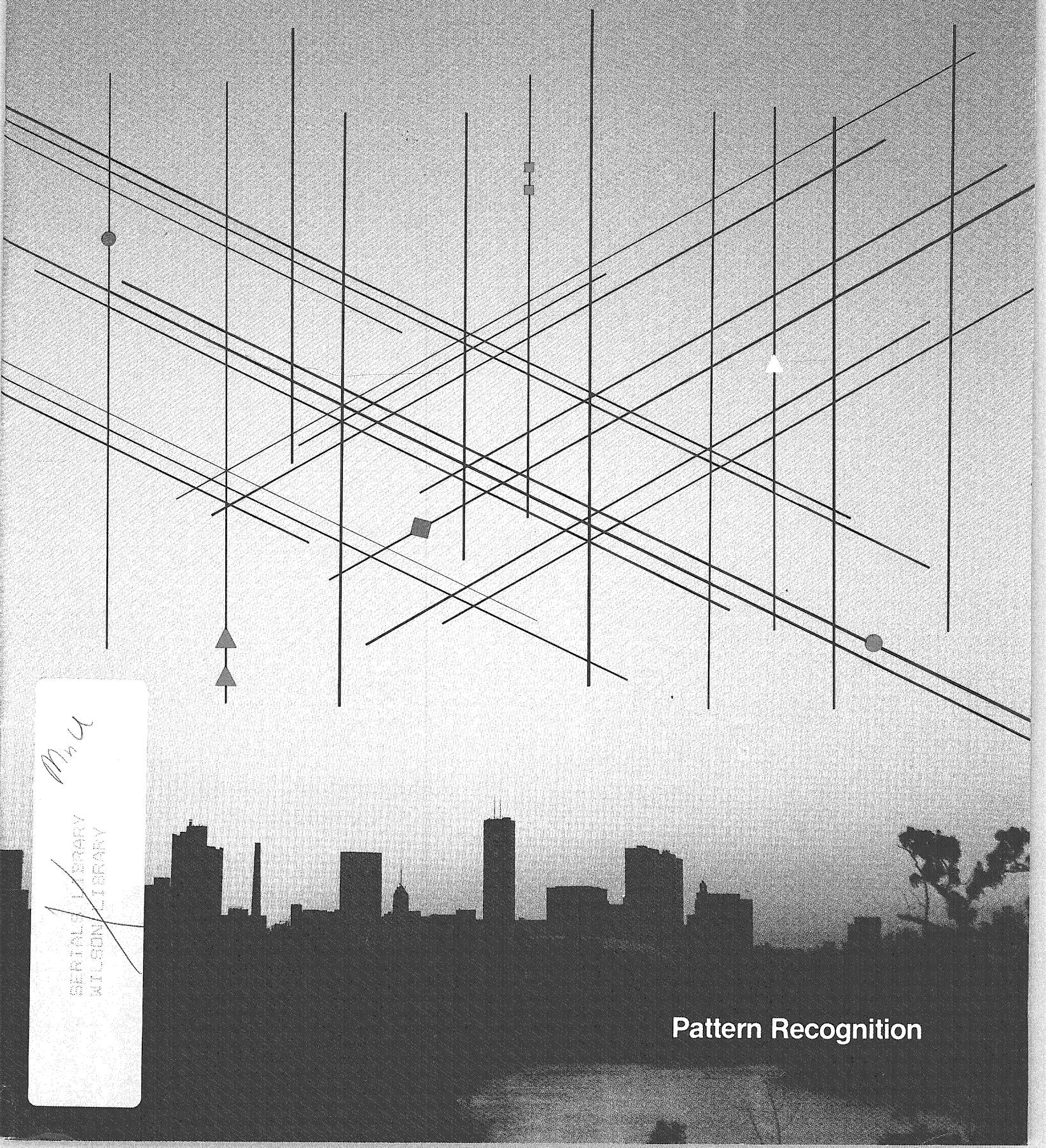
minnesota

TECHNOLOG

Fall One, 1985



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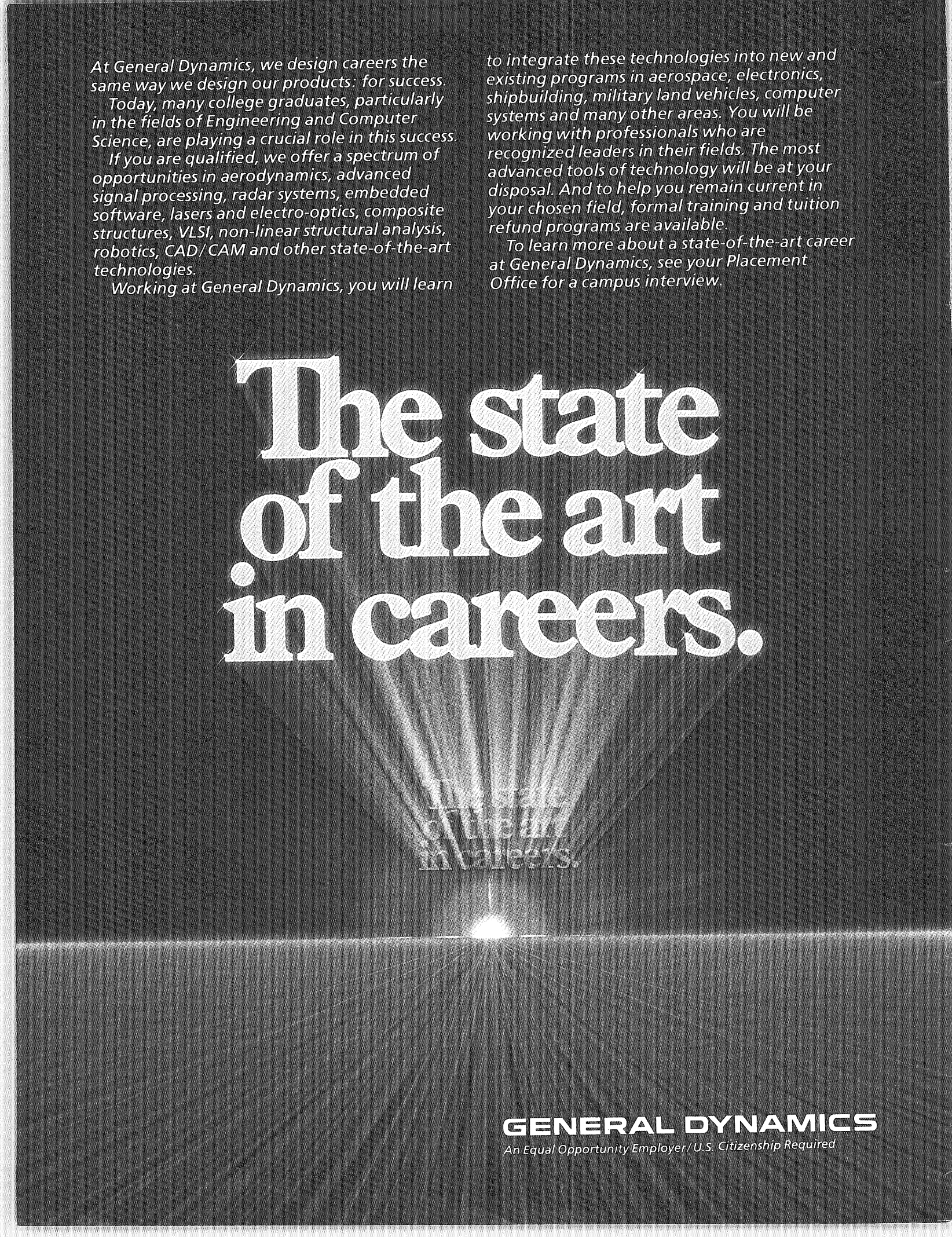

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Cover art by Julie Lees and Debby Latimer

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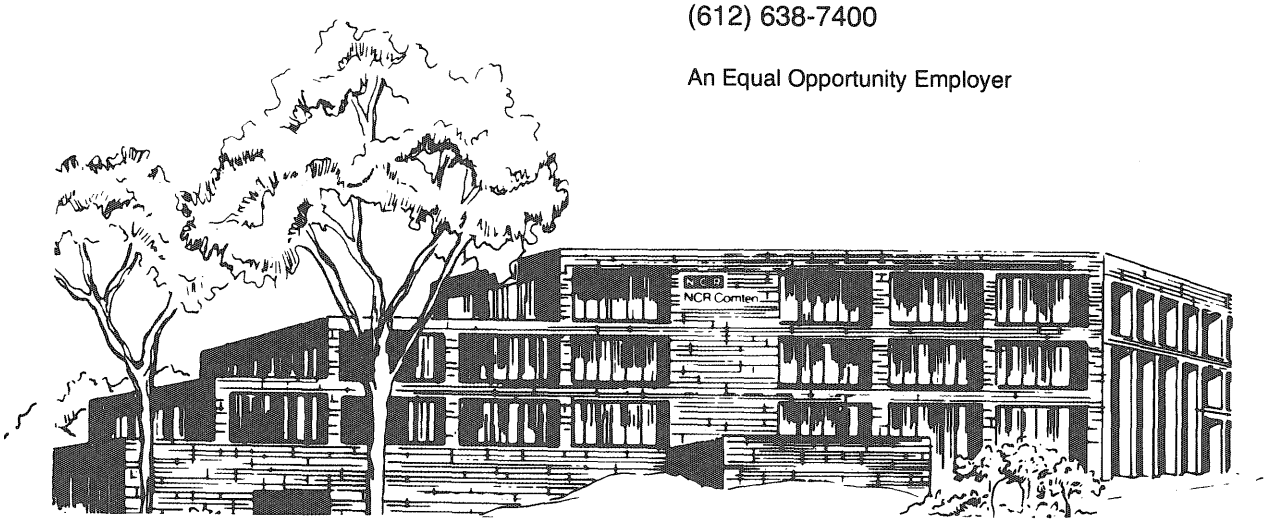


Editorial

Minnesota Technolog Has A Secret . . .

that is about to be revealed. Did you know that *Minnesota Technolog* is the oldest continuing university publication? This is not by chance! For over 60 years, IT students have been contributing their ideas and skills to this magazine.

Since we are not able to 'clone' any previous or current staff members, we will be relying on your participation to ensure the continued success of this publication. If you have an interest in writing, photography, illustrating or just gluing things together, stop by room 2, Mechanical Engineering and take this opportunity to become involved in magazine production.

1985 continues to be a year full of invention and controversy; new phases of space exploration, robotics, computer technology, medical achievements—star wars, espionage, apartheid . . . . Technology cannot progress in a cultural vacuum. Let your opinions be known. *Minnesota Technolog* is a vehicle for student expression.

So, in spite of all the hours that will need to be spent studying, explore a little—don't let your life become an extracurricular activity.

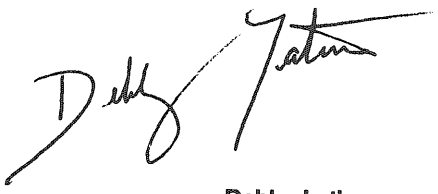
The Summer-Second

The momentum picks up around the first week of September. Summer mornings fused with lazy afternoons synthesize into evening sunsets, accelerating swiftly through time, flickering patterns of past events. The movement is broken only by large, block-type, free-falling images of functional activities: sleeping, eating and working. Every blink of the eye marks whole days of time as the weeks on the calendar slip into a whirling oblivion.

The whole experience crystalizes in one retrospective moment: the summer-second. It's catalyst? Setpember 26, 1985, the beginning of fall quarter at the University of Minnesota. Was it just a fantasy? Where did the summer go?

Was it just a fantasy? Where did the summer go?

The summer-second is a very ambiguous unit of time that takes its place within the larger scholastic unit which is composed of three quarters and one summer. For those of you who are just beginning to think in terms of scholastic time-structure, remember that it will require some refined pacing techniques to syncopate your study and leisure schedule to the subtle inhalations and exhalations of the university calendar.



Debby Latimer
Editor

Bulletin Board

FIFTEEN MORE YEARS!

We would like to thank GreenHaven Printing Company for the personal attention and good quality service that they have maintained with *Minnesota Technolog* over the years. Don Sztuk and E.J. (Joe) Bender, started the company in 1970. For 15 years, they have been working with our staff, patiently explaining the fundamentals of printing to each new editor. A good, long-standing business relationship is not easily established. We appreciate it! The chant for "15 more years" is already gearing-up in the background. GreenHaven Printing is located at 1611 Polk Street N.E., Minneapolis.

Don Sztuk and E.J. Bender, founders of Greenhaven Printing.

HOW IS DRY ICE MADE?

This strange substance—ice so cold it burns—is an excellent refrigerant, of course, and also a useful source for the ghoulish vapors in vampire and mystery movies. Dry ice is actually composed of carbon dioxide, which at normal temperatures sublimes, or becomes a gas.

The carbon dioxide is stored and shipped as a liquid in tanks at pressures approaching 1,073 pounds per square inch. In order to make dry ice, the liquid is withdrawn from a tank and allowed to evaporate at a normal pressure in a porous bag. This rapid evaporation consumes so much heat that part of the liquid CO_2 freezes to a temperature of -109 degrees Fahrenheit. Looking something like snow, the frozen liquid is then compressed by machine into blocks, which can be shipped and sold, and which will, in time, melt away to a gas.

How Do They Do That, Caroline Sutton

THE YEAR OF THE U.R.O.P.

In 1969, MIT began the nation's first Undergraduate Research Opportunities Program (UROP), which permits undergraduates to do research alongside their professors, and now the University of Minnesota has done the same thing! Most of the projects funded were targeted for completion by the end of Spring quarter, 1985. This year, we will be publishing many of these projects in *Minnesota Technolog.* Keep an eye out for these articles—the innovative research that has been done is amazing!

FUTURI$T CONTE$T

Honeywell has just announced the beginning of its 1985 futurist awards competition. All you need is enough imagination to leap from reality to posssibility. Your three short essays could win you a cash prize of up to $10,000. Imagine your idea of the future 25 years from now. For more details, call 870-2142, ext. 1523. Good luck.

FIRST CRAY IN U.S. SEMICONDUCTOR INDUSTRY

Fairchild Camera and Instrument has ordered a CRAY-1 S/2000 supercomputer. The system will be installed at Fairchild's Gate Array Division in Milpitas, Cal., in the fourth quarter of 1985.

John Rollwagen, Cray Research chairman, noted that Fairchild will be installing the first CRAY system in the U.S. semiconductor industry.

Lanny Ross, General Manager of the Gate Array Division, said: "The CRAY will be integrated into the existing CAD environment for use by Fairchild's customers, and standard cell and gate array simulation and layout software will be moved to the CRAY system." Ross noted that the new capability will reduce design turnaround by a significant factor.

Continued on page 11

NEW LASER TECHNIQUE REVOLUTIONIZES SATELLITE-TO-SUBMARINE COMMUNICATIONS

As reported in the May issue of *Outlook,* researchers at the University of Illinois at Urbana-Champaign are engaged in spectroscopic studies to find out exactly why lasers work as well as they do and how to optimize their efficiency. For the first time anywhere, engineers in the UIUC Gaseous Electronics Laboratory were successful in measuring the ultraviolet and visible absorption spectra of excited rare-gas molecules.

Recently, these spectroscopic studies have led to an additional break-through involving a similar class of molecules—mercury halides—that have lased in the visible spectrum. UIUC engineers, operating a mercury bromide laser at several million watts of power in the visible, blue-green spectrum, have devised a new, efficient pumping scheme. This new capability promises to revolutionize satellite-to-submarine communications and will be of practical use in other applications.

J. Gary Eden, professor of electrical and computer engineering, and visiting research associate Dennis P. Green have successfully demonstrated that mercury bromide—until now a laser of little practical value—can be excited, or pumped, at an efficiency of 22%. Compared with currently used techniques, their pumping scheme is about 20 times more efficient.

The mercury bromide laser emits radiation in the center of the blue-green spectrum and matches the absorption spectrum of ocean water, which absorbs conventional radio waves. Normally, a submarine must come very close to the surface to transmit and receive messages by trailing an antenna that breaks the water's surface. Deeply submerged, the submarine is presently unable to receive messages. Surfacing, however, makes the submarine vulnerable.

Ocean water can be penetrated to a depth of 200 meters with a mercury bromide laser, allowing a submarine to receive communications without having to surface.

How Do They Do That, Caroline Sutton

BLINKING...

Every day, blinking causes the eye to close for 30 minutes.

HALLEY'S COMET CRUISE

Halley's Comet Cruise. Astronomer Carl Sagan lectures on this 14-day cruise of the deluxe Royal Viking Star. Travel: Aukland, New Zealand, to Sydney, Australia. Ports of call: Nuku' Alofa (Tonga), Pago Pago (American Samoa), Suva (Fiji), and the Isle of Pines (New Caledonia). Leaves Aukland on March 26. Cost: $2,828-$10,220 plus air fare. Fee covers accommodations, meals and entertainment aboard.

Royal Viking Line, 1 Embarcadero, San Francisco 94111, (415) 398-8000.

HOW IS INTELLIGENCE MEASURED?

"Convergent thinking", the ability to logically deduce correct answers, can be measured, and your score is your I.Q., or intelligence quotient. Einstein's was estimated at an incredible 180! But scientists still haven't found a way to measure "divergent thinking", the ability to discover and invent new answers—in other words, creativity.

MINIMIZE EYE STRAIN

Minimize eye strain by placing your video display terminal no higher than eye level... tilting it back 10-20 degrees... keeping it about 18 inches away... adjusting the brightness control for minimum glare.

The National Safety Council, cited in Popular Science, 380 Madison Ave., New York 10017, monthly, $13.94/yr.

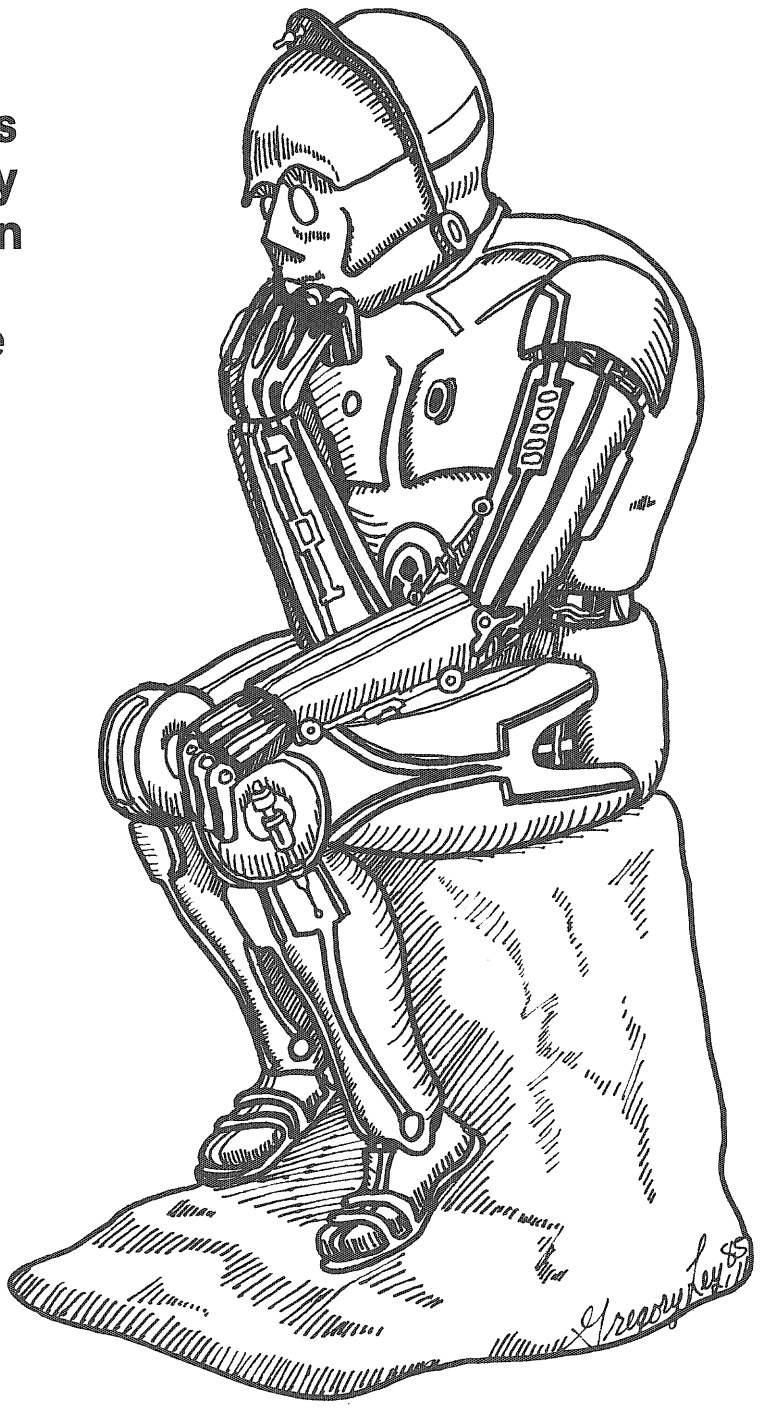
Continued on page 11

"He's the organized type."

Making Robots Smarter

Robots run reliably as long as the programmer has correctly anticipated the errors that can occur. In the real world, however, you can't anticipate everything.

By Rick Smith



When they hear the word 'robot' most people think of the androids in Star Wars, or of those expensive toys in catalogs like *The Sharper Image.* But when you take the word 'robot' seriously you have to think of factories, conveyor belts, and giant mechanical arms. Names from science fiction give way to commercial ones: T3, Unimate, Puma, Adept. And robots are slowly but surely making their way into industry.

Researchers have achieved impressive results by using computer systems to drive robot arms. There are robot programming languages that let you develop robot control procedures without using a robot. There are systems that incorporate proximity and vision sensors. There are even a few mobile systems. Unfortunately, many of these systems are masterpieces of engineering that aren't easily adapted to different applications or environments.

In practice manufacturers haven't found it easy to install robots or automate complicated processes. It is often too expensive for them to program the robots to do the required tasks. Most robots used in factories today do simple and repetitive tasks such as parts movement, spot welding, and spray painting. Few do parts assembly or rely on complex sensors such as cameras. Even the Japanese, with the largest industrial robot population in the world, use robots mostly for simple tasks.

Why are robots so difficult to program? First, it is hard to describe typical tasks in terms the robot understands. At best, most robots understand commands of the form **Open gripper** or **Close gripper** and motion commands of the form **Move to position with coordinates x,y,z.** Imagine trying to describe the assembly of a bicycle this way. It's possible to do, but it's very, very hard to do correctly. A second difficulty is that robots can only handle errors that they have been specifically programmed to recognize and have little flexibility in how they respond to these errors. Automatic error handling is not a simple programming problem. Errors may involve the positions and orientations of several objects and it's hard to devise a strategy that takes all possibilities into account. Error handling must take into account the effects of collisions, gravity, and other physical interactions. There is no simple way to characterize the errors a robot might encounter.

