britain who discovered a way to deal with invading barbarians who considered his home to be theirs."

Agitation again crept into Sean's voice. He spoke in a kind of frenzy. "His solution was the logical one, the one designed to make sure of his children's freedom, regardless of the consequences to himself. Genocide you can call it, but it would have been suicide for him, and for us, to do anything else!"

Nadya nodded. This she could understand; it was the other side of the coin, the opposite of the bold gamble her own people had taken to escape a devastated country. If someone has what you need to survive and refuses to share, take it! And if that other needs that thing himself, then he must fight to retain it!

Glaring at her tormentor, she spoke out: "Do what you want then, Sean the Butcher. It doesn't matter. Your people are weak and can't hold what they have. When you're gone — not long now! — they'll forget all this, and we'll push them into the cold Atlantic!"

Nadya looked at Sean in expectation of a reply. Instead she recoiled from the blank and unfocused stare on the war Leader's face. She flinched as she heard him cry out.

"Verus!" he called. "Bring my sword! The Saxon woman her own doom has spoken! Wake, everyone!"

Moss and Schiller came rushing toward Sean and Nadya, followed close behind by Alex Chauvin. Around them, the sounds of the camp stirring into wakefulness could be heard.

"Bedivere," Sean shouted, "My sword!"

"Let me do it, Sean," Chauvin replied "We both know it needs to be done, but you're not in any shape to do it."

"Give me a sword . . . a gun . . . Alex, now while I still have the nerve to do it. Now Verus, I command it as your war leader!"

Reluctantly, and with agonized slowness, Chauvin handed his automatic pistol to Sean. Sean — Arthur, Dux Bellorum — sighted down the barrel at the defenseless woman and child.

Nadya, recognizing the imminence of death, didn't try to rise from the ground. Rather she held her son to her and exclaimed loudly in English, "Shoot then, Sean the Butcher! Did this help your Arthur?"

She turned to address the gathering raiding party, pitching her voice for the crowd. "He is right! We will not give in, we cannot, for we have nowhere to go. But when he is gone, you will forget his lesson and we will triumph in the end!"

With a strangled cry, Sean aimed his weapon, and with two pulls of the trigger, discharged the ancient duty of the war leader, the dux bellorum. With those two shots, Sean took up the guilt of his people, dooming himself that they might live.

"Verus? I'm so tired and . . . Verus? Are you there?"

"I'm here, Arthur. Lean on me."

"Alex, don't let them forget."

"They won't forget, Sean. I won't let them." **MT**

C. Ray Coleman (he does like his first name, but he feels it lacks dignity) is a graduate student in sociology. His personal area of interest is in social psychology, and he tries to bring social and psychological insights to his fiction. Right now he is aiming for an academic career, but would chuck it all to be a successful author writing on the beaches of the Virgin Islands.

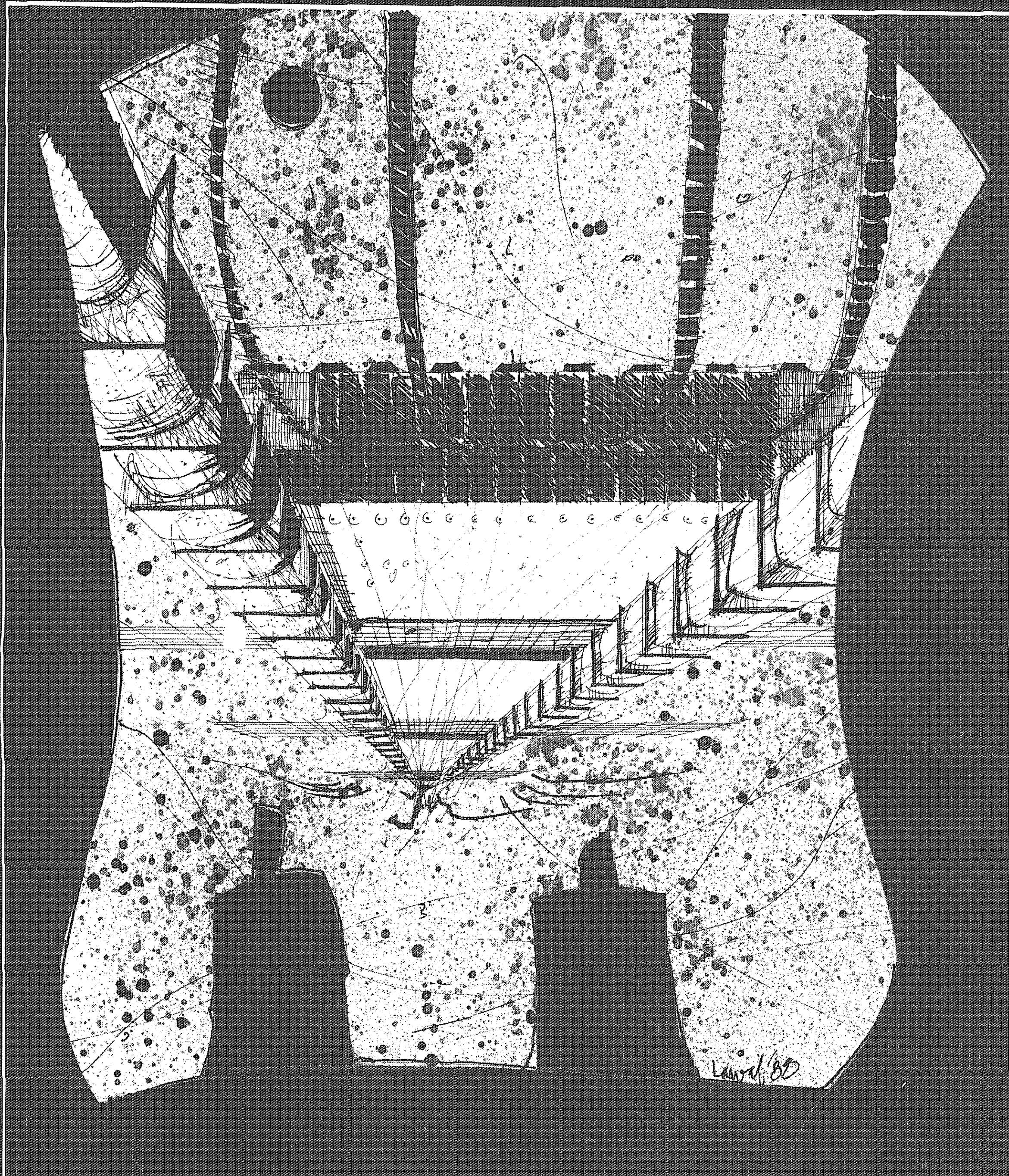


Illustration by Mohammed Lawal

The Death of Asgrim

Second Place

by Michael Walsh

People are extremely adaptive, even alone. A thousand of them are capable of surviving decades in an outsized apartment building hurtling between the stars at essentially light speed.

The ship was large and well-lit. In the dark crannies there were love and intrigue, murder and childbirth. The ship was a benevolent mother, using the energy of the fusing hydrogen in her drives to recycle everything needful. Bodily wastes, household wastes, and carbon dioxide went into the system, and oxygen, food, clothing, and rubbery condoms, among an infinitude of other things, came out. Life was good, better than it had been on crowded Earth.

The long deceleration was over, the last of the ship-sized tanks of fuel discarded. There was a brilliant sun in the black sky. Beneath them, a thumbnail at arm's length, was a crescent planet.

Asgrim Captain was furious. Worthless, it was worthless! The elaborate scientific guesswork that had justified their one-way ticket to this planet had failed. The planet was worse than Venus.

Asgrim (the officers went by their titles instead of regular last names) had always wanted to have children. He wanted to have dozens of them, and watch them play in a garden under real sunlight. He grew bitter.

Expressions were grim all around. As Wu Engineer finished his last measurement, he looked up at Asgrim. They all looked at him.

"Ellen," he turned to the pilot, "can you get us out of the gravitational well and put us on intercept with A151, the big asteroid back there?"

If the target isn't habitable, they had told him all those years ago — before most of the present crew had been born — try to mine asteroids for oxygen and minerals, whatever will keep you going.

Wu Engineer caught BJ McKinnon's eye as he left the bridge. She smiled back suddenly, as people do under tension. He nodded, and shining streams of black hair swirled around his head.

The rock in the sky grew until it loomed over the mile-long ship by two orders of magnitude. To Jeff Erlander out on the hull, it seemed unimaginably huge, all the space he could ask for. If it only had an atmosphere . . .

. . . he could make out fine crosshatch patterning and a matrix of tiny metallic glints.

They were in low orbit. Jeff swept his binoculars over the crags, looking for a good landing spot.

He scanned a blip on the sunlit horizon. He looked back, and tried to make sense of it.

"Erlander to bridge. Part of the surface is black. I . . . don't understand."

"Asgrim to Erlander. What do you mean? Shadows?"

"No. It's . . . regular. Rectangular."

The ship was moving towards the day side, and more and more of the unnatural sharp-edged black was showing. Through his binoculars he could make out fine crosshatch patterning and a matrix of tiny metallic glints. It was huge.

"Man-made," Jeff said, and was immediately conscious of the impossibility.

Ellen Pilot brought them down carefully not far from the plain. After orbital free-fall, the infinitely gentle gravity was perceptible, though nothing like the one-gee acceleration everyone had grown up with. BJ McKinnon weighed something under a pound donning her spacesuit. She joined Jeff and a dozen others at the airlock.

They moved towards the edge of the plain in cautious bounces.

It was a chest-high black table surface, extending off indefinitely, with metallic catwalks crossing it every few hundred feet. Jeff put his hand on the edge, and shook it. It was solid. He looked under it. Metal struts supported it. Cables led off into the darkness.

He bent his head to examine the patterned surface. There were small leads . . .yes. The whole thing was an array of photoelectric cells. He looked out over the surface. Power. A lot of power.

His eye caught something out there, and he hopped up to the nearest catwalk. The others followed.

As they approached, the thing resolved into an eight-foot robot, or a space-suited giant, apparently kneeling on the surface. Jeff went ahead alone. He reached the point on the walk opposite the figure, and waved. It was only thirty feet away, but it paid no attention to him.

A panel on the surface immediately behind Jeff opened, and another figure emerged. Nothing was audible in the vacuum, but Jeff felt the vibration, and turned. He instinctively leapt as far away as he could, which turned out to be a great deal farther than he had imagined. The faint gravity hardly slowed him as he rose. He panicked until he remembered that the escape velocity here was two-hundred miles an hour. He would not float off into space.

It still took him more than a minute to reach the top of his arc, three hundred feet off the ground. BJ's voice came through over the radio.

"They appear to be repair robots. One is fixing a small meteorite hole. The other one ignored us and left."

Jeff came down on the rock, a quarter mile back. He landed gently, no harder than he had kicked off, and bounced.

He shook his curls, amazed. You could jump off a cliff here and not get hurt.

In three days they found an airlock to the interior of the asteroid. Asgrim and Vince Casey led the first party in, including Jeff and BJ. Asgrim pushed the large square button by the side, and the lock cycled normally.

A wide corridor with irregular steel

The whole thing was an array of photoelectric cells . . . a lot of power.

walls led down and ahead. It was pressurized, but they did not take off their helmets. Progress was slow until they got the knack of bouncing and kicking of the walls in semi-controled flight.

The corridor was brightly lit by yellow-white point sources behind frosted panes that turned on ahead of them and turned off behind them. Several times they came across airtight steel doors hinged at the top. These opened both ways without trouble.

After many hours, they unexpectedly drifted into a tropical jungle. Clear sunlight seemed to pierce the canopy formed by the interlocking foliage of weightless giants and creepers.

They discovered they were in a cave large enough to hold the entire ship several times over. Features grew small in the distance. The bright sky was steel, reflecting and re-reflecting a point source's light. Below were the lakes, placid until you splashed them — then there were marbles of water floating all over, until they reached the ground and soaked in.

"It's a bubble, out of solid steel," Jeff's voice said on radio.

Vince Casey raised his hands to his helmet, dropped them, and then raised them again. The others watched him intently. He fiddled with the clasps, lifted off his helmet and put it under his arm. Tension showed in his jaw. He looked around, his short hair ruffling slightly. They all suddenly became aware that there was a soft wind. Vince grinned. They all started grinning, then laughing, wildly and uncontrollably.

Since a radio won't transmit through a metal shell, Jeff carried the news to the ship. The twenty-mile vertical climb was equivalent to only a few hundred feet under normal gravity, but the day passed before he returned with more people.

BJ and Asgrim followed one of the many corridors leaving the bubble. After three or four hours they reached another bubble. There they literally bumped into an alien who appeared out of nowhere, going fast in the opposite direction. It was five feet tall and light brown.

The alien shrieked and leapt into the trees.

BJ followed, but lost it almost immediately. She stopped to listen, but there was complete silence in all directions.

She and Asgrim floated into the woods as quietly as they could, rifles poised. Twenty shapes rose out of the bushes. Most were unarmed, but one carried what looked like a machine gun.

Asgrim screamed and fired. So did the alien with the machine gun. They were blown in opposite directions by the recoil. BJ caught a glimpse of Asgrim gone very pale and doubled over. She grabbed him by the collar of his space suit and dragged him back the way they had come. A bit down the tunnel BJ patched Asgrim up as best she could. The lights had grown dim for the night before they reached the others.

Over the following months the human colonists took over about a score of the bubbles, while the aliens retained several times as many.

The colonists also held a control room which seemed to control nothing. Wu Engineer spent most of his time here. He was sitting in one of the enormous armchairs, trying to decipher undulating columns of symbols strewn over a wide transparent surface, when BJ came in. She settled, somewhat awkwardly, on the arm of his chair.

"Figured anything out?"

Wu startled out of his concentration.

"Oh . . . I've hardly seen you since . . . since you married Asgrim." He stopped.

BJ glanced down at her already large belly with distinct pride.

Wu changed the topic.

"Well, some of the things this computer does make me think this asteroid's got a drive. However, I suspect we'll find it's broken."

"Why?"

"Another thing I've found is that we're in a pronounced elliptical orbit. Right now, we're moving farther and farther from the sun. I figure the photocells are only going to be generating about half the current in a few months. What happens then? The lights go dim? I don't know. I suspect that those incredible repair robots would have

They all started grinning, then laughing, wildly and uncontrollably.

fixed the orbit if there were a working drive on board."

"I'll ask the aliens if there are seasonal variations."

"What is actually happening with the aliens?" Wu asked. "You're the language expert, I hear."

"Yes. Sort of. We've learned some things. They call themselves the K'firn, and the asteroid is Erak. They didn't build it themselves."

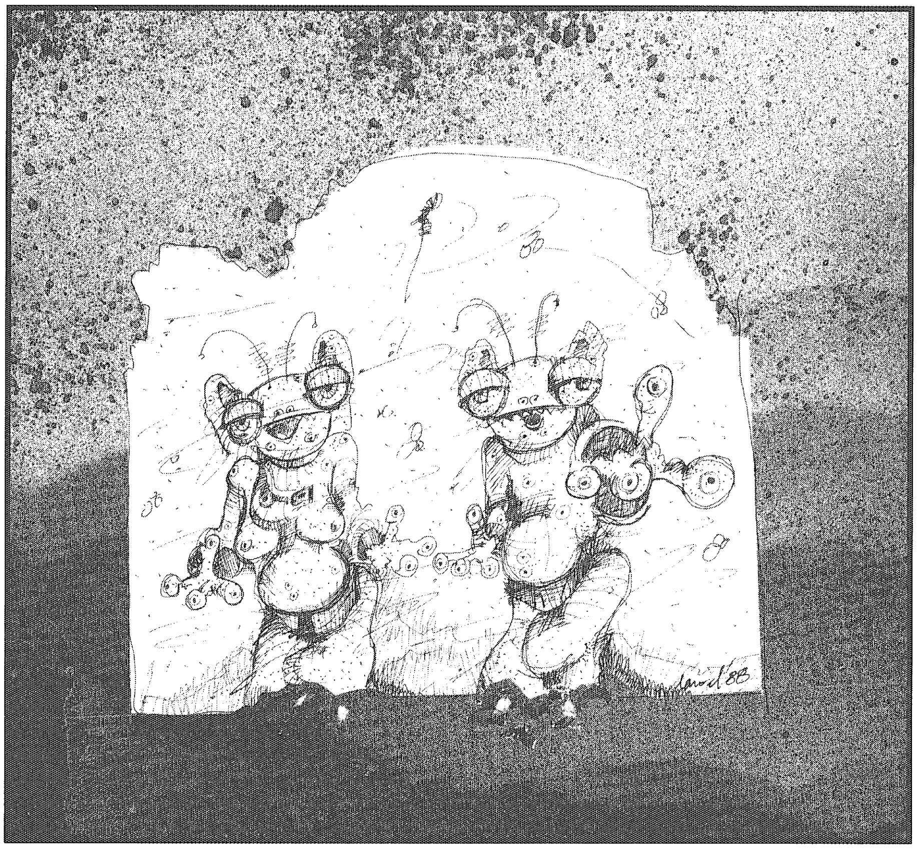


Illustration by Mohammed Lawal

"That's clear. The chairs in this room are built for people twice the size of these . . . K'firn."

"Yes, but now comes the interesting part. They say they're from the planet we couldn't settle."

"No. They can't have evolved on a planet with a hundred atmospheric pressures of carbon dioxide."

"They're serious. Their descriptions of the system and the planet check out. You know, they have some very old space suits and sophisticated weaponry."

"But how . . ."

"Let me finish," she said. "They have an explanation. I'm not sure I got it straight — it's taken some weeks — and it may not make sense even if I understand what they're saying. They say that the people who built Erak — they call them the Leira — built it for war. For some reason, the Leira dumped huge quantities of genetically tailored bacteria onto the planet that somehow ate the rocks and filled the air with poison. The K'firn here are descended from a troop of commandos sent off to kill the Leira. They succeeded after what was described to me as an epic battle, but it was too late."

Wu was staring in her direction, his eyes focused on infinity.

"That might make sense," he said slowly. "A planet like the Earth has fifty to a hundred bars of carbon dioxide locked into carbonaceous rocks on the surface. Some of it gets cycled through the atmosphere at various times. The more you have, the hotter it gets. Greenhouse effect. Usually there are corrective mechanisms, organic and geological. But if you messed it up real bad, very quickly . . ."

"You think it could have happened? In just a few generations?"

Wu was still tuned out.

"That explains a lot, you know. I was wondering why there was still so much water in the upper atmosphere. All that water should have been lost eons ago, through photo-dissociation and hydrogen escape. It puzzled me at the time, but I let it pass." He looked at her, then away. Her breasts had grown during her pregnancy. He told himself that it was none of his business.

"I doubt we can do anything about the planet," he said. "The bacteria may have just been accelerating a process that was already happening. As a sun gets older and brighter, habitable planets tend to start losing their water. Like Earth. A few million or billion years, and they're hot and dry."

BJ looked grim. She got off the chair's armrest and drifted out of the room. Wu returned to the unexplained control panels lined up along the front of the room.

Soon Erak wandered from the sun, and winter began. The lights dimmed, the trees withered, and food was scarce. There was starvation among the K'firn, though not among the humans, who had the ship.

The K'firn sent several delegations asking the colonists to give up the bubbles they held, at least for the winter. They said the resources were needed. Asgrim refused.

The attack came while most of the colonists were sleeping. The K'firn concentrated their forces on one bubble at a time, wiping each out in turn. Someone made it out alive, though, and spread the alarm.

BJ awoke to see Asgrim leaping out of their tree-tent, gun in hand. When the gunfire started, she was out of the tent and hiding in the foliage, new baby in her arms. Under the circumstances, she had no intention of joining the defense.

After an hour, everything was quiet. The battle continued elsewhere, leaving only its dead. BJ found Vince Casey with his face missing.

Asgrim returned, and the six-hundred surviving colonists gathered in the bubble two days later. They built a fire of wood in celebration.

Late in the evening two of the K'firn appeared, chanting and holding up their arms to show their empty palms. Asgrim motioned for them to approach the heap of glowing embers.

One of the ambassadors spoke, and BJ translated haltingly.

"She says that you — that's us, plural — are to be congratulated, while they are to be . . . lamented. She says that two thirds of them are dead now, more from starvation than from war. They have lost a planet . . . no, I'll switch to direct translation. We have lost a planet, and almost all of us died. Erak will mark our final extinction.

"We would like to save our lives, and make peace. It is not our desire to kill

The aliens stood unmoving in the red light of the embers.

the humans. We were driven into that plan because we had no other choice. We ask whether you would not have done the same thing under the circumstances.

"Though we did not plan it this way, there is now a possible solution in sight. The K'firn and humans together who are still alive number no more than Erak can support. Even in winter, there would be enough for all of them. If our populations do not grow, the survivors can eventually become siblings despite the dead ones between them . . . The K'firn think this is a reasonable plan. If Asgrim refuses, they see no hope for themselves, and they will . . . She says there is a way to destroy Erak. She offers, if you agree, to show you that way as a sign of good faith. She says the K'firn know how to find the drive. It occurs to her that you might be able to do repairs that were beyond the K'firn. She says she is finished."

The aliens stood unmoved in the red light of the embers. BJ was watching the smile on Asgrim's face, a smile that played over into nastiness. She worried.

"Tell her that I agree," Asgrim said, "and want to settle terms of a treaty right now."

BJ translated, and negotiations took much of the night. After that, the K'firn went away. Asgrim got very drunk along with the others.

The baby was mercifully asleep in BJ's arms when they reached their tent up in the tree. They undressed, and Asgrim was impotent due to the alcohol. Instead, they talked.

"Your face was strange when you agreed to the treaty, Grim."

"You could tell? I hope they couldn't."

"I doubt it. I can't read their expressions. Why?"

"Good. Because we're going to kill them all, soon, and I'd rather they didn't know about it."

She started against him.

"What? Oh. You want vengeance."

"No. A man my age has grown beyond vengeance. No, it's us or them. Only one can live."

"But there is enough food, at least. As long as the population doesn't grow . . ."

"But it will grow." Asgrim pointed at the baby. "We are stronger. We have the responsibility to grow, and whether the K'firn die does not matter. As it stands, they must. I will not be limited."

"Then you made a treaty, fully intending to break it ?"

"What happened to the natives of the American continent when the Europeans arrived, do you know that?"

She was silent.

"Asgrim does not intend to honor the treaty. . . ."

Asgrim went to sleep quickly, and BJ went down to the lake with a blanket wrapped around her. Wu was kneeling by the edge, cooling his reddened face with big blobs of water. Alcohol sometimes gave him reactions. He looked up as BJ approached.

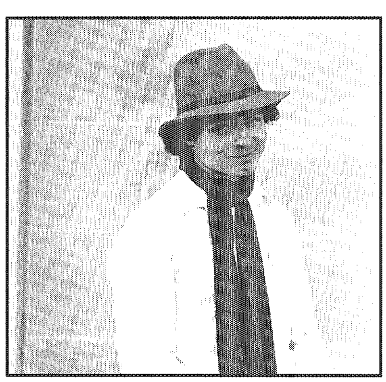
"Asgrim does not intend to honor the treaty," she said without intending to. She squatted down beside him.

Her belly had not receded completely yet, he noticed, though it had been several weeks since she had given birth.

"I know that." His tongue felt thick and slurred his speech somewhat.

"I wonder if he would honor the opinions of the colonists if they were to disagree." She mused, staring out at the trees on the other side, small in the distance.

"I couldn't say." Wu changed the subject. "I have found that you have to be careful with water in this gravity. Surface tension pulls it into big spheres



Michael Walsh is a senior majoring in physics and minoring in Latin and math. His areas of writing interest include writing persuasive and opinion pieces as well as science fiction. Among Michael's goals for the future are passing the GRE, getting other science fiction works published and being involved with politics.

when you have it in the air. But when it touches your face or something, it sticks and starts running down. I got some in my nose, and had a hard time getting it back out. You don't notice it, just drinking out of a cup."

BJ looked at him without speaking. There seemed to be something going on inside her head. He couldn't figure it out.

She reached out and washed up a basketball-sized sphere of water. She teased it from above so that it didn't have anything to run down along. Then she stood up and carried it back to her tree, leaving her blanket behind. Wu was supernally aware of her body. He quickly turned back towards the lake. He felt great sorrow, and wasn't quite sure why.

BJ rose up to the tent noiselessly, and held the water over Asgrim's face, as he slept on his back. She detached a small ball, and let it fall over his mouth. When it touched his lips, it lost shape and slowly started running down his throat. He coughed, and she added some more. He closed his mouth, and she put some into his nose. In his stupor, he struggled, and she sat straddled on his chest, holding him down while she fed him more water.

When she came down out of the tree, Wu was no longer by the lake. She went to find him in his tent. He sat shadowed in one corner.

"I didn't realize what you were going to do, at first. But you're right."

"They'll think it a result of the alcohol or something. I doubt anyone will believe I drowned him in his sleep, up in his own tree."

"Hm. BJ, there's something I can't wait . . ."

"Yes."

She moved closer to him. Wu thought her smell the most wonderful thing he had ever known. They touched, and then held each other.

A few minutes later Wu tore open a small paper package and took out a rubbery sheath, which unrolled easily. The population would not grow. **MT**

Harkins from 6

qualify yet, but it's just a matter of time."

The physical component, or sex, was the major concern for both men and women who spoke with Harkins during almost 300 radio call-in shows he participated in during one year. "About nine out of ten female callers were positive about marrying a robot, particularly if that robot had a lot of stamina," Harkins says. "About ten out of ten men were positive because they saw in almost all cases the robot in physically important terms. They felt that if they had some robot in their lives, some android that would be a good partner in the sack, and at the same time, compatible with them and growing with them in the directions that they wanted to go, where they weren't engaging in constant battles with this thing as they are, or think they might be in the future, with their spouses or their lovers than they'd be delighted. It sounds like a kind of slavery: the older image of marriage where the wife supports the husband in what he wants to do. There are still millions of these marriages in the United States."