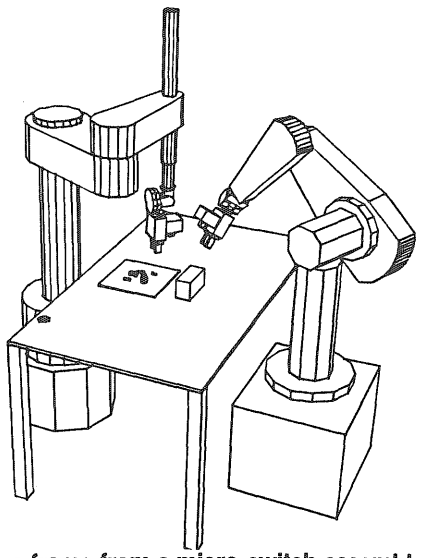
Most robot programmers these days don't try to do anything difficult. Programming usually takes place on the factory floor and is carried out by workers trained to use the robot. The worker uses a *teaching pendant* to manually move the robot through its sequence of motions. The robot 'remembers' the sequence of motions and repeats it continually when told to do so. There are several problems with this technique. First, robots are expensive and their time shouldn't be wasted on programming if this can be avoided. Second, the robot only remembers one sequence and can't vary that sequence in response to touch or vision sensors. And third, the robot ignores errors because it has little ability to sense them.

Researchers all over the world are working on various approaches to simplify robot programming. A lot of work is going into simulation systems. These systems combine computer graphics with computerized models of robots and the parts they handle. The programmer uses the simulation system to see if a robot program contains errors such as collisions or misplacements of parts. Such systems are called *off-line* programming systems since they don't use a real robot in the early stages of programming and testing. Here at the University of Minnesota, the Mechanical Engineering Department has developed a robot simulation system called MnCell. Simulators provide an economical way to verify the operation of complicated robot procedures.

Automatic error detection and recovery is being studied by a group of students working with Dr. Maria Gini, in the Computer Science Department. We are working on a robot control system that recovers from errors without human intervention. The system should be able to take a program from a robot simulator and make it work reliably on a real robot system in the face of real world uncertainties. Our system will make it easier to program robots because the programmer won't have to write laborious error handling code into the programs.

Computers are terrible at recognizing things that are similar but not identical.

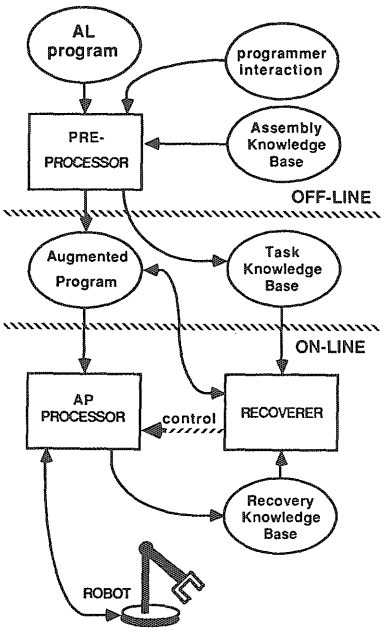
Errors in robot programs are harder to handle than errors in other kinds of programming because robots violate the *closed universe* assumption. Most programmers appreciate (and even derive some comfort from) the fact that computers follow precise rules and work with precise data. Computer output can be forced to comply to specific rules. Even the activities of unreliable things like physical memories and communications links can be characterized to the point of being predictable. In essence, everything can be made to work together like a fine watch. In such systems, a programmer can anticipate, characterize, and explicitly handle almost every error. The programmer simply creates a 'cookbook' of errors and corresponding recovery strategies. Closed systems run according to their own rules, barely affected by outside forces.



One frame from a micro-switch assembly simulation. The ADEPT 1 robot is approaching a part with a Puma monitoring the action with a camera.

Robot systems, on the other hand, are not closed systems in this sense. You can put walls around a robot work cell, control the lighting, the air, and almost everything else, but you can't eliminate the laws of physics. Space and Motion give us a multitude of possible errors, easy to describe in general but hard to be specific about. For example, assume that our robot arm is carrying a metal casting across our work table and it slips out of the gripper. How does the robot guess what has happened? If could be that:

- the casting fell onto the table.
- the casting fell onto the table and bounced.
- the casting fell onto the table and rolled off.
- the casting fell onto the table, knocking over another part.
- the casting fell onto the table, knocking over a different part, and so on....



System Diagram

In many robot programs only twenty percent of the code is responsible for really doing what the robot must do. The rest of the code checks for errors and tries to prevent disasters. These cookbook-like error handling routines are usually developed through trial and error with specific robots on a particular assembly line. The robot runs reliably as long as the programmer has correctly anticipated the errors that actually occur.

In the real world, however, you can't anticipate everything. The robot really needs to 'understand' what it is trying to do if it is to automatically recover from errors. Cookbook-like procedures for operation and error recovery tell the robot *how* to do things, not *what* to do or *why*. To recover from an error, a system needs to identify the differences between what has happened and what should be happening. The system must also plan how to correct these differences itself. Computer systems that 'understand' and act in this way are generally said to use *artificial intelligence,* (AI).

There is no definition of which computer problems involve AI. Here, AI refers to an attempt to make a computer do something that is easy for people but difficult for computers. Introductory programming teaches us that computers are good at following precise instructions and at making exact decisions based on exact data. Computers can find patterns that match precise rules; this is the basis of compilers for computer programming languages. On the other hand, computers are terrible at finding patterns without rules to describe them, or at inventing rules to describe patterns in raw data. In other words, computers are terrible at recognizing things that are similar but not identical, something that people and most animals do very easily. This is why pattern recognition problems such as those with speech and vision are so hard for computers. Computers also have no built-in mechanisms that help them understand space, motion, or gravity. In this sense, a squirrel or even a mosquito is more intelligent than a typical computer system.

Computer scientists have succeeded in making computers handle specific kinds of human-like problem solving: chess playing, calculus, and some systems that understand complex machines like ship engines. Much success has come from feeding computers facts instead of instructions; this is the basic notion behind *expert systems.*

For our purposes, the subject of interest is the handling and assembly of small parts. Typical examples include:

- picking up objects and placing them on pallets
- moving objects between conveyor belts
- handling 'parts buffers' that store excess parts on assembly lines
- assembling small parts like micro switches
- assembling printed circuit boards

Our system will exploit general and specific knowledge about robots, assembly tasks, and robot programs. It is designed in 3 parts: preprocessing, execution, and error recovery. The Preprocessor collects information about what the robot is supposed to be doing and decides how to monitor the robot's activities when it is working. The second part, the AP Processor, controls the robot and watches its activities for signs of failure. If an error occurs, the AP Processor starts the Recoverer that analyzes the failure and creates recovery strategies.

There is no simple way to characterize the errors a robot might encounter.

Our progress so far consists of background research, design and some implementation. A presentation of our initial design was given at the IEEE International Robotics Conference last spring. Since then we have developed working prototypes of portions of the Preprocessor. There is also a prototype simulator for the AP Processor. Work has started on an AP Processor to operate with the robots in the University's robotics laboratory.

These first two parts of the system are crucial even though the actual recovery takes place in the third part.

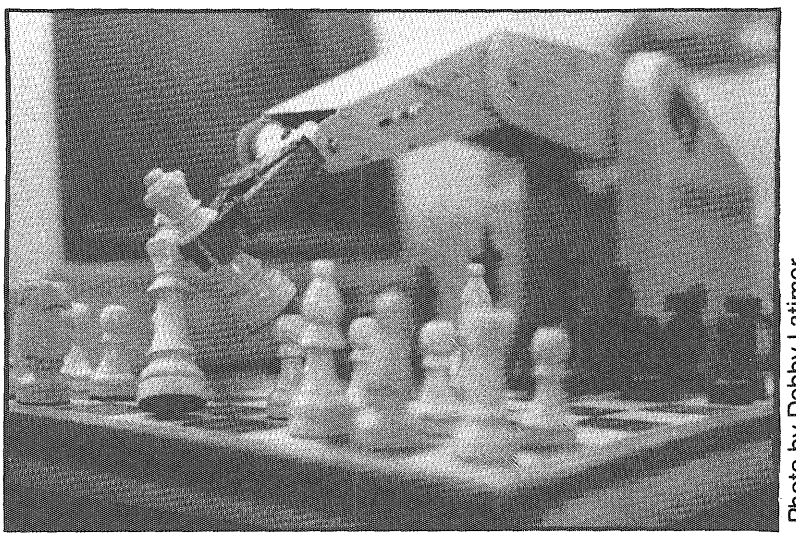


Photo by Debby Latimer

HOW COLD IS ABSOLUTE ZERO?

There isn't any limit to how *hot* something could be, if an infinite supply of energy were available. But cold is just the absence of heat, and there is, theoretically, a state of "no heat" or *absolute zero,* which is the coldest anything can be anywhere in the universe— -273 degrees Centigrade, or about -459 degrees Fahrenheit. That is far colder than the Siberian steppe, where winter temperatures dip to an invigorating -100 degrees Fahrenheit, and colder than any temperature ever reached in a laboratory. Scientists know what it is, though, by measuring how gases expand and shrink with changes in temperature.

Heat is the motion of the atoms or molecules making up an object. Any substance—solid, liquid, or gas—contains some heat, its particles somehow moving: vibrating, rotating, or bumping into one another. When we say, for instance, that one pot of water is hotter than another, we mean its molecules are colliding more often than those in the other pot. Objects expand with heat because their particles move around more, propelled by collisions with other particles. Thus a cold automobile tire looks flatter than one that's been driven on for an hour.

Scientists use gases at various temperatures to study heat, because the behavior of gases demonstrates the action of particles, which are the "stuff" of heat, very clearly. If you confine a gas in a container and heat it, its molecules collide more and more frequently, raising the pressure on the container walls as the gas tries to expand. If you cool the gas, the pressure drops. If you confine the gas in a *flexible* container that changes its volume in response to the volume of gas, keeping the pressure constant, the gas expands or contracts at a constant rate with every change in temperature, corresponding to its molecular motion.

By measuring its volume at 0 degrees Centigrade and then at other temperatures, it can be determined that any gas shrinks by 1/273 of its volume for every degree Centigrade that its temperature is lowered. Scientists reason that the coldest possible temperature must be one at which there is so little molecular motion that a gas takes up no volume at all. If the volume of a gas sample is 2 liters at 0 degrees Centigrade, and it drops by 1/273 of that (.0073 liters) for every degree Centigrade that its temperature is lowered, it must take a drop of 273 of those degrees Centigrade to reach zero volume. If volume in a gas is caused by heat, the temperature at zero volume must be "zero heat" or absolute zero: -273.15 degrees Centigrade. Absolute zero is also called 0 degrees Kelvin or 0 Kelvins, after Lord Kelvin, who established the idea of absolute temperature. The Kelvin scale, which is commonly used in physics and astronomy, defines all temperatures as a given distance from absolute zero.

Absolute zero can never actually be reached, according to cryogenic physicists, who specialize in producing very low temperatures in the laboratory. Any refrigeration process gets less efficient as a substance approaches absolute zero, since refrigeration uses molecular motion itself to slow down molecular motion. Using such tools as magnetic fields and liquid helium, however, experimenters have achieved temperatures only .0001 degree above absolute zero in samples of copper. Individual particles smaller than a copper atom have been cooled to .000001 degree above 0 degrees Kelvin.

What is the use of producing such low temperatures? One use is making a revolution in computer technology. Computers built to take advantage of a process called superconductivity, which occurs only below 7 degrees Kelvin, will be ten times faster than today's machines, use a fraction of the electricity, and fit nicely into a box a few inches long on each side. The new computers will use a type of superconducting switch in their circuits called a "Josephson junction." This switch operates with *no* electrical resistance, unlike any electronic device now available. It can go from "on" to "off" in 6 *trillionths* of a second, defying classical physics.

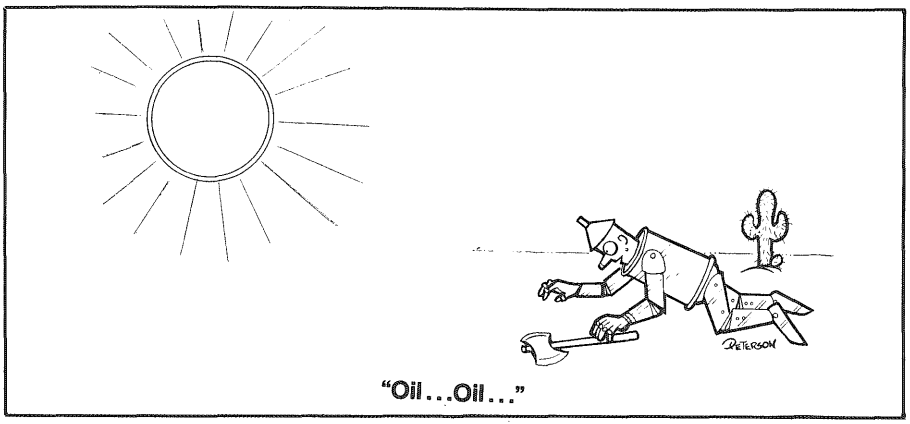
Superconductivity is possible when certain substances get so cold that their larger particles, such as molecules and atoms, hardly vibrate at all; this allows the smaller electrons to flow smoothly without getting "bumped" by nearby atoms. It is the disruptive vibration of large particles that causes electrical resistance and wastes time and energy in an electrical system. A Josephson junction computer would contain about 1 million superconducting switches and could work only while submerged in a bath of liquid helium at a temperature of 4 degrees Kelvin, which keeps the circuits cold enough.

How Do They Do That, Caroline Sutton

GRAMMAR HOTLINE

Grammar Hotline Directory lists numbers of 26 hotlines in the U.S. and Canada that answer questions about spelling, punctuation and sentence construction.

Grammar Hotline Directory, Writing Center, Tidewater Community College, 1700 College Crescent, Virginia Beach, VA 23456, free. Send a stamped, self-addressed envelope.



"Oil...Oil..."

Errors in robot programs are harder to handle than other programming errors because robots violate the *closed universe* assumption. They *are* affected by outside forces.

We rely on both the Preprocessor and the AP Processor to collect the information we need during error recovery. The Preprocessor combines information from the robot program with general knowledge about robots and assembly tasks. From this information the Preprocessor determines the goal of the task and decides how to use sensors during the robot's operation. During execution, the AP Processor keeps a running history of what the robot does. Recovery can only take place if we have the information about the task compiled by the Preprocessor and the robot's execution history compiled by the AP Processor.

Most of the work on the Recoverer is yet to be done. In order to build the Recoverer, we will have to solve several of our hardest problems: The analysis of failure and the recovery plan. Failure analysis depends on being able to determine the condition of the robot and the parts in the work cell. This will require accurate and efficient reasoning about space and motion—a hard problem. It also involves reasoning about the robot's task in the context of robot tasks in general.

As in many academic research projects, solving the problem is only part of the goal. To make a robot smarter we will have to solve other problems, such as those of spatial reasoning and planning that are significant to researchers with different goals. A working error recovery system won't be the product of one person, but the result of cooperation among several researchers, each solving a different problem. When you think of the microelectronic and biomedical discoveries that stemmed from research for the space program, you can see that a good research project is one that generates good problems to solve. ★

X-Ray Diffraction Patterns: Decoding Atomic Structures

X-ray diffraction results from the interaction of atomic layers in a material with an X-ray beam. These layers diffract the beam in certain ways creating patterns.

By Renee Bergstrom

There are some exciting subjects that require so much technical jargon to explain, that they quickly lose the reader's attention. X-ray diffraction, with all its nuances and variations is one such subject. The best way to bypass the technical information and yet describe the process will be through the use of fundamental examples.

X-ray diffraction results from the interaction of atom layers in a material with an x-ray beam. The atom layers diffract the beam in certain ways creating patterns. According to Dr. Marlys Howells, a professor of chemistry at St. Paul Technical Vocational Institute, x-ray diffraction, in the simplest terms, is a three dimensional representation of a structure in the reverse order of how it actually exists. A number of different planes in the material act to give an x-ray diffraction pattern. These patters can yield valuable information about a material. They can be used to determine density, unit cell measurements, crystallinity of a material, and texture, among other things. The material can also be identified by its diffraction pattern. Each material has a characteristic pattern whether it's a powder or polymer.

X-ray diffraction is therefore a valuable tool when very little information is available about a particular material. X-ray diffraction is also a practical testing method when you need to maintain the integrity of the sample or if there is a finite amount of sample available.

There are many x-ray diffraction processes. For example, there is a transmission as well as a back-reflection Laue camera. The Laue camera uses a single crystal specimen and white radiation. The pattern obtained by this camera is a sequence of spots. These spots can yield valuable information about the material.

Patterns are also formed using powder photographs. These photographs can be taken with a Debye-Scherrer camera, Seemann-Bolin camera, a back-reflecting focusing camera or by a pin-hole photograph. The Debye-Scherrer camera is cylindrical with the sample placed in the center. The x-ray beam is directed by a collimator onto the sample where it is then diffracted.

Continued

Diffraction pattern created by electron channeling.

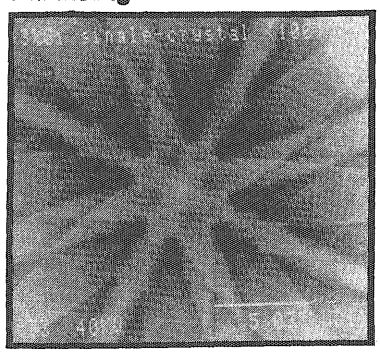


Photo courtesy of Professor Gerberich

X-Ray diffraction patterns are three dimensional representations of a structure in the reverse order of how it actually exists.

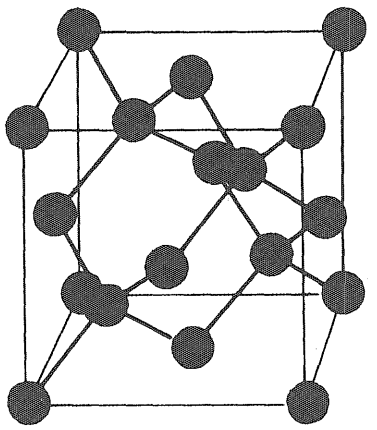
The film for the camera fits around the outside, and when the diffracted beam hits the film, the film is exposed. The resulting strip of film has characteristic lines on it.

Another powder camera available is the Seemann-Bolin camera. This particular arrangement is also cylindrical and passes the x-ray beam through slits. The ray then diverges onto the specimen where it is diffracted onto the film.

The third type of powder camera is a back-reflection focusing camera. This camera employs the same principles as the Seemann-Bolin camera except the sample is placed diametrically opposite the slit. The pattern produced is similar.

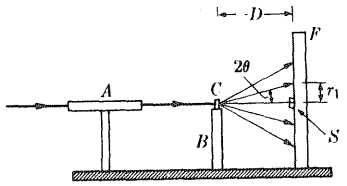
Another type of method for producing a powder pattern results from transmitting an x-ray beam through powder. This is passed on to a film below. The resulting pattern is a series of rings.

Another type of x-ray diffraction pattern available is produced by using a diffractometer. The x-ray beam is situated on the circumference of a circle with the sample at the circle's center, and a detector on the other side of the circle from the beam source. The beam is then moved through various angles and the intensity of the diffracted beam is charted against the angle. The pattern looks like a straight line with sharp peaks at various angles.



The atomic structure of a diamond

Rotating a crystal around one of its axes and bombarding it with x-rays also produces a diffraction pattern. The pattern for this looks like rows and columns of spots.

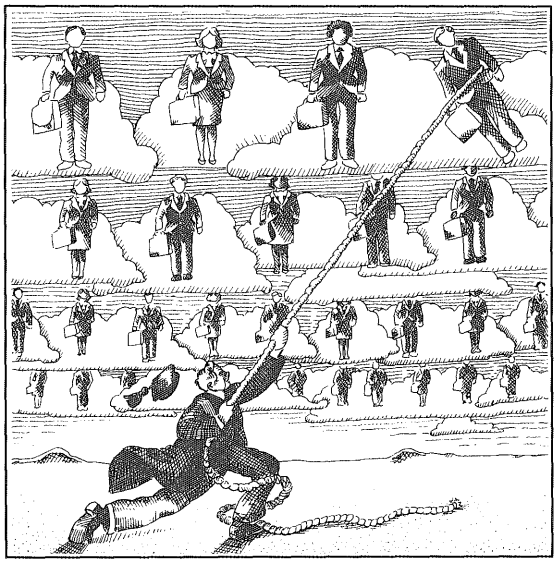


Transmission Laue camera

One type of variation on x-ray diffraction uses electrons instead of x-rays. This set-up uses a scanning electron microscope and a detector. The electron beam functions nearly the same as the x-rays. As the beam is moved in a helix around the sample, the detector picks up diffracted electrons and a pattern evolves yielding good information about the material. This approach is called electron channeling.

Dr. Howells observed that working with x-ray diffraction was like working with a three dimensional jig-saw puzzle. It is a good problem solving exercise that often requires trial and error. X-ray diffraction yields first hand information that you couldn't get anywhere else, such as information about compounds that have never existed before. Crystallography, which uses x-ray diffraction to solve complex structure questions will not, in Dr. Howells' opinion, become outdated until scientists come up with brand new technology. ★

On October 8 pull a job out of thin air.



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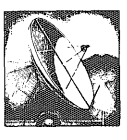

BPI SCAN™
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BPI SCAN's free teleconference will be held at 10:00 AM (CDT) at Nolte Center–Room 140, University of Minnesota

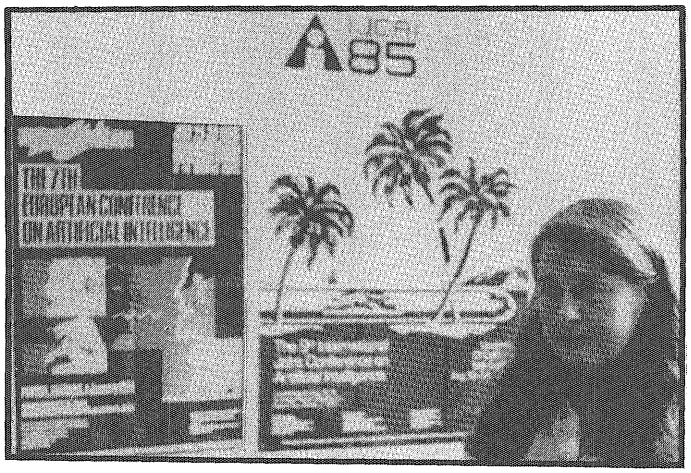
BPI SCAN is not an employment agency.

Faculty Profile

Professor Maria Gini

of the
Computer Science Department

A.I. involves working with patterns of symbols and lists of sequences. When you think of intelligence, what we are actually doing is manipulating concepts and symbols.