Advances in robotics won't only affect our business or educational lives; we may be living or falling in love with robots. Now that's something to think about. **MT**

M42

Third Place

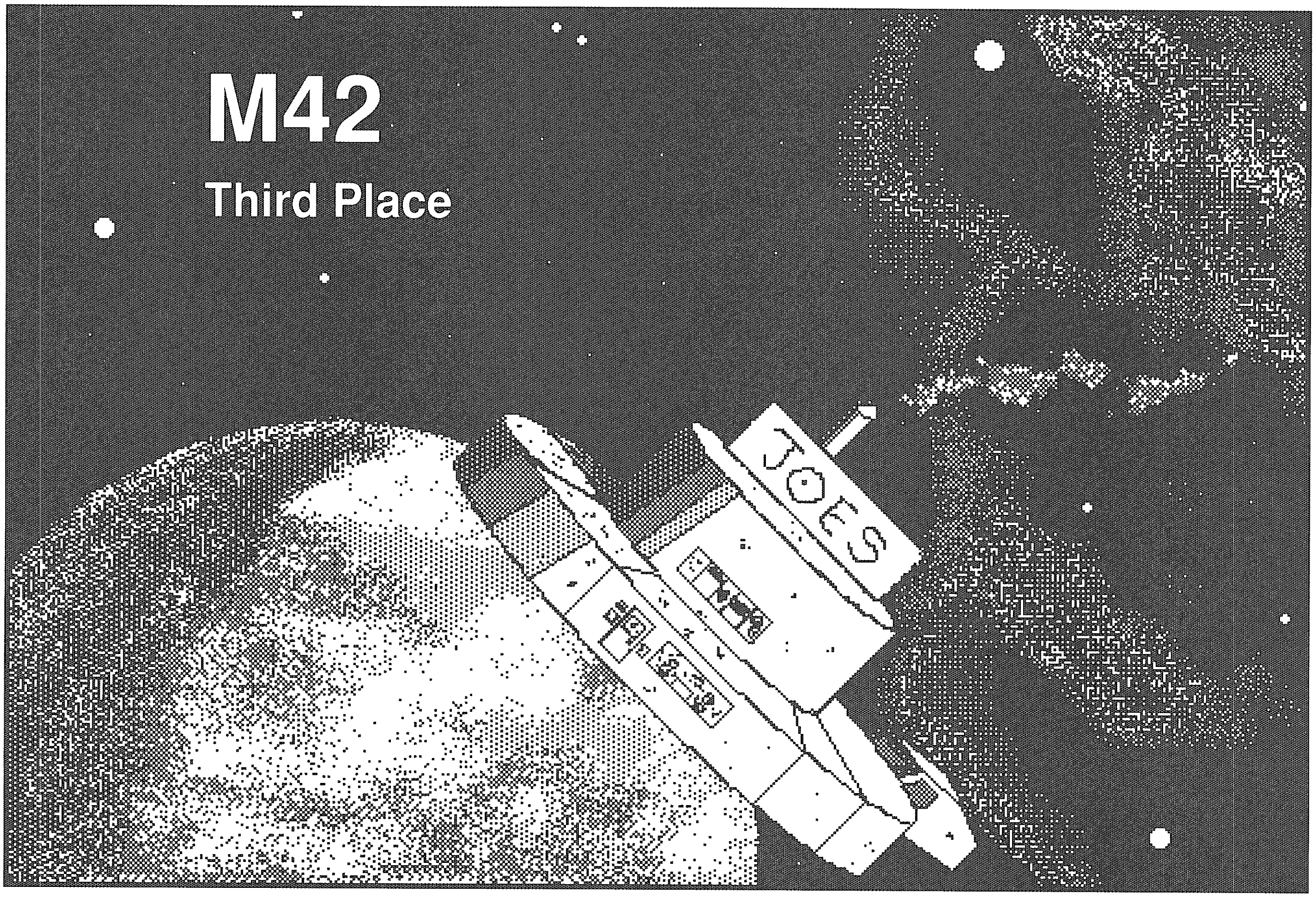


Illustration by Bill Swanson

by Ernesto Paredes

Two thousand light-years away lies the M42 nebula. Twenty-six light-years across, it can be seen from Earth. This galactic cloud of gas and dust appears as a veil of luminous material: like a neon light in fog. It is a spectacular sight, especially if you are floating in space around it. It is an unforgettable sight, but today Frank Cartwright is busy watching something else. His eyes are glued to a monitor sitting on the counter of the spacious room. Silence reigns. Only the sounds from the viewer break the stillness of the chamber.

Frank looked up, surprised by the unexpected sound of the outer air-lock door closing.

"Strange," he thought,"there are no freighters scheduled for a few days and the cruisers won't be here until next month. I better check what . . ."

He never finished the thought. The inner door flew open with a loud hiss and there stood the most horrifying sight Frank had memory of. His hair stood on end and his jaw dropped, his limbs paralyzed with fear! The creature stood twelve feet tall and made an ear-splitting, blood-curdling noise.

Memories of sixth grade flashed by Frank's eyes. He remembered going on a field trip to the history museum and seeing an old figurine from the late twentieth century that looked like the creature in the room. The inscription describing the figurine said it was called "Gumby." The only difference was that this thing was twelve feet tall, grey, slimy, and had no face, and it was moving towards him going, "EEEEEeeeeeeEEeeeeOOOOooooglblblg-EEEEEEEEEEEE!"

In what must have been a primordial urge to preserve his brains from being sucked out by who knows what means, Frank reached under the console and pulled out the old trusty frapling fragmentizer his dad used to have, aimed it as the creature stomped towards him, and let him have it. A blast of flames, sparks, and light spewed out of the gun and perforated

. . . this thing was twelve feet tall, grey, slimy, and had no face. . . .

the creature in the stomach.
"EEEEEEeeeeOOOoooglblgb . . . *"
Kathump!

The recoil of the gun had thrown Frank down on the floor. Slowly he got up, eyes wide open, staring at the creature sprawled on top of the console with smoke coming out of the cleanly cauterized manhole-sized orifice in its mid-section. It didn't move or make a sound.

"What the hell is all the . . . ! Frank! Not again! You stupid idiot!" yelled a little man that had burst through the door after the noise of the blast. This was Joe Cartwright, Frank's older brother. He had a grimy cooking apron on, a balding head with disheveled black hair, needed a shave, and smelled of spoiled fish. "This is the fifth time you've done this in a month! The FIFTH time! How do you expect us to make a living if you keep frapling every customer who comes because he looks a bit weird?"

"How do you know he's a customer?" said Frank.

"You brainless bonehead. Why do you think anybody would come to a space fast burger joint and have money in his hand?"

Frank looked at the appendage of the creature and lo and behold, there was money in it.

"That's not a hand though," said Frank, trying to avoid the subject.

"Shut up! You're going to drive us to ruin! We agreed we would float around M42 because of the tourists flying between Rigel and Betelgeuse. We are SUPPOSED to get weird aliens! Where is that Sears mail catalog disk? I'm going to have to buy you a universal communicator. Frankie, let me explain to you again. We are in business to make money, NOT TO SPEND ON UNNECESSARY COMMUNICATORS! But if I don't buy it for you, WE WILL STARVE TO DEATH!" And with that Joe strode out of the room mumbling and grumbling.

"And clean that mess!" he yelled from the other compartment.

Frank mumbled to himself, "One of these days. . . ."

"Shut up and start moving!"

"All right. All right . . . Scooter! Scooter, come here!" shouted Frank.

A little droid came in and said, "What's up? Oh no, not again."

"Got work for you, Scoot. Clean the mess up."

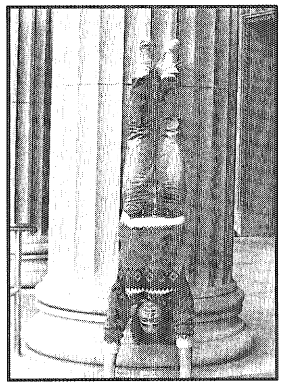
"But sir. . . ." started the two-foot droid while looking at the behemoth on the counter.

"No buts, Scoot. Get to work."

Diligently the tiny robot took a hold of the leg of the thing and started to pull. The poor thing grunted and gasped but its wheels just kept spinning. It switched positions and managed to move "Gumby" off the counter.

"Great," said Frank, "now I can finish watching 'General Hospital.'"

M42 loomed in all its gigantic beauty. Nearby Rigel, an incredibly bright star, shone in all its glory. And in the tiny fast burger joint, a man sits glued to his monitor. MT



Ernesto Parades is a junior biology major. He would eventually like to work on development issues in his native country of Peru. Ernesto's hobbies back home include many things most of us Minnesotans have only read about or seen in the movies. He has worked as a tour guide for mountain expeditions and jungle trips down rivers, and enjoys surfing and spearfishing. This is his first piece of published fiction.

Boldly Going Where No One Has Gone Before

Science fiction, considered a relatively new literature form, has origins that can be traced back to the early 1800s. It's growth seems to be mirroring the rapid pace technology is setting today.

by Angela Miller

Do you worship Isaac Asimov as a god? Perhaps you're a devoted *Dr. Who* viewer, longing to travel through time and/or to far away planets. Or maybe you prefer your science fiction on the big screen in the form of special effects and weird creatures of the latest *Star Wars* or *Aliens*-type movie. Science fiction in its various forms is not easily avoided; its impact on society affects everyone to some degree. But where did science fiction come from? How did it begin, and what changes has it gone through before reaching the stage it's at today? What follows are some of the outstanding highlights in the history of science fiction.

Although the term "science fiction" — originally "scientifiction"— was coined in America by *Science and Invention* magazine owner/editor Hugo Gernsback in 1923, science fiction literature originally began in Europe at the onset of the nineteenth century. Most critics and researchers agree that Mary Shelley's *Frankenstein*, written in England in 1818, is the first actual work that includes the major characteristics of a science fiction story. A type of science (here biology) is presented realistically, yet fantastically, and is used as the focal point for the novel. In Shelley's tale (the idea for which came from a dream) a scientist becomes obsessed with the knowledge and power he obtains and creates a living human-like being. Since this humble beginning, authors have proceeded to develop a new genre and take their readers on fantastic voyages of imagination.

Exactly what, then, is science fiction? Webster's New World Dictionary defines it as "fiction of a highly imaginative or fantastic kind typically involving some actual or projected scientific phenomenon." Science fiction contains many of the characteristics of romance literature; both attempting to created feelings of awe and wonder in the reader, usually using larger-than-life heroes and heroines. It has also been classified as a sub-group of fantasy literature since it presents as-of-yet untrue situations and settings. Science fiction is unique in its dealing with broader, philosophical issues. The author can escape the "here and now" by creating new settings in which to display their ideas.

Obviously, science fiction could not exist until the study of science and the development of scientific thought began to be accepted in society. Predictably, the science fiction topics being discussed mirrored the types of discoveries being made, inventions being developed, and theories being proposed. The discoveries of Darwin (1859), Edison (1879), and Einstein (1905), and the like, opened up brand new worlds of time, space, and possibility. But science fiction took these ideas one or more steps further, exaggerating them and pushing them to their absolute limits. Authors speculated on where science could go and what the results, both positive and negative, of technological advances might be.

As the genre began to grow and develop, several categories sprang up to catch the different varieties of science fiction being produced.

[Science] opened up brand new worlds of time, space, and possibility.

Among them are: Utopian Societies, Imaginary Voyages, Adventure Tales, and Incredible Discoveries or Inventions. Utopian designates those stories dealing with different—usually better, or at least more "advanced" — societies. Many times these societies were invented to illustrate political theories, or question the ethics of scientific research. Traveling to unexplored lands has always intrigued and excited people. Authors can use voyages to show development in a character, or an idea or theme. Jules Vern, with *20,000 Leagues Under the Sea* and other "voyage" novels, emphasized conquests and exploring the unknown.

H. G. Wells (1866-1946) was one of the first science fiction authors to have training in and an understanding of scientific principles. He believed that although the future cannot be foretold, its conditions can be. In many of his writings he hoped to warn mankind of what the results of carelessness and failure to think ahead could be. Wells' works , including *The Time Machine*, *War of the Worlds*, and *The Invisible Man* signify the growing effect both science and literature were having on society.

These are, very broadly, the general origins of science fiction literature. But science fiction did not stall at this point with the turn of the century. Far from it . . . especially in America. In the United States, the awakening to science fiction can be summed up in two words: PULP and FANDOM.

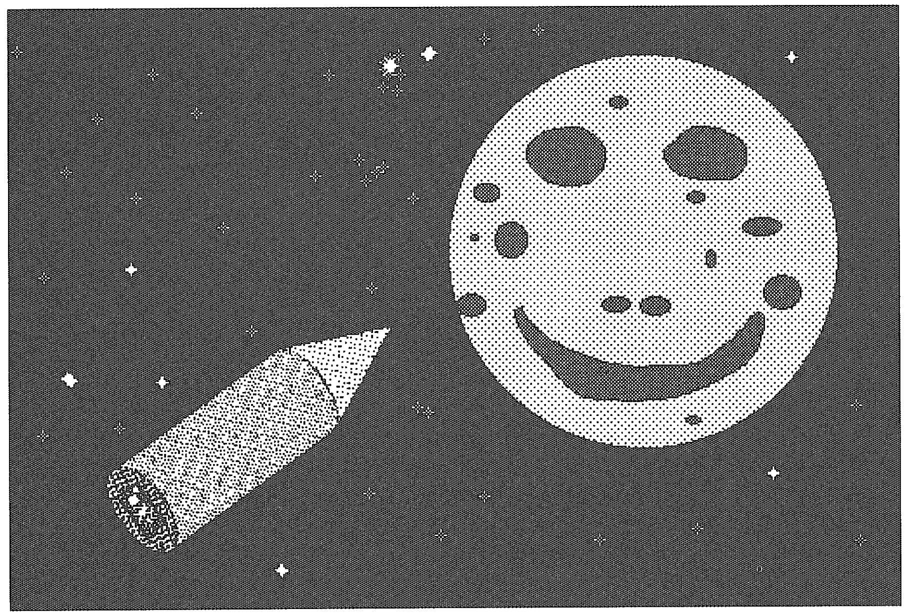


Illustration by Bill Swanson

Magazines made from cheap paper, or pulp, dealing with topics ranging from Westerns to non-fiction science and technology were extremely popular among the reading public during the early 1900s. Several of editor Hugo Gernsback's technical science magazines began including fiction stories along with their regular features. Soon annual issues were devoted to science fiction literature; and finally entire magazines were created to meet the demand for fantastic science tales. *Amazing Stories* competed with *Science Wonder Stories* and *Weird Tales*.

. . . elements of supernaturalism and horror began to dominate story lines.

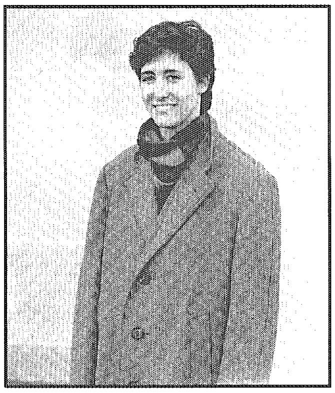
Each pulp had a particular angle or gimmick that is concentrated on most often. Some pulps emphasized hardware in their stories; new machinery and rocket ships, not to mention the arrival of robots—fascinating for their humanoid forms and abilities—provided great special effects and opened new worlds for technological advances. In many ways it made the totally impossible and impractical plausible, "shock proofing" society from technology.

Other pulps stuck with the tried and true adventure tale format. Making their first appearances were the macro-histories of Robert A. Heinlein, including time-lines of supposed future events, dates of inventions, planetary wars, or whatever. The "space opera" formula was used often among pulp authors. Space operas resemble soap operas or westerns in basic good vs. evil plot , but have science fiction settings and props. Finally, some pulps veered away from a strict science-type format and elements of supernaturalism and horror began to dominate story lines. These were known as Thrillers or Weird Fiction, with authors H. P. Lovecraft, Clark Aston Smith, and later Robert Bloch (*Psycho*) and Ray Bradbury at the front of the pack.

Science fiction pulps continued to gain popularity as readerships grew. An important feature of the magazines was the letters, or reader correspondence, section. Readers wrote letters: letters to the pulp itself, to the authors of the stories, and to each other. Clubs formed and many began producing their own small magazines, or Fanzines, printing their own stories, criticisms and analyses, and news about authors and the professional magazines (Prozines). The Fanzines were where many later professional science fiction authors got their start. Science fiction readers were unique in their obsessive need to discuss, analyze, and debate the works, collect the stories and 'zines, and write their own science fiction. This frenzied, frantic fan activity formed the foundation of Fandom. Fandom had a language all its own where fans, fringefans (those who are just barely fans), trufaans (extremely active and loyal fans), bnfs (big name fans), ayjays (amateur journalists), and pros (professional journalists) could converse and fanac (participate in fan activity). Some believed in the concept of "fiawol" (fandom is a way of life), while others leaned towards "fijagh" (fandom is just a goddamned hobby). Either way it was not uncommon for a fan to gafiate (get away from it all) for a time since they could always degafiate and resume fanac.

The 1940s and 50s were known as the "Golden Years" of science fiction and Fandom. The big name authors were Heinlein, Isaac Asimov, and Theodore Sturgeon. Fans began holding conventions, and in 1953 the first Hugo Awards were presented. Named in honor of Hugo Gernsback, the man responsible for the term "science fiction" and the beginning of science fiction pulp, these awards are given for outstanding science fiction literary accomplishments.

Finally the "New Wave" of science fiction began in the 1960s and continues today. Science fiction started to



Angela Miller is a senior pursuing an English major and a linguistics minor. She is studying in London this spring, and is looking forward to traveling and sightseeing when the quarter ends. Although not previously a voracious science fiction reader, doing this article has piqued her interest in this literary form. Angie enjoys fencing and is a football fan. Perhaps cricket will be her sport when she returns.

become more "literary," more critical, and more socially conscious as it incorporated discussions of current issues. Topics now began to include: feminism, human relationships, sexuality and sex roles, and different life styles. New Wave authors tend to be experimental in their use of language and style. Typical authors include: Ursula Le Guin, Samuel R. Delany, Roger Zelazny, and Joanna Russ. Many science fiction parodies and humor novels are also becoming increasingly popular. Also the use of science fiction in other media (television and movies) is affecting the way authors write and readers read it. And, as it always has, developments in science and technology have opened new areas for imaginative exploration.

Readers of science fiction are as numerous and varied as the forms of this type of literature are themselves. There is no one specific type of person who reads and enjoys science fiction. Everyone reads different material and gets something different out of it; some read for the unique angles and perspectives of current issues, others for the new ideas and possible glimpses into the future, while still others prefer science fiction's entertainment value that allows them to escape everyday realities. Whatever reason is preferred, science fiction has had a diverse enough history to include something for everyone. **MT**

Sources:

1. Allen, Dick. *Science Fiction: The Future.* New York: Harcourt Brace Jovanovich, Inc., 1971. (pp 1-7).

2. Scholes, Robert and Eric S. Rabin. *Science Fiction: History, Science, Vision.* New York: Oxford University Press, 1977.

3. Warner, Harry J. *All Our Yersterdays.* Chicago: Advent Publishers, Inc., 1969.

4. Wollheim, Donald A. *The Universe Makers.* New York: Harper and Row Publishers, 1971.

Log Ledger from 7

other remote installations in parts of Alaska, Canada, Greenland, and the Soviet Union. A small steam-type engine designed by Drs. Gerald Lock and Henry Stanford, Jr. of the University of Atlanta uses the temperature difference between the arctic ocean and the atmosphere to produce energy.

The system uses compressed ammonia which is liquified by the frigid arctic air. The liquid ammonia is then submersed into the ocean, which is warm relative to the outside air. Since ammonia boils at 32° F it vaporizes, and the vapor is used to run a conventional steam engine. Although the efficiency of this system is low, it uses virtually no fuel and therefore any energy produced is practically free. **MT**

Source: ASME News Release, February 1988

Computer for the Year 2000

Last fall, Apple Computer, Inc. sponsored a nationwide contest for college students to design a personal computer for the year 2000. The University of Minnesota team, consisting of students Lynn Linse, Scott Litman, Michelle Vig, William Burns, and faculty advisor Assistant Professor Kevin Dooley, won third place among a field of eleven other university entrants. The *Minnesota Technolog* is proud to present their winning design.

Abstract:

Personal computers of the year 2000 will have evolved beyond performing only traditional computer tasks such as text processing or data management. Users will be able to carry the cores (the essences) of their computers with them wherever they go, using them as personal aides in a much wider variety of tasks. A single "computer core" traveling with its one user will be in a position to learn, adapt, and be customized to that individual and will act as an intelligent intermediary in dealing with many of the complexities of future society.

Introduction

Today's "personal" computers have not yet risen above many of the problems inherited from their "impersonal" ancestors. Most users must still change the way they work to accommodate the needs of their computer. These changes in work patterns require a learning period that hampers computer use and reduces productivity. Since computers are only tools to aid and magnify human effort, requiring extra effort by users is contradictory. As computers become increasingly interwoven into the fabric of our society, this contradiction will become even more stark. Computers should enhance the work people do—not define or control it. Computers should undergo a training period to learn about new users, not vice-versa. The word "personal" in personal computer should come to symbolize a computer that reflects and accommodates the characteristics of its user.

As computer users, our team has developed ideas about how we would like computers to help us and become our own personal computers. These ideas are described in our design of a personal computer for the year 2000. We refer to this computer as "Core" because we have extracted the core of a computer into a durable, pocket-sized unit for a user to carry. First we will present the relationship between users and their Core computers. We will then show an extended example of how a typical user will use Core as an aid in daily life. From this example, we will be able to point out key design criteria for Core and discuss the innovations in hardware and software technology required for Core to become a viable product. Finally, we will make some concluding remarks about Core's design and potential enhancements to Core beyond the year 2000.

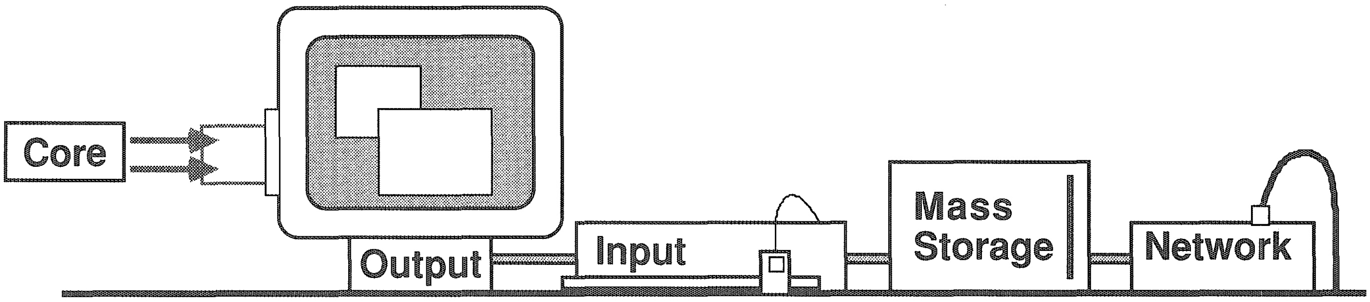
User-Computer Relationship

By the year 2000 the personal computer will have become a critical tool for the individual in a highly computerized society. The march of technology will allow us to control progressively more detailed aspects of life around us. We will each become a master of our own growing little universe. At the same time, managing these universes has the potential of enslaving us with details and responsibilities. We will be literally flooded with both relevant and irrelevant information, from which we must make decisions.

. . . personal computers will help the user make effective decisions.

Even today we can begin to see signs of this happening. Every day, more human knowledge is incorporated into public, education, and corporate computer databases. We expect this trend to continue exponentially through the year 2000, leading us into a new "information age". This incredibly rich information age could also become an incredibly impotent "decisionless age", where even simple day to day decisions become complex due to the number of choices and the amount of information available.

The problem is not requiring complete



A desktop Core personal computer system

information to make decisions—people have always made decisions without knowing everything. The problem is that in the information age there will always be at least one more fact available, one more fact that if left unexamined may mean missed opportunity or personal responsibility for a bad decision.

How to avoid this decisionless age? We see at least four solutions. First, people could avoid making decisions. Second, they could blindly choose or make uninformed decisions. Third, people could hand over decision making to computers designed to deal with the amounts of information required. Finally, people could design a tool to help them manage large amounts of information and enable them to make effective decisions themselves. Since people must take an active role in shaping their society, we feel that the fourth solution is the only proper one.

To find a form for such a tool we need look no further than the average manager's office. Effective managers make complex decisions by having subordinates (personal staffs) preview the available information before presenting the executive with only the relevant information required to make the decision. What if everyone in the year 2000 could be supplied with such a staff? Or what if everyone could be supplied with a tool designed to work like such a staff? It would need to possess an intimate understanding of the individual user in order to assist in making timely, effective decisions. **This is our vision of the role of personal computers in the year 2000. Besides helping users with day to day tasks such as text processing or data management, personal computers will help the user make effective decisions.**

Current computers are designed so that a single, generic machine can be used for a variety of applications by a variety of users. To function as highly personalized decision-making aides, future computers must instead be customized to reflect a single user's highly individualized interests and needs. It is unlikely that a single personal computer could keep track of such detailed interests for many people. Even if it could, the user should retain control over the computer because of an individual's right to privacy or the potential for abuse of such a tool. The computer should be an entity intimately familiar with and dedicated to a single user. Its sole purpose in existing will be to further the interests of that one user, and ideally it would progress with the individual from cradle to grave. While the year 2000 is too soon to expect sophisticated forms of this computer, it will just begin to show itself in Core.