Professor Maria Gini

By Debby Latimer

110 Lind Hall is a long way from Milano, Italy. The office is easily recognizable; not necessarily by the number, nor the Italian that you might hear coming from the other side of the door, but by the groups of students gathered in the hallway, waiting impatiently to see Professor Maria Gini of the Computer Science Department. Recipient of the Gordon Starr award for outstanding service at the University of Minnesota, Professor Gini always has time to see a student.

Educated in Italy, Professor Gini became involved in Artificial Intelligence and Robotics very early on in her career. The Olivetti Company donated a robot feasibility model to the Polytechnical School that she was attending. The Olivetti Company, known for their high quality typewriters, was one of the first companies in Italy to do advanced robotics research. Since then, Professor Gini spent several years at Stanford University before joining our faculty in the Computer Science Department, where her teaching and research continues to be an influential force in the fields of Artificial Intelligence and Robotics at the University of Minnesota.

M.T. How would you define Artificial Intelligence (A.I.)?

The most important aspect of A.I. is that knowledge is represented in symbolic form. A.I. involves working with patterns of symbols and lists of sequences. When you think of intelligence, what we are actually doing is manipulating concepts and symbols. Intelligence and knowledge represent a network of many interrelated concepts. Inference rules are used to form links between various conceptual units. Instead of representing ideas in numerical form. A.I. concentrates on the symbolic aspect of knowledge. A problem can be described in mathematical notation by a set of equations. However, in general, it is very difficult to translate a problem into mathematical descriptions. A.I. avoids mathematical notation and then manipulates the symbolic level of the problem. We attempt to represent common sense knowledge without going through all the levels of equations. In many ways, it is similar to the problem-solving techniques used by physicians. A doctor prescribes by looking at the symptoms. No one knows exactly how the body works. The system functions at the level of a system that is unknown. Input results are analyzed in order to draw certain conclusions. Eventually, a change might be made without knowing exactly why the system functions as it does.

Instead of representing ideas in numerical form, Artificial Intelligence concentrates on the symbolic aspect of knowledge.

M.T. At what point do Artificial Intelligence and Robotics intersect?

One of the major applications of robotics lies in industrial automation. We are trying to create systems that will reduce manufacturing costs. If you have a robot that is doing an assembly task, there must be ways of telling it what to do. This is the interaction of A.I. For example, if I remove the cap from a pen and attempt to have the robot fit them back together, this procedure can be generally classified as an insertion procedure. From that point, we can reason that when such an operation is in process, a certain number of forces need to be considered. This type of knowledge can be built into the robot.

M.T. Throughout your studies, did you have a mentor?

Not really. However, the Italian educational system is quite different. To do work at the university, you need to have a fellowship, and to receive a fellowship, a professor must be willing to provide you with office space and guidance. So, a student is forced to work closely with others and become part of a research group. I think that it is very important to see what kinds of work other people are doing.

M.T. Did you have preconceived notions about what it would be like to work in your field? In what way does your research differ from what you imagined it would be?

Well, studying as an undergraduate, I really had no idea about what I wanted to do. I didn't know whether to do research or not. In some ways, many things happen by chance. I started going around and talking to professors to find our about what they were doing, and by chance, I spoke with a professor in the engineering department who had just come back from Stanford University. He was very excited about A.I. and Robotics. Now I like my field very much, and for good reasons. But, starting can be very difficult.

M.T. Do you view your work in a larger social context, as a changing force within the society? Do you have an image of the kind of world you want to live in and the contribution that you will make to it?

Yes. I am against any type of war. There is a lot of work now done in robotics designing autonomous vehicles. I try to stay away from those applications. I don't see any need for it. Yet, it is very difficult to maintain this point of view when most of the research money comes from the military. In Japan, they are using robots to perform tasks that are dangerous for people. They are used to build houses as well as for various mining, fishing and lumbering applications. The principles behind these robots are just the same as those that would be used in a war, but, the application in mind is much different. This is all very scary! The intelligence put into robots can be used for good purposes or against other people.

M.T. In what way is teaching a learning experience for you?

Mostly because of the feedback from students. I like teaching very much. I also enjoy doing research and sitting down to think about my own ideas. But, I really value the interaction that I have with the students.

M.T. What will be the role of robots in the next 20 years? Will the growth of technology be proportional to the public's acceptance of it?

Things are happening fast, but, nothing happens in one day. Many people's lives have been affected by computers. However, I do not think that it had a traumatic impact. You won't wake up one day and find a robot taking care of your house. There should be enough time to get adjusted. It depends how big the market will be. That is what really drives technology. Computers have reached a price that is affordable to almost everyone. The same thing may happen with robots. Many people are already talking about the robot for the house that will open the door, take care of the kids, etc. There are some that do a few of these things now. But, I feel that to produce a really good robot will take quite a few years of research. In Japan, they are making toys that are robots for kids. For example, robot horses, dogs, and people, etc. They feel that if children start playing with more robot-like toys, their acceptance of robots in every day life will increase.

M.T. How does your work relate to other disciplines in or out of the Institute of Technology? Will there be a multi-disciplinary approach in the future?

Robotics is an interdisciplinary field. To do work in this field you need mechanical engineering, control science, and computer science. There are people from many different backgrounds working in A.I. such as; psychology, perception, natural language, and human learning. However, I still consider A.I. a computer science.

M.T. As an active participant in Undergraduate Research Opportunity Proposal, (UROP) what do you feel are the benefits of such a program to students and faculty?

Undergraduate research is very important. It gives the students an idea about what is available in research. There is a delicate balance between theory and practice. If you build houses for a living, it is very easy to explain what

you do to others. To do research, or become a professor, is work that is extremely difficult to understand and describe to others.

M.T. There has been a lot of discussion about placing more emphasis on communication skills in the technical fields. Would you like to comment on this subject?

This is an essential aspect of a student's education. Eventually, the student realizes that he needs to know how to sell his ideas in order to fund research projects. At the graduate level, students give oral presentations. For some, this is the first that they have ever given. How can students be convinced that communication skills are important? Many times, the realization occurs when the student loses something important because he or she did not communicate well.

M.T. Are you ready for an unfair question? Which geometric shape best describes the problem solving skills used in your field: a sphere, circle, triangle or cube?

Oh my, I have never thought of anything like that. Let me start by ruling out something. I do not think that the sphere is good.

Robotics centers around the fact that everything in space has a position and an orientation. So, the sphere would not be good because it has no orientation. I would also rule out anything without three dimensions. The concept of three dimensions is important. You cannot use yourself as the third point of reference. I would probably pick the cube.

M.T. Does intuition play an important role in Artificial Intelligence?

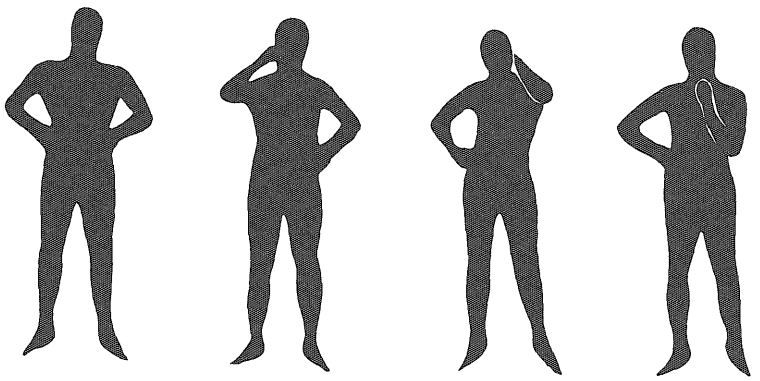
Yes. There is a lot of common sense used. One of the most important and difficult aspects of A.I. lies in developing the ability to convey common sense to the computer. We need to learn how to represent implicit knowledge explicitly.

M.T. What advice would you give to students that are just beginning their studies?

What is good for the computer science student will be good for A.I.—a solid math background, and the ability to make abstractions. We now have a sequence for A.I. and I suggest that the students take one course to get an idea of what it is like. Even if the student does not continue, it won't have been a waste of time. There are good opportunities for A.I. graduates. I know that the market is an important factor in a career choice, but, I believe it is also essential to find something that you like to do.

M.T. It has been said that, "What the mind can conceive, it can achieve". How would you interpret this quotation in regards to A.I. and Robotics?

In the long term, everything can be done. In theory I do not see any limitations. The difficult part of our work is that we don't really know how we think. We do a lot of things in an implicit way. For this reason, giving intelligence to a computer is difficult. Robotics allows us to visualize and test various applications. Remember, intelligence is not just a mental activity; it needs to be expressed in actions. ★

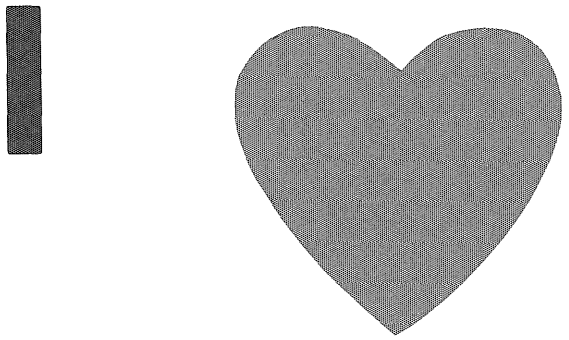


DON'T HESITATE

join our staff

- writers
- photographers
- illustrators
- assistant editor

room 2 mechanical engineering



DOPPLER RADAR

An interview with Meteorologist Paul Douglas on the advantages, disadvantages and future implications of Doppler Radar Systems in weather forecasting.

By Debby Latimer and Vernon Thorp

M.T. How long has the Doppler Radar System been in use at Channel 11, WUSA?

It was installed in March, 1985 and has been on the air since the first week of June.

M.T. Does the Doppler system replace or complement the previous system?

It complements. We are using the same existing dish, antenna, and geodesic dome. The 8 foot high antenna is protected from the weather and the elements by the dome that houses the entire system. Beyond that, everything else is new. We're going to Solid State Electronics. In the past, tubes and an analog signal were used; it was just a conventional radar. Now, we are using a doppler radar system that uses all microchips, silicon-chip technology, and it puts out a very clean coherent signal. Some of the dopplers that are around send out just a myriad of wavelengths. I'll be honest; I am not an engineer and I don't want to get too technical, but, I know that even though we are pushing less power than other doppler radar systems, our signal is so clean that it doesn't require as much power to produce the same results. The others need to push a lot of power in order for the antenna to receive any kind of readable signal. Some of the older dopplers still use an analog signal along with tubes that soak up so much power. I don't know if you have ever seen pictures of the first computer ever built. It occupied a whole room at Princeton and was just a power pig. The same computations today can be done on a chip the size of a thumbnail using only a fraction of the power. There has been some debate between stations as to who has the better system. Those that claim to have more power, neglect to point out that they are using an old system that requires more power.

M.T. Is the Doppler the result of new or old technology?

Actually, it's rather old technology. Theoretically, any radar system can be modified to act as a doppler. The radar beam consists of 3 moments: the zeroeth, first and second moment. For example, if the radar beam encounters a raindrop, the zeroeth moment measures its reflectivity and determines where it is located. The first moment measures radial velocity, distinguishing it as a raindrop as opposed to pollen or dust. It also indicates whether the particle is moving towards or away from the radar site. Basically, doppler measures the shift caused by movement. The second moment is what we use here at Channel 11, and it measures turbulence and windsheer. This is called spectral width. You have to get into things like standard deviations, but, essentially, what the doppler is doing is matching strong winds located in one region with light winds in another. This is an indication of turbulence or windsheer. We have chosen the color pink to represent windsheer on the screen. Our doppler is used

We use a doppler radar system that uses silicon-chip technology, and puts out a very clean coherent signal.

out to 40 miles. Beyond the curvature of the earth, you don't know if what you are looking at is actually on the ground or a mile up in the atmosphere. This is a real problem. In general, there are fewer false alarms when using the second moment measurement, or spectral width. Some of the other dopplers around use the first moment, radial velocity measure. There are some advantages as well as some distinct disadvantages to using the first moment. When looking at radial velocity, doppler gives rise to a serious problem called folding. Imagine a thunderstorm 50 miles out. If the winds exceed a certain factor, that thunderstorm may appear on the doppler screen as if it were 20 miles out. In other words, folding causes false targets. The wavelengths overlap until they become resonant, creating false echoes. If you have ten meteorologists looking at a doppler radial velocity display, they will probably arrive at 8 or 9 different versions of what is taking place. Because of the real-time situation, I need to be able to look at the doppler screen and immediately decide if a cell is potentially severe. Unfolding the real from the imaginary echoes is just too time consuming. When using the second moment, there seems to be less room for error. Another advantage to using spectral width lies in the ease with which it can be displayed on the air. We can overlay doppler on top of conventional radar. So, we keep the appealing blues, reds, greens and yellows of conventional radar and overlay pink as the turbulent color. Whenever pink appears on the screen, we know that there may be a potential problem in that cell. If you have ever seen a radial velocity display on the air, it looks like something from another planet. For the public, false echoes are fundamentally deceiving. We want to show people what areas to watch out for. From an aesthetic standpoint, it makes more sense to air the spectral width display. The doppler is an important tool, but, remember that it is not a perfect radar system. Although, it is certainly more valuable than a conventional radar that only picks up rain and hail.

M.T. Can the doppler be tuned to discriminate between different size particles?

Yes. First of all, our system is calibrated at 5 centimeters, which means that the wavelength cannot be changed in any way. It is possible to increase the sensitivity of the Doppler system. However, in doing so the range is decreased. There is a certain tradeoff.

M.T. As radar systems begin to produce more and more data, will the interpretation of such a tremendous volume of information become a problem?

Definitely. Incredible software will be needed to handle the flood of data. NEXRAD can do so much. It can point out areas of possible flash flooding, it can give quantitative precipitation amounts over 1 or 3 hours. It integrates, differentiates, shows areas of hail and strong windsheer. To transmit all this information simultaneously requires a tremendous software capability. There are some logistics problems.

M.T. In the future, do you anticipate more refined doppler systems?

Technology rarely stands still. I'm sure there will be improvements. I think that the doppler will continue to be refined and the warnings will continue to get better. Eventually, warnings will be issued for just portions of counties. That's something the weather service will be trying here next summer. Instead of issuing a warning for all of Hennepin County, they will have a warning for Northeastern Hennepin County, or the Southeastern corner of Hennepin County, I believe that with NEXRAD, we will soon be able to display each individual city block, and predict, for example, a possible tornado in the 73 hundred block of Hennepin moving northeast at 6 miles per hour. I would say that that might be 5 years down the road.

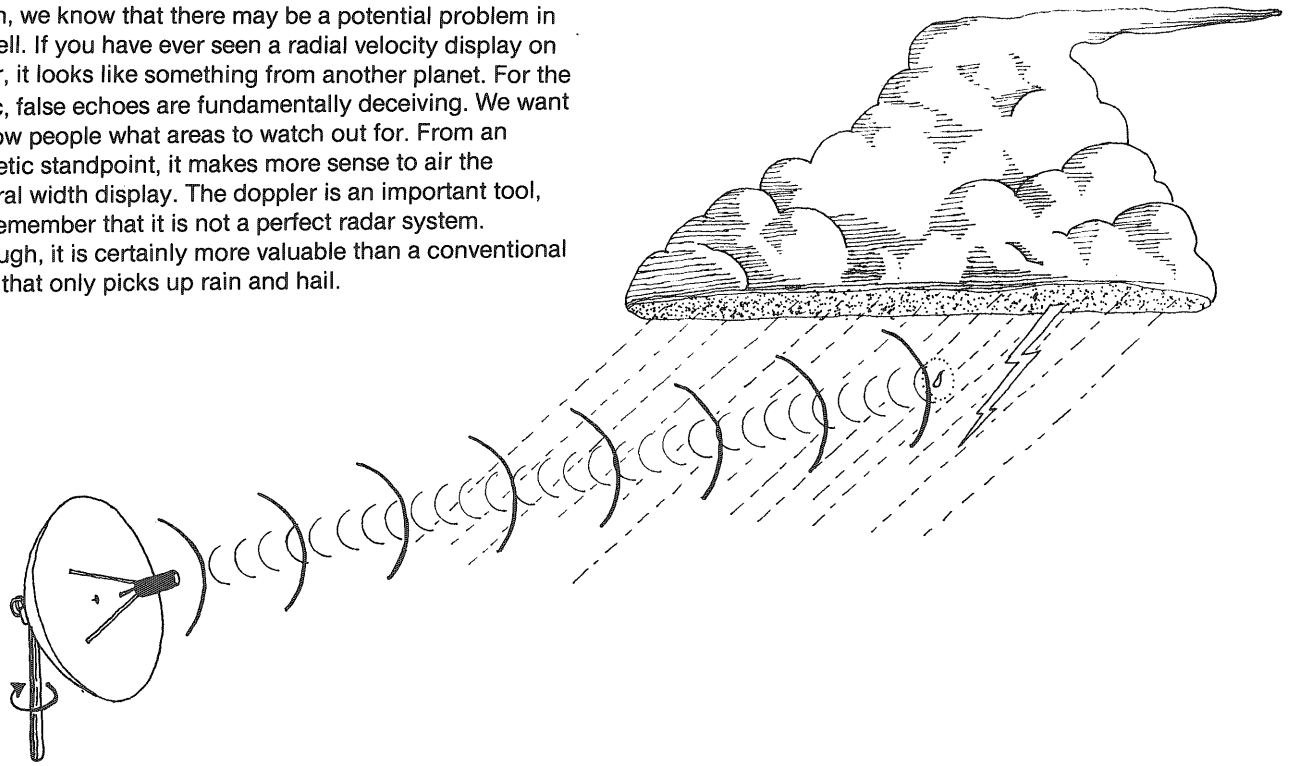
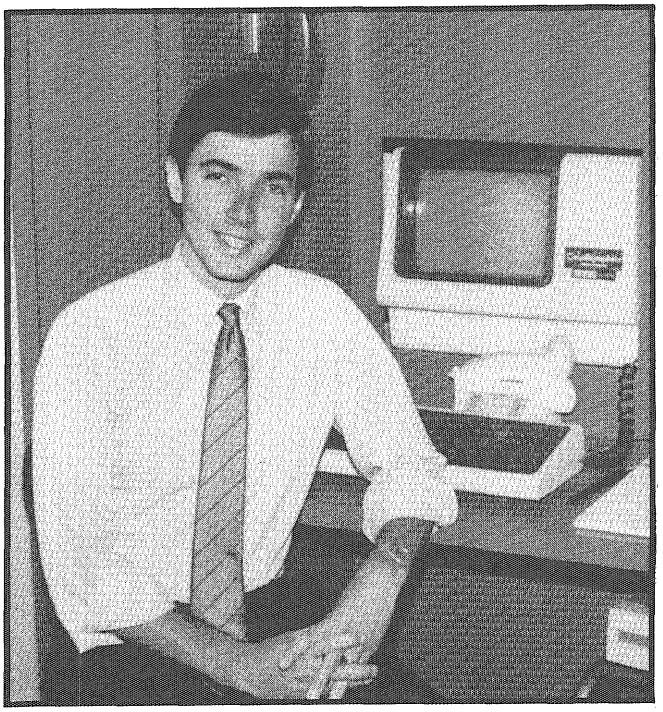


Illustration by Greg Ley

Doppler radar beam tracing thunderstorm activity



M.T. Does your doppler system represent part of a national radar network?

No, not at this point. The National Weather Service is going to come out with an incredible 10 centimeter doppler radar system called NEXRAD sometime by the end of the 1980's. This will be fantastic because local TV stations will be able to tap into this larger system. In many ways, it represents the next evolutionary step in radar. With a 10 centimeter radar, the increased wavelength yields greater accuracy and less attenuation. Attenuation is present in any kind of radar. Whenever a strong line of thunderstorms moves in ahead of another, the first line of thunderstorms acts as a filter. The radar beam will be reflected back to the radar site without any indication of other storm activity. This is called attenuation. The smaller the wavelength, the greater the attenuation. The 10 centimeter wavelength doppler costs a couple of million dollars and is used primarily for research. Some very interesting studies are being done on tornadoes and severe weather. Congress is now considering the possibility of funding a whole network of 40 or 50 of these nationwide.

M.T. What is the role of the National Weather Service?

The National Weather Service in Washington functions as a worldwide data base. They collect information, process it, and then distribute the computer output to various users all over the world. Anyone can have access to the information such as: pilot briefing centers, National Weather Service offices, TV stations, commodity brokers etc.

M.T. What caused the 3 to 5 day forecast to improve?

The computer age of the mid 60's. Suddenly, we had satellite data filling in the gaps over the oceans. Before, all we had were a few lonely ships and a few planes for data over the entire Pacific, and that's a huge source of weather.

M.T. Is broadcast meteorology a competitive field?

Believe it or not, I think there is still a demand for meteorologists. Nationwide, meteorologists still make up less than 15-20 percent of all on-air weatherpeople. Usually, the sportscaster, or an announcer ends up doing the weather. That's unfortunate but it is changing. More and more news directors are hiring meteorologists with degrees. I would, however, encourage people who are interested not to neglect their English.

"Meteorology is 60% science, 20% intuition, and 20% good old-fashioned luck."

M.T. In spite of all the technical instruments used in meteorology, is intuition a strong influence in forecasting weather?

Yes, there is a certain amount of intuition involved. This is not a pure science like math. Meteorology is 60 percent science, 20 percent intuition, and another 20 percent good old-fashioned luck. There are scientific principles that drive weather forecasting. However, there are still big gaps in the data. We don't have very good weather observations over the oceans and third world countries. Although we have great data from the Soviet Union and China, it is still like trying to put together a jigsaw puzzle with most of the pieces missing. We don't know how the oceans and the atmosphere interact, nor how mountains create friction and drag in the atmosphere. If you get beyond 48 or 72 hours, small data errors that are initially loaded into the computer blow-up into huge, monstrous mistakes. For this reason, weather cannot be predicted much beyond 4-5 days. I have seen no evidence that specific temperatures and precipitation can be accurately predicted in the Twin Cities beyond 5 days. In certain cases, it may be possible to say that temperatures for the next 30 days might be slightly above or below normal. I would like to know what is going to happen at Christmas, but, the state of the art has just not progressed to that point yet. Improvements have been made in certain areas of weather forecasting. There are fewer false alarms for tornadoes and hurricanes. Your parents and grandparents only had a one day forecast. Surprisingly enough, the accuracy for the one-day forecast has not improved. It is still around 87 percent. Despite the computers and all the toys, the one-day forecast accuracy is not much better than it was back in the 1940's. However, we have made gains in the 3 to 5 day forecast as well as severe weather prediction.

M.T. Do you look upon public speaking skills as an essential aspect of your career?

Yes. I've done radio since I was a senior in high school and that has really helped in terms of being able to ad lib and talk without a teleprompter with cue cards. I don't

Continued on page 24

Texas Instruments Job Fair

Tuesday, October 29, 1985

University of Minnesota
Coffman Union Great Hall

Interviews Scheduled

✓ No Bidding Necessary ✓ No Lottery ✓ No Standing in Line

TALK TO TI's MAJOR PRODUCT & SERVICE GROUPS.