Many futurists and science fiction writers describe worlds where people and computers are always separate and competing factions; where people may eventually lose some competition with "The Computers" and be brushed aside. But there is no reason that people cannot design computers as tools to help people work better than computers alone. Most people have seen such movies as *Star Wars*, where personal computers (such as R2D2) help people make use of complex, unknown technology (such as the Empire's "Death Star").

We propose that by the year 2000, personal computers will begin to act as personal staffs, aids, interpreters, representatives, and even advocates for their users.

Core Design Criteria

Core must adapt and grow with the user over the years. Users come in endless varieties, each with unique experience levels, expectations, and work patterns. Core must be able to adapt to any user who purchases it, and we believe this will lead to the principle of "one computer, one person." The longer a user works with Core, the more intimately it will be adapted to the user. Since all information to and from the user passes through Core, it will be in a position to learn from the user's mistakes, successes, and general patterns of use. Advanced users will want Core to magnify their efforts, taking charge of trivial detail. Beginners will want Core to watch over their shoulder and make the necessary double checks to avoid mistakes. Users with special needs, such as the handicapped or users in non-traditional environments (inspectors, factory workers, etc.) will want Core to accept or present information in unconventional ways on unconventional devices. By being so versatile, Core will help to close the generation gap between users who grow up with computers and users who must learn to utilize computers at an older age.

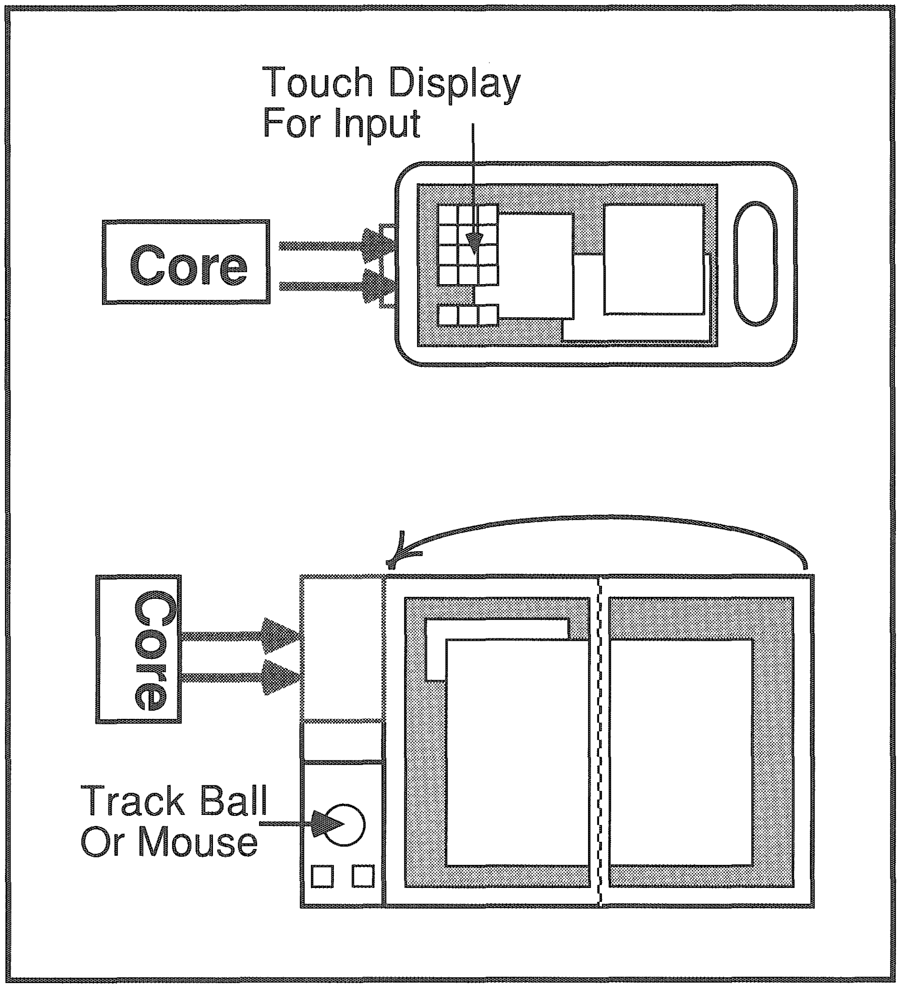
Core will carry its user's information wherever the user goes.

Core must be extremely portable. Presently, dealing with one or two computers can be frustrating, but by the year 2000 many users may have to deal with dozens of different computers daily. Since local copies of information will exist on each of these computers, how will changes or additions be reproduced across them all? By incorporating the applications and knowledge of a computer in a durable, pocket-sized module, Core will carry its user's information wherever the user goes. The problem of inconsistent or "left-behind" files will be eliminated.

Core must be completely peripheral independent. Users of today's portable computers must utilize less-readable screens or abbreviated keyboards whenever they use their computers. Since Core is peripheral independent, users will be able to select the appropriate peripherals for their immediate needs—be they miniaturized "portable" peripherals, standard desktop peripherals, or highly specialized peripherals for specialized tasks.

Core must adapt to interact with existing systems. Just as Core must adapt to a variety of users, so must it adapt to the variety of systems they utilize. Utilizing multiple computer systems, a user may be exposed to multiple adaptations of standard applications and other inconsistences. For example, a user working on five different systems may have to use five different financial analysis packages. Core will adapt to these differences by acting as an intermediary. It will present the user with a consistent interface while satisfying the native applications running on the other computer by responding as if the user were using it directly.

Core must enhance existing investments in equipment. A fortune is invested in existing computer equipment and training. Core will not be successful if it ignores this investment. A module to accommodate Core must be designed to retrofit existing equipment. Under the control of Core, the existing equipment will initially continue to function as before, while gradually adding new support and functionality as the weeks progress. Core can also utilize the processing power in existing equipment.

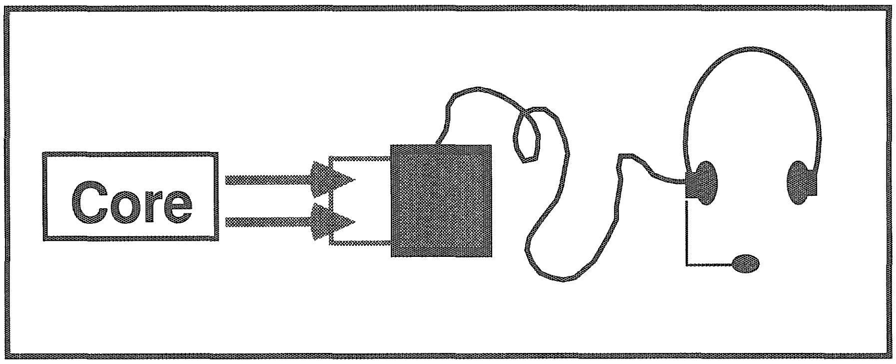


The Core slate display (top) and notebook display (bottom) configurations. Both peripherals will have a variety of specific and general applications.

Core must make output more effective. Everyday more of the world's knowledge is encoded into computer readable form, and Core will play a key role as the window into this storehouse of knowledge. Not only will Core spend more of its time displaying information than today's personal computer, but users will expect Core to manipulate and present the information in ways that aid their comprehension. The designs of personal computer peripherals must adapt to reflect this shift in function.

Core must accommodate future designs. Like all devices, Core and its peripherals will eventually become obsolete. In equipment today, the strong hardware dependence of components often dooms all of the modules when only one becomes obsolete. By separating the main unit and peripherals into modules, each module can be replaced or kept as desired. Another aspect of future design means that Core will have to adapt to uses and peripherals not even imagined today. When an obsolete Core unit is to "retire", the knowledge and essence of the old Core must be transferable to the new Core.

Core must be a rugged device. Although peripherals may continue to be designed for specific environments, Core must be able to work in any environment that the user can. It must survive water, dirt, and temperature changes without fail. The communication method used between Core and the outside world must completely isolate Core from damage due to contamination or malfunctions in connected devices. The connector between Core and external devices must also withstand repeated use.



A Core and a "computeman" voice input/output device. Full understanding of human speech is possible along with human-sounding computer generated speech.

Technological Innovations Needed

Micro-chip technology will advance at least as far as it has in the past decade. Dense, multi-layered, low-power chips will put the computing power of today's smaller mainframes in a few chips. This will allow very powerful Core models to fit in a pocket and run for a reasonable amount of time from a battery.

International standards for networking intelligent devices will become reasonably mature over the next five years. These standards will lead to the development of other standards, such as standards for knowledge representation and device interfaces which will allow Core to work with most applications and intelligent peripherals.

High speed communications links will allow the processors, memory, data storage, and input/output devices of a work station to be "distributed" and placed in separate modules. This will allow specialized work stations to be assembled for specialized tasks.

A low-power optical link will allow the degree of portability and ruggedness envisioned for Core. Optics will allow both contact-less connectors capable of surviving dozens of reconnections per day and provide the electronic isolation Core needs to survive in a world where imperfections and failures will always occur.

Advancements in human speech recognition will allow peripherals to be created for Core that open whole new ranges of applications. Speech recognition and generation will allow the use of Core when the user's hands and eyes are required on other tasks. Although true natural language interfaces may not be possible yet, the creative use of key words and phrases will give the impression that they do.

Advancements in heuristic classification methods will allow Core to "learn" to classify items and actions for the user's benefit.

Hardware

A Core personal computer system will consist of three main classes of devices: the main computer unit (the "Core"), input/output (I/O) devices, and network access devices. In a general sense, any I/O devices are optional enhancements to Core, and network devices are optional enhancements to the I/O devices.

One output device (such as a display) will be designated as the main I/O device by connecting Core into it. Attaching any other devices to this main device will make them appear to Core as "windows" of the main device. Even printers and data storage devices will be viewed as such windows. If a network device is attached, then windows can also exist remotely over the network.

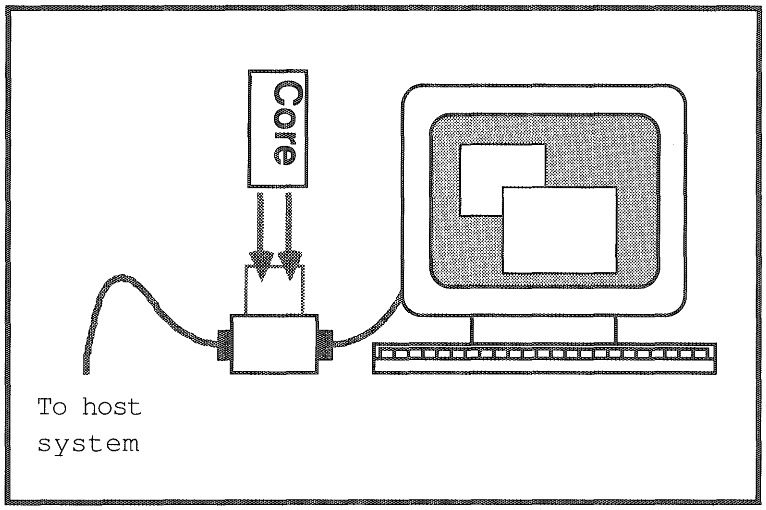
Core, the main computer unit, will be a small, sealed box about the size of a wallet. It will contain only the main processors, memory, and components needed to communicate with the outside world. Being small and nearly a solid chuck of plastic and silicon, Core will be rugged enough to go anywhere its user can. Its processors will provide at least 30 times the power of today's fast personal computers. Its 1 gigabyte (at least) of memory will function like both memory and magnetic disks do in today's personal computers. The memory will be either non-volatile or ultra-low power circuitry to allow Core to retain its knowledge on battery power for at least one year.

Core will communicate with its peripherals via a high speed, optical communication link. Optical signals will be used to make Core water and dirt proof, plus they will isolate Core's circuitry from external devices. One channel will carry data into the Core. The light energy will then be reflected back out through the other light channel, carrying with it output data on a different frequency. The external device will be responsible for powering the link and handling any waste energy involved. In the future this optical link may evolve to provide a trickle charge to Core, keeping its batteries fully charged.

Core will have to adapt to uses and peripherals not even imagined today.

When not connected to an external device, Core will either wait in a suspended state, or if power reserves permit, it can continue performing unfinished tasks or perform internal knowledge "housekeeping."

To be of any direct use, Core must be connected to at least one ***Input/ Output device.*** Core will treat all external devices connected as intelligent (but slightly subservient) peers. All models of Core and all devices designed accommodate Core will have a standard type and location for connection. All peripherals will communicate with Core (or any other computer) by standard protocols that will make computers in the year 2000 device independent. In addition to the traditional desktop peripherals available today, Core's size and portability will allow the creation of a wide range of new peripherals. Here are descriptions of some exciting new peripherals possible that will change the way people use personal computers.



A Core and a retrofit terminal. Public services such as automatic teller machines, pay phones and other computer-based services would have compatibility with Core.

The *NoteBook display* will be about the size and weight of an open text book. Capable of presenting the image and text quality of an open book, it will fold like a book for convenient, safe transport. Core will plug into one corner of the display and the desired input device(s) will plug into another corner. The most common input device will probably be a track ball with a few page-flipping buttons, which would fit neatly into the space provided for input devices to make the display self-contained. The display could be adapted for either right or left handed people. Special input devices could be added to meet special needs.

The *Slate display* will be used for "on-the-move" tasks. About the size of a clipboard, its primary input will be by program generated "buttons" displayed on the touch screen. Unlike today's soft, fragile touch screens, the slate display will have a hard, washable surface capable of surviving use in industrial applications. Slate displays could also be supplemented with bar code or vision scanners to input data and radio network connections to access central database systems. Today, hand-held, radio-connected terminals are increasing used in industry. The power of Core and the touch display will greatly magnify their effectiveness.

Voice input/output combined with a portable headset will allow the Core to function like a "walkman". This will open a broad new range of applications for personal computer use. Voice recognition will understand simple, deliberate human speech without training; understanding complex, full-speed human speech will require a "training" period where the system learns to recognize the speaker's voice and speaking habits. Good intonation will allow computer generated speech which sounds nearly human.

Standard terminals and *other public access points* (such as ATM, pay phones, check-out counters, etc.) can be retrofit to accommodate Core. Although no terminal should assume a Core will be attached, future terminals will be designed to take advantage of the computing power offered when a Core is available.

Voice recognition will understand simple, deliberate human speech.

Keyboards will be intelligent devices that allow users to teach the keyboard how to save the user effort and key strokes. They will learn by example to substitute long key stroke sequences for the users' simpler ones.

Light sensitive tablets will allow sketches, formulas, and other input to be entered free hand. The tablet will also scan printed material placed on its surface, allowing existing text or graphics to be loaded into the Core in useable formats.

Small pressure sensitive tablets will allow users to write notes into the system without speaking out loud or using a keyboard. If Core cannot understand what is written, it could always store it as binary images and allow the user to translate them later.

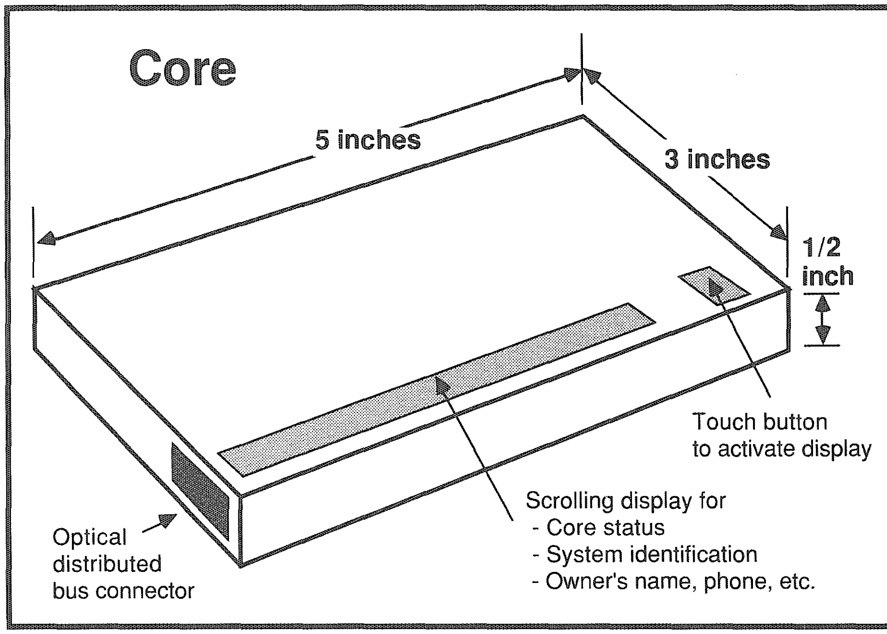
For ***Network and external data connections***, a device that acts as a bridge between the internal high speed communication link used by Core and its peripherals and any external networks. External networks will greatly expand the knowledge and power available to any personal computer and help make it part of a computer society to link users and ideas. Access could be either by a direct connection into an organization's Integrated System Data Network or remotely through a public packet switching network—in effect by "pay phones" for computers.

Snap-Shot backup devices will prevent the total loss of experience for Core, which would be a catastrophe. Connecting a Snap-Shot device would allow the memory contents (the essence) of Core to be quickly copied either in or out. The device could be either a unit smaller than Core to be carried along or it could be a larger desktop device capable of more sophisticated uses.

Other data storage devices, such as optical, electronic, or magnetic devices will allow external data to be brought into the Core personal computer system. These devices may be used to access large amounts of data when network access is not possible or practical. For example, some companies may still supply data or programs via physical disk. A high-capacity device may be used for archiving old data or saving back-ups like a Snap-Shot device. External network devices may be used to hold data that cannot or need not be held in Core's active memory.

Software

The operating environment will undergo the greatest change in the evolution to Core. Continuing the trend towards device independence, Core's operating environment will assume complete control of the computer—isolating users, applications, data, and peripherals from each other. Core will learn to process the flow of information between these "entities" in a context-sensitive manner, allowing each to be presented with information in the form that they expect to see it.



The main computer unit of Core will be about the size of a wallet. Communication will be handled through high speed optical links.

Another major change will be Core's ability to learn. Although creating programs that learn like humans learn may not be possible by the year 2000, the simple type of learning we envision for Core exists today in research form. Applications and resources will come equipped with the knowledge required to teach Core, so Core "learns" about its environment and be self configuring. When dealing with its one user, past use will have given Core "stereotypes" of how the user prefers to work, allowing Core to do some of the work for the user.

This learning would include, but not be limited to, these methods:

- Core could learn by imitation. Since it handles all information flow to and from the user, Core could be told to "watch what I do".

- Core could receive training from specialized programs that use forms of expert systems to determine either directly what the user wants to teach Core or indirectly other general characteristics of the user to teach Core.

- During actual use, Core's knowledge could be fine-tuned by using a "reward and punishment" scheme, where feedback from the user helps Core evaluate its understanding of the user's likes and dislikes.

Regardless of the methods Core uses, experts in learning stress that all learning takes time. People spend decades learning the skills required to be valuable members of society. Although it should not take near as long, Core may take months to become a truly valuable tool for the individual. The first generation of Core computers may have to grow up with their users from childhood before we know the true potential for computers to learn by these methods.

Core will run with or without ***external network access***. When external sources are available via a network, Core will "know more" and be more capable. The system will detect what external resources are available and make appropriate use of them in a self-configuring manner.

Data and knowledge will rarely exist in files as we know them today. Instead they will exist in a more general knowledge base format that reduces traditional application and file boundaries. All data will be owned and accessible by Core's operating environment, and applications will merely be users of this data. This will assure that different types of knowledge representations (sketches, text, etc) can be freely mixed by Core into associations that allow simple retrieval by various search mechanisms. For example, a letter may consist of a date written, the address of people to receive it, a body, and a signature block. All of the data units would be free to be used in other letters and documents as well.

Text knowledge can exist in language-free formats that allow the text to be displayed in many languages. Although such language-free formats will not retain all of the subtle beauty contained in human languages, they will be indispensable for sharing information between people of different cultures, such as simple letters and technical books.

Core could learn by imitation . . . and be told to "watch what I do."

The form of ***application programs*** will also change. Instead of being explicit instructions to manipulate data and computer resources to meet objectives, they will evolve into collections of knowledge about the objectives to be met. Core will then use various control paradigms and computational engines built into its operating environment to carry out the explicit tasks required to meet the objectives of the application. Applications by the year 2000 will begin to look more like today's expert systems than the application programs of today.

Internal storage of massive amounts of data will be a major challenge. To retrieve data in a timely manner, knowledge will have to be divided into

Data and knowledge will rarely exist in files as we know them today.

a hierarchy. Automatic aging functions, supplemented by some semi-automatic merit functions, will shift knowledge to less expensive (and less searched) storage as required. Commonly used or important knowledge will be maintained in short-termed memory. General knowledge will only be known in related contexts and stored in long-term memory, still memory resident, but not always searched. Finally, "old" knowledge will be off-loaded onto auxiliary storage, but may retain some key words, indexes, or abstracts in long-term memory to allow faster retrieval. Knowledge (data) will not be "lost" on floppy disks as it is now.

Core Challenges

In addition to the numerous advantages associated with Core, we believe it appropriate to discuss some of the challenges facing the designers and users of Core computers. Creative solutions by designers to these problems will enable companies to differentiate their products in the marketplace.

The most obvious challenge is to minimize the impact of loss or failure of Core to the user. One solution is to use knowledge saved within a snap-shot device to "clone" a new Core, but this would require the snap-shot device to be used regularly to archive Core's memory. Could such backups be made without relying on user initiative? Special models of Core could be created to store a redundant copy of its memory internally to be extracted in case of failure, or devices to which Core is commonly connected could make backups as a secondary function.

What if a user forgets to bring Core along? Will future users be helpless without a Core? Will the computer systems of the future evolve to the point where Core is required to act as a translator for the user? Possible solutions include designing large systems to temporarily emulate Core in such situations, or generic Cores could be designed to be quickly adapted to the user for temporary use.

Another challenge is that of limiting dependence on Core. The power and flexibility of Core may prove more "addicting" than the addiction to automobiles, telephones, and televisions combined. Can this reliance on Core become another human need, like the needs for shelter, food, water and a Core computer? Is this good or bad or indifferent?

As with all man-made devices, there is always the challenge of designing a marketable product. To profitably design a Core computer, decisions regarding the trade-offs between capacity, reliability and cost must be addresses. Different models or brands of Core would naturally combine different levels of these features to fill market niches. For example, the reliability needs of a six-year-old student may be very different from those of a corporate lawyer.

A more difficult challenge will be that of maintaining the integrity of Core. Since one of Core's functions is to filter information for the user, subtle alterations of Core's learning could act to censor what the user receives. Because of the massive amounts of knowledge contained in Core, such subtle changes would be hard to detect. Could organizations create "computer viruses" that infect Cores to further their own interests? How could users or Cores protect themselves from such influences?

While we are on the subject of dishonesty, since Core may contain confidential information about users and/or their companies, what would be their value if stolen, copied or modified to act as a "spy". How would confidential information be protected? For example, how valuable would a Core taken from Mikhail Gorbachev or Oliver North be to the CIA or to the U.S. congressional committees? Could Cores be "core-napped" for ransom? If Cores become used as identity devices, how to prevent unauthorized use? A whole industry could evolve around supplying tamper-proof, possibly even self-distructing Cores.

Conclusion

Core will be just the beginning of a new era in personal computers—one in which the personal computer will continue to become smaller, smarter, and more personal. Core will be

. . . the personal computer will continue to become smaller, smarter, and more personal.

pocket-sized, yet durable enough to accompany its user anywhere. Core will enable its user to communicate easily with existing computer systems and databases. Core will learn how to separate relevant from irrelevant data for its individual user, promoting Core as an effective decision making tool.

Core and its descendants will become a "sixth sense" for its user—a sense that both simplifies and magnifies the effectiveness of the human/computer interface. Core will become a powerful asset which will enable its user to keep pace with the rapid advancement of knowledge and technology in the future. **MT**

Editor's note: special thanks to Apple Computer, Inc. and Dean Russell Hobbie for their cooperation with this article.

Technotrivia

Star Trek Trivia

by Mitchell Skiba

Questions:

1. On the bridge, who is nearer to the science officer, the navigator or the helmsman?
2. What was V'ger's original name?
3. In "The Deadly Years," Kirk successfully bluffed the Romulans into thinking that the *Enterprise* would self-destruct using what device?
4. What is the normal complement of crew members aboard the *Enterprise*?
5. How many crew members were required to operate the *Enterprise* after the M-5 computer was installed?
6. What year was "Star Trek" first televised?
7. Approximately where in the body of a Vulcan is the heart located?
8. How had Captain Kirk gained captaincy of the *Enterprise* in the bloodthirsty parallel universe in the episode "Mirror, Mirror"?
9. What do the letters UFP on the Star Trek banner stand for?
10. What did Spock say "was not aesthetically pleasing on humans"?

Scoring:

0-1	Have you heard of television?
2-4	Tribbles have scored higher than you.
4-6	Not a true trekkie, but keep trying.
6-9	You've been beamed up one too many times.
10	Seek immediate psychiatric help.

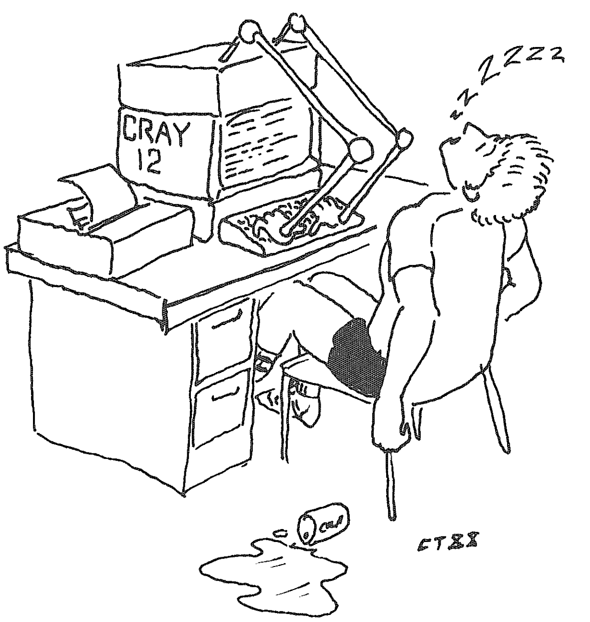
Answers:

1. Navigator.
2. Voyager 6.
3. Kirk claimed to have a Corbomite device, which doesn't actually exist in the Star Trek world.
4. 430.
5. 20
6. It first appeared in 1966.
7. It is located in the lower left side of the trunk.
8. He assassinated the Enterprise's former captain, Christopher Pike.
9. United Federation of Planets.
10. Vulcan ears.

Technocomics

The Near Side

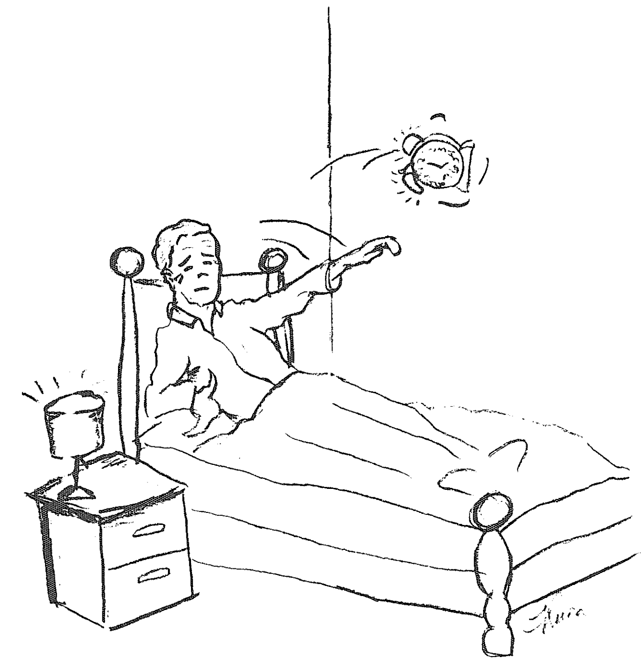
by Steve Littig and Conrad Teves



After the invention of the Cray-12, homework was never quite the same.

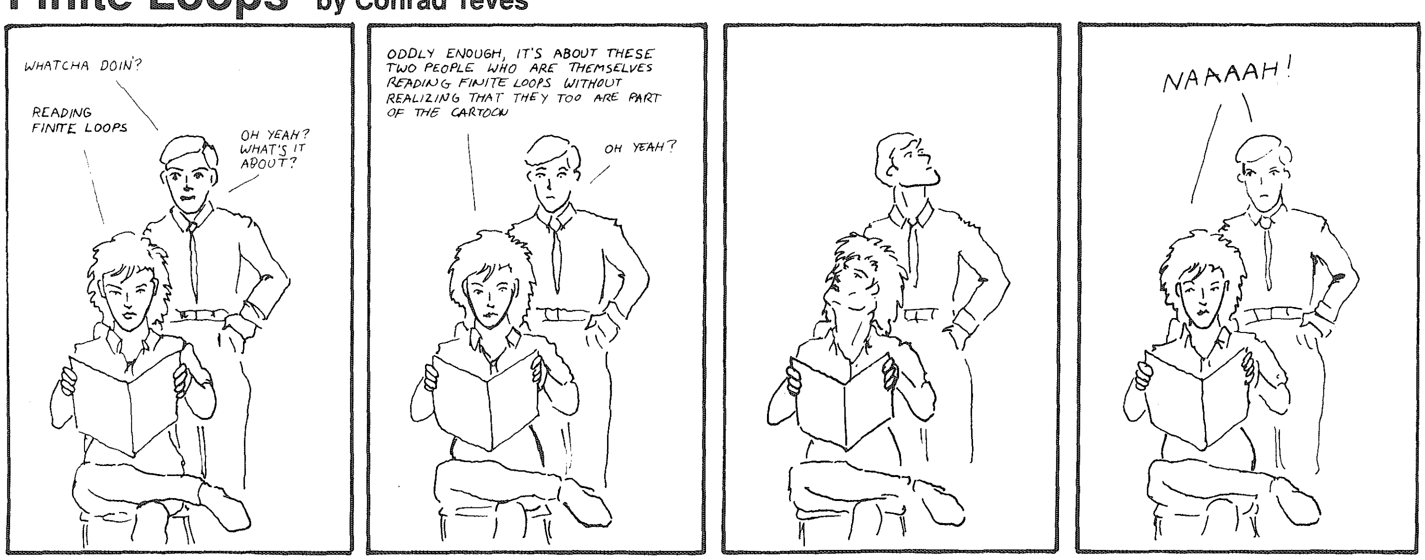
The Flip Side

by Jim Willenbring and Tom Rucci



When faced with the reality of an 8:15 class, Steve took to heart Newton's First Law of Motion: a body at rest remains at rest.

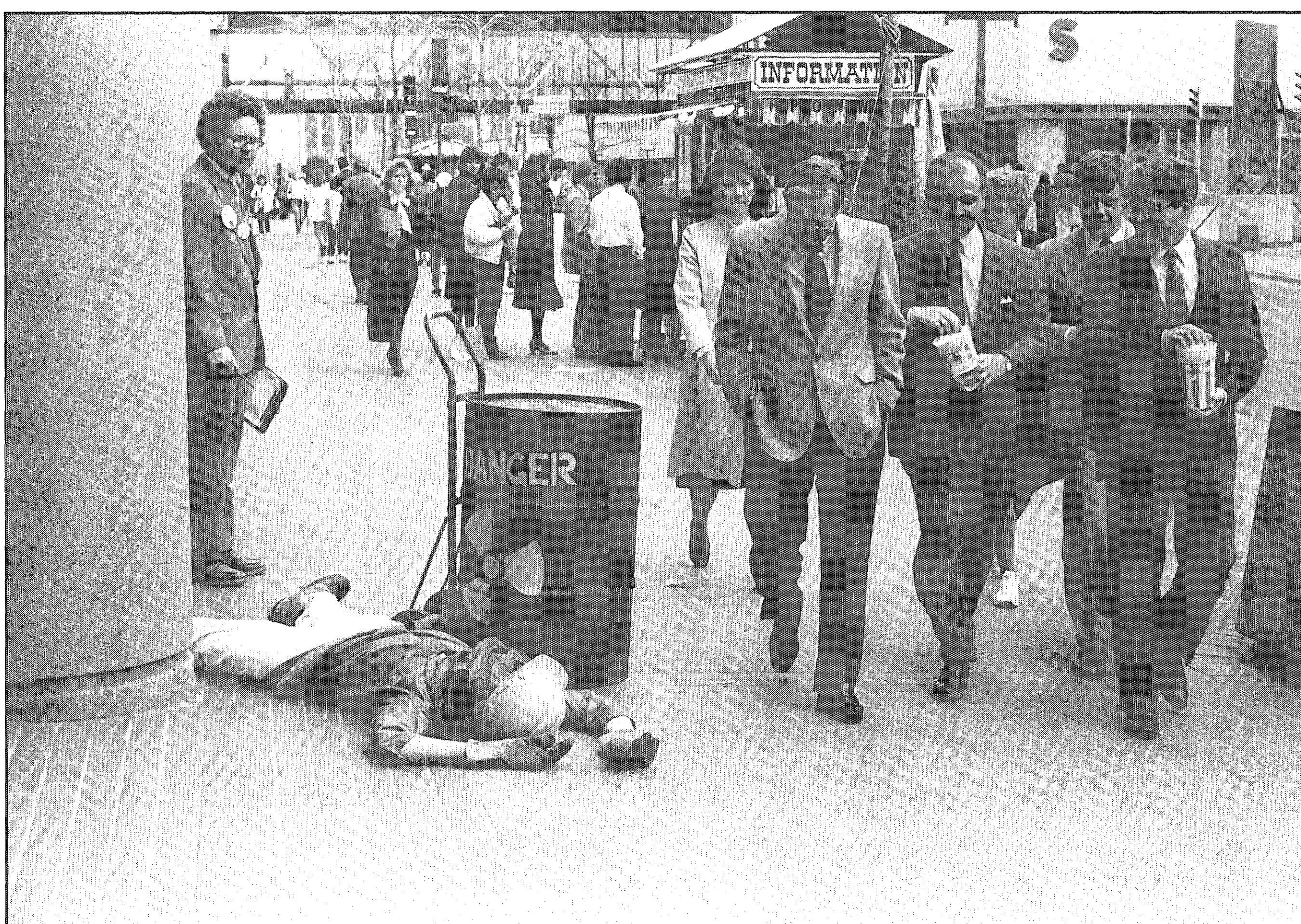
Finite Loops by Conrad Teves



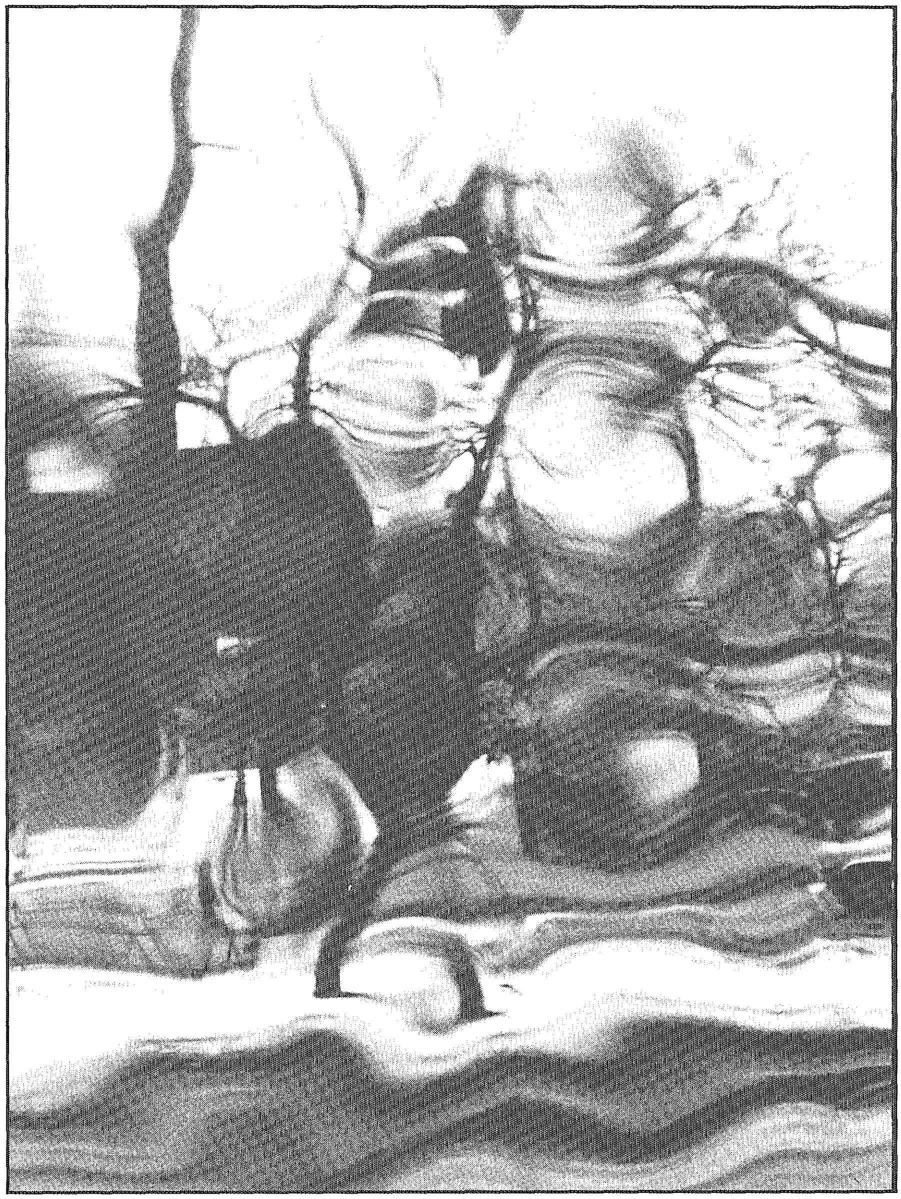
Science Fiction Photography Contest

For the past 15 years, *Minnesota Technolog* has sponsored a science fiction writing contest. This year *Technolog* initiated its first annual science fiction photography contest to accompany the writing contest. The winning photographs are published in this issue. *Technolog* would like to thank everyone who entered their artwork and also the judges: Cheryl Chang-Yit, Eric Nevalainen, and Mark Werner.

First Place
G. McDaniels

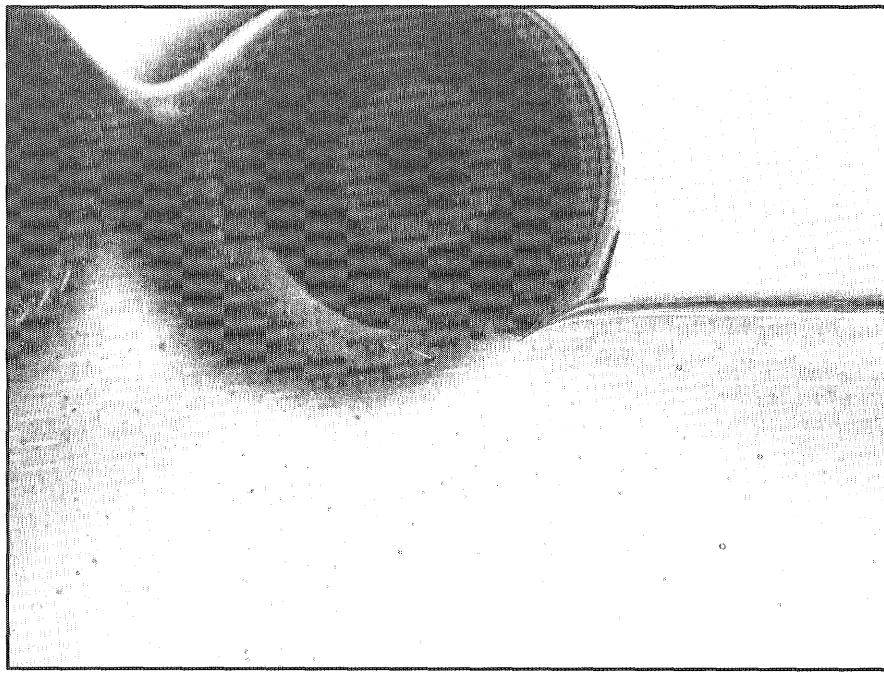


Second Place
David Frailey



Third Place
Lance Allred

Honorable Mention
Nick Baumann



"The past is but the beginning of a beginning, and all that is and has been is but the twilight of the dawn."

— H. G. Wells, *The Discovery of the Future,* [1901].

"Human history becomes more and more a race between education and catastrophe."

— H. G. Wells, *The Outline of History,* [1920].

A Thousand Words

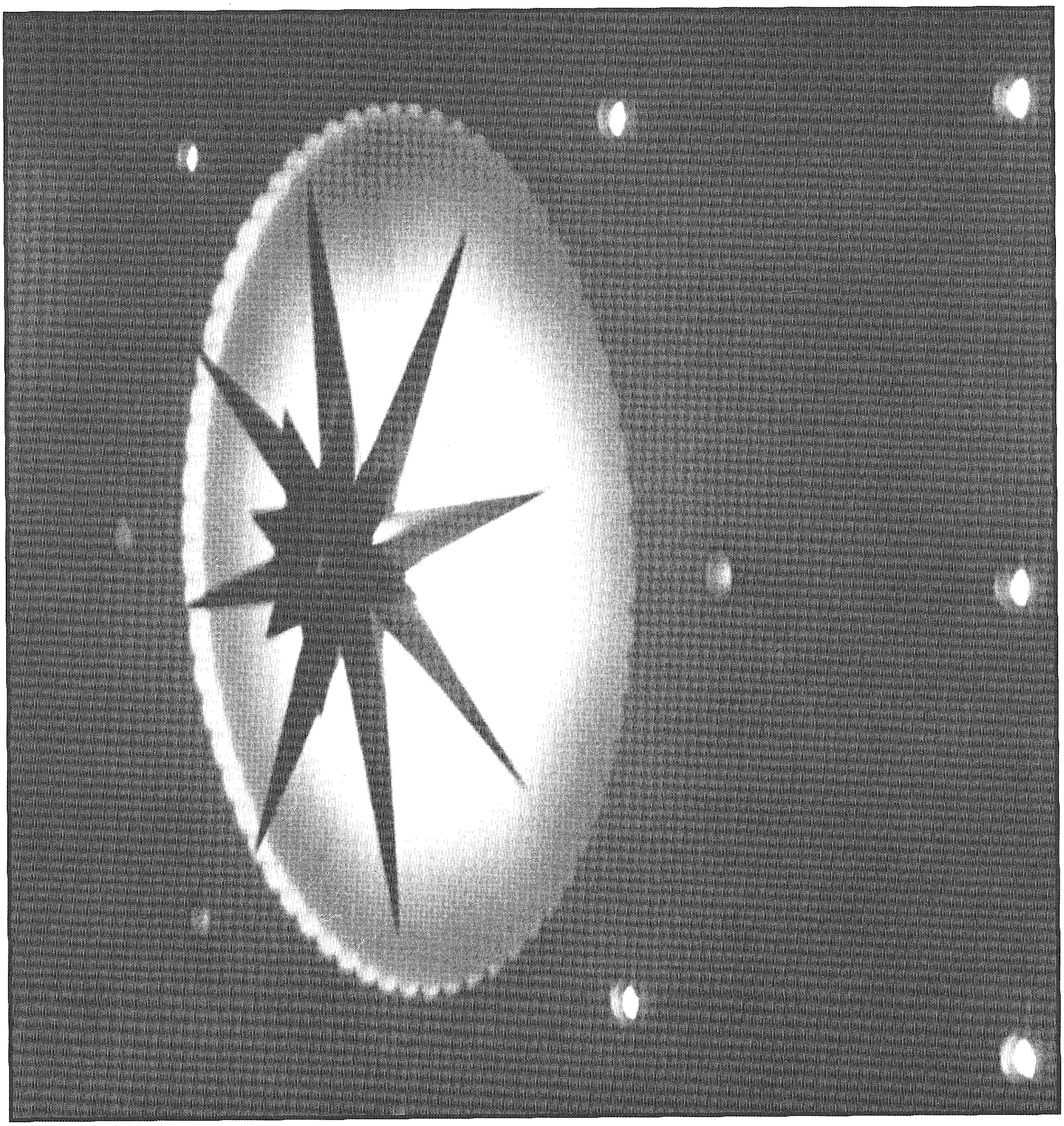
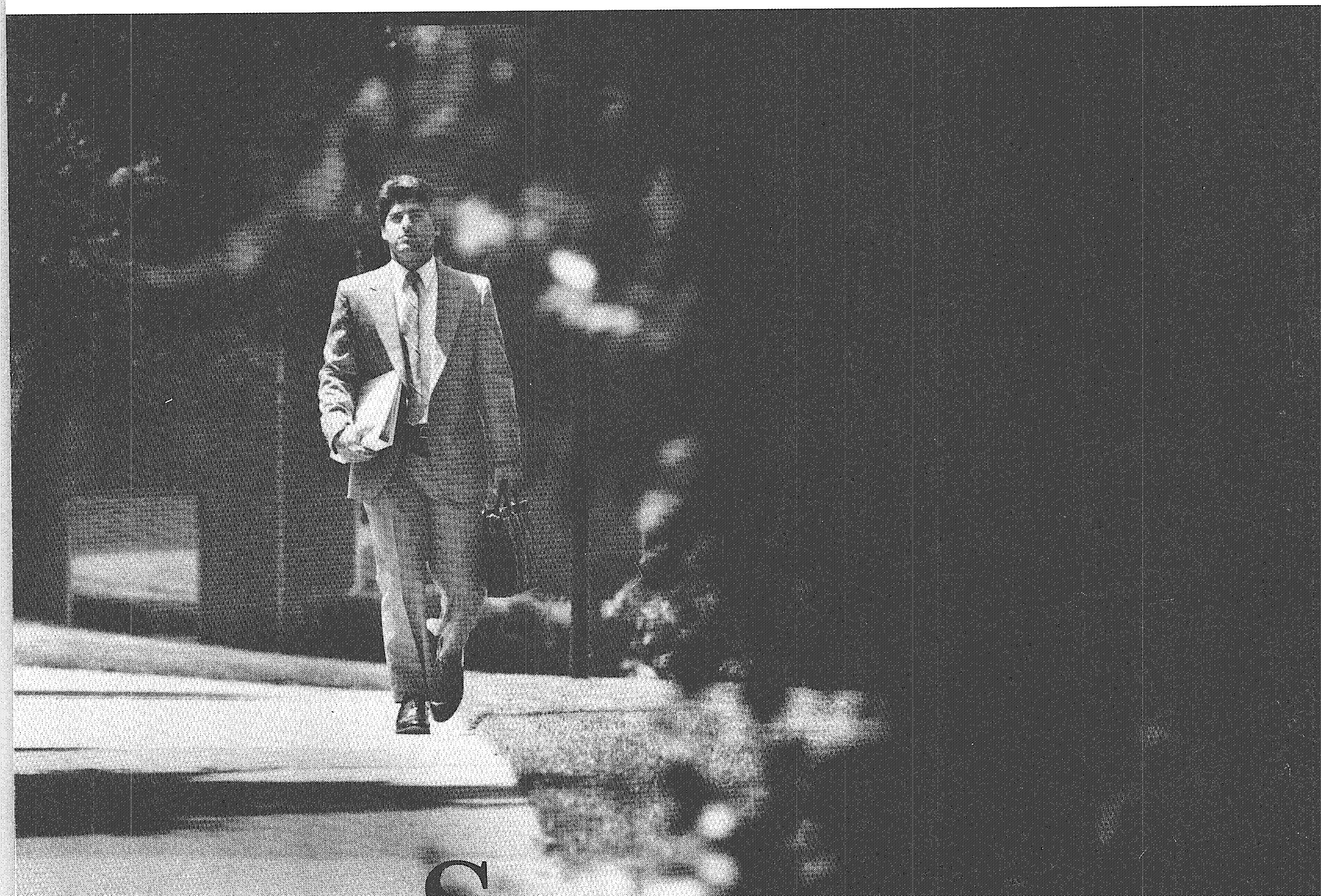


Photo by Thomas J. Rucci

Rob Bongiorno hardly ever shows up at the office.



Staying out of the office is a big part of Rob's job. He's out in the marketplace working with customers. That's what he likes and does best.

Rob is in GE's Technical Sales Program, an 18-month leadership experience for engineers with strong interpersonal skills. It's a great choice for technical people who want to provide solutions to customers' problems.

Rob stays on the leading edge. He anticipates change in highly competitive markets. He responds to customers with creative problem solving. His efforts are supported by resources that only a multi-billion-dollar company can offer.

On top of all that, Technical Sales has put Rob on track as a potential leader of GE. Did you ever think staying out of the office could make someone look that good?

The mark of a leader.

An equal opportun

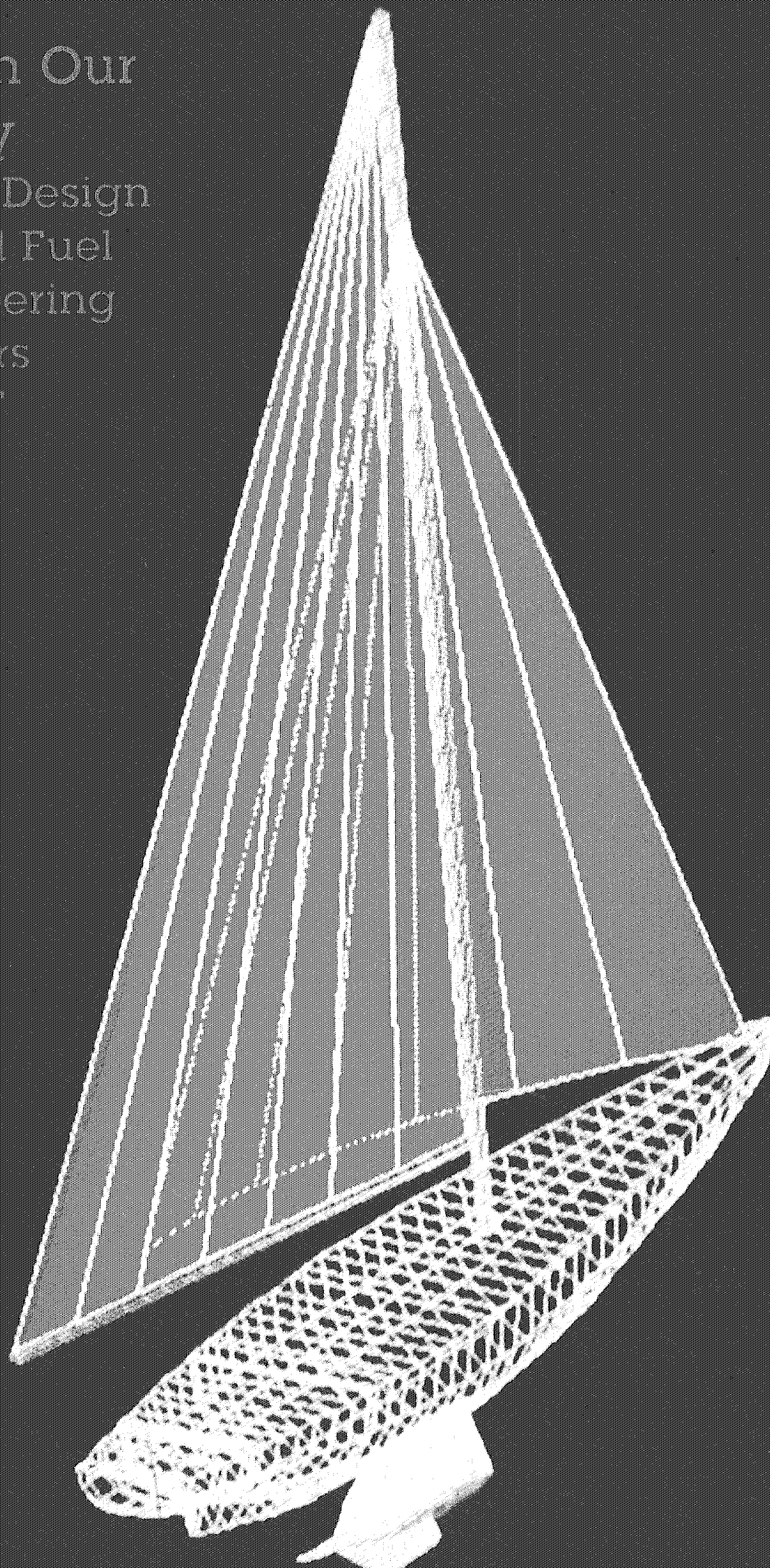
minnesota

Spring Two, 1988

TECHNOLOG

Technology In Our Society Today

- Stars & Stripes Design
- Refuse Derived Fuel
- Finnish Engineering
- Radar Detectors
- Minorities in IT
- Plumb Bob
- IT Societies



How to get what you're after, after hours.