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That's why TI is having a Job Fair on the Minnesota campus October 29 and 30. It gives the company two days to bring in key engineers and managers to meet you. They'll come from TI labs and sites to describe programs, answer questions, and schedule interviews.

If you're a top student, particularly in EE or Computer Science, this is an event you won't want to miss.

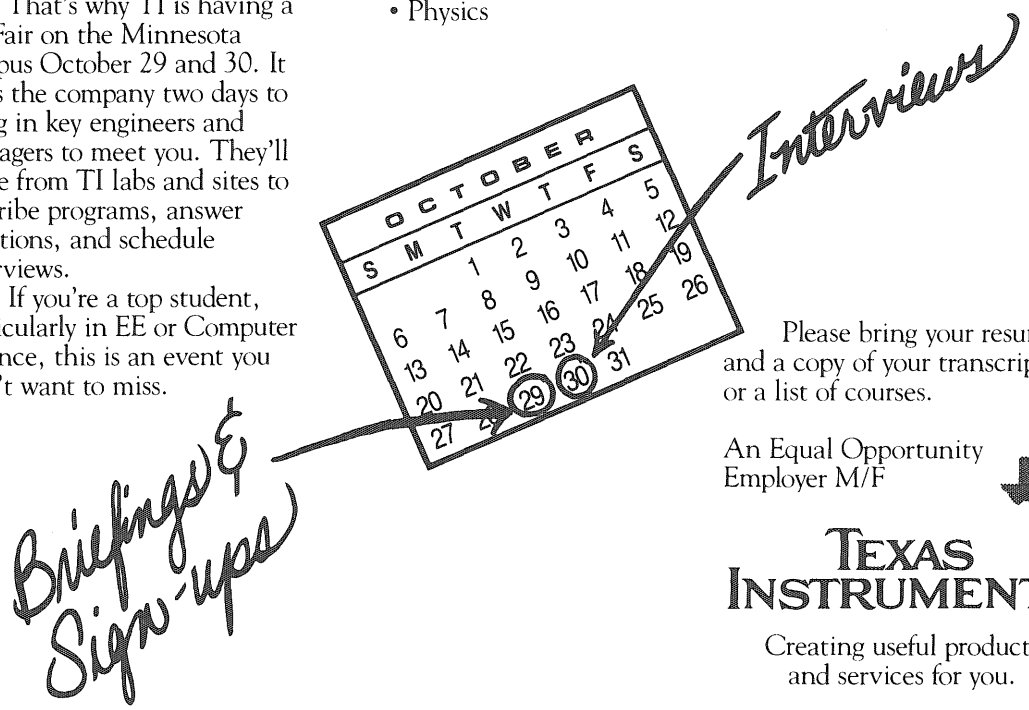
SIGN UP FOR INTERVIEWS IF YOU ARE GRADUATING WITH THESE DEGREES:

Bachelor's, Master's or PhD degrees in:

- Electrical Engineering
- Mechanical Engineering
- Industrial Engineering
- Physics
- Computer Science (Scientific only)
- MBA with technical undergraduate degree

Briefings and sign-ups for interviews: 10 a.m. to 5 p.m., October 29, Coffman Union Great Hall.

Interviews (by appointment): October 30.



Please bring your resume and a copy of your transcript or a list of courses.

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TEXAS INSTRUMENTS

Creating useful products and services for you.

Doppler from 22

memorize my weather show word for word, I outline it roughly in my head so that when a graphic appears, I know what I want to say.

M.T. What advice can you give to students who are just beginning their studies in meteorology?

Reconsider. Go into a respectable field of work. No, I don't mean that! I would suggest going to the library and reading some basic books on the atmosphere and weather. Buy a camera and take pictures of clouds and interesting weather phenomena. Then, try to figure out what triggered a particular cloud to form or the causes of a front formation in a specific area. Take your math seriously. I also suggest advanced English courses and speech communication. Do some research into the programs offered at various universities. I'm partial to Penn State. Florida State also has a good program, and if you're a tornado freak, the University of Oklahoma is great.

M.T. Would you comment on the importance of graphics used in a typical weather show?

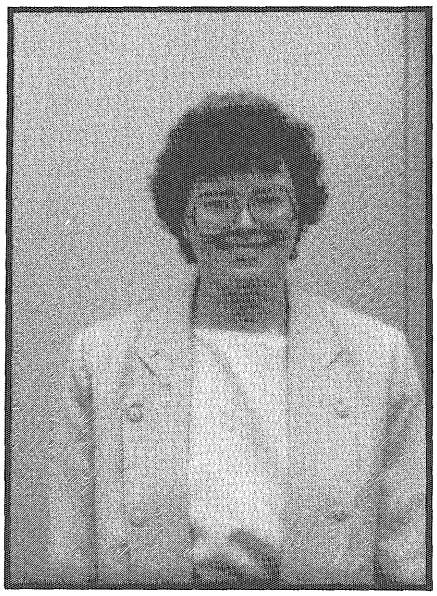
Much of my afternoon is spent not only trying to predict the weather but also creating the accompanying graphics. Some TV stations hire computer graphic artists. Each one of those maps takes approximately 20 minutes to complete on the computer. The base maps are stored on a disc. In a typical weather show we have 8 to 12 graphics. It is very time consuming, yet, the graphics are important.

With NEXRAXD we will be able to give tornado and severe weather warnings for each individual city block. That is about five years down the road.

Ten years ago, one big magnetic map was used with a few symbols on it. Only a limited amount of information can be conveyed this way. Now, we go through 8 or 9 maps in a typical weather show. The viewer can pick and choose what information is important to him or her, and in general, much more information can be communicated. Colorful graphics are appealing. ★

Reawakening Our Dreams

Janice Kail skillfully delivered this graduation address to the University of Minnesota Institute of Technology, class of 1985. Janice received her degree in Chemical Engineering from the University of Minnesota and is currently employed by 3M in their Magnetic Materials Resources Group as a process development engineer for magnetic pigments.



Fellow students, faculty, honored guests, parents, and friends. The class of 1985 has finally made it. We are getting that degree that we worked so long for. Now its time to go out in the world and do, well, whatever it is we always were working for. I hope most of us can remember why we came here. We must have taken all those notes and studied all those hours for a reason. Thinking back to when I started my college education, I was interested in math and chemistry and a more applied science, so I thought that chemical engineering was the major for me. I thought that this was where I could fit in and use my talents to benefit the world. With high aspirations and almost no knowledge of what an engineer actually does, I began my studies. Today, it has brought me here.

I'm supposed to be representing the students today. That means I'm supposed to assume that I know what you, the class of 1985, is like. Although I got to know some of you through serving in student organizations, I'm sorry to say that many times I was so busy taking notes along with the rest of you, that I didn't have much time to get to know you as well as I would have liked. Most of our parents out there would be glad to hear that we were so attentive to our studies, but I wonder how they would feel about having someone like us as a neighbor or co-worker. How would they feel if some of the best and brightest of today's youth chose to devote their lives to their own little corner of the world and not offer any of those abilities to the community around us? By being with you in classes, I already know that the class of 1985 is bright and determined, but how many of us have really thought about who, other than ourselves, all our intelligence and determination is going to benefit.

The community needs people who aren't afraid to stand by their dreams and take risks.

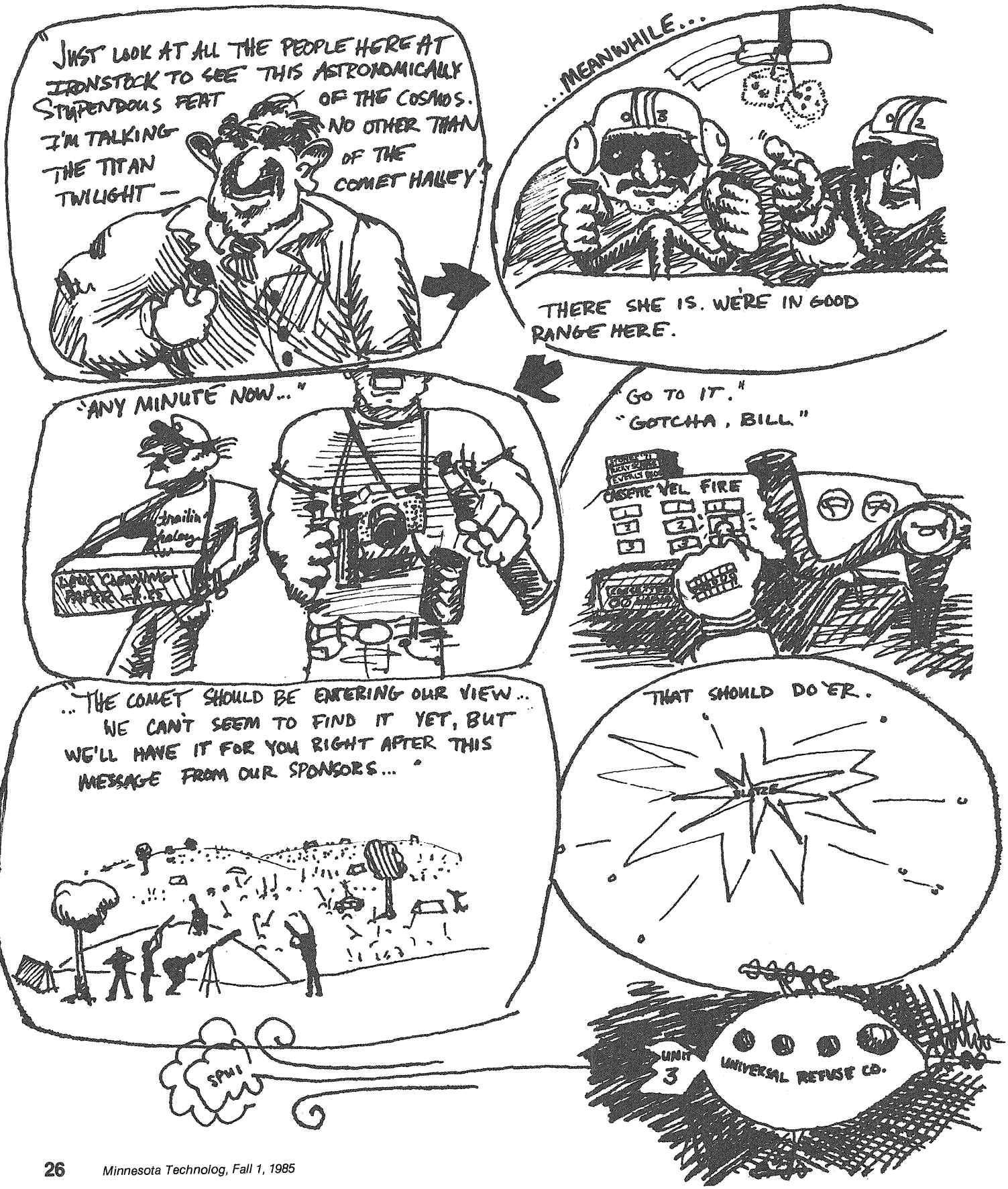
Are we the "me" generation with no thought of others and the community? I don't think we are. However, many of us these last few years among all the homework assignments, exams, and concern for that grade point average which gets us our job, have thought *"Oh My God* if I don't get a job what am I going to do?" Somehow, we have forgotten some of those dreams and ideals that we had when we entered the Institute of Technology. Many of us wanted to use our engineering to make great advances in medicine. We wanted to save our precious energy reserves and make inexpensive cars that would run well, save energy, and not pollute. We wanted to discover the stars and possibly find a way to make a home away from home on another planet. We really wanted to help and benefit the world.

What I want to tell you to do today, is to remember those dreams and let the dreamer loose again. Let the dreamer loose. What most of us have not yet begun to realize is that we now have many of the tools to make those dreams reality. The world has lots of power brokers and cynics and people who are working only for their paychecks, but, it has so few people who can dream and also have the skill to turn their dreams into reality. Employers highly value (or at least they should), people who aren't afraid to live by their dreams, and take risks. The community as a whole needs those dream-makers to accomplish the seemingly impossible community projects. They need us to participate in the political process and use our analytically-trained minds to help identify which politicians are perpetrating illusions, and which ones really know what they're talking about. Most of all, they need

Continued on page 30

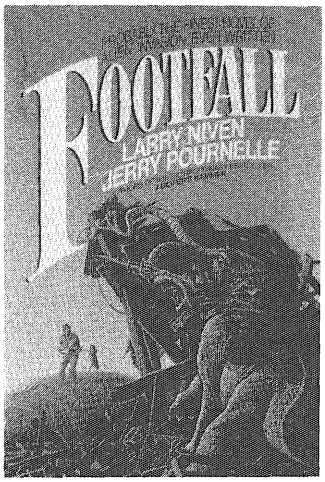
ON THE EDGE

D. LATIMER, J. LEES ©1985



Assigned Reading

ALIEN INVASIONS



***Footfall*, Larry Niven and Jerry Pournelle**
Hardcover, pp. 495, $17.95

By Renee Bergstrom

The attack is in progress. Del Rey Ballantine Publishers are bombarding bookstores with a new series of novels about invasion. *Black Star Rising,* by Frederik Pohl, and *Footfall,* by Larry Niven and Jerry Pournelle are two such novels, offering bizarre extremes in newly released science fiction literature. Before discussing the striking differences between these two novels, the similarities of the plots merit some attention. Aliens plan for many years to come and conquer earth. Mankind then discovers their approach, but just a little too late. A group of astronauts and politicians go into space to welcome them only to be captured by the hostile visitors. War predictably follows.

The plot of *Black Star Rising* fails where *Footfall* succeeds. Pohl has a very loosely woven plot and the twists and turns of the story are relatively insignificant in the long run. Half way through the book, the outcome becomes predictable. Niven and Pournelle on the other hand, have written every episode to play a part in the final outcome.

A second point of strong contrast between the novels lies in the characters themselves. Castor, the main protagonist in *Black Star Rising,* starts as a nobody in a rice paddy and remains a nobody throughout the story. His character never develops and becomes a disappointment.

Footfall does have some minor problems with characters. This is mainly due to the large number of characters involved in the story. But compared to Pohl's characters, Niven and Pournelle have created real personalities with whom the reader can identify. Although there isn't one major protagonist, the story is told in many voices, a technique which adds color and flavor to the novel.

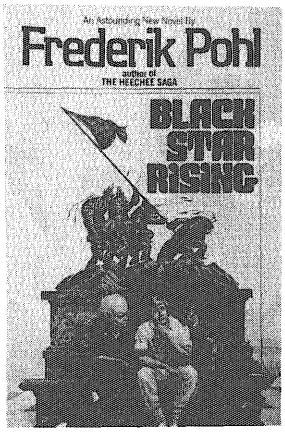
***Black Star Rising* hands out a 'freeze-dried' solution to the conflict.**

Another point of distinction between the novels involves the settings. Pohl puts his characters on earth after the third world war. This is a little too far removed for modern Americans to appreciate, and comparisons between now and then are difficult to find. *Footfall* does better in this respect. The setting closely resembles modern day earth, and the familiar allows more genuine interest in the situations and events to evolve in the reader's imagination.

Still further, the resolution of conflict in the novels differs in quality. *Footfall* earns the reader's respect. *Black Star Rising* hands a 'freeze-dried' solution to both characters and reader alike.

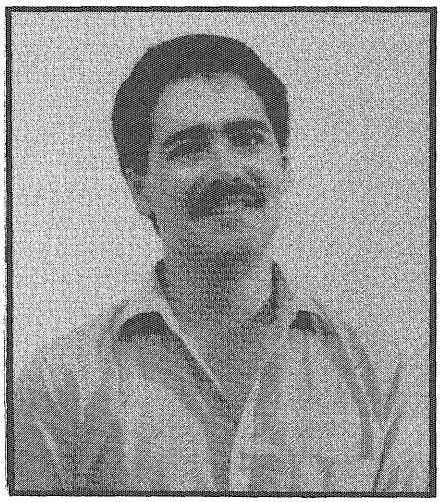
Finally, the alien races created by each party are strikingly different. Niven and Pournelle create a completely different species and give them a philosophy, a code of ethic and a language of their own. They are fresh, different and understandable. The differences that Niven and Pournelle leave between the humans and the new aliens are essential for the development of the novel, and realistic for the species that they have created. The aliens follow a strong character development. In *Black Star Rising,* the aliens blend in too easily and are therefore mundane, silly and boring.

So, if you have a craving for alien invasions, *Footfall* is the book to look for. It is a skillfully written novel. Each piece fits together like a carefully crafted jig-saw puzzle which will keep you intrigued throughout. ⋆



***Black Star Rising*, Fredrik Pohl**
Ballantine Books, 1985
Hard Cover, pp. 282, $15.95

Alumni Profile



John Stronczer received his Bachelor of Science degree in Electrical Engineering from the University of Minnesota in 1983.

By John Stronczer

Not long ago, I found myself glued to an article that was questioning some very delicate aspects of engineering education. Some of the more controversial statements guided my thoughts toward my own background and educational process. For example, is the typical four-year baccalaureate degree obsolete for entry level engineers in industry? Will the need for more technical courses for specialized topics mean that the humanities and social sciences will be neglected? Is there a general lack of experience and good hands-on courses that a beginning engineer needs to successfully find a place in industry? With these questions in mind, I will attempt to describe my somewhat unusual and varied experiences during the five years that I spent completing my Bachelor of Science in Electrical Engineering (BSEE).

I began my term at the University of Minnesota in the fall of 1978, after graduating with honors from Lindbergh high school in Hopkins. In spite of a good start with my classes that fall, I soon got caught up in the alternatives to course work offered in the dorms and fraternities on campus. (Pure distractions.) Needless to say, my dean's list performance started to waver. I decided that I needed a break from the calculus-physics-computer routine, so, a trip to Paris, France was organized for the following year. At least one semester of my year abroad was to be spent studying at the Sorbonne. This year long sabbatical proved to be a good way to learn skills other than those which constituted the traditional engineering degree. The exposure to courses in French, philosophy and art, along with the wide variety of people that I met in Paris, was more rewarding than I could have ever imagined. Interestingly enough, that year of study cost no more than if I had stayed in Minneapolis. When I returned, I was ready to continue my technical studies; with the added advantage of having nearly completed the major requirements for a French degree.

I decided that I needed a break from the calculus-physics-computer routine. So, I spent a year in Paris

Early in 1981, I was forced to find employment in order to continue my studies. Not wanting to push a broom or a spatula for 20 hours a week, I was fortunate to find a job at the Honeywell Corporate Technology Center, as a student aid. (Watch the bulletin boards.) For the next three years, I worked an average of 20 hours per week while attending courses full time; and I finished my degree.

I have since discovered that my work in semiconductor research has proven invaluable In my full time job as a GaAs integrated circuit designer at the Honeywell Physical Sciences Center (PSC). I have found a good mixture of technical, communication and practical work skills that are so important in any career. My coursework was often complementary to my work at Honeywell, providing crucial analytical tools.

Overall, the results have been more than satisfactory, and near the end of

my degree work, I branched into a new group at PSC involved in designing with the new technology of Gallium Arsenide integrated circuits for very high speed (.1Ghz) analog and digital circuits. This is a fascinating field and I'm learning more and more each day. Actually, I am considering returning to the University to work on a masters program in my field. So, although it was at times bumpy, my unorthodox five year bachelors degree has worked very well.

The exposure to courses in language, philosophy and art was more rewarding than I could have ever imagined.

Twenty hours of work along with 15 credits of EE courses was at times hard on my studies. Yet, financial concerns as well as my desire to learn, sometimes resulted in an uncomfortable compromise: instead of an A, I had to settle for a B or C.

The intern program in the Institute of Technology is a good alternative, but in my case, I needed to have an income while completing my studies. I would strongly recommend that you don't forget the humanities and social sciences. Some of my most satisfying courses were in philosophy and language. Above all, keep up the hard work, it's worth it! ⋆

Dreams from 25

responsible engineers and scientists who care about the community; to insure that technology develops ethically, for the benefit of everyone.

In a recent "Doonsbury" cartoon, a speaker is shown addressing the graduating class of 1985. The students have apparently all been put into a hypnotic trance by the last four years of grinding away at their studies. The speaker says to them "when I snap my fingers, you will all wake up and remember nothing but the sweet, gauzy scenes of unspent youth." He snaps his fingers and all of them wake up and remember nothing of what happened during their college years. It is time for all of us to wake up now as well. Not to forget what

"When I snap my fingers, you will all wake up and remember nothing but the sweet sense of unspent youth."

has happened to us and what we have learned here, but to remember why we came here in the first place. It's time we recommit ourselves to those high ideals of how we might use our scientific and engineering skills to help our community and the world. Wherever your dreams take you, have a wonderful life. ⋆

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As they say in mechanics, "Every couple has its moment."

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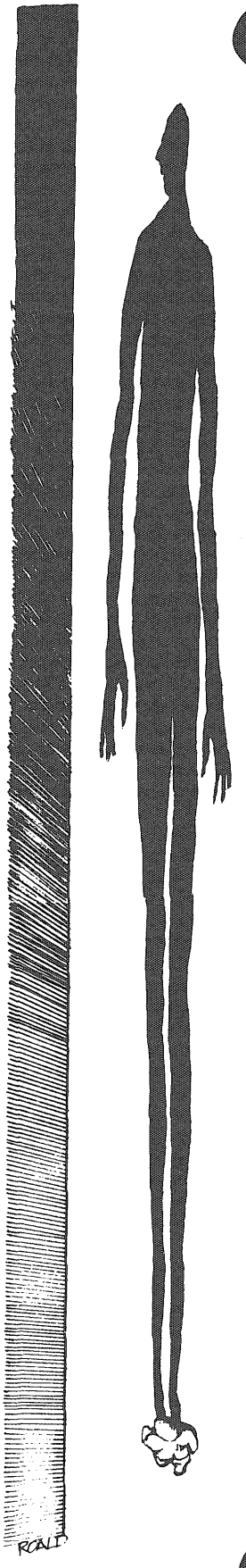
Science Fiction and Essay CONTEST



see next issue for details!

My Summer Vacation

This essay will have you rolling on the floor.

By John Krumm

You've probably been wondering what I did on my summer vacation this year. I'm not talking about the three month reprieve from classes, but rather that one or two weeks when you pack the station wagon full and cruise around the country. Well, I basically spent a week or two cruising around the country in a fully packed station wagon. We did manage to see a few sights in between cruising, however, and oh, what sights they were! If only that car could talk. (It's a '79, so of provide an adequate written recap, a printed portrait, yes, a stapled slideshow if you will, of some of the highlights of our trip.

We drove out, my friends and I, one warm Saturday morning with nary a care in the world, especially since none of us own irons. Did we have everything? Chips, cassettes, a change of socks... it was all there. It would be a long, hot day, because our destination was a distant motel, merely an outpost on the way to big fun. The first 20 minutes were a blissful release from the pressures of the day to day routine. The next 6 hours and 40 minutes were a torturous banquet of senseless boredom. After exhausting our imaginations on our game of, "Weird Alien Space Monsters from the Planet Domelight," we sat back and thought about what kind of deranged sub-humanoid invented vinyl car seats.

We arrived at our fabulous motel about ten cassettes after we started. For a place named Happy Murray's, it was surprisingly bearable. Murray had even gone to the trouble of putting a strip of paper around the toilet seat that said "Sanitized for Your Protection." I, for one, was glad to see this, not knowing what kind of demented deviant might have used that strip of paper last. In addition to a sanitized strip, the bathroom featured a myriad of electrical conveniences designed to produce just the right mood that's so important when you're grooming. Oh, the standard light switch and fan switch were there, but there were also controls for the heat lamp, coffee maker, soap dish heater, and shower security system. (This was a relief to those of us who had seen "Psycho." Being a victim of multiple stab wounds while in the shower can be so annoying, especially when you're on a tight schedule like we were.

The main room featured a cavalcade of loud, unmatched fabrics comprising the curtains and carpet. Of special note was the brash bedspread, covering specially designed, ultra-thin, heat-sucking blankets guaranteed to keep you cool even on the coldest of nights. (Where would we be without the space program?) In the desk drawer we found the requisite free postcards. These particular photographic masterpieces showed a swimsuited 1950's couple admiring the motel's ice facilities. The caption on the back read "Happy Murray's, where we've got ice for you." After naively putting a quarter in the Magic Fingers, we found out where to unplug the thing and drifted off to sleep.

The morning couldn't arrive soon enough for us, no siree. Today was the day we'd start seeing what tourists come to see. Our first stop was exciting Pike Land. Pike Land is one of those places where you pay to catch a fish, have it cleaned and cooked, and eat it right there. To the experienced fisherman, however, there's not much sport in catching a pike out of a metal tub with more fish than water. They were anxious to get out, even if it meant getting eaten. This explains why we were so successful using only shards of styrofoam Big Mac boxes as bait. Our complacent-looking catch was skillfully wrestled to the ground by Big Bob, one of Pike Land's prize fishing experts. (Big Bob, who couldn't have weighed more than 120 pounds, taught high school Latin during the off-season, so we suspect his connection with sport fishing was tenuous at best.) Bob brought the pike back to the kitchen, assuring us that the chef would have it fried up in no time. This happened to be a suspiciously accurate prediction on Bob's part, since in approximately no time we had a steaming plate of fish in front of us that tasted surprisingly like tuna. Our suspicions were confirmed when we saw Bob slink over to the fish tub and deposit a terrified pike into the water.

The first 20 minutes were a blissful release from the pressures of the day-to-day routine. The next 6 hours and 40 minutes were a torturous banquet of senseless boredom.

Continued

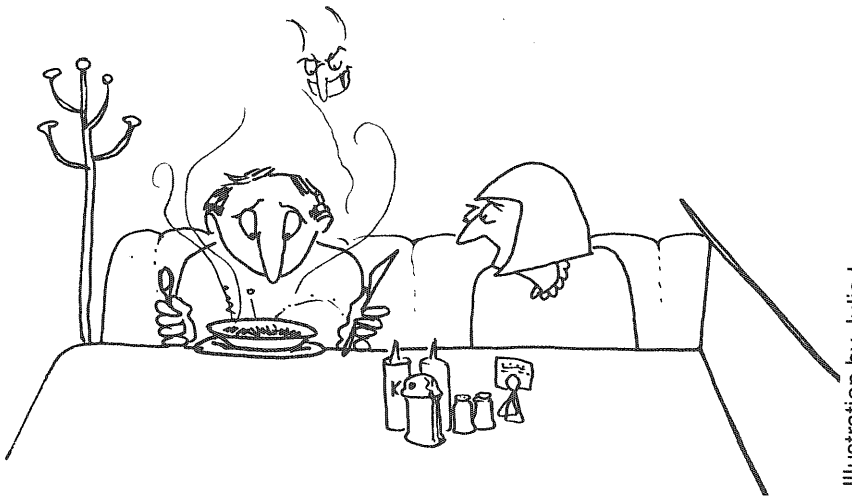


Illustration by Julie Lees

The acme of our eating experiences took place at Luverne's Insect Palace.

After the memories of Pike Land, the rest of the trip is one wild blur. We visited Real Scarey Cave (where we saw an incredible one-man reenactment of World Wars I and II), and Smurf City, U.S.A. (where lifesize wax replicas of your loveable friends repeat charming prerecorded messages for as long as you can stand it). We made a special trip to see the awesome World's Second Largest Ball of Twine, collected over a lifetime by an Iowa farmer. (The visitors' center at the World's First Largest Ball of Twine, you will remember, was abruptly shut down after an ugly accident involving a fraternity initiation and a group of preschoolers.)

The acme of our eating experiences took place at Luverne's Insect Palace. We were greeted by Luverne herself, whose husband is an entomologist with the state's Department of Wildlife. Following the lead of other theme restaurants, that crazy Luverne had thought up all kinds of topical names to emphasize the institution's motif. Working our way down the cafeteria line, we were tempted by such delights as horse fly hamburgers, earthworm fries, tick tacos and Luverne's praying mantis pie.

Our stamina depleted, we headed for home. The trip had been a venture in vending, a mission in money, yes, a realization in retailing. We were reflective as we drove home, thinking that we might someday return to that nebulous place called Vacation. Then again, we might just stay home and paint the house. ★


CAPTAIN COSMIC
AND THE SPACE PIRATES
FAR BEYOND OUR GALAXY, PAST THE CRAB NEBULA, PAST THE DOG STAR, SLIGHTLY TO THE LEFT OF THE HORSEHEAD NEBULA, BUT NOT QUITE OVER THE THOMPSON'S GAZELLE NEBULA, OUR HERO; CAPTAIN COSMIC, IS COURSING THROUGH THE VOID OF SPACE...
ABOARD HIS MIGHTY STARSHIP ...THE CUISINART 5! DESTINATION: THE ANTARES MALL!
CUISINART 5
ZOOM!
ARF!
ON BOARD WITH OUR HERO:
E=MC²
HIS FAITHFUL SPACE-DOG, EDDY...
...INTREPID & HYPER-SMART ROBOT, QUORG,
ARE WE THERE YET?
...AND HIS FAITHFUL, INTREPID, MYSTERIOUS AND RAVISHINGLY CUTE GIRLFRIEND, LAVORIS.
NOT YET, FAITHFUL, INTREPID ETC. LAVORIS, BUT SOON WE'LL... GREAT SCOT!
GADZOOKS
WHAT? WHAT?
ARF!
SPACE PIRATES!
AVAST, SWABS! PREPARE TO BE BOARDED! ARRR...
CRASH!
ARR! TAKE THE SHIP, LADS! STEAL THE HUBCAPS! BUST THE WINDOWS! AND AS FOR THE CREW..
AIR LOCK PLEASE KNOCK
AIR LOCK PLEASE KNOCK
PIECES OF EIGHT! SQUORK!
WHOOSH
©1985 RUSS PETERSON
...SAY; WHERE IS THE CREW?
SQUAAWK!
AT THAT MOMENT...
CUISIN-ART 5
ARR!
FORTUNATELY, THE CUISINART 5 COMES EQUIPPED WITH THE "NICK-O-TIME" ESCAPE ROCKET.
"NICK-O-TIME"
ARF!
UNFORTUNATELY, THE "NICK-O-TIME" HAS ONLY ENOUGH FUEL TO REACH THAT SMALL, UNCHARTED PLANET AHEAD — AND WHO KNOWS WHAT AWAITS US THERE?
ARF!
NEXT EPISODE: PLANET OF THE FERNS!

TIME MACHINE

A reprint of a very humorous story from **Minnesota Technolog, Spring, 1978**

WORKING

By John Charnes

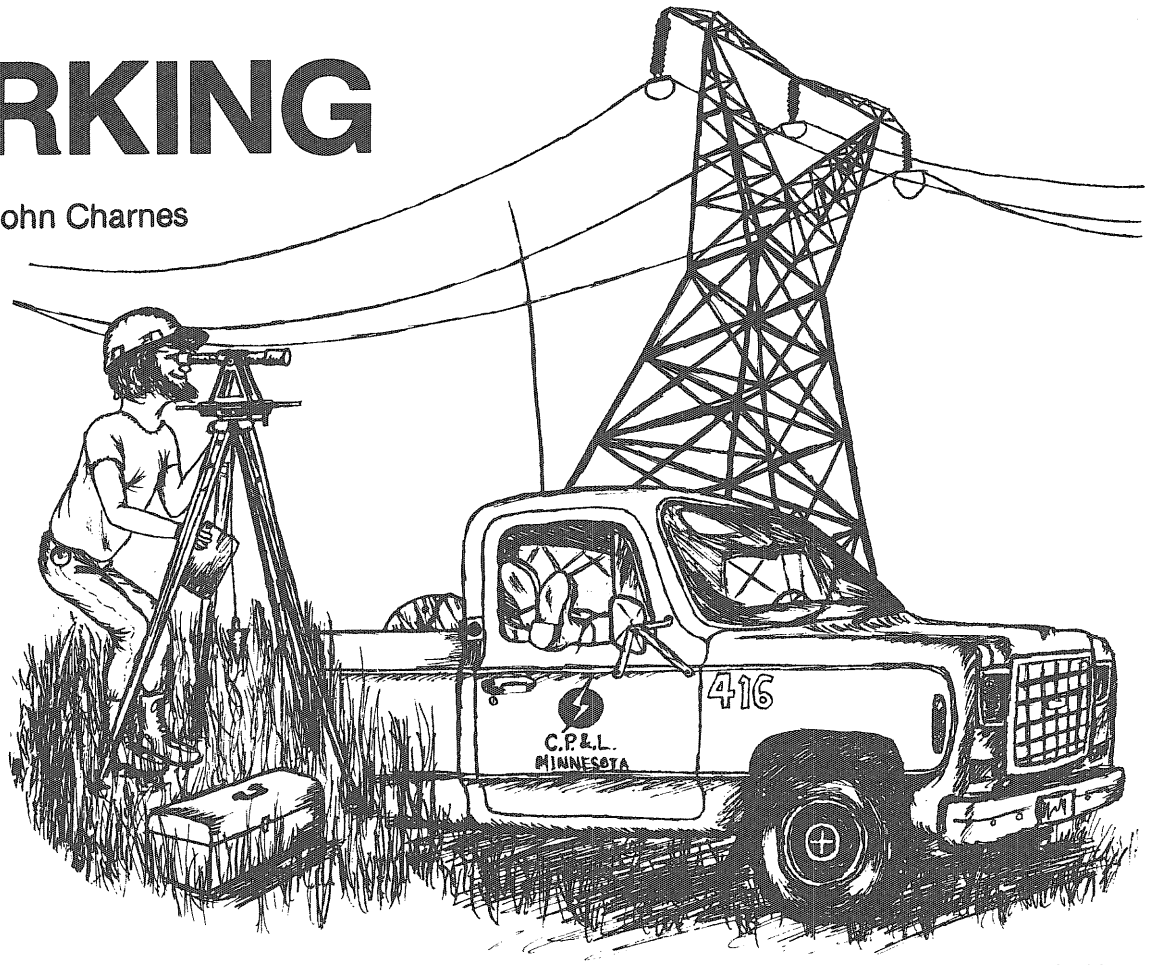


Illustration by Steve Smith

Governor Brown

"School is a vacation from life."
—Jerry Brown

So says the golden state's guru governor in a recent issue of *New Times* magazine. Some vacation. Wake up late, brush your teeth and rush off to a seemingly endless barrage of line integrals, Carnot cyles and nth order matrices culminating in that frenzied, button-pushing, anticlimactic ordeal known as finals.

It's half-time in my college career. To date, I've earned 97 of the 194 credits needed for the distinctive title of bachelor of science and alumnus status at the University of Minnesota. In so doing, I've managed to experience the great American pasttime of going into debt.

For this quarter and the next, I'll be a civil engineering intern student. I landed a job with a consulting engineering firm in Minneapolis. I was hired to inspect construction work, but until the work gets going I was put on a survey crew.

Before I started college, I worked on a survey crew for a large electric monopoly based in Duluth. We ran preliminary surveys for high-voltage transmission lines. I became very adept at walking through swamps knee-deep in loon shit, battling mosquitoes and deer flies, carrying a 25-pound chain saw.

My boss used to say that it took a special breed to be a surveyor. Hopefully, recombinant DNA research will rid the world of this deficient genotype forever.

The most notable difference in the transition from an academic to a workingman's environment occurs in the vocabulary. Construction workers are fond of using a certain four letter expletive referring to one of man's basic drives. I seemed to be the only one who noticed it the first hundred times or so that it was used on the day I joined the crew. By lunchtime, however, I had overcome that affliction and could speak this rhetorical redundancy with the best of them. Usually the word is uttered without consciously realizing it. Occasionally, however, it is spoken from the heart.

Monday of the third week on the job found our three-man crew driving between

different job sites where the boss, Hal, would converse with the foreman on the project while I was recuperating from an excellent Patti Smith concert I'd attended the night before. Sometime in the afternoon, during one of Hal's B.S. sessions, I happened to doze off for a few minutes. My slumber was rudely interrupted by a bop on the head with a rulled up blueprint.

"Wake the (expletive deleted) up!"

I looked up to see Hal glaring at me with fiery eyes.

"What for?" I asked innocently.

"Wake the (expletive deleted) up, you (expletive deleted)!!"

Sometimes I feel I'm being discriminated against because I'm a college student. Many people have a definite stereotypical role that they would like to cast me in. You know the one—the four-eyed egghead intellectual who can integrate from zero to infinity or spell sesquipedalian with ease but who has trouble pounding a nail without bending it—as if too educated to have any common sense.

Matriculation is basically an individual challenge. Unless you take classes by proxy, have peripheral vision or are a damn good guesser, you have to rely on your own skills and knowledge to get through four years of intellectual feeding and regurgitation. Most jobs involve teamwork—a group of people working toward the common goal of making money for the company. Here's where the trouble begins. Given a set of humans trying to accomplish a certain task, you will find that the number of opinions on the most propitious means of achieving that goal increases arithmetically.

We all have brainstorms on how to do a specific job, plus reasons why every other idea (not his own) is doomed to failure. Everybody wants to be the boss. At times it gets to the point where outpsyching your co-worker becomes such a great concern that no one gets any work done and everyone goes home cursing the audacity of his associates.

University people are generally transient in nature. Moving around quite a bit, they are used to seeing different people and make friends easily. Going to work involves joining an established group. The neophyte who wants to fit in has to be friendly but not overbearing, alert but willing to let some things slide by without comment and willing to listen to people tell him things that he already knows. But since people are creatures of habit, acceptance into the group comes only with time. Which brings us to another problem.

Familiarity breeds contempt. Contempt produces backstabbing. Backstabbing implies two-facedness. Your jocular associate, beaming as he comes to the punchline of his story, was just telling the boss yesterday what a bumbling, babbling, inept fool you are. That's all right though, tomorrow you'll reciprocate by inadvertently mentioning his blatant misuse of company time and total lack of professional manner in your conversation with the man in charge.

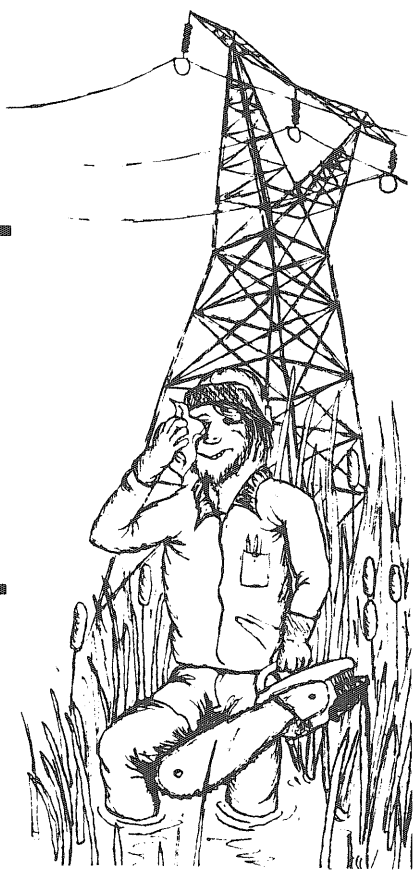
And bosses have ways of keeping subordinates in line in the working regimen. One of the ploys, used by those who have reached what the Peter principle defines as their level of incompetence, is to keep underlings in the dark as much as possible about the ultimate purpose of their own actions. Bosses must gain a sense of security by playing the game of "I've got a secret." They act as if they have latched on to some esoteric knowledge, far too advanced for any of the lowly hirelings to grasp. Two kinds of people work well with bosses—clairvoyants and automatons who think no further ahead than five minutes ago.

Politics, nepotism and personality clash are three very real aspects of the working world that are seldom mentioned in school. "It's not what you know, it's who you know" is one form of an idea commonly expressed among workingmen. An employer will swear up and down that he runs his business as a strict meritocracy but it takes little perception to see that this is not always the case.

Perhaps these psychological challenges are what Governor Brown is alluding to in his pithy remark. They are much less apparent inside this scholastic bubble straddling the Mississippi than elsewhere.

Despite an oftheard platitude about the grass being greener, I'm looking forward to getting back to school in the fall. I'd like to stay there until I reach mandatory retirement age. Now, all I have to do is find a benevolent benefactor to finance it. ★

"I became very adept at walking through swamps knee-deep in loon shit, battling mosquitos and deer flies, carrying a 25-pound chain saw."



TechnoTrivia

Questions

1) What's happening down there when you have heartburn?

2) Have any earth-bound humans ever been killed by pieces of satellites falling from the sky?

3) How long is a Svedberg? (Hint: It's a unit of time and it's pretty short.)

4) True or false: The smell of a person's breath is a reliable indicator of his or her sex.

5) Carnac the Magnificent, in his mystical way, can divine the answers to questions which have been hermetically sealed in a mayonnaise jar on Funk and Wagnall's porch since noon that day. What does it mean to be hermetically sealed?

6) Why do students cough more during boring lectures?

7) True or false. You can produce a live chicken by electrocuting a grocery store egg with ordinary house current.

8) True or false. Smoking makes you glow.

9) Why was the Mad Hatter mad?

10) True or false. The last time Halley's Comet came by in 1910, worried North Americans sealed windows and doors, purchased gas masks, dug comet shelters, and stocked up on Comet Pills in an effort to protect themselves.

Answers

1) The digestive juices of your stomach are gurgling back into your esophagus.

2) No, but a cow in Cuba bought the farm this way (it's true). (Anti-space reactionaries, of course, milked the story for all it was worth.)

3) The Svedberg, named after the Swedish chemist Theodor Svedberg, is a mere 10-13 seconds.

4) True. Researchers at the University of Pennsylvania put 10 "odor judges" to the task of testing samples from 36 "odor donors." (Which would you rather be?) The good-humored aroma adjudicators were able to correctly determine a donor's sex 95% of the time. Males, they observed, generally had worse smelling and more intense breath.

5) The neck of the jar is heated until it becomes soft and is then twisted shut. The term comes from Hermes the Thrice-Great, legendary founder of the hermetic art of alchemy, who was attributed with the idea of hermetic sealing. (May a crazed chemist cough on your catalyst.)

6) Research has shown that people who are busy processing interesting information tend to be less distracted by subtle internal sensations. Likewise, runners on an interesting trail feel less tired than those on a dull track.

7) False. The egg will only produce desperate screaming noises, similar to those of Slim Whitman when he yodels. (Kids, don't try this at home.)

8) Amazingly, incredibly true. Japanese researchers have reported that the blood of smokers emits three to four times as many photons as that of non-smokers. Granted, you probably haven't noticed a blinding light coming from the smoking sections of local restaurants; a milliliter of blood from a non-smoker emits less than one photon per second.

9) The hatmaking industry of the 19th century used mercury nitrate, $Hg(NO_3)2$, to mat rabbit fur into felt. Many of the hatters were subjected to mercury poisoning, causing them to act insane.

10) True. They were afraid of, among other things, the cyanide gas that had been discovered in the comet's tail. The comet's closest approach, however, was still many millions of kilometers away.

Scoring

0-1 Turn off the TV and read a book for once, pinhead.
2-4 Apply for a government position.
5-7 A- (grade inflation)
8-10 Put down your book and join the real world, wisenheimer.