It's the middle of the night. You're working on your paper, "Identifying Kafkaesque Symbolism In The Film, "Porky's II: The Next Day." You have no idea who Kafka is. You need information. Your library is closed. You'll get an F. You are depressed.

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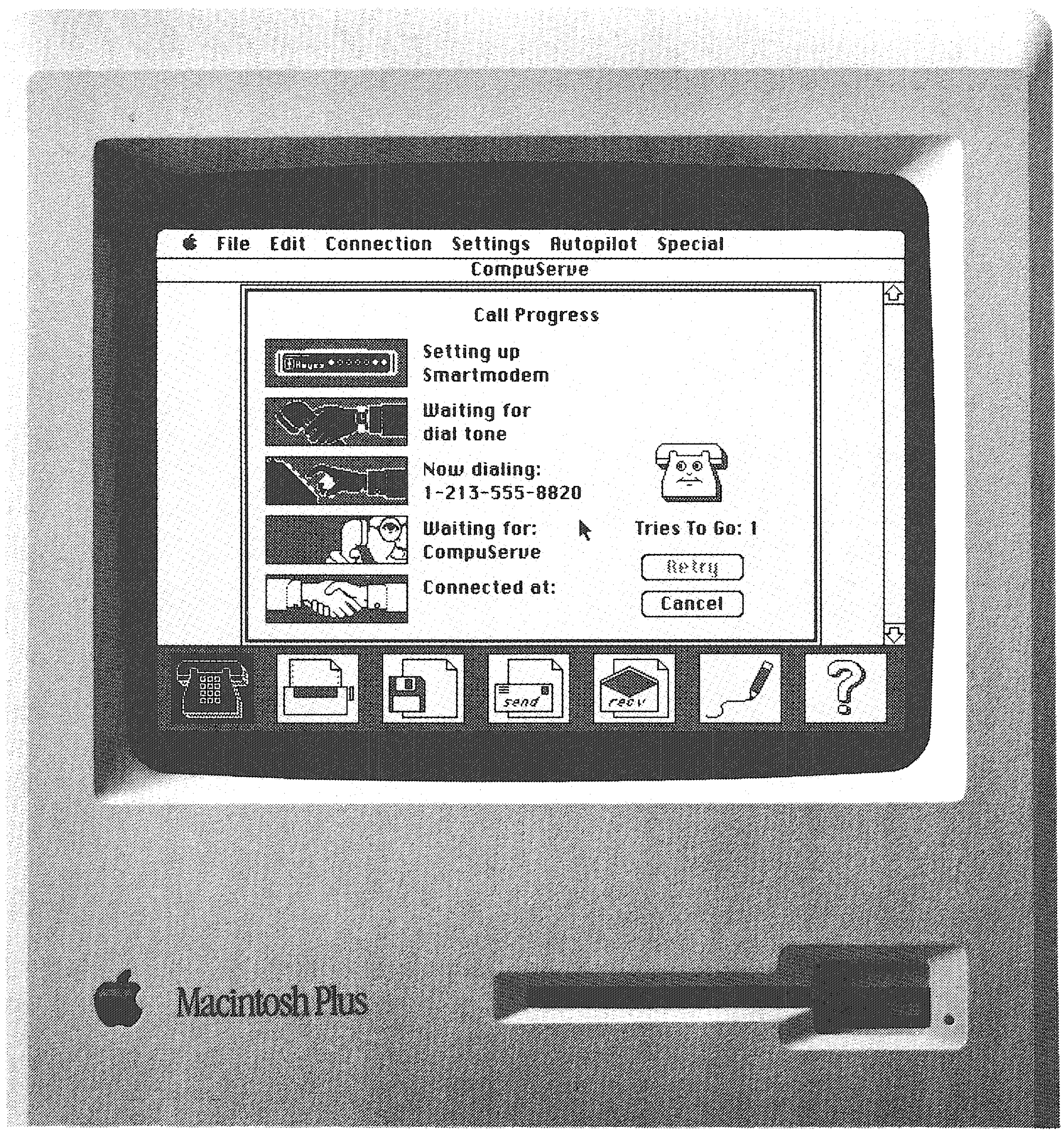

MIW/9M66t (Dup.)

Cover photo by Paula Zoromski

The cover photo is a computer model of a 12-meter yacht generated by a Cray X-MP supercomputer. Of particular interest in the model is the keel, with its revolutionary winglets. Special thanks to Cray Research, Inc. for performing the simulation.

minnesota TECHNOLOG

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Technology In Our Society Today

Features

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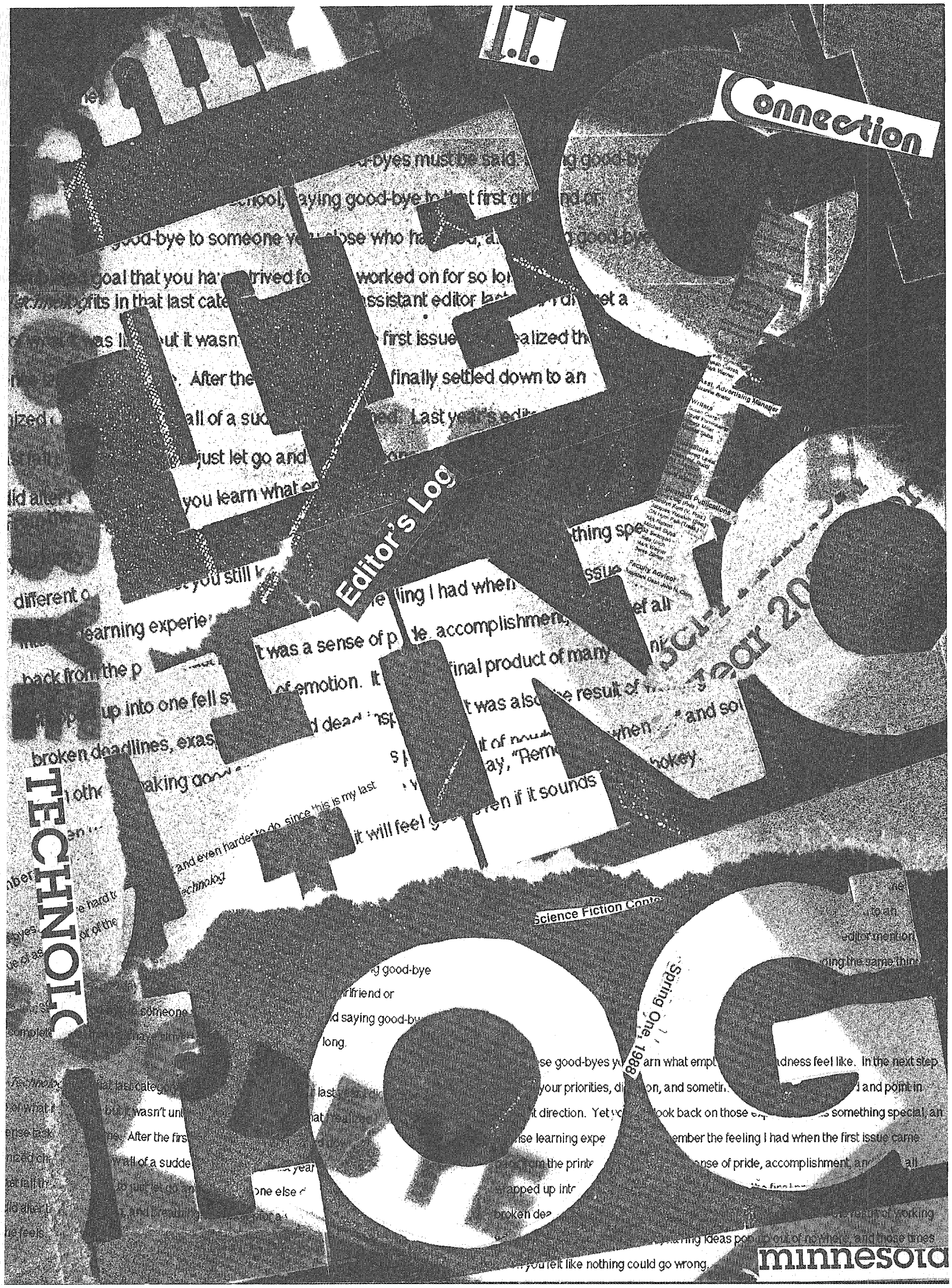
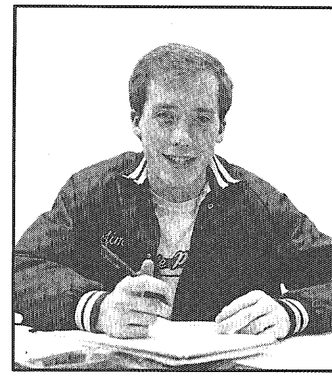


Illustration by Mohammed Lawal

Editor's Log



Remember When . . .

Good-byes. They are hard to think about and even harder to do, since this is my last issue of as the editor of the *Minnesota Technolog*.

We reach many stages in life when important good-byes must be said: saying good-bye to mom on that tearful first day of school, saying good-bye to that first girlfriend or boyfriend, saying good-bye to someone very close who has died, and saying good-bye to a completed goal that you have strived for and worked on for so long.

The *Technolog* fits in that last category for me. As assistant editor last year I did get a taste of what it was like, but it wasn't until I started the first issue that I realized the immense task ahead of me. After the first two issues it finally settled down to an organized chaos. And now all of a sudden it is finished. Last year's editor mentioned to me last fall that it was hard to just let go and see someone else doing the same things you did after thinking, eating, and breathing *Technolog* for a whole year. Now I know how he feels.

From these good-byes you learn what emptiness and sadness feel like. In the next step you turn your priorities, direction, and sometimes your way of life around and point in different direction. Yet you still look back on those experiences as something special, an intense learning experience. I remember the feeling I had when the first issue came back from the printer last fall. It was a sense of pride, accomplishment, and relief all wrapped up into one fell swoop of emotion. It was the final product of many late nights, broken deadlines, exasperation, and dead inspiration. It was also the result of working with others, making good friends, having ideas pop up out of nowhere, and those times when you felt like nothing could go wrong.

These will be some of the times for me when I'll say, "Remember when . . ." and sound like a Kodak commercial. But it will feel good even if it sounds a little hokey.

*   *   *

Next year's *Minnesota Technolog* will be headed by Steve Kosier. Steve was my assistant editor this year, so he at least knows what he is getting into. He is an electrical engineering major and hopes to graduate next spring. He has some very interesting ideas planned and I wish him good luck.

I would like to thank everyone involved with the *Minnesota Technolog* this year, including all the editors and managers, the illustrators, and especially the writers, without whom the *Technolog* wouldn't be of much substance. The IT Board of Publications, publisher of the *Technolog*, was especially supportive and I thank everyone who helped write and illustrate. Thank you also to Assistant Dean John Clausen, our advisor, who is always willing to help out in any way he can.

Some people have said that engineers can't write. But the *Minnesota Technolog* couldn't have been in existence for 68 years for that to be true. We are student-edited, student-written, student-illustrated, and even student-published. This obviously implies that students are needed. You supply the interest and we will supply the experience that recruiters look for. Many openings exist on the *Technolog* staff. The *IT Connection* and IT Board of Publications also need help in many different areas. Stop in to Room 2, Mechanical Engineering and help contribute to our successful tradition. **MT**

Jim Willenbring

Jim Willenbring
Editor

Stars & Stripes Forever

The *Stars & Stripes* sailboat, the United States' entry into the America's Cup competition, captured the attention of most Americans last year when it reclaimed the Cup. What most don't know is that two Minnesota high-tech firms assisted the racers and gave them a great advantage.

by Chadburn A. Blomquist and David Kortenkamp

For 132 years not much had changed in the world of yacht racing. It's most prestigious prize, the America's Cup, had never left the New York Yacht Club, and the basic design of 12-meter yachts had changed very little. Then, in 1983, Australia shocked the United States by winning the America's Cup using a radically different yacht design. The five years since then have seen the America's Cup race become a technology race, and two Twin Cities companies, Cray Research, Inc. and 3M Corporation, are leading the way. Both contributed much to the victory of the *Stars & Stripes* in 1987.

Cray helped the *Stars & Stripes* design team use a Cray X-MP supercomputer to test boat designs and predict performance. Until 1987, the only way to test a new boat design was to construct a model and then pull it through a large tank of water. Since this method costs a great deal of time and money, it's only possible to consider a few models. With supercomputers, however, designers can test numerous boat designs before constructing a scale model for testing.

According to Kent Misegades of Cray, the computational methods used in boat design are similar to those used in aircraft design. This allowed the *Stars & Stripes* design team to use a computational fluid dynamics program called VSAERO to find the combination of hull, keel, and rudder that would cut through the water with a minimum of turbulence and drag. VSAERO was developed under a NASA contract and solves simplified forms of the Navier-Stokes equations, which are the most accurate numerical representation of fluid motion. The most simplified form of the Navier-Stokes equations are called potential equations. Potential equations assume that a fluid is incompressible, which works well for boat design since water is, in fact, incompressible. Potential equations also neglect the effect of friction , which is referred to as viscosity in fluid dynamics.

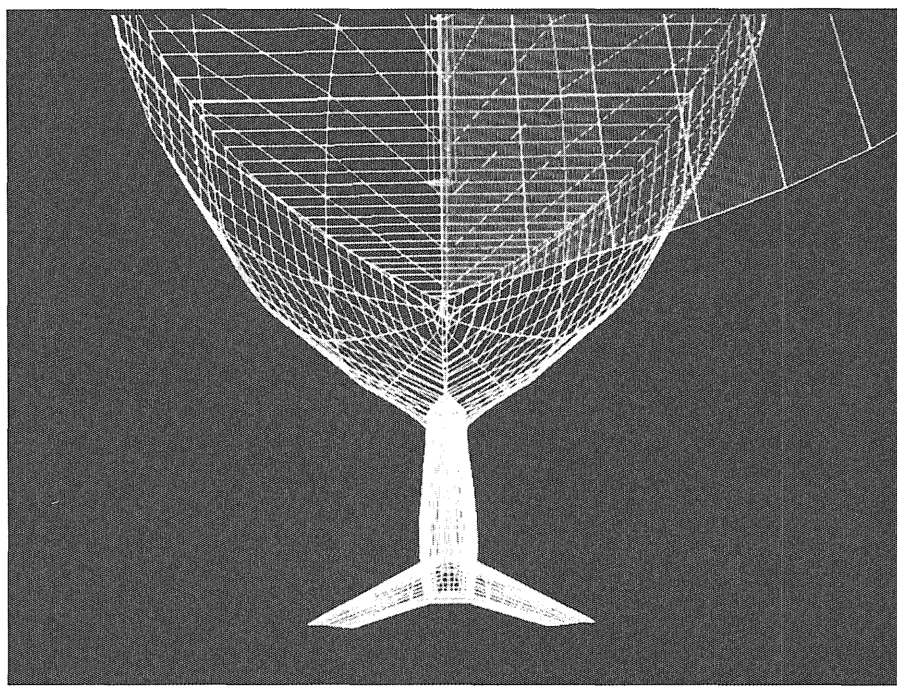


Photo by Paula Zoromski

Image of Australia II's keel generated by a Cray X-MP supercomputer. The keel's winglets were a major factor in the yacht's 1983 America's Cup victory.

Solving the potential equations tells the designers many things, including the distribution of pressure on the hull and keel, the fluid velocity and direction of water flow, and the integration of pressures on the hull surface. From this the designers come up with the components of force acting on the boat, such as the lift, drag, and turning moments. Designers can then try various designs and see which ones minimize the drag.

However, even with these simplified

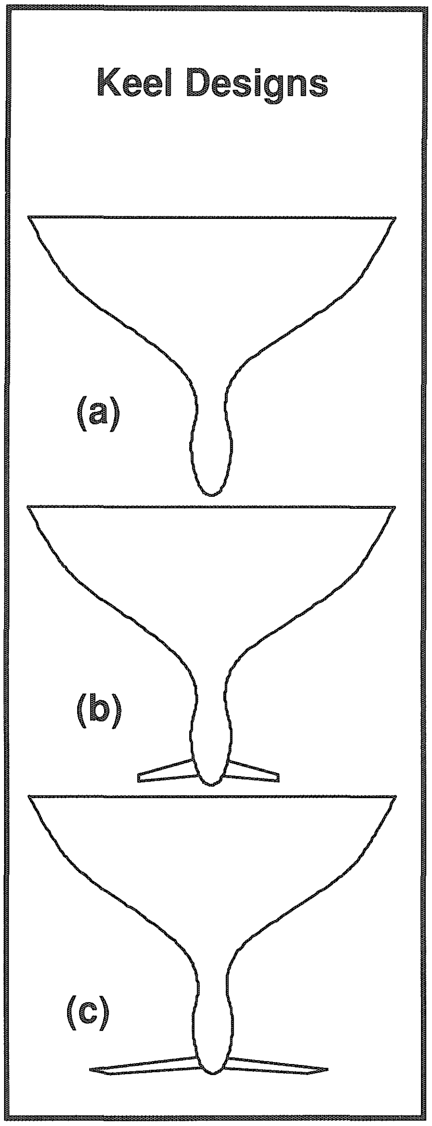


Illustration by Jerry Fiala

Figure 1: (a) shows the standard, trapezoidal keel, (b) shows *Australia II*'s keel with winglets, (c) shows *Stars & Stripes*' keel using a wider winglet span.

potential equations the computations are still quite extensive, especially since the *Stars & Stripes* designers were aiming for only about a one percent improvement in speed. According to Misegades this is equivalent to the difference between a crew member dragging two fingers in the water during a typical two and one-half hour race and the boat sailing without the two fingers being dragged. While this might not seem like a lot, it can add up to a full boat's length by the end of a race, which can be enough to decide a race. Achieving this kind of accuracy in a reasonable amount of time is only possible on a supercomputer like the Cray X-MP.

One of the most visible innovations brought about by the Cray X-MP was the design of the keel of the *Stars & Stripes*. Until 1983, 12-meter yachts used a standard trapezoidal keel (see figure 1), but the win by Australia II in the 1983 America's Cup revolutionized yacht design. Australia II had a radically different keel; it was swept forward and had winglets. The winglets help to reduce drag when the yacht is going upwind, however even the best winglet designs will show an increase in friction drag (due to a larger surface area) when the yacht is traveling with the wind. The trick is to find a winglet design where the decrease in drag while going upwind more than compensates for the increase in downwind drag.

Faced with this dilemma, the *Stars & Stripes* team used the Cray supercomputer to test numerous winglet designs. However, even with the Cray X-MP, the job was tedious; it wasn't until the middle of the Challenger Elimination Series that the new computationally derived keel design was ready to be installed. After that, the *Stars & Stripes* lost only one race en route to reclaiming the America's Cup.

Another Twin Cities company contributed to the victory of the *Stars & Stripes*. 3M Company, of St. Paul, developed a material to reduce the skin friction of the Stars & Stripe's hull. This so-called "secret weapon" uses a technology developed at NASA called riblets. Riblets are small triangular grooves that can best be described as long tracks. As you slide your hand up and down the surface of the material you get the sensation of speed. The magic behind the riblets is actually the way the fluid touching them acts. The area just above the surface of an object flowing through a fluid is called the boundary layer. It is this layer of viscous fluid that creates what is know as skin friction. The riblets control the turbulence above an object's surface, which in turn minimizes the skin-friction drag. The riblets act as "tiny fences" cutting down the turbulence of the fluid as it passes through them. Testing shows skin friction is reduced up to eight percent using riblets over flat smooth surfaces.

Frank Marantec, a 3M engineer, first

. . . riblets act as "tiny fences" cutting down the turbulence of the fluid . . .

heard of the riblet technology in an article published in *NASA TECH BRIEFS* called "Grooves reduce aircraft drag." The article described how a NASA scientist in Langley's high speed aerodynamics division, Micheal J. Walsh, aligned v-shaped micro-grooves (named riblets) in the direction of an air flow. The idea was to overcome the problems of drag on an aircraft. Up to 50 percent of the fuel burned by a commercial aircraft is lost due to the effects of skin friction.

There was a problem however. The riblets were being made on a flat sheet of aluminum that was difficult to mold into different shapes and was expensive to install.

Marantec, after reading the publication, called Walsh and offered an idea: it would be easier to make the riblets on a plastic film with adhesive backing that could be placed on a surface after construction. This provided two large advantages over the aluminum model. One, if the surface of the riblets became damaged the film could easily be removed and replaced. Two, the tape could be applied to existing vehicles without welding or special molding.

The riblet tape 3M manufactures varies for many applications. The dimensions of the triangles depend upon the speed of the body that they will be attached to. The faster the object, the smaller the grooves. The film on the *Stars & Stripes* was 0.045 inches high and 0.045 inches from peak to peak and is made of poly-vinyl chloride (see figure 2). According to Marantec, this was one of the larger films made because it was for water. Films made for air can run as small as four microns high.

3M reports that the first use of the riblets on boats was in the 1984 Olympic games. The Olympic rowing coach, Dietrich Rose, was persuaded to use the 3M film on a four-oar-with-coxswain shell. Testing on shells previous to the games indicated the film reduced drag by six percent. Although the United States had been shut out of the event for many years, the team competing with the 3M film earned a silver metal.

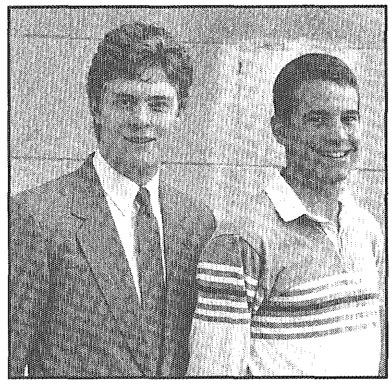
Two years later, Britton Chance, the designer of the *Stars & Stripes*, was looking for a way to make his boat even faster when he meet a 3M scientist, William Friedlander, at a

. . . all agreed that the riblets gave the boat a significant advantage

sailing club in Minnesota. At Friedlander's invitation, Chance gave a seminar on the boat design at 3M. It was at the seminar that Chance was told about riblets and their success story. Intrigued, Chance commissioned MIT to create a computer model of the boat with and without riblets. The results indicated a large decrease in hull skin friction when using riblets.

Dennis Conner, captain of the *Stars & Stripes*, immediately called Marantec after successfully testing the film in the waters off the Australian coast. Marantec flew "down under" with a 3M team to place a coating of film on the hull of the *Stars & Stripes.* Approximately 30 sheets of three-foot square film were used.

The true test of course was the race. On February 5, 1987, the yacht *Stars & Stripes* beat the Australian *Kookaburra III* by one minute, 59 seconds that completed a 4-0 overall victory for the America's Cup. The crew, the designers, and coordinators all agreed that the riblets gave the boat a significant advantage over the competition.



Chadburn A. Blomquist and **David Kortenkamp** both are previous *Technolog* writers and especially enjoyed writing about this side of the America's Cup. David, our most prolific contributor this year, is graduating this spring in computer science and will spend this summer working for NASA. Chad is a junior in mechanical engineering and is active in Toastmasters here at the University.

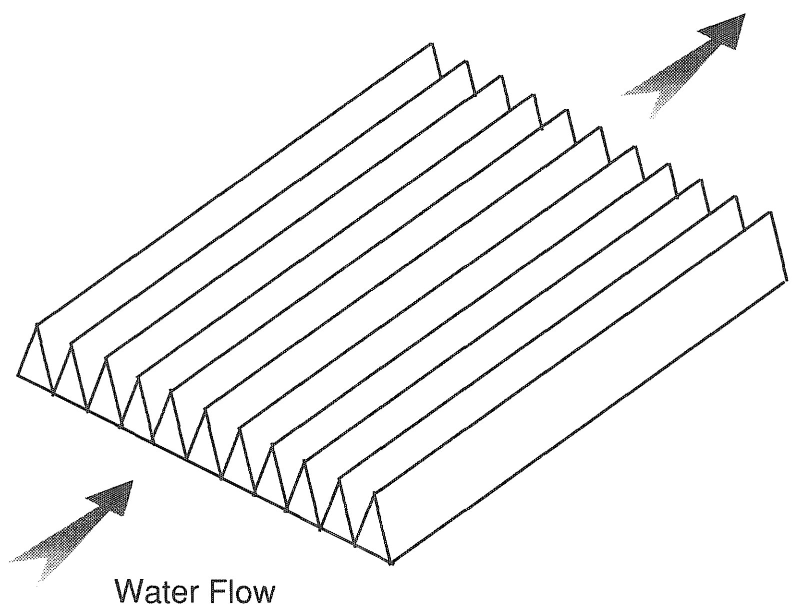


Illustration by Chadburn Blomquist

Figure 1: The riblets for the Stars & Stripes were specially designed to account for water instead of the normal air medium. Water-flow friction along the triangular surface is reduced because the riblets control and minimize the interaction between the fluid and the surface.

Although the America's Cup race involves the traditional human skills, timing, and endurance, technology is becoming an important aspect to victory. Yacht designers for the next America's Cup race are using Cray supercomputers to enhance the performance of their boats. Likewise, the success of 3M's riblets is certain to have an impact on the surfaces of the new hulls. Both these innovations illustrate the ties technology has with traditionally non-technical fields. MT

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Log Ledger

DAT Update

by Kirk V. Nelson

Consumers of high quality audio products recently scored a victory in the form of a report released by the National Bureau of Standards (NBS). The report centered on the fight in Congress over digital audio tape (DAT) and the "copycode" that would stop home copying of notched material on DAT tapes. The research done by the NBS answered three questions about the performance of the copycode system.

1. Does the copy prevention system prevent DAT machines from recording notched material?

Answer: NBS concluded the system only works about half the time; i.e. notched material was recorded. Also the system failed to record some unotched material.

2. Does the system diminish the quality of the notched prerecorded material?

Answer: Yes. The system both degrades the electrical signal near 3840 Hz and for some selections also creates audible distortion.

3. Can the system be bypassed (thus allowing copying of pre-recorded tapes)?

Answer: Yes. NBS engineers designed five circuits to defeat the code, all of which worked. The circuits are easy to construct and can be made for approximately $100.

The report was paid for by representatives of both sides of controversial copycode system and the results are binding to both parties. This report has effectively killed the chances for a law requiring the copycode system in DAT recorders.

ECMA Awards

by Mark J. Werner

The *Minnesota Technolog* staff recently returned from the Engineering College Magazines Associated's (ECMA) national convention at Virginia Tech in Blacksburg, Virginia. ECMA is an organization of 41 college magazines from around the United States that exists to support and further develop the member magazines. While at the convention, staff members attended seminars on magazine production, marketing, computer graphics, and the social implications of engineering.

The *Technolog* won several awards at the convention including:

- 1st Place: Best Art/Photography for Single Issue
- 2nd Place: Best Single Cover
- 3rd Place: Best Single Issue
- 3rd Place: Best Pure Technical Article for General Science Background
- Honorable Mention: Best Layout Single Issue
- Honorable Mention: Best Pure Technical Article for Technical Background

Perhaps one of the best aspects of the convention was the opportunity to compare and discuss with the other magazine staffs similar problems that they face.

America's Cup Technology

by Dean Harrington

Never before has high technology played such a large part in the America's Cup races. In 1987 several of the 12-meter yachts used the Micro Vax II, a computer that has received some of the credit for returning the America's Cup to America.

The winning boat, *Stars & Stripes*, was partially designed on a Micro Vax II using specifically designed Computer Aided Design (CAD) software. About $10 million went into the research, design, and production of the boat. The entire operation reportedly cost $16 million.

The generated data was primarily used for wind and wave analysis and performance evaluations. It was also used to forecast weather conditions in Freemantle, Australia where the races were held. With all the factors taken into account, the resulting boat was perfectly tailored for the 18-20 knot Australian trade winds. While the new boat was slow when tacking or turning corners, it was four to five percent faster in straight runs compared to any other boat in the competition.

The computer software used on board produced numerical data that helped forecast laminer winds and turbulent flow of sea breezes. Laminer winds are parallel to the hull, keel, or sail and turbulent flow is an unsteady wind coming from many directions. *Stars & Stripes* captain Dennis Conner and his crew used this data to calculate and revise tactical maneuvers during the course of the race.

Solving Our Landfill Crisis

When the garbage barge *Mobro 4000*, turned away from many ports in its 6000 mile journey, finally discharged its cargo at its starting point, it brought to national attention the alarmingly full conditions of our landfills. Refuse derived fuel could be a good preliminary step to help control this problem.

by Michael Behnke

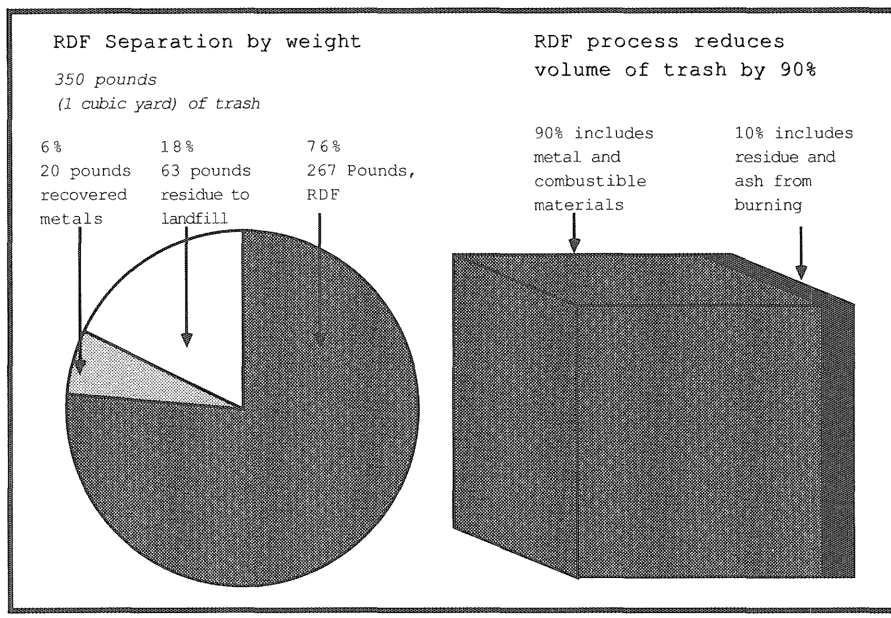

Illustration by Jerry Fiala

A pile of garbage in one of New York City's landfills has grown so high that the landfill will need to close in less than fifteen years to remain out of the flight path of planes landing at Newark International Airport. Already 150 feet high, this mountain of trash will peak at 500 feet by the time it closes. This trash, amassed at New York City's Fresh Kills landfill, has also been discovered to be discharging four million gallons of toxic leachate each day. In a few years it will also be the city's last open landfill. New York's shortage of landfills is also what led to last summer's plight of the barge that travelled 6,000 miles looking for someone who would accept its cargo, 3,100 tons of garbage.

New York City is not alone; many states are facing serious shortages of landfill space for their garbage. And every year the amount of garbage we create increases, the United States generating 220 million tons last year. Estimates indicate that the country will run out of landfill space by the year 2000. Even here in Minnesota, 40 percent of our 110 landfills will be full within the next five years. The public's concern about unsightly landfills ruining their communities, along with fears of groundwater contamination, has rendered it virtually impossible to open any new landfills.

Many cities are turning to waste-to-energy plants to solve their refuse disposal problems. Today there are about 70 such plants in operation across the country and many more are in the planning stages. It is predicted that by the end of the century, the amount of the nation's trash being incinerated will increase to around 30 percent, up from the current 6 percent.

Two basic types of waste-to-energy plants currently exist: mass burn and refuse derived fuel (RDF) plants. The first type incinerates the refuse as it comes from the waste haulers. In an RDF plant, the garbage is processed before combustion to remove most of the recyclable and non-combustible materials.

Environmental Concerns

Strong opposition by environmental groups has accompanied most cities' plans for waste-to-energy plants. Their concerns are well-founded with the finding of dioxins (see sidebar) in the fly ash created by incinerators. Incineration is considered to be a major contributor of dioxins to the environment. Scientists have found about 200 different types of dioxins being produced in incinerators, many of which are toxic and some are suspected of being carcinogens. But currently there are no regulations or standards established for incineration emissions. This is due in large part to the wide disagreement on dioxins' harmful effects and how to test emissions for these dioxins.

With the finding that heavy metals play

a large role in the formation of dioxins, some research has been aimed at adding substances to the fly ash to render it completely inactive, thus preventing the formation of dioxins. But until further advances are made, the sources of heavy metals should be removed from the garbage before it is incinerated. A large portion of the heavy metals are believed to come from the burning of metals. In the processing of garbage to RDF, most of the ferrous metals are removed and recycled.

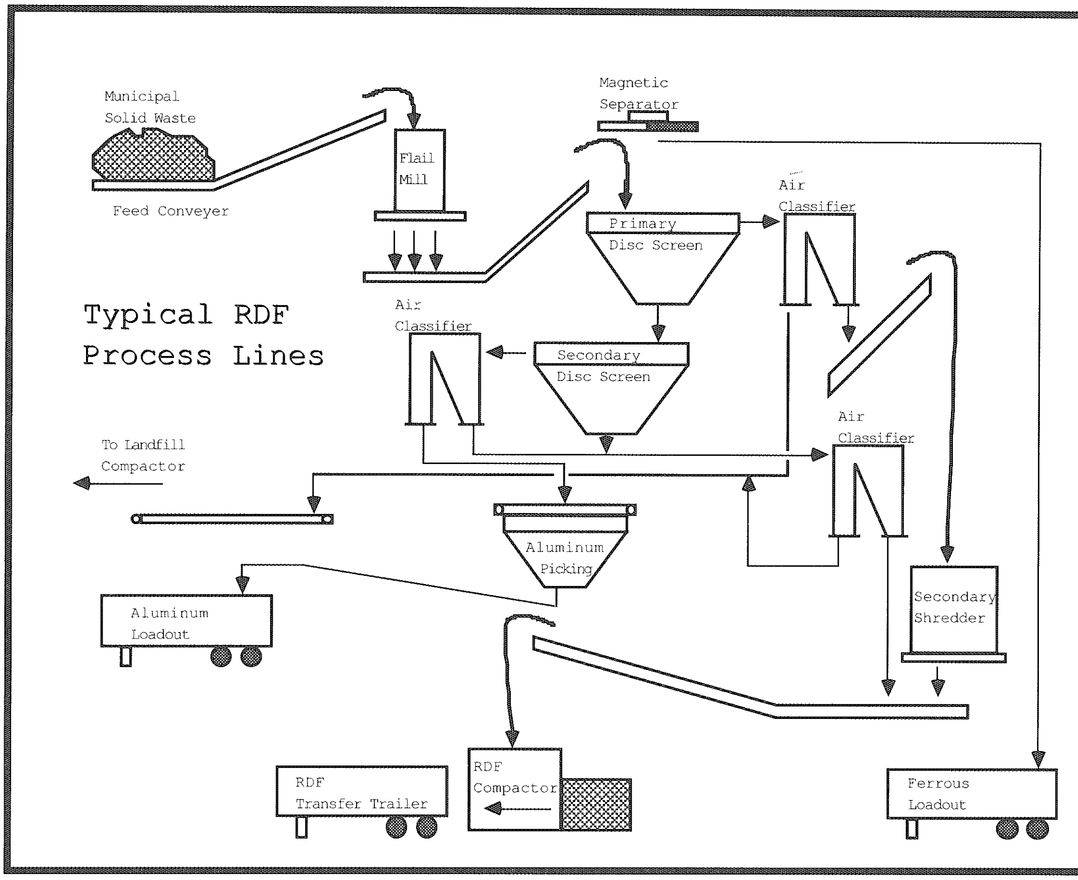

Illustration by Jerry Fiala

RDF Processing

Ramsey and Washington counties teamed up with Northern States Power Company (NSP) to initiate Minnesota's first RDF facilities. Each day, 250 truckloads of trash arrive at the processing center in Newport, Minnesota.

The waste-to-energy process cycle starts when the trash haulers empty their loads on a tipping floor where operators are able to remove any unacceptable or large, non-combustible material. Front-end loaders then push the trash onto a conveyer where another operator, equipped with a grapple crane, inspects for any other unacceptable items. At the end of the conveyor, the waste enters a flail mill that is intended primarily to tear open the bags of trash and reduce the contents to ten to twelve inch pieces. After the flail mill, a magnetic separator removes a large portion of the ferrous materials for later recycling.

The trash then enters the primary and secondary disk screens that divide the material by size. At this point, the only materials that have been removed from the trash are the ferrous metals. The combustible materials are removed next from the refuse with the use of air separators, taking advantage of the fact that, as a general rule, most of the usable fuel is lighter than the non-combustible materials.

This processing results in about 76 percent of the original material weight being converted to usable RDF. Another 6 percent consists of ferrous metal that are directed to recycling centers. The remaining 18 percent is sent to a landfill. The design of the Newport facility also leaves room for the recovery of aluminum once the technology is refined and economically feasible.

RDF Combustion

One of the reasons NSP chose RDF over a mass-burn system is RDF's ability to be burned in existing modified coal burners, whereas a mass-burn incinerator must be built new, a more costly venture. NSP has two plants, one in Red Wing and one in Mankato, which were only in operation as coal plants during periods of peak demand. Both of these plants underwent the modifications for RDF combustion that included enlarging the combustion

Dioxins

Dioxins (polychlorinated dibenzo-dioxins) are artificial organic compounds that can be created at temperatures around 300° F. Recently it was believed that if high enough furnace temperatures were reached, the dioxins would be destroyed in the incinerator. But now it appears much of the formation of dioxins occurs after the fly ash (the particles contained in the flue gas) has cooled to about 300° F, often within the pollution control devices. Recent studies indicate that temperatures that are too high can also lead to higher levels of carbon monoxide, which has been shown to increase dioxin levels. High temperatures may also lead to the vaporization of larger quantities of heavy metals, which act as catalysts for the production of dioxins. By controlling the carbon monoxide levels and temperature, dioxin production can be minimized.

area to improve efficiency and reduce the rate of corrosion in the boiler.

Forty truckloads of RDF are transported to the two combustion plants each day. The fuel produced at the Newport plant generates 5,500 to 6,500 BTU's per pound. This heat is then used to generate electricity. But it must be remembered that the

This volume savings will buy time to develop better methods of waste disposal. . . .

primary purpose of the waste-to-energy process is not to produce energy, but to help solve our landfill problems.

The RDF process does succeed in that respect. The remaining products, consisting of the non-recyclable materials removed during processing and the fly ash produced during combustion, have a volume of one-tenth the original volume of the trash. This volume savings will buy time to develop better methods of waste disposal and encourage the public and industry to recycle and use products that permit recycling before our landfills become completely full. MT

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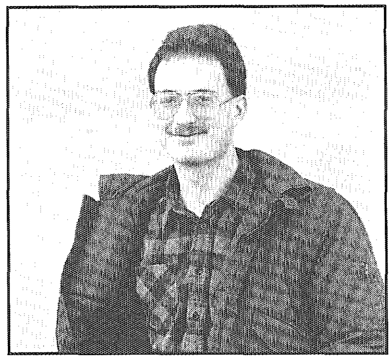
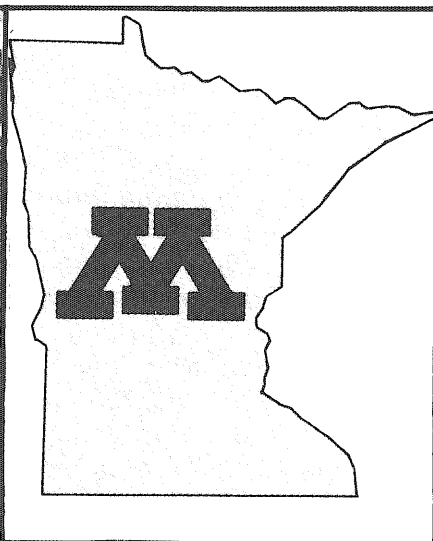


Michael Behnke is a junior in civil engineering emphasizing in structures. He is from Cottage Grove, right near the RDF facility in Newport. This summer he hopes to be an intern to gain some practical civil engineering experience. If he survives next year, Mike is considering graduate school. He likes to read science fiction in his spare time.



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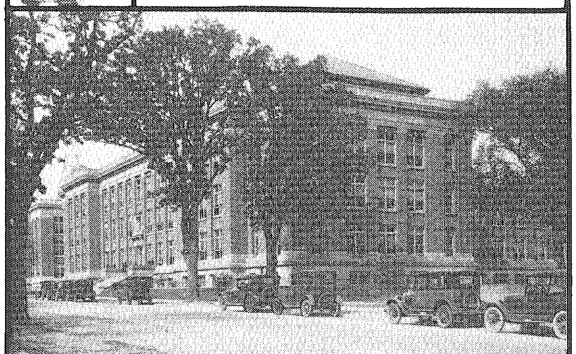

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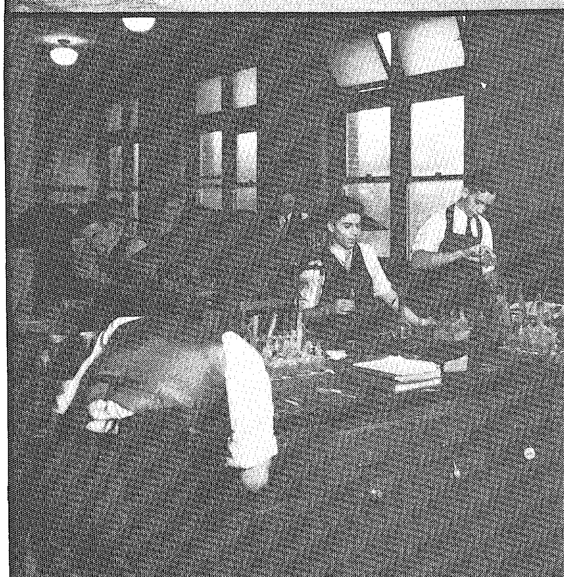

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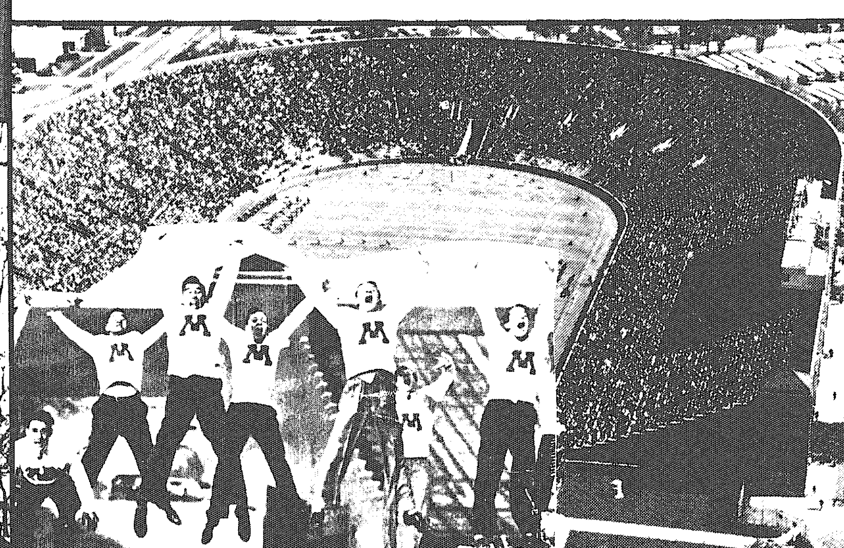


Finnish Engineering Education

Engineering education structure varies greatly not only in our own country, but especially overseas. Tom O'Rourke, *Technolog*'s "foreign correspondent," is spending this school year studying engineering in Finland and he relates his observations.

by Tom O'Rourke

Oulu, Finland, a city of 90,000 inhabitants, sometimes referred to as the capital of northern Finland, is home to Finland's second largest state-owned university and is my home for this year. The University of Oulu student body has 7,000 students, 2,000 of whom are studying technical areas. At the University of Oulu I am studying electrical engineering with 250 other students in the department. I have been attempting to do everything a Finnish student does, which was not easy in the beginning since the language of instruction is Finnish. My observations pertain to what I have experienced, but also reflect the Finnish system as a whole.

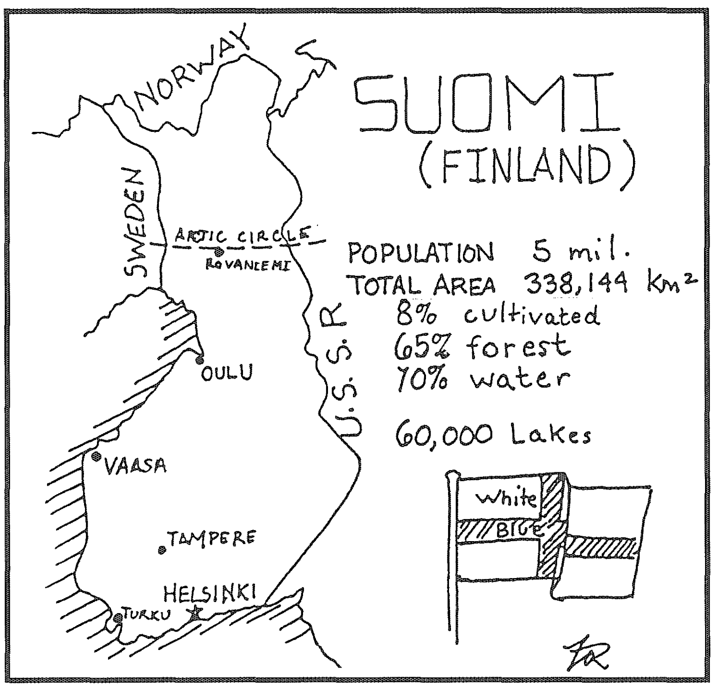


Illustration by Tom O'Rourke

Even considering Finland's high cost of living, these programs allow students the luxury of being fairly divorced from money concerns that many United States students face.

The basic degree in Finland takes six years to complete and is roughly equivalent to a masters degree in the United States. Graduation requirements are completion of the required number of courses, a masters dissertation paper, and any other major dependent variations such as an industrial assignment. Originally a four year program, the extra two years of study were added in a higher education reform in 1974 to make graduates more job ready.

Admission to the university is based on the results of secondary school matriculation tests and university entrance examinations. Approximately sixteen percent of those eligible are admitted and they enter directly into their majoring department. Students are guaranteed a place for the duration of their studies. Admission figures are set by a joint university-government agreement. Presently it is easier to be accepted into a science or engineering major program because of deliberate policy to reduce the number of students in the arts and social sciences and to increase the number studying natural sciences, engineering, and medicine.

Tuition is free in Finland. There is no course of term fees whatsoever. To finance their studies, students receive the equivalent of $1500 each year, which they don't need to pay back. They also are eligible for $3500 in low interest student loans. In addition, the state, partially through the student unions, subsidizes student meals, housing, health care, and offers discounts on bus and railway tickets.

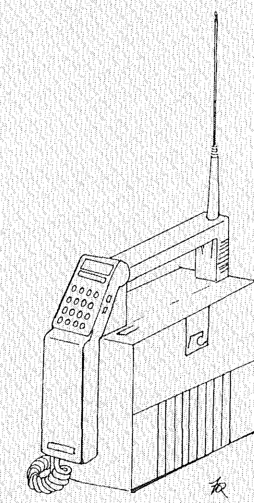
Formalities of the school system include the credit system, degree requirements, and registration. The revamping of the credit system was a result of the 1974 reform. The credit system is based on a unit called the study-week, each study-week representing 40 hours of work. This includes lecture time totals, exercise hours, estimated homework time, laboratories, etc. Courses usually total three or four study-weeks and are offered either in the fall or spring semesters, each semester lasting

Finland's Technology Environment

It is important for a small industrialized nation such as Finland to develop and market new technologies to compete in the world market. Finland is trying to find new areas of expansion and to apply technology to existing areas of industry to replace those that are stagnating or being lost to competition coming from lesser developed nations. The realization of technologies is not easy, and to be carried out smoothly it requires the cooperation and interaction of several key elements. Industry, government, and schools plays these most important roles in developing technology.

World competition forces Finland's industries to specialize; they must concentrate their limited technology resources into small areas. This concentration is referred to as finding a *niche*. Once established, this niche must be vigorously defended. Finland's Nokia Corporation is a good example that controls a technology niche. Nokia is the world's largest manufacturer of mobile phones and mobile phone networks (see illustration). Nokia reported a 70 percent growth in profits for 1987.

The Finnish government has done several things to promote and assist these industries. It has conducted several surveys and published literature to increase the public's understanding and attitudes towards technology in Finland. The government has also organized several committees to investigate the feasibility and development possibilities of several different technologies. Automation, computerization, and telecommunication were listed among others as most favorable to Finnish development. Finland has planned to increase basic research spending in these areas by ten percent each year for the next five years.



With industry and government cooperating, the last element needed is schools, both to assist industry in research and to produce qualified engineers and scientists. Finland claims to have initiated a close relationship between industry and universities. According to *High Technology in Finland*, "as a small country, Finland has one great benefit: industries and the universities have easily achieved close cooperation where mutual interactions bring synergy." In almost all technical majors, an industrial assignment is an essential degree requirement. Another example of this synergy are the "high technology villages." These villages are built near universities to facilitate the pooling of research resources. Several of these villages are presently being built at various sites in Finland. Schools are important to Finland as reflected by the fact of the 99 percent literacy rate and that 20 percent of the national budget is allotted to schools. The universities provide the most important element of technology development, that of producing qualified engineers and scientists.

fourteen weeks. A normal class load is four or five courses per semester.