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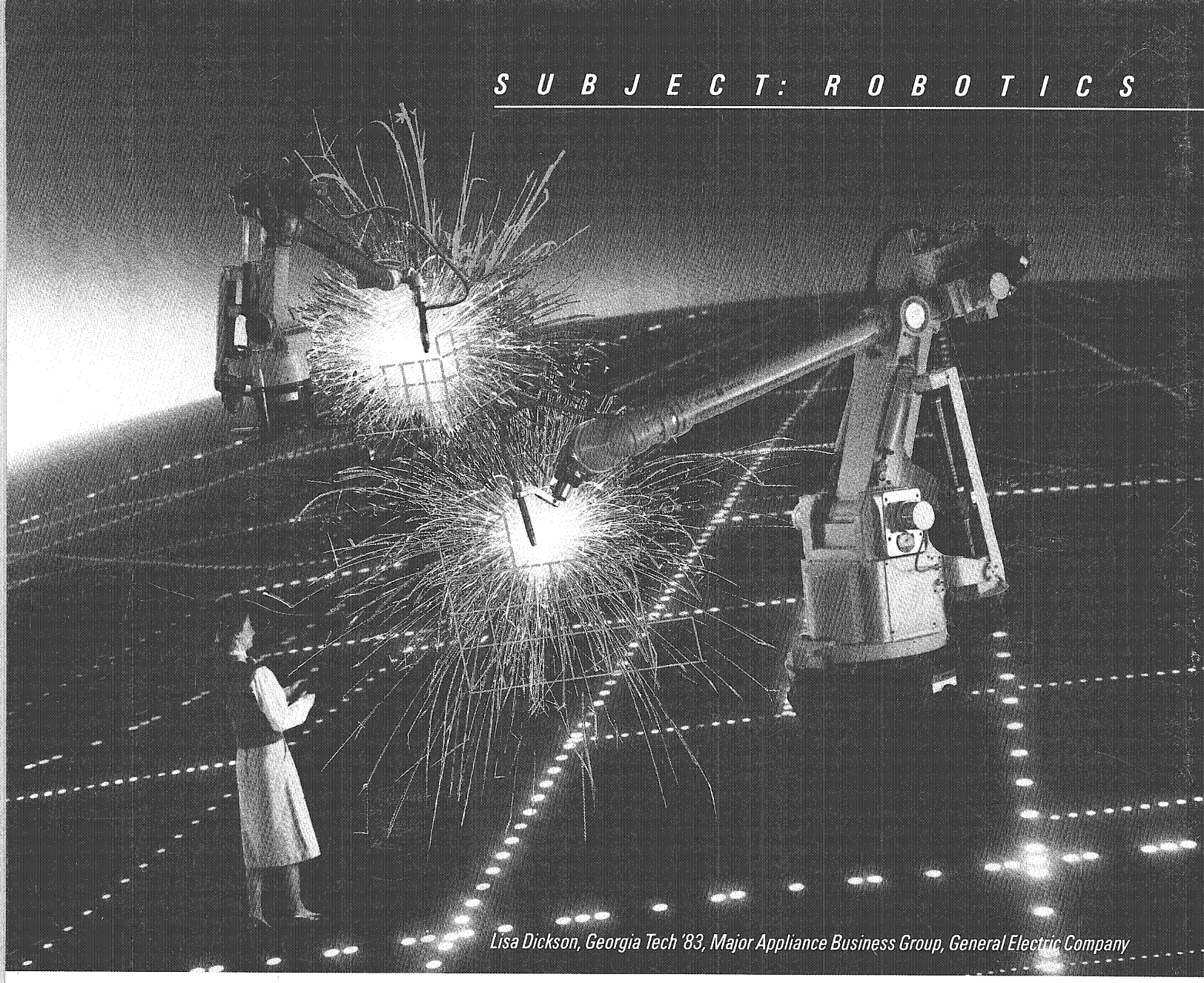

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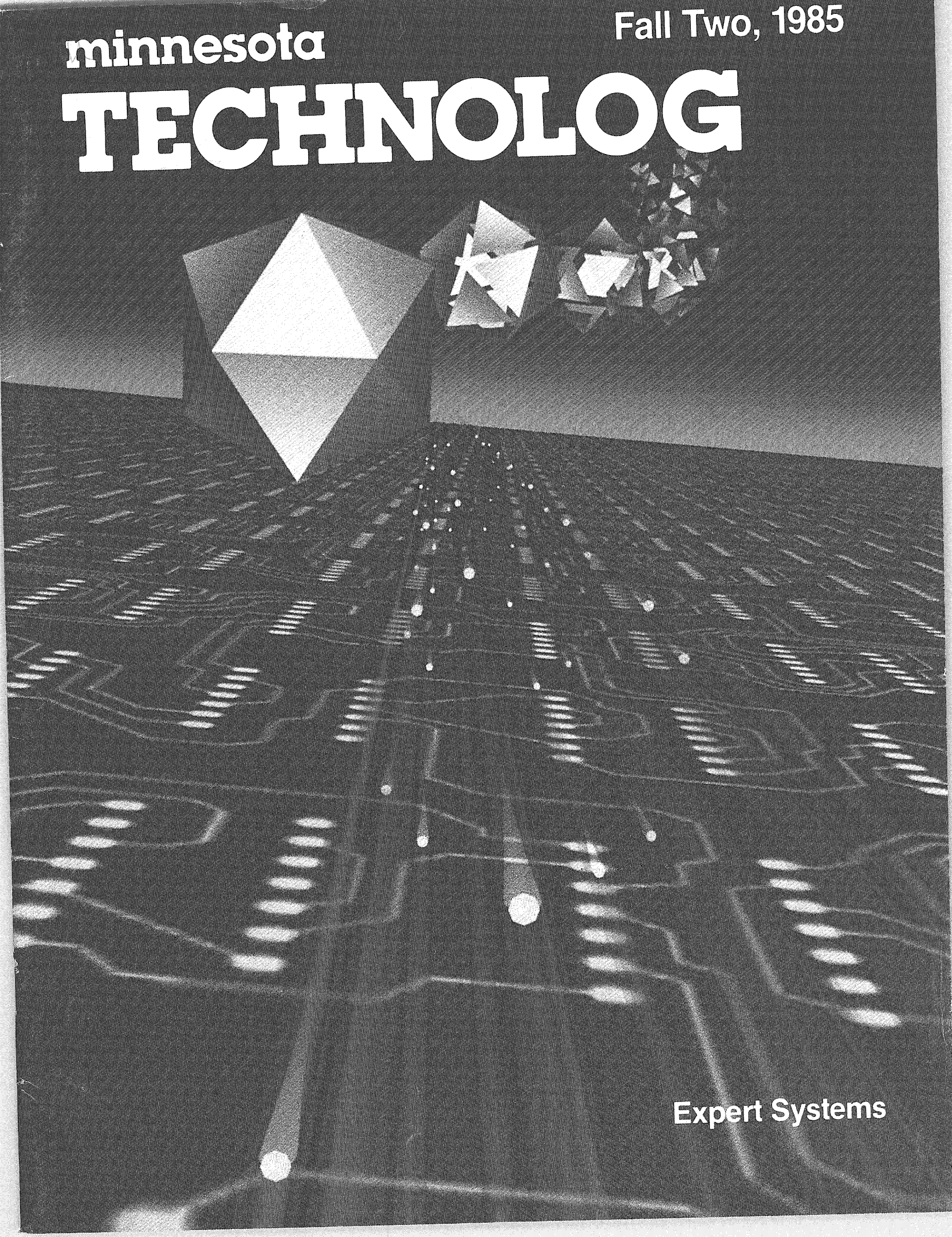
Fall Two, 1985



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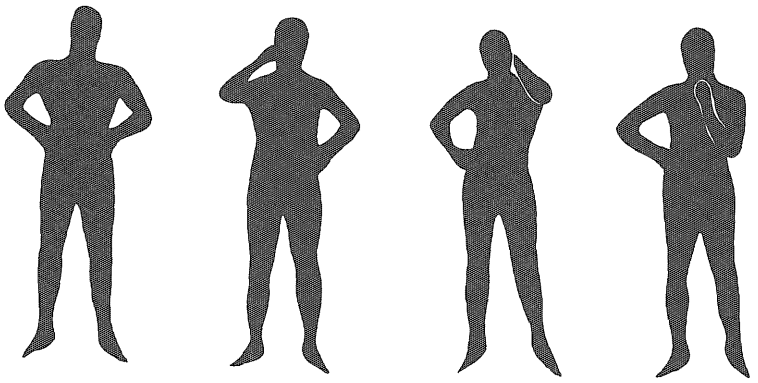
 ISSN #0026-5691. So there!



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room 2 mechanical engineering

Editorial

ARCHITECTURE OF A CHOICE

"You" are not a machine. Yet, it is known that the human being relies upon the brain and nervous system to automatically make certain physiological choices. In a sense, they constitute a goal-seeking mechanism, bringing about the achievement of particular tasks or making appropriate responses to the environment.

It's very fortunate that we don't have to think about each breath we take or regulate our heartbeats. Yet, other physical and psychological choices that appear to be scarcely within our conscious control have an enormous influence on our daily activities.

The whole realm of emotions remains, for the most part, a mystery. We can understand through certain cause-effect relationships and hormonal balances that a particular emotion is likely to occur, but we can't always get beyond the symptomatic level. This sort of superficial understanding works well for relatively simple emotional situations. However, for an ongoing process, such as your life, decisions that constitute feelings of happiness are much more difficult to judge.

What does happiness have to do with engineering, physics or any other discipline? Since they all represent various career choices, the career that you select will unfold as an integral part of your life style. Choosing a career represents only the first step in a series of personal realizations. Imagine that you have decided to major in mechanical engineering. What sort of job within this field will be the right one for you? A decision such as this one might be easier to make once alerted to one very important consideration: the feedback cycle.

You may be familiar with the principles of a *feedback control system,* as being a type of self-correction system in which the error in the system's behavior is controlled by means of the error itself. The most famous historical example of this system is the steam engine. Currently, the *feedback control system* is used to reduce distortion in electronic amplifiers, as well as for many other applications. Most *feedback control systems,* as well as biological control systems, are regulated by negative feedback, ultimately reducing the deviation of the output from its desired value.

I am referring to a different sort of feedback cycle that occurs when an individual in a real job setting views his or her accomplishments in a micro-social context: in industry, the office, at a board meeting, etc. Moments within the working environment when the individual can understand the meaning and value of his or her work in the context of personal and company goals.

There are various forms of feedback and each person must determine his or her need. There is no correct or incorrect measurement. Perhaps, meeting a deadline, the completion of a project, or a pat on the back from a supervisor will be sufficient for you to maintain a feeling of self-worth in your job. Or, maybe you can project your particular task onto an entire operation of enormous size. For example, working for NASA.

If you are the sort of person that requires a lot of personal feedback about your work, then producing designs that become parts of much larger projects, to the extent that you never see them materialize, may not be a very rewarding application of your particular skill.

Having discovered that you are the sort of person that needs individual feedback or a more intimate relationship between your design and its application, you might want to investigate mechanical engineering applications that are known for this sort of rapport. Rehabilitation engineering is a good example of a mechanical engineering application with a high level of feedback. Other avenues to explore are internships that provide insight into real job situations.

The choice is yours to make. Becoming aware of the feedback cycle will hopefully allow a more realistic job application choice, encouraging a more pleasurable life style to develop.

The reasons as to why we seem to have certain emotional needs are yet to be understood. However, tuning in to the delicate balance of the feedback cycle will be an important step in self understanding.

It is not a choice that should be left up to the involuntary nervous system. Think about it.

Debby Latimer
Editor

Bulletin Board

IN MEMORY OF LEE PONTO

Lee Ponto, Director of Student Affairs and Director of Placement in I.T. died October 2 of cancer. Lee graduated from the University of Minnesota in 1962. He had worked at the university since 1964, and for I.T. administration in various capacities since 1968. Most recently he served in a dual capacity as Director of Placement and Director of Student Affairs. He was also adviser to Plumb Bob and the I.T. Student Board. He was tireless, compassionate, and dedicated to the welfare of the students. His concern for all people was grounded in a strong Christian faith which shone quietly through everything he did. His good judgment was appreciated far beyond the University of Minnesota; he was a Trustee of the Lutheran Bible Institute of California.

Lee loved golf and had a handicap of 6 for an 18-hole course. He was treasurer of the University of Minnesota Men's Golf Club for many years. He also participated in the Faculty Golf League and was former league champion.

We miss him greatly. At the suggestion of a number of students and staff, and with the concurrence of Lee's family, a Memorial in the form of a Scholarship Fund has been established through the University of Minnesota Foundation.

Russell K. Hobbie
Associate Dean

UNIVERSITY COMPUTER CENTER

Beginning early this fall, the University Computer Center (UCC) started some major changes, both in facilities available and the location of those facilities.

The most exciting change is in the SuperComputer Lab. Right now, the UCC owns 2 Supercomputers, a CRAY-1 and a Control Data CYBER-205. During the next several months, they will acquire a CRAY-2 prototype and a CRAY-2 regular model. The CRAY-2 is considered to be the fastest computer in the world, and with the other supercomputers, the University will become one of the best Supercomputer locations in the nation.

The Supercomputer Lab will have some location changes. It was decided recently to form a private company that would employ Lab staff, but would not be under direct UCC funding and control. Located on the new Technology Corridor, the Supercomputer Institute would continue many of its research functions for the University, and would also provide time for local businesses to use its computers.

The UCC will concentrate on the use of its other computers, because these are used exclusively by University personnel. Part of this streamlining effort involved moving all the computers to the Lauderdale lab, where they will henceforth remain. The administrative and accounting offices of UCC had to move to Wulling Hall.

Once the new Computer Science/EE building is completed (est. Fall '87), the UCC will probably move into the new offices there.

The non-Supercomputers that UCC owns are in two groups: interactive computers located in Lauderdale and connected to terminals by phone; and microcomputers in Shepherd Labs. Students and faculty interested in using or buying microcomputers

should go to the lab for information and answers to questions.

The interactive computers have different jobs, depending on the user's needs. A Control Data CYBER-174 is the main interactive computer for classes in Computer Science and Engineering. Another interactive computer is the CYBER-825, used primarily by IT students for special functions like graphics and CAD/CAM (Computer Aided Design and Manufacturing). The "flagship" of the UCC is the CYBER-845. Almost exclusively a research computer, this very powerful machine is used by graduate students and for public service. The UCC also uses a VAX-11/780 for research.

The two interactive computers, the CYBER-174 and the CYBER-825, operate the MERITSS system. Most students at IT and some others will probably use the MERITSS system sometime during their University career.

Despite all these transitions, access to the computers has not been significantly diminished. In fact, with new terminals throughout the campus, and batch entry stations in 6 different locations, computer access is better than ever.

Assistance for any of the computer systems can be obtained at the UCC Reference Center in 125 Lind Hall, or by buying a pamphlet on the appropriate system at Williamson Bookstore in the electronics department.

By Kevin Cummings

CREDIT WHERE CREDIT IS DUE

Due to an electrical storm, the following credits were left out of the Fall One issue of *Minnesota Technolog;* Glen Larson is the artist who designed the illustration of one frame from a micro-switch assembly simulation in the article titled, **Making Robots Smarter.** The photograph of **Meteorologist Paul Douglas** was shot by Mike Moffa. The three sentences that were missing from John Krumm's essay, **My Summer Vacation** have been seen skipping time dimensions in the last Dr. Who episode. In all sincerity, please accept our apologies for these oversights.

DIGITAL EFFECTS

Digital Effects, established in 1978, is one of the leading production companies that specializes in two and three dimensional computer-generated imagery, optical effects and print graphics.

Fusing state-of-the-art computer graphics technology with creative talent, Digital Effects designs and produces some of the most imaginative and innovative effects for the advertising and film industry. A significant amount of work is also devoted to editorial and advertising illustration. The production process centers on the company's proprietary software system Visions®, which allows two dimensional images or three dimensional spatial environments to be defined, rendered and displayed. Capabilities include fully-rendered two and three dimensional simulation, image processing, and paint systems. Their technical ability and thorough knowledge of film production and print, ensure an effective working relationship with our clients.

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Digital Effects, 321 West 44th St., New York, N.Y. 10036. Tel. 212-581-7760. For additional information contact Michel Pyles.

Minnesota Technolog would like to thank Don Leich, the artist who designed our cover, as well as Digital Effects for their cooperation.

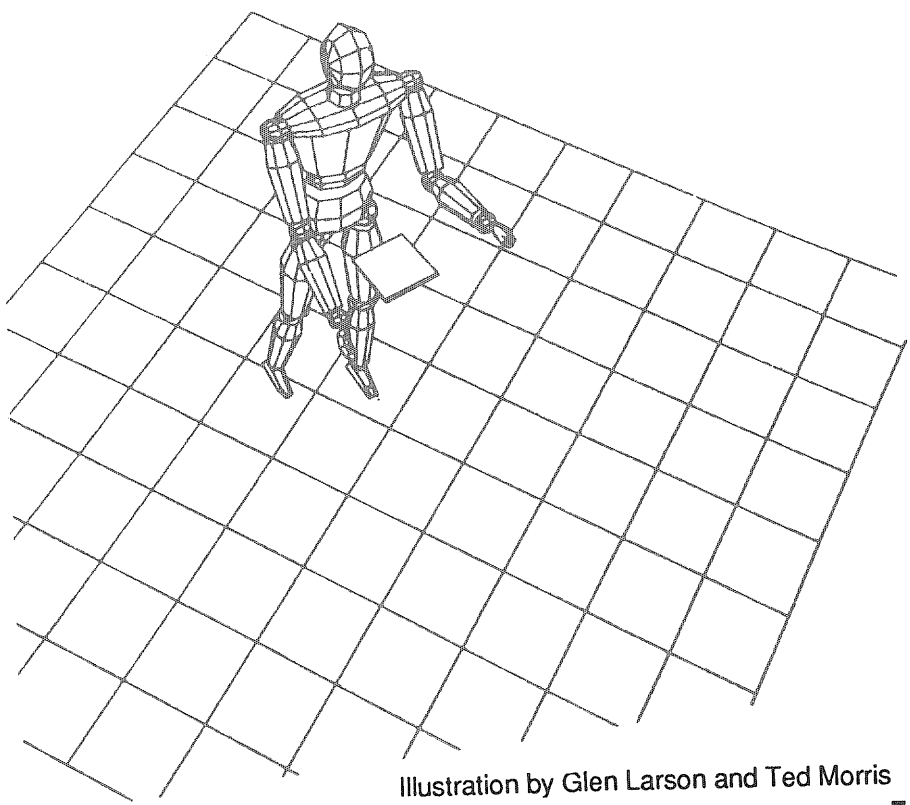


Illustration by Glen Larson and Ted Morris

The Boundary Dynamic

The performance of a polymeric adhesive depends on the properties and composition of its surface. Now a scientist at the General Motors Research Laboratories has developed and validated a theory that describes the coupled effects of diffusion and chemical reaction on the changing surfaces not only of adhesives, but of chemically reacting surfactant systems in general.

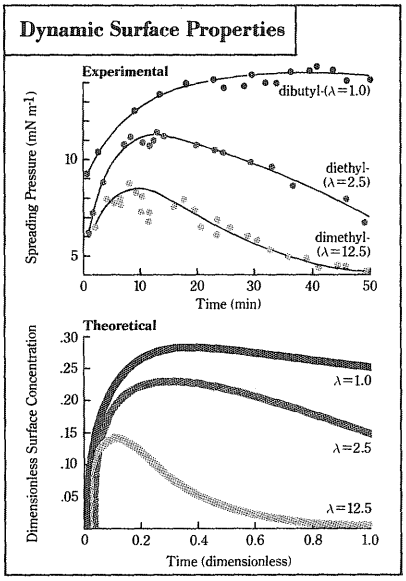


Figure 1: Experimental measurements of spreading pressure v. time for dialkylaminopropylamines with various Damköhler numbers (λ), and corresponding theoretical calculations of surface concentrations.

Figure 2: Evolution of an adhesive surface: Surface-active Solute 1 reacts with host resin to form surface active Solute 2.

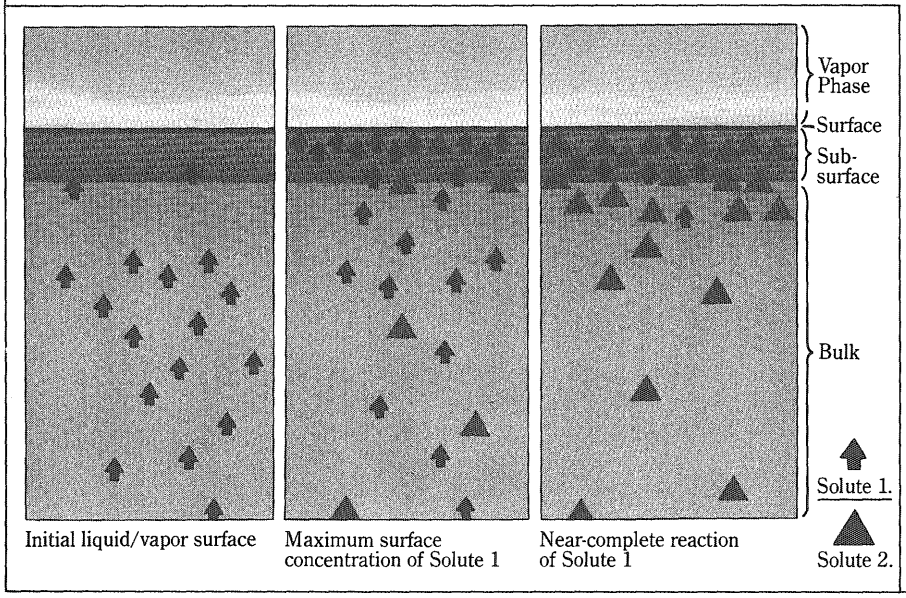
THE USE OF adhesives in the production of an automobile promises to make both the product and the process more efficient. Both weight and operations can be reduced. In practice, however, steel and other metallic surfaces are often contaminated by process lubricants. A durable bond depends on the ability of an adhesive to displace contaminants and to wet the substrate.

Assuring intimate contact between adhesive and substrate requires detailed knowledge of adhesive surface tension, since it is this property that controls displacement of contaminants and wetting. Up to now the surface tension of an adhesive has typically been assumed constant. In reality, though, surface-active components in the adhesive collect preferentially at the interface and also react, so that the surface composition varies with time, giving rise to dynamic surface tension. Variations can be large enough to significantly affect adhesive performance.

The understanding of time-dependent surface tension has been advanced by the work of Dr. Robert Foister, a scientist at the General Motors Research Laboratories. Investigation of dynamic surface properties of thermosetting adhesives led him to develop a general theory of adsorption kinetics in binary, chemically reacting surfactant systems. The significance of this theory is that it includes the coupled effects of surfactant diffusion and chemical reaction, making it possible for the first time to describe quantitatively the changing surfaces of such systems.

In a typical adhesive that polymerizes, or "cures," by chemical reaction (Figure 2), a surface-active curing agent (Solute 1) reacts with the host resin to form a second surface-active species (Solute 2) that is also reactive. Both solutes migrate to the surface, lowering the surface tension. Diffusion to the surface is driven by a potential energy gradient between the surface and the bulk, with the solute molecules experiencing a lower energy at the surface.

Dr. Foister derived appropriate transport equations to describe diffusion and chemical reaction in the bulk, in a subsurface region, and at the surface itself. The transport equations can be solved analytically if the chemical rate equations are assumed to be first order in the concentrations of reacting species, and if the subsurface and surface concentrations can be related to one another by a linear adsorption isotherm. For more complicated isotherms, a set of coupled, non-linear integral equations is generated.



These must be solved numerically.

Analytical solution for the special case of the linear isotherm indicated that the change with time in surface concentration (and consequently in surface tension) is composed of two terms: first the diffusive flux of Solute 1 into the subsurface from the bulk, and second the depletion of this solute due to chemical reaction. Hence, the surface concentration of Solute 1 exhibits a maximum with time (Figure 2). This maximum in surface concentration corresponds to a minimum in surface tension.

MODIFYING the transport equations to include binary adsorption isotherms allowed for consideration of competitive adsorption of the two reacting and diffusing solutes. By solving these equations numerically and conducting dimensional analysis, Dr. Foister identified various dimensionless parameters as predictors of system behavior. The most important of these parameters was a dimensionless number (λ), of the Damköhler type, involving terms representative of reaction, diffusion, and adsorption.

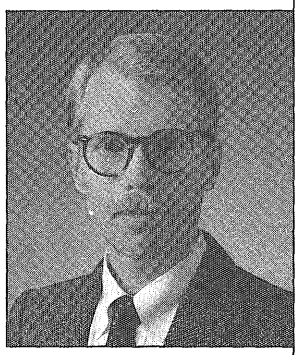
$$\lambda = \frac{k\,(\Gamma_m\, a)^2}{4D}$$

Here k is the reaction rate constant of Solute 1, D its diffusivity, Γ_m its "surface capacity" (the maximum number of molecules absorbed per unit surface area), and a its "surface affinity" (a measure of its energy of adsorption). For an adhesive, lowering λ by reducing k (the reactivity of the curing agent), for example, would prolong the time to maximum, and would increase the value of the surface concentration at the maximum (see Figure 1, Theoretical). As a practical consequence, this would improve wetting by minimizing the surface tension.