I found the progression of subject material in electrical engineering was similar to that of the University of Minnesota with some major specific subjects introduced earlier. In general, Finnish progression schedules and course selection are extremely flexible. The student is given much more initiative in determining the rate of his or her progress in completing the degree. The registration left me confused, not from the red tape, but from the lack of it. After consulting the course reference book, which includes class meeting times, you simply go to the class you want. No attendance is ever taken. This non-registering system system works because the number of students attending the university is precisely controlled and the schedules and options are very flexible.

Facilities are good in Finland because they are a high priority. Classrooms are always comfortable, well-equipped, and never overcrowded. Computer laboratories are set up according to a scheme similar to the one used by the University of Minnesota. Libraries are another big advantage for the Finnish school system. They have many volumes and used regularly by students.

Course material presentation is composed of different methods and emphasis than in the United States. Lectures for a course usually meet three to four times a week and last one to two hours, including a one-hour exercise session each week. Class size in electrical engineering is approximately 25 to 50 students for the beginning courses and 10 to 15 in the higher-level courses. Attendance is usually about 80 percent, but it drops off steeply if the course is boring or repetitive. Exercise hours, when problems are worked through, are better attended. In lectures, instructors never use chalkboards; they prefer to use overhead projectors. Lecture time is spent more on defining and outlining reading material than in the United States.

In the electrical engineering courses, lecture time was sometimes spent in extensive translation of English texts, the language 90 percent of the texts used. Textbooks are about double the price for the same book in the United States and students in Finland, as a rule, avoid buying books. Instead, they borrow them from the library or copy them whenever possible. Student participation in class is low; rarely is the lecturer interrupted to answer questions. Also included in a course may be a lab time. Labs are the most difficult parts of many electrical engineering classes. The labs are well-equipped and the experiments are carried out smoothly. After having completed the necessary course requirements, the student decides whether he or she is ready for the final exam.

Test times and locations are posted in every department at the beginning of the school year, the same test being given three or four times a year. To take the test, you merely put your name on the appropriate list at least three days in advance of the time it will be given. All tests last three hours, which is ample time to complete them in. If after beginning the test you decide it is too difficult for you, you may choose not to turn in the test and leave the testing room. No record will show you attended this exam. Also, if you do not pass the test, you may retake it as many times as you want. This was another aspect of the Finnish system that took some getting used to. Tests are evaluated on a three-point scale and the results are posted on the appropriate departmental boards.

In conclusion, the Finnish university system is strongly student oriented. Although this system has drawbacks such as motivation and attendance, it also has the advantage of freeing students of the complications many American students have to deal with.

See you next year. **MT**

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Tom O'Rourke is a junior studying electrical engineering in Finland for a year through the International Student Exchange Program and hopes to be fluent in Finnish by the time he returns this summer. Tom is a member of the U of M Nordic Ski Team and is on the *Minnesota Technolog* staff. At Oulu University, he is the vice president for the Association of Foreign Students. His reasons for going to Finland were mysterious and many.

Assigned Reading

by David Kortenkamp

Engines of Creation

by K. Eric Drexler
Anchor Press/Doubleday, 1987

It's rare for a research scientist to write a book about a developing technology and devote as much ink to the social implications as to the technical details. Then again not every new technological breakthrough promises to extend the human life span by some 500 - 800 years. K. Eric Drexler's *Engines of Creation* is an extraordinary book; it will have an impact on how you see the future. If you're an optimist, then Drexler's book will read like your wildest dream. If, on the other hand, you're a pessimist, then Drexler's book will seem like your most frightening nightmare.

The subtitle of the book is *The coming era of nanotechnology*. To understand what this means, just recall that we are in the microtechnology era right now. Nanotechnology is simply a step smaller. In Drexler's world we will manipulate things at the atomic level—rearranging individual molecules to produce anything we want. Drexler calls the infinitesimally small machines that would do this work "assemblers." Here's an example of how Drexler thinks that assemblers might build a rocket engine:

> Where great strength is needed, the assemblers set to work constructing rods of interlocked fibers of carbon, in its diamond form. From these, they build a lattice tailored to stand up to the expected pattern of stress. Where resistance to heat and corrosion is essential (as on many surfaces), they build similar structures of aluminum oxide, in its sapphire form. In places where stress will be low, the assemblers save mass by leaving wider spaces in the lattice.

This may sound fascinating in itself, but it's only a start. If assemblers are able to build a rocket engine from the ground up, couldn't they also be used to repair living organisms? Of course, exclaims Drexler, as he introduces a new type of assembler called a "cell repair machine." These would be about the size of bacteria and could enter a cell and make repairs. With an army of cell repair machines constantly at work in your body, the aging process could be stopped and even reversed. Disease would be wiped out and the human life span greatly extended.

It's important to stop and point out that Drexler's book is not science fiction. He is currently at MIT and is actively researching this technology. His time span for the creation of assemblers and cell repair machines is measured in decades, not centuries, which means that our generation has a chance of living to be 800 years old. To his credit, Drexler spends quite a bit of time discussing the limits to nanotechnology. He also realizes that this technology could be abused and gives his opinions on how abuse might be prevented. The whole book is fascinating and convincing, while at the same time seemingly farfetched. The best thing to do is to read it, enjoy it, and then think about it.

The Search for Extraterrestrial Intelligence

by Thomas R. McDonough
John Wily & Sons, Inc., 1987

Are there other civilizations in our galaxy? If there are, would it be possible for us to communicate with them? These are the types of questions that scientists involved with the Search for Extraterrestrial Intelligence (SETI) are hoping to answer. Thomas R. McDonough, in his book *The Search for Extraterrestrial Intelligence* examines these questions, as well as looking at the history of SETI, some of the people involved with it, and what the future holds. He covers everything from science fiction to science fact. He even includes a chapter on UFO's, a subject usually shunned by SETI scientists.

McDonough starts with a brief history of astronomy, biology, and SETI. He recalls the days when astronomer Percival Lowell had convinced the world that there were canals, and thus intelligent beings, on Mars. It seems that humans have always been fascinated (and frightened) by the prospect of extraterrestrial life. Martians, Little Green Men, and aliens have been a fixture in our literature, and more recently in movies and television shows. McDonough includes a very interesting chapter on aliens in science fiction, ranging from the Bible to E.T. But most of the book is spent examining the serious scientific issues raised by SETI. The two foremost questions are: Where do we start looking and How can we communicate with someone (or something) which is sure to be vastly different from us? Needless to say, science is hard at work on these questions.

McDonough's book is very easy to read, it's generous margins contain numerous cartoons, making it also very enjoyable to read. However, the book tries to cover a broad range of topics, so it can only cover each one superficially. Those of you who are already well acquainted with SETI will probably find nothing new. If, on the other hand, you are a SETI novice, this book would be a good starting point. You can use the bibliography (which sadly lacks one of the better, albeit fictional, SETI books—Carl Sagan's *Contact*) to continue your personal search. **MT**

Reflection on Detection

Police radar and radar detectors have had an on-going battle since the 55 mph speed limit went into effect. State governments, the FCC, special interest groups, and the general public have all been drawn into the fray.

by Steve Gasal

Of the nearly infinite frequencies in the electro-magnetic spectrum, two terrify drivers who like to travel faster than the posted speed limit. The offending frequencies are 10.525 GHz (X-band) and 24.15 GHz (K-band). You see, these frequencies are used in radar speed-measuring devices and they result in millions of dollars in fines every year. However, these personified frequencies aren't very interested in our speed laws; Maxwell's laws of electro-magnetism are their only concern. They will do anything people want them to as long as they aren't asked to violate these laws. As such, they are perfectly willing to help law enforcement officers catch speeders and just as willing to tell the speeders when they're in danger of being caught. The result is electronic "warfare" between radar toting police and radar detector equipped drivers.

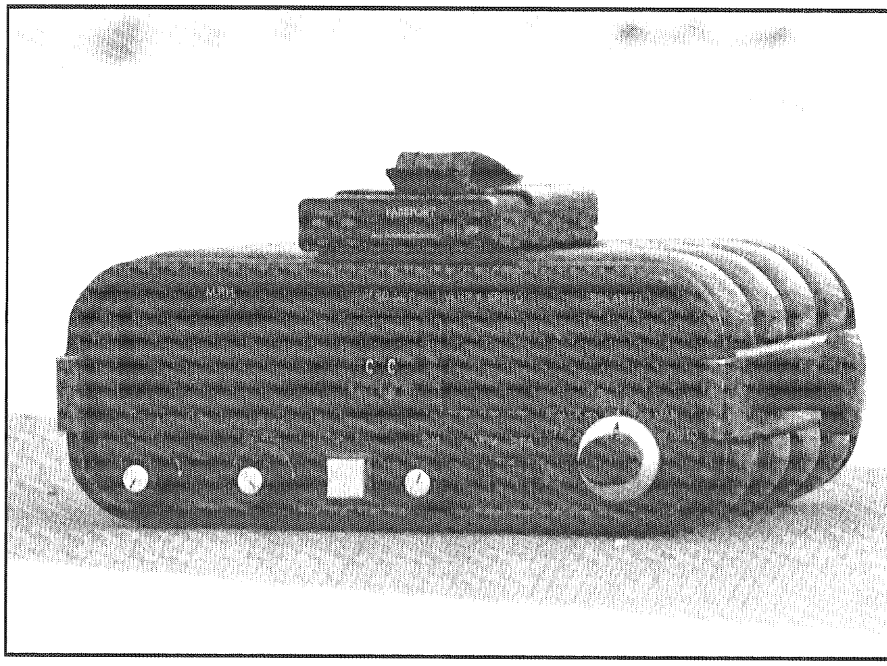


Photo by Paula Zoromski

Two examples of the weapons used in this battle. Their existence supports Newton's theory that every action has an equal and opposite reaction.

Police radar has been around since the late 1940s and went virtually unnoticed by drivers until 1973. It was in this year that the 55 mph national speed limit went into effect and large sums of money were spent on radar units in an attempt to enforce the new speed limit. Every measure has a counter-measure and radar detectors began appearing on the market.

The most successful radar detector manufacturer in the mid 1970s was Electrolert Inc., headed by Dale Smith, a former designer of police radar units. Mr. Smith's product, the now famous Fuzzbuster, was his answer to what he perceived as misuse and misinterpretation of police radar. He was also disturbed by the idea of monitoring drivers without their knowledge. In fact, Mr. Smith spent large amounts of time and money fighting state laws banning radar detectors and defending drivers arrested for their possession. Regardless of the moral and legal implications involved, the battle for technological superiority between radar units and detectors had begun.

Radar detectors seemed to have the edge until 1975 when a second frequency (K-band) was introduced. This was supposedly the solution to the drivers possessing X-band detectors. Of course new radar detectors soon became available that would monitor both frequencies for the presence of radar. The new radar frequency presented more of a problem to detectors than just having to monitor two frequencies. The higher frequency of K-band just didn't travel as far as X-band. Not only that, but K-band detectors were more expensive and less sensitive. Up to this time the available radar detectors were of a passive design. It suffices to say that the configuration of the passive circuit was nearing the end of it's useful life. A new breed of radar detector, the

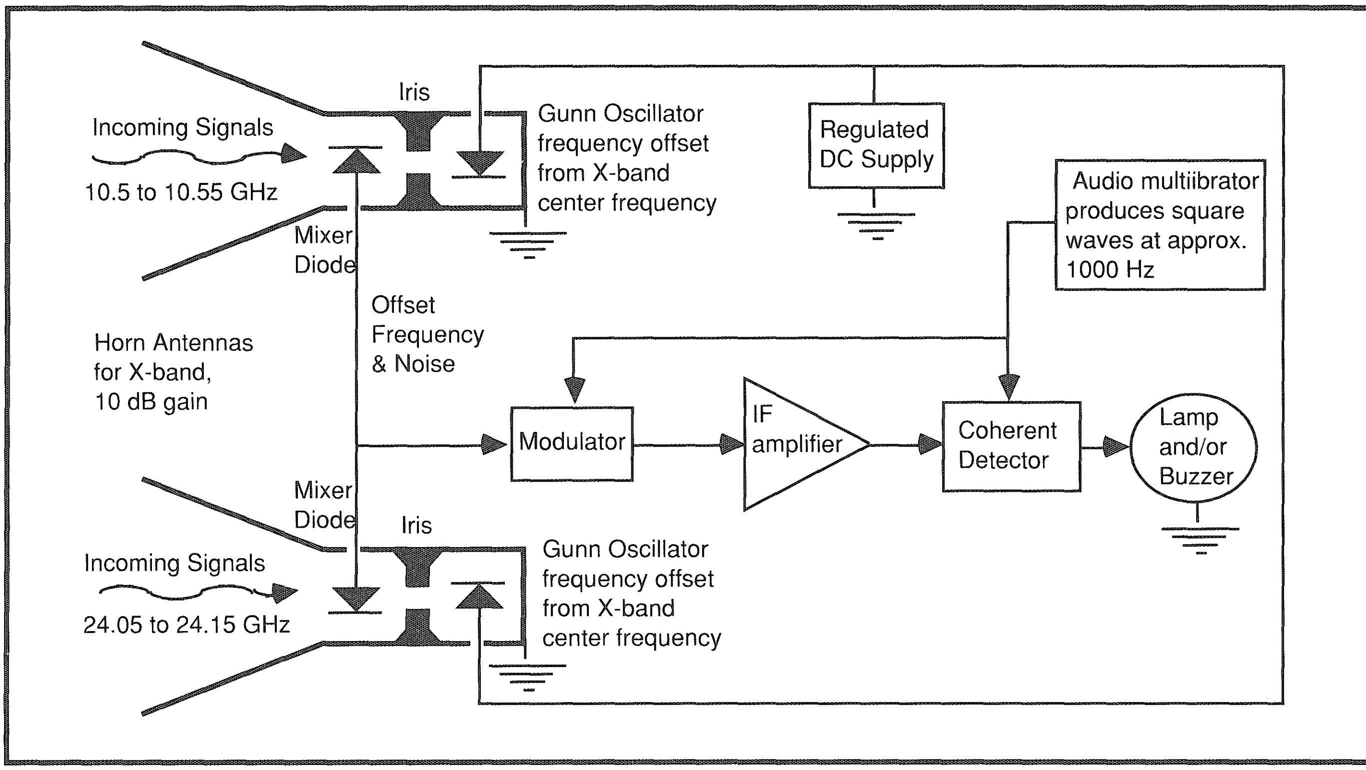


Illustration by Chi Hum Paik

Figure 1:Dual-band heterodyne detection uses a Gunn oscillator in each microwave antenna. The mixer diode is exposed to both the radar signal the local oscillator signal, yielding an intermediate frequency of 60 MHz that can be easily modulated, amplified, and detected to run the lamp and/or buzzer alarm.

heterodyne, was coming.

The heterodyne circuit employs Gunn-diode oscillators operating at a frequency that is offset a certain amount from the X- and K- band police radar frequencies. The radiation from the Gunn oscillators passes through an iris to a mixer diode which is also exposed to any incoming signals (see figure 1). A difference frequency results from the combination of the offset oscillator and the incoming signals. This resultant frequency is much lower than the actual radar signal being sought and therefore is much easier to work with. This signal is then modulated, amplified, and run through a detector that determines when the desired hybrid frequency is present. If the desired frequency is present, which means radar is transmitting, an appropriate alarm is sounded. This description is, of course, overly simplified. Actual detectors use complex circuitry to eliminate false alarms from various sources.

Police radar doesn't have exclusive use of their assigned frequency ranges. Communication equipment, door openers, and collision avoidance systems also use the frequency bands. The best detectors use sophisticated signal processing technology to eliminate false alarms which are very annoying. The details of these circuits are kept rather secret by the manufacturers for obvious reasons.

Regardless of how good a radar is, it must be kept in mind that these devices are just a collection of electronic circuits and not capable of intelligent thought, i.e. they aren't a license to pretend you're in Germany on the autobahn at all times. Almost all modern police radar units are of the "instant-on" variety. As the name implies, they are "off" until they are instantly turned "on". The idea behind this is that a patrolman will wait until a likely speeder is within range and "instantly" turn the unit on to get a speed reading. As soon as a reading is obtained the unit stops transmitting, thereby limiting the emitted radar signals and making it harder for a detector to find the signal.

This type of radar doesn't mean that current detectors are obsolete, however. Present day detectors can pick out a transmitting "instant-on" radar unit at a range of up to 3 miles of X-band and 1.5 miles for K-band. Under most traffic conditions, a patrolling officer will check the speed of some other vehicle within the detectors range before the detector equipped driver is the target. But this doesn't always happen. On lightly travelled rural roads, where there is no other traffic for a patrolman to check, a radar detector is less effective because of the lack of radar transmission. This means that the driver must realize the limitations of the radar detector and drive accordingly.

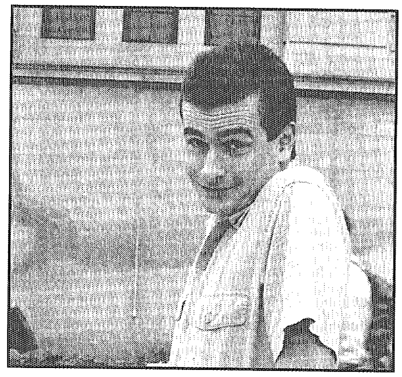
Several new advances have recently been made in police radar. The first is radar units with 2 transceivers, allowing a patrolman to check the speed of vehicles to the front and rear of the patrol car. Some patrolmen are waiting until a suspect vehicle passes in the opposite direction and then get a speed reading from behind. This drastically limits the signal available to alert oncoming traffic of the radar threat. The second advance is in the form of two new radar frequencies for police use.

The FCC authorized the frequencies of 13 GHz and 34 GHz to be used in photographic radar units. These devices are placed along a roadway and take a picture of the license plate and driver of any speeding car. The ticket is then mailed to the offender. These devices have more drawbacks than just the Orwellian aurora surrounding them. They cost close to $20,000 and will probably result in legal challenges. Vandalism to these stationary units is also another possibility.

Three states have banned the use of radar detectors.

The National Highway Traffic Safety Administration (NHTSA) is now conducting a study concerning the safety aspects of radar detectors. It is widely perceived by most people, including police organizations and radar detector manufacturers, that the study's results will claim that radar detectors are a safety hazard. Patrick Bedard, an editor for *Car & Driver,* recently pointed out that the NHTSA's radar detector study is flawed in that it doesn't compare accident rates among drivers with and without radar detectors. Instead it will measure speed changes of traffic in the presence of radar and make safety determinations based solely on this data. Bedard pointed out that a valid study of radar detector safety based on accident rates has already been conducted by the research firm Yankelovich Clancy Shulman, which does research work for the Internal Revenue Service. The results? Radar detector users average 233,900 miles between accidents compared to 174,600 miles for nonusers.

The Federal Government , in the form of the FCC, has sole jurisdiction with regard to regulating the use of the airwaves and has stated a lack of interest in banning the use of receivers in any form. Three states have, however, banned the use of radar detectors and it is safe to assume that the release of the NHTSA study will result in more states following suit. It's doubtful that these state laws could stand up to a legal challenge, but that's no consolation when your $300 radar detector is taken away. **MT**



Steve Gasal is a senior in aerospace engineeringand is the advertising manager for the Technolog. He also works part-time for Honeywell. His current obsession is to create a stealth car, which he fondly refers to as the "Advanced Tactical Mazda." Results to date: large sums of money spent, mediocre results.

Sources:

P. David Fisher, "Shortcomings of radar speed measurement," ***IEEE Spectrum*****, Dec. 1980, pp. 28-31**

D. Mennie, "Helping speeders beat the radar rap," ***IEEE Spectrum*****, August 1978, pp. 38-42**

Steven Cole Smith, "The Finest Open-Mindedness Money Can Buy," ***Car & Driver*****, April 1988, pp. 92-95**

Editor, "Letters," ***Road & Track*****, March 1988, pp. 13**

Project Technology Power

Minority enrollment at the University of Minnesota has always been small. This program exists to increase that number and support those enrolled.

by Steven Subera

Currently, minority students (Blacks, Hispanics, American Indians) comprise approximately 8.5% of the national engineering undergraduate enrollment and 4% of the engineering profession. Project Technology Power (PTP) is an Institute of Technology program attempting to increase minority participation in its college.

Started in 1970, PTP's goal is to improve the retention and graduation of the underrepresented minority groups in the Institute of Technology. The program provides pre-college and college support services. The pre-college programs are arranged in pipeline fashion with a different program each year. According to Don Birmingham, the present administrator, many high school students participate in successive programs.

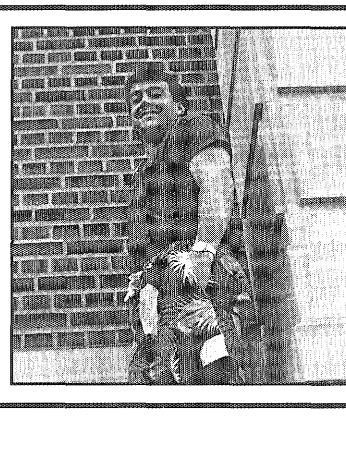
At the eighth grade level, the MathBridge program begins. This program is an early identification program where 150 minority students from the Twin Cities are chosen by instructors or counselors for activities designed to increase a student's interest in math and science based careers. This year there were three major projects. The students completed a chemistry project in Kolthoff hall, a computer graphics project in Folwell hall and a problem solving project. Students also visited the Science Museum of Minnesota. Four years ago a computer camp was established for ninth graders. At the sophomore level a college preparatory program is offered to prepare students for the Preliminary Scholastic Aptitude Test (PSAT). Birmingham is currently working on initiating a pre-college program for junior and senior students. This would complete the pipeline process. Birmingham would like the participants of the pre-college program to enroll in the Institute of Technology when they complete high school, but he considers the program a success if they attend any college. He noted that there are a number of students who go on to schools such as Stanford, Berkeley and the University of Michigan

Approximately $75,000 was awarded by industry for students in PTP.

Presently, students are recruited predominantly from the Minneapolis and St. Paul school districts where the greatest number of minority students attend classes. The majority of program participants are black students. Instructors are obtained from the Minneapolis and St. Paul school system and current minority students enrolled in the Institute of Technology. Alumni who live in the Twin Cities area are extremely active in PTP, Birmingham said. They provide role models for the students and also help teach pre-college programs. "We have students in industry come back and talk to our students about what is really going on in the work world," Birmingham added.

At the college level PTP offers several services including industry funded scholarships summer internships, tutoring and a student organization, MINIT (minorities in IT). Birmingham, who is also MINIT's adviser, said the main goal of the organization is to "enhance academic and social life of Blacks, Hispanics and American Indians." The organization conducts meetings that provide practical help on exam studying and resume writing. Professional engineers also give presentations. The meetings also enable members to plan study groups and tutoring sessions. Tutoring is available for lower division courses, but Birmingham hopes to provide tutoring

Minorities to 24



Steven Subera is a junior in electrical engineering and is looking forward to attending classes in the new EE/CSci building this fall. He is vice president of KHK, the electrical engineering fraternity on campus. This summer Steve will keep busy attending summer school, writing for the *Technolog*, and writing freelance for the *Minnesota Daily*.

Plumb Bob and I.T. Week

This honorary leadership society has traditionally planned and developed I.T. Week since the about the 1950s. This year's events promise to build successfully on that tradition.

by Paula Zoromski

What is Plumb Bob?

Whenever I wear my Plumb Bob shirt, people ask me what Plumb Bob stands for. Before I explain, I ask them to guess. Unfortunately, very few students guess correctly or know anything about this organization and its duties.

Many engineering students say a plumb bob is a weight used to find the depth of water. Then, they try to figure what type of organization would be named after this tool. Usually the conversation stops here. One student thought Plumb Bob sounded like some kind of African group or a religious organization. He thought it sounded like something that would work well in a chant, "Plu um bob ba Plum bob ba."

A minority of students know that Plumb Bob is a student organization in the Institute of Technology, but they do not know its function. Most of these people think that it is a group to convert C.L.A. majors to I.T. or to recruit new students. Maybe the history of Plumb Bob, its function, and a preview of this year's I.T. Week will help clear up some of the confusion.

Photo by Paula Zoromski

This year's Plumb Bob Honorary Leadership Society members: (back row, left to right) Darin Hauer, Jon Bovitz, Mike Sigfried, Jeff Graupmann, Dave Schmiechen, (front row) Keat Cheah, Paula Zoromski, and Shari Vigliaturo. Absent: Linda Birnbaum and Terri Schulke.

Five civil engineers: Bryon K. "Bye" Curry, Raymond V. "Ray " Johnson, George C. Schaller, Lloyd S. "Mike" Mitchell, and Julian R. "Spike" Garzon started Plumb Bob after World War I. In the beginning, Plumb Bob actually was a secret organization. To be eligible for membership, a student had to be an I.T. senior who flunked at least one five-credit math class or general physics. These early intellectuals held their meetings in bars on Hennepin Avenue and their sole purpose was to socialize. Since all the original members were civil engineers, the organization was named after the common tool, the plumb bob. I am not sure why they chose this particular tool, but the plumb bob was used in ceremonies until the early 1980s. Members also received a plumb bob when they graduated.

New members used to be initiated into Plumb Bob. Professor Jim Holte, a former advisor of the fraternity, reported one initiation of the 1970s. First the new members had to do sit-ups in Main Engineering (Lind Hall). Then, they were blindfolded and put into wheel barrels that were pushed across planks. This was supposed to symbolize self-composure. The ceremony ended in Mechanical Engineering where they circled a wooden frame filled with sand. Here, the members recited the initiation speech and a plumb bob was dropped into the sand.

The bylaws of the fraternity were changed during its third year to include students who did not flunk any classes. Several years later Plumb Bob added a minimum Grade Point Average of 3.1416 to its entrance requirements.