In experiments using a series of dialkylaminopropylamine curing agents (dimethyl-, diethyl-, and dibutyl-) in a host epoxy resin matrix, good agreement has been demonstrated between theoretical predictions for surface concentration and the measured dynamic spreading pressure, which is the change in adhesive system surface tension due to the curing agent (Figure 1, Experimental).

"I expect," says Dr. Foister, "that the physical insights gained from this analysis can be applied to other reactive surfactant systems by using specifically tailored isotherms and chemical reaction schemes. Predicting surface behavior can certainly help us design better adhesives for specific applications, but it is also pertinent to the performance of anti-oxidants and anti-ozonants in synthetic rubber, for example. And applied to interfaces in biological systems, a suitably modified theory may prove valuable in understanding the phenomenon of enzyme activity."

THE MAN BEHIND THE WORK



Dr. Foister is a Staff Research Scientist in the Polymers Department at the General Motors Research Laboratories.

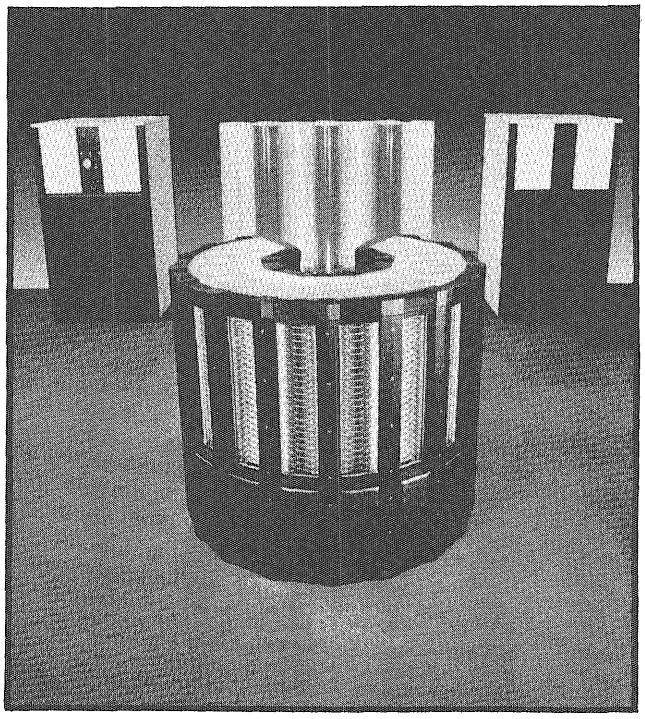
Dr. Foister received his undergraduate degree from Guilford College, and holds a Ph.D. in Physical Chemistry from the University of North Carolina at Chapel Hill. His thesis dealt with the role of liquid inertia in the intrinsic viscosities of rod-like polymers.

He did post-doctoral work in Canada as a Fellow at McGill University in Montreal, and in the Applied Chemistry Division of the Pulp and Paper Research Institute of Canada, working on the microrheology of colloidal dispersions.

Dr. Foister joined General Motors in 1980. He is the leader of the Structural Adhesives Group in the GMR Polymers Department. His current research interests center on surface chemistry and adhesion.

Two New Cray 2's

As of this fall, the University of Minnesota is the first academic institution to have direct access to the Cray-2 supercomputer, the fastest computer in the world.



The Cray-2

All photos are courtesy of 3M/Marketing Public Relations.

By Phil Decker

The University of Minnesota, as of this fall, is the first academic institution to have direct access to the Cray-2 supercomputer, the fastest computer in the world. The University was also first to get the Cray-1, purchased in 1981. Two Cray-2's have been purchased. The larger unit with four processors costs $17.8 million and can store 256 million words in local memory. The price of the smaller, single processor unit which stores 16 million words has not yet been finalized. "It's not cheap either," said John Sell, vice-president of Research Equipment, Inc. (REI). REI is a for-profit corporation set up by the University to allow purchase of computers and sale of computer time to outside customers. The Crays will initally be installed at the Lauderdale computer center, then moved to the Technology Corridor when construction of the facility is completed.

Primary users will be graduate and faculty researchers, the National Science Foundation, and corporate customers.It will not be accessible to undergraduates.

The cost of using the Cray-2, $8,000 per hour, sounds extravagant compared to the Cray-1's $2,000 per hour, but is really about 25% less expensive because it is so fast. The rates imposed are to cover on operating costs and depreciation on the computer.

The computers are many times faster than the supercomputers already installed. Supercomputer speed is measured in MegaFLOPS—millions of floating-point operations per second. The Cray-1 operates at 150 MegaFLOPS, the Control Data Cyber 205 cruises at 200, while the Cray-2 zips along at 1,000 MegaFLOPS, or one billion floating-point operations per second. To compare, the IBM PC plods along at one-twentieth of a MegaFLOP.

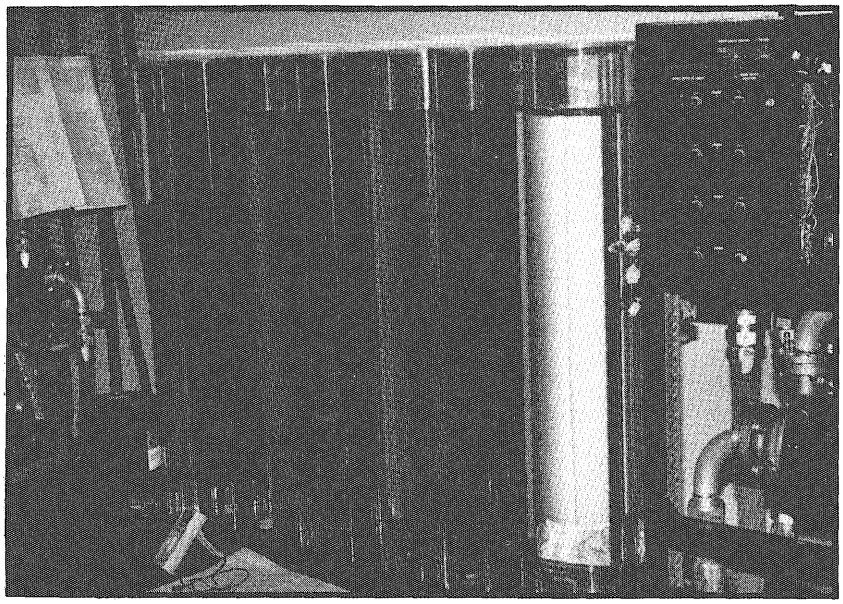
Detailed modelling and simulation in three dimensions can only be done on supercomputers. The Cray-1, for instance, has been used to model sandstone saturated with oil, water, and natural gas. As a result, researchers found how to extract two percent more oil—about $2 billion worth—out of the oil fields at Prudhoe Bay, Alaska. Another simulation was a thirty-second segment of the film "The Magic Egg", a collection of computer-generated shorts shown at

the OMNIMAX theatre of the Science Museum of Minnesota. It simulated a fly-by of Saturn using data and software provided by the Jet Propulsion Laboratory in Pasadena, California. It gave viewers the sensation of sailing past the moons, rings, and surface of the planet. It took 175 hours of computer time on the Cray-1, performing 94 trillion instructions. It would have taken the IBM PC sixty years to do the same thirty-second clip.

Part of the reason for the Cray-2's great speed is its short clock cycle of 4.1 nanoseconds (billionths of a second). A digital pulse can travel through eight inches of wire in one nanosecond, so a signal can only travel about 32 inches in one Cray-2 clock cycle.

This requires that the computer be made as small as possible. Where the Cray-1 was six feet in height, the Cray-2 stands less than four feet tall and has a footprint (floor area) of one-third that of the Cray-1. Like the Cray-1, the Cray-2 is built in the shape of a "C" to shorten wire length. The Cray-3—already on the drawing boards—is predicted to be about one cubic foot and has been dubbed the "breadbox computer".

The Cray-2 is made with ECL (emitter-coupled logic) devices that switch in a half nanosecond, whereas TTL and MOS devices switch from two to twenty nanoseconds. The ECL circuits also require a great deal more power than TTL and MOS. The total power requirement of the Cray-2 is 194 kilowatts.

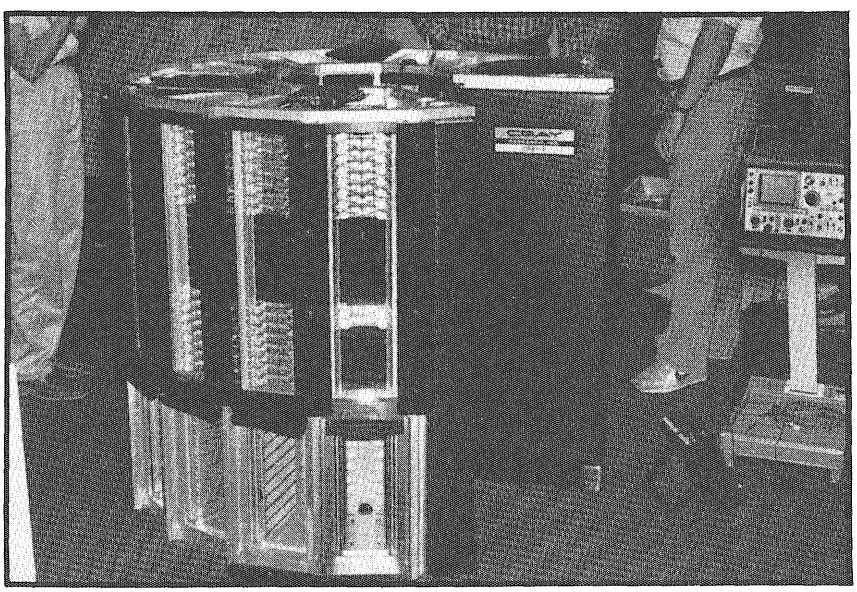


A bank of clear acrylic tubes serve as holding tanks for the Fluorinert® liquid to a Cray-2 computer.

Part of the reason for the Cray-2's great speed is its short clock cycle of 4.1 nanoseconds.

This generates a great deal of heat that would destroy a computer if not for a revolutionary cooling fluid made by 3M called Fluorinert® electronic fluid FC-77. It is a clear, inert dielectric perflourocarbon that is pumped directly over all the computer circuits. It was originally developed some years ago as a substitute blood. The advantage of total immersion is that coolant can come in contact with every heat-producing device without intermediate heat transfer. There is no thermal lag, and overall reliability is enhanced because powering up or down does not thermally stress the components. One hundred and seventy gallons of Fluorinert® is pumped through the Cray-2 under low pressure (2 psi or less) at a rate of 70 gallons per minute.

"It's a very unusual-looking computer," said John Sell, of REI. "It's fun to watch. You can actually see fluid movement." The mainframe has clear acrylic access ports on the top and sides which can be removed for servicing components. The Cray-2 also comes with a cluser of tall, clear acrylic towers which serve as holding tanks when the fluid is removed for servicing the computer. ★



This Cray-2 is undergoing final test and assembly. Panels are removed and individual module stacks can be seen.

Computer Abuse And Other Crimes

It is believed that only one out of every one hundred cases of computer crime is ever discovered or reported—the rest go unnoticed. It is estimated that the total annual loss to computer crime reaches nearly $3,000,000,000.

By Lee Atchison and Rick Smith

Computer Crime

Jerry Schneider, a 21-year-old UCLA engineering graduate, entered a Pacific Telephone and Telegraph's office disguised as a consultant to study how their operations worked. Later, he placed orders for telephone equipment by using a touch-tone phone to access the phone company's computer. In all, he stole about $1,000,000 worth of telephone equipment.

In New York, officials raided a bookie and discovered an $11,000 a year bank teller was making $30,000 a day bets. Investigation revealed that the teller had managed to shuffle $11,500,000 to his account from the Union Dime Saving Bank in New York.

Stan Rifkin posed as a consultant from the Federal Reserve Bank and walked into the Security Pacific National Bank's bank wire room, where electronic transfers to other banks were made. He observed the operations of the room and wrote down numeric security codes used to make transfers. A few minutes later he called the wire room from a nearby phone booth and used the security codes to order the transfer of $10,200,000 to a Swiss bank account. With that phone call Rifkin had pulled off the largest bank theft in U.S. history. The only reason he was caught was because he turned himself in.

About 100 cases of computer crime were reported annually over the past several years with an annual take of about $100,000,000. But in 1984 about a half a billion dollars was reported lost to computer criminals.

Approximately 27% of all businesses are victimized by computer criminals, or more likely only 27% have noticed that they were victimized. These statistics only describe *reported* computer crime; it is estimated that the total annual loss to computer crime really reaches nearly $3,000,000,000 annually. It is believed that only one out of every 100 computer crimes is ever discovered or reported—the rest go unnoticed.

Computer crime comes in many forms. There are the white collar workers who steal money and property for personal gain. The average take of a normal bank robber is approximately $8,000 while the average take in a computer related crime is $500,000. Computer assisted theft and embezzlement is the most costly computer crime, but it is not the most common. Some criminal acts are for revenge instead of money. There have been many cases of sabotage by employees and former

employees. Unhappy programmers and operators have been known to delete files or damage working programs in response to being fired; some cases have even involved theft for ransom of important company records on computer tape. A few cases began as computerized practical jokes. Sabotage in the name of humor may not intend to cause harm, but it often causes more harm than the saboteur expects. The newest form of crime is a form of electronic hitchhiking in which the criminal uses a computer and a telephone line to try to break into other computer systems. There were several cases reported in the national news several months ago involving young teenagers connecting to nationwide computer networks and breaking into computers all across the country.

But is all this *really* crime? It's obvious that a crime is involved when someone transfers a few million dollars they don't own into their personal bank account. Sabotaging someone's computer system is obviously a crime, too. If a criminal erases all the programs and data on your system you'd agree that's a crime even if you were able to recover everything you lose from spare copies. Having an uninvited visitor in your computer isn't much different from having someone sneak into your home. Even if the visitors only want to look at your magazine collection, you can't be sure they won't disturb something else at the same time. It's hard not to disturb something in a computer system; an unauthorized user will at least be taking away computer time from legitimate users, thus slowing things down for others.

Theft By Computer

Theft by computer has much to be recommended as a form of crime. It pays extremely well, involves neither violence nor weapons, and seldom leaves sufficient clues to unmask the perpetrator. Usually though, it is a crime of opportunity: the perpetrators often have special knowledge and are in the right place at the right time. The unnamed teller at Union Dime exploited his ability as Chief Teller to change computerized account balances and thus keep the books in balance while he withdrew huge sums of cash. Stan Rifkin actually worked as a communications consultant for Security Pacific on occasion and used his knowledge of their procedures to fool them into giving him millions of dollars.

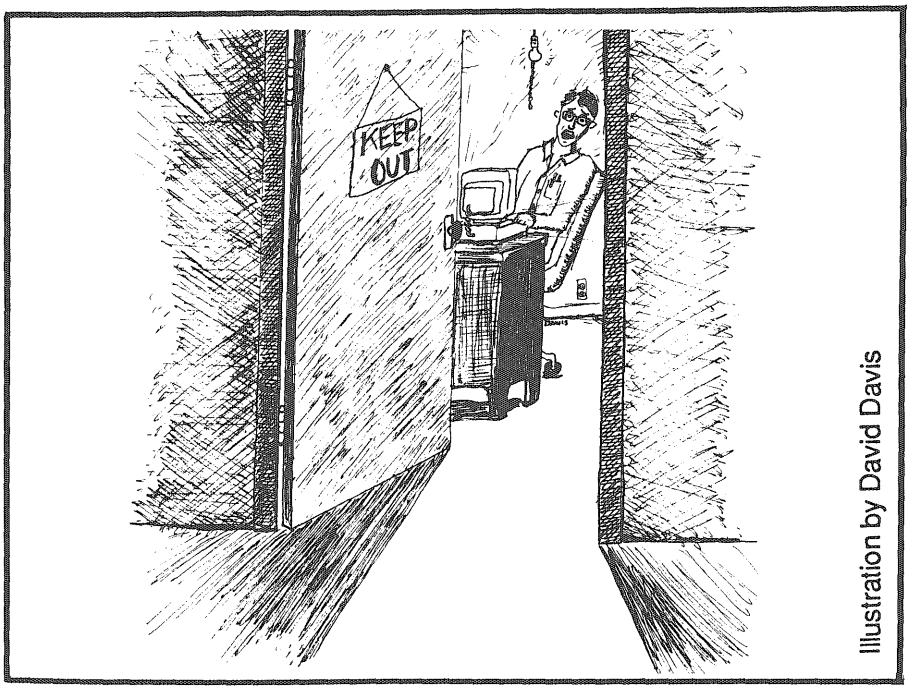


Illustration by David Davis

Computerized embezzlement is often simply a high-tech version of an ancient form of theft. In general embezzlers explore 'cracks' in an accounting system. They find ways in which money isn't accounted for and simply take the money out of the system. In manual accounting systems an embezzler may simply pocket any cash that appears and destroy evidence of the transaction; more elaborate embezzlers create phony expenses charged to phony companies that they control. Computer embezzlers play similar tricks by manipulating the computerized records of transactions. One form of this is called the 'salami embezzlement' in which small amounts of money are shaved from each transaction and funneled into an account paid to the embezzler. Even pennies per transaction will add up to a tidy sum in a large company. An embezzler at an agricultural concern in California even used the computer to help him plan his embezzlement strategy. He developed a computerized model of the company finances and used it to decide where the latest losses caused by his embezzlement would be least visible.

Occasionally an automated teller machine is the target for computer crime. Most teller machine thefts involve stolen cards; such crimes aren't purely computer crimes since they begin with a physical theft. A few teller machine thefts involve 'bugs' in the teller machine's program that have been found and exploited by computer criminals. A classic case occurred in California a few years ago when several teller machines were completely emptied of cash. The thief had found a subtle bug in how the teller machine responded to a very slow user. If the user asked for cash and failed to remove it from the machine within a given time limit, the machine assumed that the transaction failed. The teller machine couldn't take the money back, but since the transaction failed it didn't deduct the money from the user's account.

Having an uninvited visitor in your computer isn't much different from having someone sneak into your home.

Not all computer thefts require a connection to the bank's computer. At the Riggs National Bank in Washington, D.C. a thief tricked numerous people into depositing

Computerized embezzlement is often simply a high-tech version of an ancient form of theft.

money into his bank account without ever seeing or speaking to them. The thief simply visited the bank and replaced the pads of blank deposit slips with deposit slips magnetically marked with his own account number. The customers who used these forms would fill them out as usual when making a deposit, but since there was already a magnetic number on them the Bank's computer would use that account number instead of the actual customers' numbers. Thus, the customers' deposits all went into the thief's account. Later, the thief withdrew $100,000 and walked away, never to be seen again. He was never caught.

Computerized Trespassing and Hitchhiking

It used to be that few people knew how to connect to a computer via telephone. The equipment was expensive and required special technical knowledge to use. Computer systems that accepted connections over phone lines weren't common and varied widely in how they operated. The technical obstacles made it uncommon for computer systems to have trouble from uninvited strangers trying to break in. Possible trouble was minimized since the troublemaker could reach only computers within the local dialing area. Technical improvements of the past decade have changed all that. Anyone can buy a personal computer today for a few hundred dollars, and another hundred dollars will buy a *modem,* a circuit for sending computer data over telephone lines.

Over a decade ago a high school student named Geoff Goodfellow used his parent's home terminal to break into a computer system at the Stanford Research Institute (SRI) near where he lived. At the time this was an impressive achievement, and Geoff was eventually hired by SRI. He is now a well-known consultant on computer security matters. But things were different back then. Today it is common for high school students to know how to use computers and antics such as Geoff's are common enough to be a problem. Recent news has taked about the 'computer hacker,' a sort of knight errant, Robin Hood, or brigand, depending on who you talk to. Computer people have used the term hacker (taken from a medieval word for *one who makes furniture with an ax*) for decades. Hackers of the old form are programmers with exceptional knowledge about the systems they use. You could almost think of them as knights errant, wielding technical expertise instead of swords, and causing some trouble as well as striving to do good. Jerry Weizenbaum in his book, *Computer Power and Human Reason,* points out that much of the finest modern software technology comes from people who proudly called themselves hackers.

Classical hackers most often got into trouble because of their casual attitude about computer security systems. Since security systems would often protect parts of the computer unnecessarily, many hackers would see no harm in circumventing the system when they wanted to get at things they needed. While this technical expertise allowed them to perform programming miracles, it also opened them to accusations of abusing the computer. This aspect of being a hacker led some youthful electronic vandals to claim the title themselves. In mass media today, a hacker is someone who makes a hobby out of trespassing in other people's computers.

The growth of computer networks over the past decade has spawned a newer problem: electronic hitchhiking. Computer networks provide high performance long distance connections between different computers or between computers and computer terminals. Commercial networks, such as Telenet and Tymenet, and private ones such as Arpanet and Milnet, give electronic hitchhikers ways to connect to computers around the country.

Hitchhiking wasn't a problem in the early days of networking. The Arpanet, the first large scale network of its kind, was set up for research into the operation and use of computer networks. Some of the early research funding was used to pay for 'guest' accounts on major computer systems so that users from other sites could make limited use of different systems. After a few years it was clear that the guest accounts were too expensive and didn't really serve a useful purpose. It was rumored that these accounts were primarily used by unauthorized users such as members of high school computer clubs. As the Arpanet became less of an experiment and more of a working network , guest accounts disappeared and systems became harder to use without permission.

The researchers at Sloan Kettering are still wondering how much of their cancer research has been damaged by electronic vandalism.

Meanwhile, commercial computer networks were growing and themselves becoming the target of network hitchhikers. The case of the '414s' from Milwaukee, Wisconsin, made national news when they were caught abusing the Telenet computer network several months ago. The '414s' were a group of kids with home computers and modems who would use Telenet to find and connect to computers around the country. Once connected, they would try to break into the computer system and 'play' with it until the system managers could figure out how to get rid of them. Among the systems they broke into were computers at the Sloan

Continued on page 19

An Automated Knowledge Acquisition Program For An Expert System

Experts are often unable to communicate the knowledge they wish to impart. This is known as the paradox of expertise.

By Robert Macneal

Searching through the literature on expert systems and constructing expert systems (an intelligent computer system which stores information and has the ability to reason), one is hard pressed to find a paper in which the author fails to mention the difficulty acquiring and representing expert knowledge. The paradox of expertise (Johnson) is that often experts are unable to communicate the knowledge they wish to impart. The job of acquiring knowledge and representing knowledge in a way that makes it transferrable to a machine is a difficult task often referred to as the "bottleneck".

Imagine that designers of an automated cash card system are seeking to redesign their present machine so it is easier to use. At any time while using the machine, customers can press a bright red button labeled 'I NEED HELP' and will be given the information necessary to make the transaction. You have been identified by the management of a local bank, which has a record of your weekly cash card withdrawals for the past four years, as an expert in the use of the machine and they have submitted your name to the cash card designers.