The discovery of the Blarney Stone was independent of Plumb Bob. In 1903, a stone was found during an excavation for the foundation of an engineering annex. The green, glowing stone had the inscription, "Erin go Braugh" . This hieroglyphic phrase was translated to mean Saint Patrick was an engineer. Saint Patrick's Day was declared a holiday for engineers in Minnesota and Missouri. Within a few years other schools such as Iowa and Wisconsin also recognized this special day.

The first official E Day recorded was celebrated on March 17, 1904. The senior engineering students celebrated this day by skipping school and attending a banquet at the Gordon Hotel.

Technolog file photo

The gift of the golden tongue was supposedly bestowed upon this student when he kissed the Blarney Stone in a past E Day celebration.

By 1914, E Day was a major event at the University of Minnesota. At noon, there was a parade and a pep rally where university band performed. The knighting ceremony, where Professor Priester was crowned as Saint Patrick, and the kissing of the magical Blarney Stone followed the band. Everyone who kissed the magical stone was said to possess the gift of the golden tongue. In honor of Saint Patrick, green tea was served in the Electrical Engineering building to students and faculty. At night there was a vaudeville show at the armory and the Engineers' Ball followed.

In later years, E Day was moved to April because of Minnesota's harsh winters. The day was still held in honor of Saint Patrick but a few of the rituals changed. A group called the Technical Commission organized the early E Days. One member of the Technical Commission was required to be in Plumb Bob. Even though Plumb Bob was not completely responsible for E Day, it played a big part in the planning of events, and the group protected the sacred Blarney Stone throughout the school year.

The criteria for Plumb Bob members was changed many times through the years. In the 1950s and 1960s all of the fourteen branches of I.T. were equally represented in the organization. The first female member, Sally Ahola, was not initiated until 1966. The fraternity required half its members to be women when the Equal Rights Amendment was an important political issue in the 1970s. Finally, in the early 1980s Plumb Bob adopted the structure that it has now. One half of the group consists of junior members who are trained by the officers, the senior members. The members are chosen according to academic achievement and most importantly, involvement in extracurricular activities.

. . . Plumb Bob required a minimum grade point average of 3.14159 . . .

Plumb Bob did not take over the full responsibility of E Week (by this time one day was not enough time for all of the activities) until the 1960s. Because I.T. was made up of a large number of scientists and computer programmers, the name was changed from E Week to I.T. Week.

The current function of Plumb Bob is to direct I.T. Week and get the I.T. student organizations involved in the festivities. Last year the organizations were more involved than they have been in the past. Groups were involved with everything from booths at the Technology Fair to sponsoring the volleyball tournament, picnic, and Olympic events.

This year's I.T. Week begins on May 9 with speeches from both Pat-the-Wise and Dean Infante at the opening ceremonies. On Tuesday, the Consulting Engineers Council will hold a seminar, and the Technology Fair begins on Wednesday, May 11. At least fifteen companies and numerous student organizations will host booths in the mall area. The companies will distribute information about employment, new products, and some will even sell computers. The technology fair will end Thursday afternoon, May 12, with the I.T. Student Awards Banquet at the Campus Club in Coffman Union.

Finally, the sixth annual I.T. Olympics will be held on Friday, May 13. The Olympics features events like the fast-paced bed race, the chariot race, death of an automobile, and the transistor toss. The top three teams will receive cash awards of $100, $50, and $25. The Theta Tau party is last event of the week.

Other events to watch for throughout the week are the free movies, the picnic, and the volleyball tournament.

Now that the function of Plumb Bob and the beginning of I.T. Week is a little bit clearer, the next time I wear my Plumb Bob shirt I hope someone will ask me if I am a junior or a senior member or when I.T. Week starts. MT

IT Professional Societies

These groups can provide valuable contacts, new friends, and great experience.

by Linda A. Urich

You just relaxed, realizing the next time your parents ask that sticky question, "So, what exactly is your major?", your response will be straight forward and to the point. It only took a few years of gutting partial derivatives and scanning appendices packed with charts, but now you narrow your academic scope and actually focus on the requirements for just one of those wonderful technical majors. Suddenly, life (read: school) seems manageable, requiring that you only take classes designated for your major — and they are even listed for you in the IT course catalog.

Later on the road through academia, you might find any IT class long on the great chunks of theory but short on providing real life experiences, which usually appear in the form of contrived homework problems. Next, seeing recognizable but still nameless people in your classes starts to bother you. And then there is your parents' next reoccurring question, "What exactly are you going to do with that extractive metallurgical engineering degree?"

That is where IT's professional societies enter your life. Belonging to a professional society will do more than pad a resume; it will provide a valuable opportunity to define career objectives, make friends in your major, and offer support when tough classes hit. All of these organizations are student chapters of national professional societies and often coordinate activities with the senior section members. This contact with the science and engineering community leads to company contacts, scholarship money, and internship opportunities, not to mention leadership experience within the student chapter. Usually a small annual membership fee provides free activities within the student chapter and discounts at senior section activities, along with the society's national magazines.

The following is a partial list of professional societies in IT. The complete list can be found in your *IT Student Guide*. Contact them if you are interested in becoming more involved within your profession.

American Institute of Aeronautics and Astronautics Engineers (AIAA)

305 Akerman Hall
625-9318
Advisor: Prof. William Garrard

AIAA coordinates activities to interest students in the aerospace engineering field. They act as unofficial advisors for the department by helping students plan their schedules. The officers meet weekly and activities are planned monthly.

The student chapter also meets monthly with the senior chapter for dinner meetings at the Campus Club or the Ft. Snelling Officers' Club. Plant tours are arranged with local companies such as Northwest Airlines, Rosemount Engineering, and out-of-state companies such as McDonnell Douglas in St. Louis.

AIAA sponsors an annual student paper contest. The subject matter can be work or classroom inspired and is presented before faculty members. Winners advance to the national competition being held in Denver this April.

American Institute of Mining and Metallurgical Engineers (AIMME)

122 CME
625-5828
Advisor: Prof. Randall Barnes

The student chapter of AIMME consists of geo-engineering undergraduate and graduate students. They work closely with ASCE in planning activities and fund raisers.

AIMME sponsors brown bag seminars in conjunction with ASCE. Guest speakers this year were from the Bureau of Mines and other related jobs. Members receive job information from the national organization. Each year members also attend meetings in Duluth sponsored by the state chapter.

American Society of Agricultural Engineers (ASAE)

213 Ag. Eng.
Advisor: Prof. Jonathan Chaplin

Members of ASAE are not only agricultural engineering majors, but students from the soil sciences and other agriculture disciplines. There are monthly meetings and members participate in activities on two campuses: IT Week in Minneapolis and agriculture events in St. Paul. The group also conducts its own Career Days in October.

ASAE sponsors guest speakers from many areas. This year's speakers have been an insurance representative and staff from the IT Career Placement Office. ASAE raises funds by selling t-shirts and sponsoring ice cream socials.

ASAE arranges several joint meetings with the senior chapter each year, including one being planned for this summer. These meetings are excellent sources of academic and professional contacts for members.

American Society of Civil Engineers (ASCE)

217 CME
625-6638
Advisor: Prof. Cathryn French

ASCE claims to be the largest student society in IT with 170 members. There are few formal meetings, but ASCE sponsors many activities. Every two or three weeks there are brown bag seminars. Recent speakers have been department professors, a consulting engineer from TKDA Engineering, and the president of the national chapter. Plant tours this year have been to the new Lincoln Center and Norwest Tower buildings in downtown Minneapolis. ASCE also sponsors training in job skills and resume writing once a year.

The highlight of the group's year is participation in the annual concrete canoe races with other student chapters in the country. During winter and spring quarters, members test possible material mixes for the canoe so if the canoe breaks it will float. ASCE is experimenting with a new canoe design this year and, as usual, has high hopes for advancing past regional competition.

American Society of Mechanical Engineers (ASME)

316 Mechanical Engineering
625-0365
Advisor: Prof. Kim Stelson

ASME sponsors group activities several times a quarter. These events expose students to opportunities available in the mechanical engineering field. This year active members toured Rosemount Engineering, TSI Corporation, and IBM. Members also attend activities sponsored by the senior section once a month. They usually consist of a tour or presentation and are great opportunities to make potential job contacts.

Other social functions sponsored by ASME are end of the quarter parties and intramural volleyball and softball teams.

Institute of Industrial Engineers (IIE)

190 Mechanical Engineering
Advisor: Prof. Edward Barnett

IIE serves a connection to the industrial engineering profession, providing its members with a wide exposure to topics in their field. IIE also emphasizes the leadership opportunities in the organization and encourages members to be actively involved all year.

The senior chapter provides strong support to the student members and provides guest speakers to the student section meetings. Speakers this year have been from the Pillsbury Traffic Management and Medtronics. IIE also coordinates activities with other student societies in IT, such as seminars and plant tours to ADC Telecome and the 3M plant.

Society of Women Engineers (SWE)

338 Walter Library
626-0093
Advisor: Ben Sharpe

SWE is no longer an all-female organization. It tries to promote itself as a common organization for all IT students to join. SWE also actively recruits new freshman and transfer students, something no other group does. Next year the group hopes to further increase its visibility when its office moves to the basement of Lind Hall.

This student section of SWE is an excellent avenue for contacts with job recruiters and professors. In the office there are test files and a resume book for members. SWE is also active recruiting women into IT with two programs. First, the Outreach program sends SWE members to area high schools to talk to students about careers in science. Second, in the spring SWE sponsors the Technically Speaking program, where female high school students visit the University for a day to tour the campus and explore technical majors. **MT**

Linda A. Urich is a junior in mechanical engineering and has impressed everyone in our office with her poker skills. She works at Twin City Testing, Inc. in the ME co-op program and has even scaled the outside of the Piper Tower in Minneapolis as part of one of her jobs. Linda has been a member of the IT Board of Publications since December and is looking forward to writing more next year.

Minorities from 19

for some upper division courses. There are approximately 24 college students participating in PTP.

Industry funded scholarships and summer internships help alleviate financial burdens and give hands-on experience. Approximately $75,000 was awarded by industry for students in

Birmingham believes they (the University) should share fiscal responsibility.

PTP. Students also receive assistance in obtaining summer internships. Birmingham said about 60% of the undergraduates were placed with companies for the summer.

Birmingham's biggest concern is fiscal. He believes PTP needs more funding. "If you ask any person who has responsibility for minority programs here at the University or probably any other university for that matter, they'll tell you that the problem is underfunding," he commented. Approximately three-fourths of PTP's funding comes from industry sponsors with the other fourth from the University. Since PTP is a University program Birmingham believes they (the University) should share fiscal responsibility. "We shouldn't have to get a majority of funding from industry. When you know the money will be there from year to year it allows you to plan more long term projects instead of spending one day running around trying to raise money and then thinking about what you're going to do."

Common problems such as financial need exist for minority students, but they also face other unique problems. With such a small minority population at the University students may feel uncomfortable in a different environment. Racism is also a problem plaguing universities. "I don't think that there is any real question that racism and sexism still exist within institutions and to say that they don't is to look the other way," Birmingham said.

Birmingham said PTP's track record is very good. Almost all graduates are placed in industry and the graduation rate for students in the program is better than the overall rate for the Institute of Technology. He cited strong community support and support within the University community. "We've established a strong reputation with industry because they keep providing us with funding and that's always a good sign showing that you're doing what you're supposed to do." **MT**

Log Ledger from 7

The Americans are already planning ahead for the races in 1990. Supposedly, a yacht has already been designed that could very well beat *Stars & Stripes*.

Single-electron Transistor

by Dean Harrington

Researchers at AT&T Bell laboratories have created experimental single-electron transistors—devices so sensitive that changes in current flow can be produced by just one electron.

These transistors are prototypes that operate at only very low temperatures. However, scientists at AT&T believe that their performance may foreshadow a generation of all-metal transistors that consume very little power and are extremely fast and small.

The devices work best when made of superconducting materials. Currently, they could be used as electrometers in experiments to measure induced charges as small as one percent of an electron.

More development will be needed before practical devices such as switches and computer elements could be made with the new transistors. These new devices use infinitesimal amounts of power and space. They have an intrinsic speed of less than a picosecond (one trillionth of a second) and use the smallest amount of charge transfer possible, Even modern, miniaturized field effect transistors (FETs) involve thousands of electrons in a single voltage change while these use just one.

These devices can now be made through new techniques developed at Bell Labs by co-inventor Gerry Dolan. Electron-beam lithography is used to pattern a high-resolution organic film layer. The electrodes are then deposited on the barrier. This new technique allows devices to be made that are smaller than one-twentieth of a micron across.

The transistors consist of three microscopic parts. The first is an island of metal a few hundred atoms across. Connected to the edge of the island are two tunnel-junction electrodes separated by an insulating barrier only a few atoms thick. The substrate forms a remote "gate" junction that applies an electrical field, creating a steady-state bias and thus a charge across the junctions.

This charge controls the current passing though the central electrode via the tunnel junctions. As in a FET, current can be turned up or down by changing the gate voltage.

I.T. Board of Publications

The Institute of Technology Board of Publications is the publisher of the *Minnesota Technolog* and the *I.T. Connection*, the biweekly newsletter for students, staff and faculty. Existing in some form or another since the mid 1960s, the Board is made up of eight members elected at-large, one freshman member, the *Minnesota Technolog* Editor and Business Manager, the *I.T. Connection* Editor, and a faculty advisor.

As publisher, the Board is in direct control of the finances of both publications while inspiring a direction for them. It provides an excellent opportuity for students to become directly involved in the management, finances, and publishing of a national award-winning magazine and a excellent newsletter.

Currently, there are three open positions on the I.T. Board of Publications for next school year. The *Technolog* and the *Connection* also have variety of opportunities available for anyone interested. Depending on the position, the time committment can be minimal, yet there are many benefits to be gained. Stop in Room 2, Mechanical Engineering Building, or call 624-9816 for further information.

This year's Board has done an outstanding job, contributing to excellence of both the *Minnesota Technolog* and the *I.T. Connection*. Stop in and join the tradition. **MT**

Technotrivia

by Jacques Youakim and Denis Zilmer

Questions :

1) What do you need in the desert to make a scorpion go mad and sting itself to death?

2) What type of insect can see ultra-violet light?

3) What is the square of 888,888,888,888,888?

4) How long is a day on the planet Mercury?

5) What animal can detect a female of its species a mile away?

6) How many men were enlisted in the U.S. Air Force at the outbreak of WW I?

7) Appoximately how many words can a lead pencil write?

8) How many gallons does a ten-gallon hat hold?

9) How thick are Saturn's rings?

10) The word "robot" was coined in 1920 in the play *R.U.R.* (which stood for Rossum's Universal Robots). Who wrote the play, and what country was this person from?

Scoring :

0-1	Sleeping in class is fun, but doesn't help with Technotrivia.
2-3	Oh come on, you can do better than that.
4-5	Better ask mom or dad for a little help.
6-7	You're almost up to average intelligence.
8-9	What, have you been reading our book?
10	Have you memorized all the answers to Trivial Pursuit too?

Answers:

1) Alcohol.

2) A bee. I suppose you thought it was Superman.

3) 790,123,426,790,121,876,543,209,876,544. Pretty hard to do on your calculator, huh? A man named Oscar Verhaeghe could do this problem and others like it in his head in 40 seconds.

4) 176 Earth days. A physics class would really drag there.

5) A male emporer moth.

6) 50 men.

7) About 50,000 words. Holy writers cramp!

8) Less than a gallon.

9) One foot (or the thickness of your average calculus book).

10) Karel Capek wrote it, and he was from Czechloslavakia. Take two points off if you thought it was Isaac Asimov.

Technocomics

The Near Side

by Steve Littig and Conrad Teves

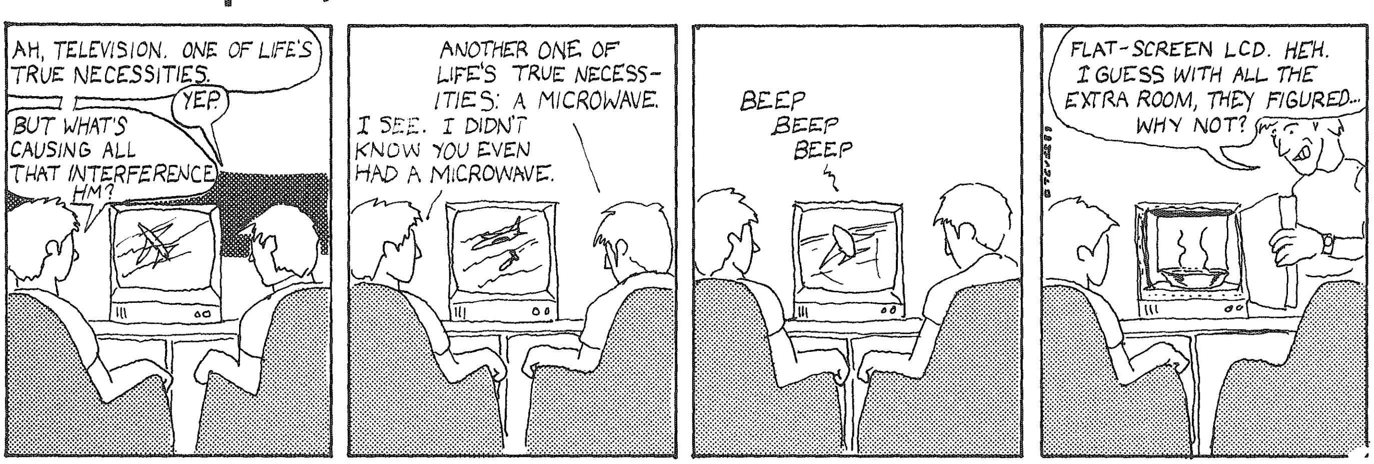
Torn between enjoying the nice spring weather and attending class, Kirk reached a compromise.

The Flip Side

by Jim Willenbring and Tom Rucci

Schoolwork was getting so out of hand that Mitch resorted to the thermo-absorbant method of studying.

Finite Loops **by Conrad Teves**



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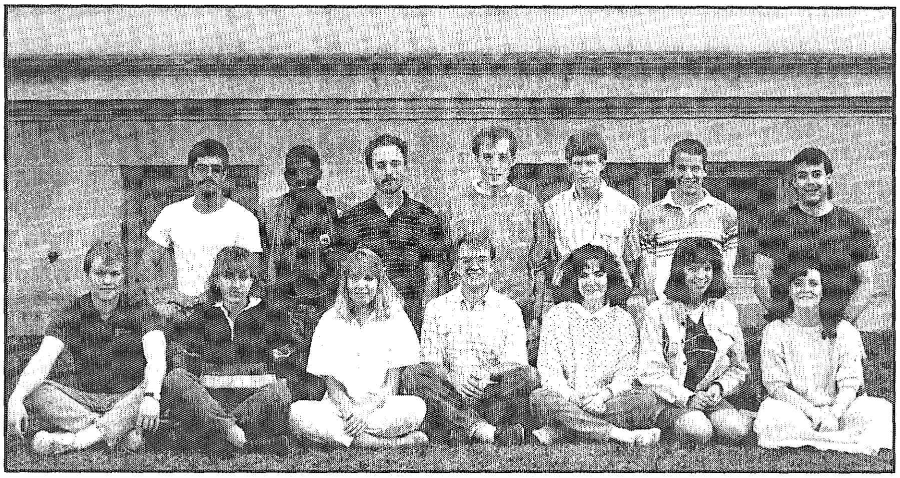
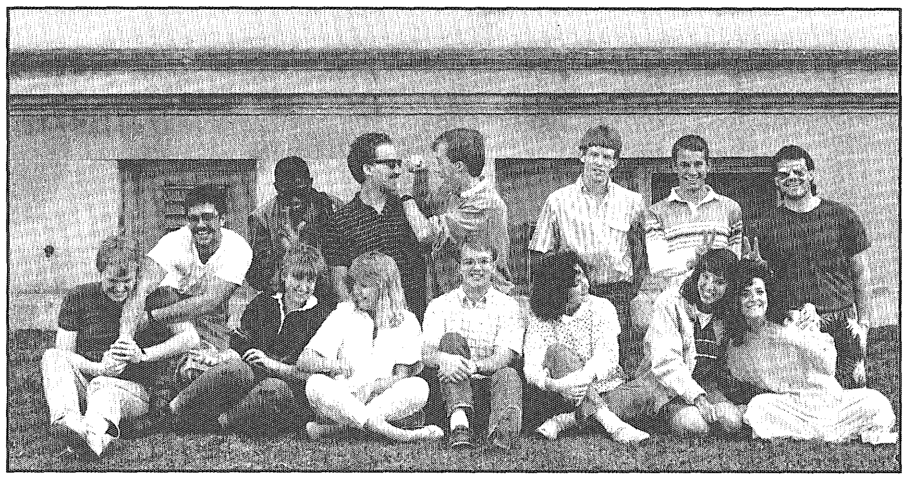


Front row, left to right: Kirk Nelson, Paula Zoromski, Heidi Berg, Steve Kosier, Susan Curran, Linda Urich, Vicki Bryner. Back row: Jacques Youakim, Mohammed Lawal, Steve Littig, Jim Willenbring, Bill Dachelet, David Kortenkamp, Steven Subera.



You could be in this picture next year!

The *Minnesota Technolog* is currently accepting applications for the following positions on its 1988-89 staff. Some of the available positions are:

- -writers
- -Assistant Editor
- -Advertising Manager
- -illustrators, computer and freehand
- -photographers

If you're interested in any of these positions, working on the *Technolog* helping with the *I.T. Connection,* or getting involved with the I.T. Board of Publications, stop by our office in Room 2 Mechanical Engineering or call us at 624-9816 and leave a message. This is an excellent opportunity to get involved with a quality organization and gain valuable communication experience. Application deadline for the *Technolog* positions is May 27 at 4:00 p.m.

minnesota
TECHNOLOG

A Thousand Words

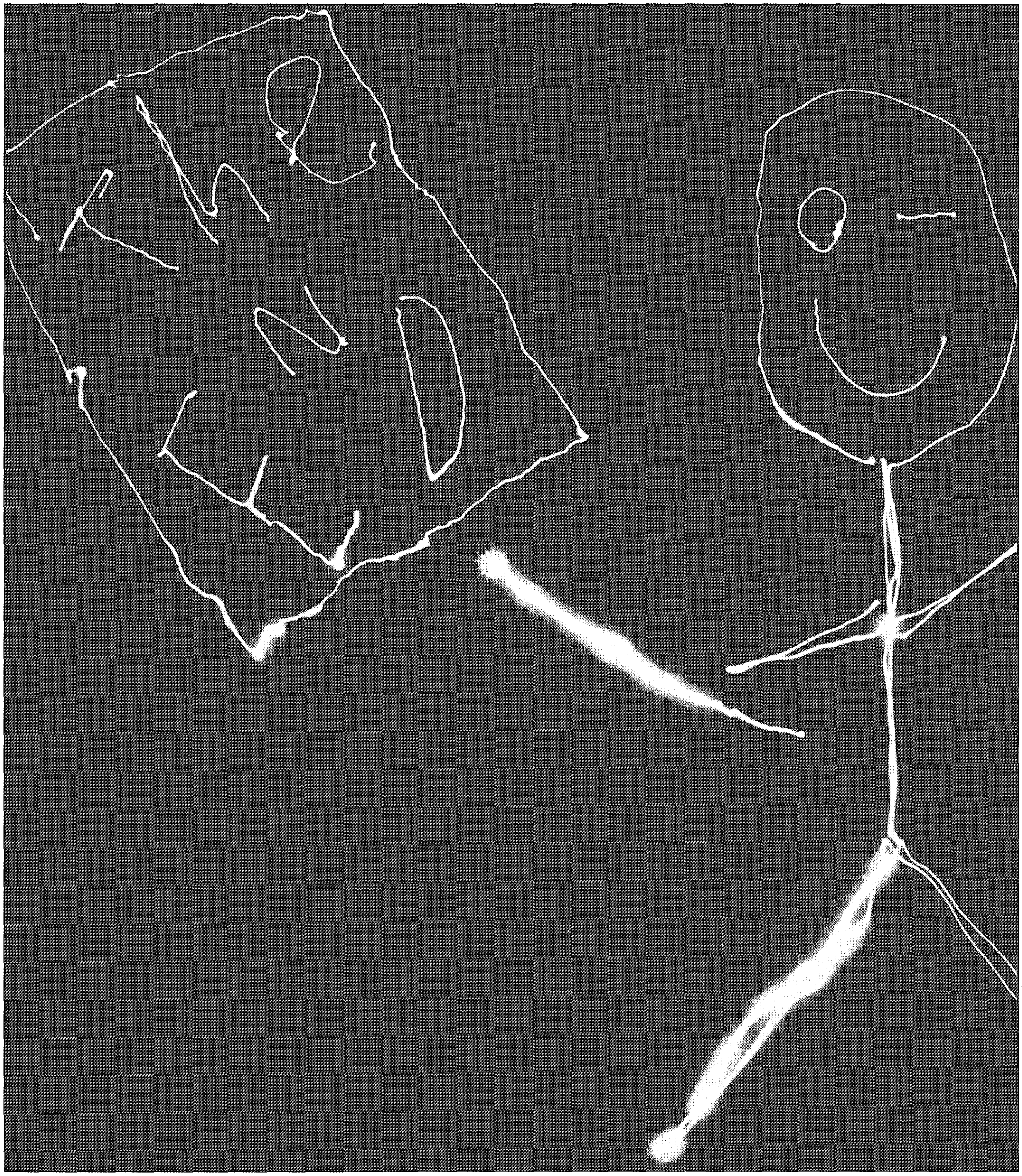


Photo by Paula Zoromski