Your challenge is to write a program which can be implemented by the machine to consider all possible customer problems and errors and respond with appropriate advice.

First you decide to list all the advice the machine might give. You begin with:

(1) YOUR CARD IS UPSIDE DOWN;
(2) ACCOUNT NUMBER INVALID, PLEASE RE-ENTER;
(3) NO VISA OR MASTERCARD; and
(4) LOOK UP YOUR PASSWORD.

Since the cash machine is not sophisticated enough to listen to and interpret the customer's difficulties, whether by mind reading or voice recognition, you must list all the possible questions the machine might ask which would solicit the appropriate advice. You decide, rather wisely, to start with a question that will eliminate perhaps more than half of the potential users, "DO YOU HAVE A VALID CASH CARD?". Now, having eliminated the pranksters and imposters, you might follow with "ARE THE RAISED DIGITS OF YOUR ACCOUNT NUMBER FACING UPWARD?" or "DO YOU REMEMBER YOUR PASSWORD?" and so on, until the machine is able to make some concluding advice like "LOOK UP YOUR PASSWORD".

Completing the list of questions and advice you are likely to proceed by building in the necessary logic. That is, if the response to "DO YOU HAVE A VALID CASH CARD?" is affirmative, then do this, this, and this... otherwise the machine should advise the person to step aside before

bank security is alerted.

Shortly one understands the difficulty in covering all the possible customer foul-ups and, at best, one can only approximate oneself as expert in the most elementary example. Soon one appreciates the difficulty of transferring human expertise to a machine. How does one represent expertise? How does one codify knowledge?

I tried to address these questions in a Undergraduate Research Opportunities Project (UROP) titled 'An Automated Knowledge Acquisition Program for an Expert System'. There is no recognized template for representing expertise and infinite approaches to codifying knowledge. Recall that the best system is only a crude approximation. Despite the scope of the project (perhaps "An Attempt at Automated Knowledge Acquisition..."), three important heuristics resulted:

(1) choose a simple model for expertise;
(2) find a powerful metaphor for knowledge representation (the physical format of a body of knowledge);
(3) make knowledge base ("data base" of rules and characteristics for a specific expert domain) construction easy for experienced and novice users alike.

One could choose a complex model for expertise, say one that faithfully models the human mind and human decision-making, spending countless years creating an analog to the mind, or one could chose a workable model which crudely approximates an expert judgment in as many cases possible. The hypothetical cash card example was knowledge representation based on a decision, question, rule model (DQR) of expert system building.

A DQR model is used by Geo-Engineering students in a systems analysis course, team taught by A.M. Starfield and K.A. Smith, to build small expert systems on microcomputers. Students are required to act as knowledge engineers, that is, to interview experts and consult the literature within a specific problem domain related to Geo-Engineering, and build an expert system using a text editor and the Starfield-Adams expert system shell (DWR shell). The DQR shell, a microcomputer based backward chaining inference engine (a software "engine" that channels information in complex chains), is shown diagramatically in figure 1. While the exercise is quite instructional, much time is spent organizing bits of knowledge, that is, representing knowledge and realizing the imbedded logic.

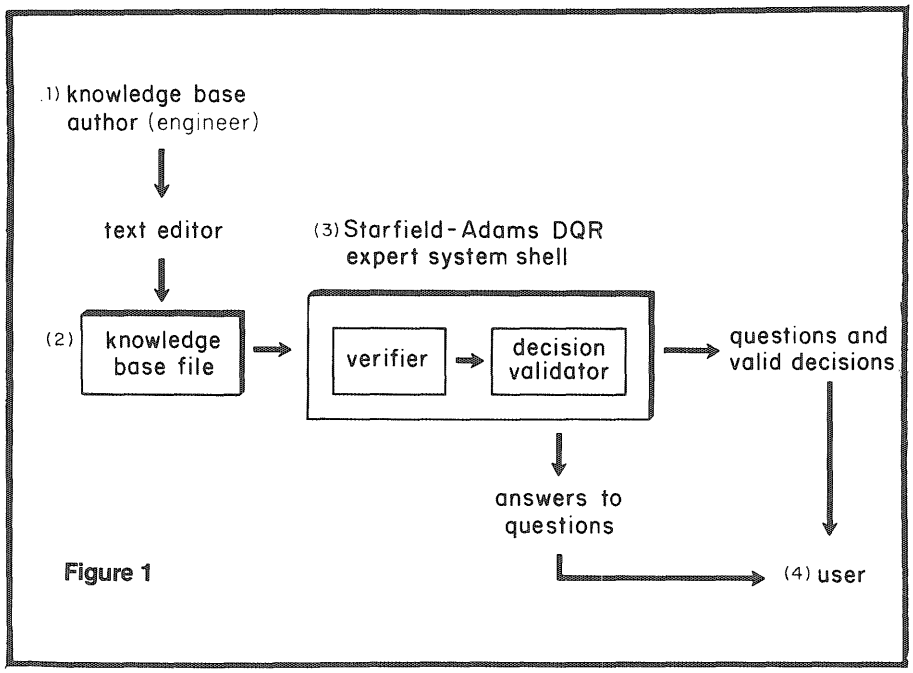


Figure 1

Illustration By Nan Gehrig

This experience was the motivation to automate, if not enhance, this process of knowledge acquisition using an approach loosely related to spatial learning techniques (Smith, Starfield, and Macneal) such as concept maps (show meaningful relationships between concepts by linking concepts with propositions) and schematizing (labeling and clustering of concepts and showing relationships such as interaction and similarity), as well as metaphor.

Given the DQR construct, I sought to enhance the process of knowledge acquisition by supplanting the generic text editor and knowledge engineer (see figure 1—knowledge base engineer) for all but the most experienced DQR shell users. The Automated Knowledge Acquisition (AKA) program was designed to obtain and organize knowledge, provide a framework for the knowledge (metaphor), and provide a knowledge base text file (figure 2) interpretable by the DQR shell.

The first task was to provide a metaphor for an approach to knowledge representation which suited the DQR model. The overriding goal was to find a user interface which was systematically natural to manipulate and which provided a clarity of purpose. Since the purpose was to build a knowledge base of decisions, questions, and rules, I chose a three-dimensional object, the cube, as a metaphor.

The "knowledge cube" is likened to a three-dimensional spreadsheet (figure 3) where decisions (y direction) and questions (x direction) appear in cells in the plane of the computer screen, while possible answers to the questions appear in cells in the z direction (into the screen). Rules are implicit in the relationships between the cells occupied by each decision, question, and answer.

Each knowledge cube cell bares a relationship to another cell, whether it be a null relationship with no logical link, ("ARE THE RAISED DIGITS OF YOUR ACCOUNT NUMBER FACING UPWARD?" and "NO VISA OR MASTERCARD") or a rule relationship, with implicit IF...THEN constructs ("DO YOU REMEMBER YOUR PASSWORD?" and "LOOK UP YOUR PASSWORD"). Those familiar

***Figure 2.* Decision-Question-Rule Knowledge Base. Example is a knowledge base which might be used for forest land management.**

Decision 1 'Do not burn'.
Decision 2 'Burn after the first rains'.
Decision 3 'Burn at the height of the rainy season'.
Decision 4 'Burn before the first rains'.
Decision 5 'Defer burning for a year'.

Q1: 'Is there old material that needs to be removed?"
Why 'old material provides fuel'
Ans 1 'yes'
2 'no'.

Q2 'Has the area recently been burned accidentally?'
Why 'if so, unlikely to be enough fuel for a fire'
Ans 1 'yes'
2 'no'.

Q3 'Are the shrubs in the area becoming dense or growing high?'
Why 'looking for evidence of bush encroachment'
Ans 1 'yes'
2 'no'.

Q4 'Is the density of Bothriochloa higher in recently burned neighboring areas?'
Why 'looking for evidence of degradation in vegatation because of burning'
Ans 1 'yes'
2 'no'.

Q5 'Is there a herbivore management priority?'
Why 'must provide suitable grazing for priority herbivores'
Ans 1 'for long grass grazers'
2 'for short grass grazers'
3 'no priority'.

Q6 'At what time of the year was the area last burnt?"
Why 'we may want to rotate burning seasons'
Ans 1 'before the first rains'
2 'after the first rains'
3 'at the height of the rainy season'.

Rule 1
Why 'cannot sustain a fire with insufficient fuel'
IF Q1A2 OR Q2A1 THEN D1.

Rule 2
Why 'hot fires needed to destroy bushes; bushes can be a problem in this area'
IF (NOT D1) & Q3A1 THEN D4.

Rule 3
Why 'if there is no urgent reason to burn, we want to avoid degradation'
IF (NOT D1) & Q3A2 & Q4A2 & Q5A1 THEN D2.

Rule 4
Why 'if vegetation is not a problem we can look to herbivore priorities'
IF (NOT D1) & Q3A2 & Q4A2 & Q5A1 THEN D2.

Rule 5
Why 'if vegetation is not a problem we can look to herbivore priorities'
IF (NOT D1) & Q3A2 & Q4A2 & Q5A2 THEN D3.

Rule 6
Why 'rotate time to burn if there is no reason for doing anything else'
IF (NOT D1) & Q3A2 & Q4A2 & Q5A3 & Q6A1 THEN D2.

Rule 7
Why 'rotate time to burn if there is no reason for doing anything else'
IF (NOT D1) & Q3A2 & Q4A2 & Q5A3 & (NOT Q6A1) THEN D4.

with spreadsheet software might recognize the rules as formulae, wherein a cell can have a value as well as have a formula imposed upon it. Similarly, cells can contain a decision in addition to being part of a rule.

The AKA enhancement is an attempt to represent decisions, questions, and rules in a manner that readily reveals lines-of-reasoning (paths leading from decisions back to root questions). The AKA approach skirts the issue of the paradox of expertise by imposing order on the chaos of information with the task simplifying decision, question, rule constraint. We don't ask "How is advice formulated", but rather "How can this model be used, given its constraints, to advise?".

The AKA program will be tested in unison with the Starfield-Adams DQR shell in Systems Analysis for Geo-Engineers (GeoE 5700) in the near future. It is hoped that the cube metaphor provides a structure from which bits of knowledge can be placed and easily manipulated and that knowledge engineering is streamlined in the DQR model.★

Figure 3

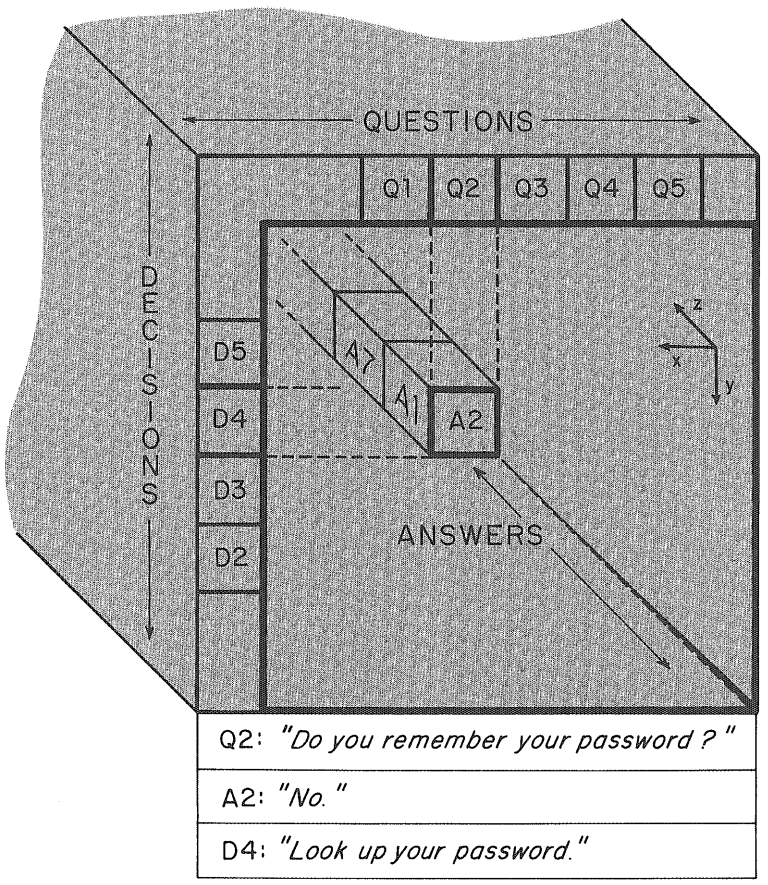


Illustration By Nan Gehrig

Computer Crime from 14

Hackers are programmers with exceptional knowledge about the systems they use.

Kettering Cancer Institute and the Los Alamos Scientific Laboratory. The researchers at Sloan Kettering are still wondering how much of their cancer research has been damaged by this electronic vandalism.

How was this allowed to happen? Generally, neither the Telenet network nor the owners of the computers were careful enough about their security. Until the '414' case, anyone could connect to Telenet on the theory that it was up to the computer systems themselves to prevent unauthorized connections. The plundered computer systems were owned by research labs that didn't have the time or expertise to prevent unauthorized connections. Usually the '414s' managed to connect by guessing what the likely access code would be. For example, words like 'system' or 'operator' or 'maint' often appear as names or passwords. Really careless users might not have any password at all. Ignorance and carelessness left the computers open for attack, almost like leaving the car keys in the ignition.

Computer Bulletin Boards

A computer bulletin board is a computer set up to allow other people with their computers to call up and read information left by other users, and to leave information of their own. It is an easy way for people from all over the country to communicate to each other about common topics. The growing popularity of these bulletin boards is a result of the falling prices of computers and of modems. Not only can many people afford the equipment needed to call up a bulletin board and share information, but the cost of the bulletin board itself is low. Almost any personal computer and modem can serve as a bulletin board, though the larger (and more expensive) the system, the more messages the board can save. There are now thousands of bulletin boards in existence. They discuss topics such as computer equipment and supplies, current clothing fashions, and even philosophical discussions about religion and science.

Unfortunately, computer bulletin boards have also been used for illegal purposes, usually the exchange of illegal information. The '414s' admitted to sharing computer access codes through a bulletin board. Recent arrests of bulletin board operators have occurred when telephone credit card numbers were found in bulletin board messages. 'Pirate' bulletin boards have appeared that provide free electronic copies of expensive copyrighted computer programs. Many of these illegal bulletin boards are run by students in Junior High and High School. There have even been reports of bulletin boards used for communication by drug dealers.

In Bloomington, Michigan, a computer bulletin board known as COSMOS was run by a 16 year-old high school student that called himself "Time Lord". The bulletin board ran articles on subjects like building 'blue boxes' for making long distance calls without charge, breaking into computers to get illegal credit card numbers, and the manufacture of illegal drugs. POPPS, a bulletin board in New York City, was operated by a 19 year-old known only as "Exorcist". POBBS was a 'pirate board' used to exchange copies of expensive commercial software available for IBM-PCs. Software packages such as Lotus 1-2-3 and Wordstar were available free of charge. Off the Wall, a bulletin board operated by "Psycho" of Boulder, Colorado appeared to be a legitimate bulletin board. Users could read and discuss computers and share information about different computer products available. Hidden below this public level was a second, secret bulletin board that could only be seen by people who had used the public bulletin board for a period of time. The second level allowed the trading of copies of copyrighted computer software and of copyrighted articles from pornographic magazines. Below this was hidden yet a third level of seriously illegal material available only to a select group of computer vandals known to the bulletin board owner. The users of the third level could trade access codes that allowed them free use of costly computer services such as those from Dow Jones and Compuserve. There was also a collection of long distance telephone credit card numbers and access codes for making long distance calls that were charged to other people. Also included were discussions of how to make bombs and other explosives. Caesar's Palace is Miami, Florida, is a clearinghouse of information on all sorts of illegal activities. There is information on how to make free telephone calls from locked phones and pay phones. Other messages explain how to defeat the antishoplifting systems in department stores.

The Dartmouth Cookie Monster

A classic story of computer crime happened many years ago at Dartmouth College. The crime didn't involve a theft but it proved costly in terms of computer time, operator harassment, and detective work. It is the story of the "Dartmouth Cookie Monster". Here is one version of the story.

The message said: "I want a cookie." The operator puzzled by the message, ignored it.

One day, a computer operator for the Dartmouth computer noticed that a message had been printed on the console. The message said: "I want a cookie." The operator, puzzled by this message, ignored it. A few minutes later, the console printed another message, this one informed the operator: "I said, I want a cookie."

Continued on page 22


THE SKY WAS THE LIMIT.

AT&T has shattered the information barrier—with a beam of light.

Recently, AT&T Bell Laboratories set the world record for transmission capacity of a lightwave communications system—20 billion pulses of light per second. The equivalent of 300,000 conversations, sent 42 miles, on a hair-thin fiber of super-transparent glass. But that's really getting ahead of the story.

Actually, the 20-gigabit record is only one of a series of AT&T achievements in the technology of lightwave communications.

But what does that record mean?

The Light Solution To A Heavy Problem

All of us face a major problem in this Information Age: too much data and too little information. The 20-gigabit lightwave record means AT&T is helping to solve the problem.

For data to become useful information, it must first be quickly, accurately and securely moved to a data transformer—a computer, for instance. Getting there, however, hasn't always been half the fun.

Metallic pathways have a limited transmission speed, sensitivity to electrical interference and potential for interception—factors that reduce the effectiveness of today's powerful computers. Factors that are eliminated by lightwave communications technology.

Ten Goes Into One 20 Billion Times

Three primary components make up any lightwave communications system. On the transmitting end, a laser or light-emitting diode; on the receiving end, a highly sensitive photodetector; and in the middle, super-transparent glass fibers we call lightguides.

Installing these fibers is a major cost of a lightwave communications system. So, once installed they should stay put—increased capacity should come from fibers carrying more, rather than from more fibers.

Which brings us to the 20-billion bit-per-second story—about experimental technology that has the potential to upgrade installed fiber to meet any foreseeable capacity needs.

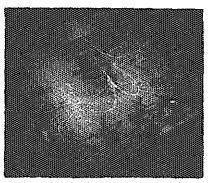
Using new, sophisticated lightwave system components, we multiplexed (combined) the outputs from 10 slightly different colored 2-billion bit-per-second laser beams into a single 20-billion bit-per-second data stream.

Playing Both Ends Against The Middle

But, let's start at the beginning—the 10 distributed feedback laser transmitters.

These powerful semiconductor lasers can be grown to produce light of different, but very precise, wavelengths. The lasers we used transmitted in the 1.55 micron (infrared) range, with only minuscule fractions of a micron between their wavelengths. The purity and stability of the beams let us pack their ten colors into the most efficient transmitting region of our single-mode, silica-core fiber.

To make the original 10 beams into one, a fiber from each laser was fed into a new lightwave multiplexer—a prism-like grating that exactly aimed each beam into the single transmission fiber. Over 42 miles later, a second grating fanned the beam back into its original 10 colors for delivery to 10 exceptionally sensitive avalanche photodetectors—receivers that convert the light pulses back into electrical signals and amplify them many times.



20-gigabit multiplexer

A similar avalanche photodetector was the receiver when AT&T Bell Laboratories set the world record for unboosted lightwave transmission—125 miles at 420 million bits per second.

From Sea To Shining Sea

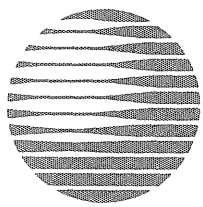
System capacity is important. But system reliability is vital. Especially when the system is going under 10 thousand miles of water—and is expected to last for 25 years.

AT&T is going to build the first lightwave communications system under the Atlantic Ocean. A similar system is planned for the Pacific. In 1988, laser beams traveling through two pairs of glass fibers will carry the equivalent of 37,800 simultaneous conversations overseas, underwater, from the U.S. to Europe and the Far East.

AT&T has manufactured and installed lightwave systems—as large as the 780-mile Northeast Corridor and as small as single-office local area networks—containing enough fiber to stretch to the moon and back. And the capacity of each network is tailored to meet the unique needs of its users.

Systems being installed in 1985 will be able to grow from 6,000 up to 24,000 simultaneous conversations on a single pair of fibers.

AT&T is meeting today's needs with lightwave systems that are growable, flexible and ultra-reliable. And anticipating tomorrow's needs with a whole spectrum of leading-edge lightwave communications technologies.



AT&T

The right choice.

Computer Crime from 19

This made the operator very puzzled. The next message made the operator nervous. It said: "If you don't give me a cookie, I'll crash this computer." A few minutes later the computer crashed. The crash brought several systems programmers into the machine room to see what was going on. They didn't recognize the message, either. The system was restarted and a few moments later the message "I want a cookie." reappeared.

At this point everyone was trying to figure out how to deal with this. Finally someone got the bright idea of typing "cookie" on the console. The system responded, "Thank you." A few minutes later the system again said: "I want another cookie." and later repeated, "If you don't give me another cookie, I'll crash this computer." So, again, somebody typed "cookie." Back then, Dartmouth ran its computer 24 hours a day but didn't have an operator present at night. Besides, operators had better things to do than type "cookie" every few minutes, so the systems staff started hunting through the system to try to find the bug. They were sure it was a trick program, so it had to be somewhere in the programs on the system. They looked everywhere, essentially turning the system upside down. They took programs out of the system piece by piece trying to isolate the Cookie Monster. But every time they started the system up the Cookie Monster reappeared.

Since Dartmouth really needed to have the computer running 24 hours a day, they hired a night operator simply to keep the Cookie Monster fed. This went on for several months and they still couldn't solve the problem.

One day a repair man was fixing a terminal attached to the Dartmouth computer when he noticed a strange box inside. Inside it he found a computer tape player and some electronics. The box would watch the data sent to the terminal by the computer, waiting for a particular message that the computer sent each time it was restarted. As soon as the message appeared, the box would connect itself to the computer as a privileged user and send it the Cookie Monster program. Since the program was hidden in the box, the Dartmouth systems staff never found it when they went looking through the computer itself. Dartmouth never really caught the perpetrator, though it was probably a former member of the computer staff.

Illustration by David Davis

New Laws

As mentioned earlier, few computer crimes are actually reported. Of those reported, only one in 33 actually lead to some form of prosecution. In the past, those computer criminals that are convicted seldom suffer a punishment fitting the crime. Jerry Schneider, who stole telephone equipment via telephone, served only 40 days in jail before he was freed to start up his own security business. The '414s' who earned fame as electronic trespassers could only be charged with a variant of making obscene phone calls.

Another example is a case in 1977 when employees were caught stealing computer time from a Sperry-Univac company in Philadelphia. They used the time to store and print music that they sold through the mail. The problem was at that time, there was no Federal law that specifically prohibited the theft of computer crime or data. The only thing they could be charged with was mail fraud for advertising their music through the mail.

Crimes related to computer bulletin boards are also hard to prosecute. Most of the people who read such boards are under the age of 18. The illegal bulletin boards are so well protected from outsiders that authorities have a hard time finding enough evidence to shut them down. When you consider that the laws governing minors are very liberal you can see how hard it is to prosecute the operators of illegal computer bulletin boards.

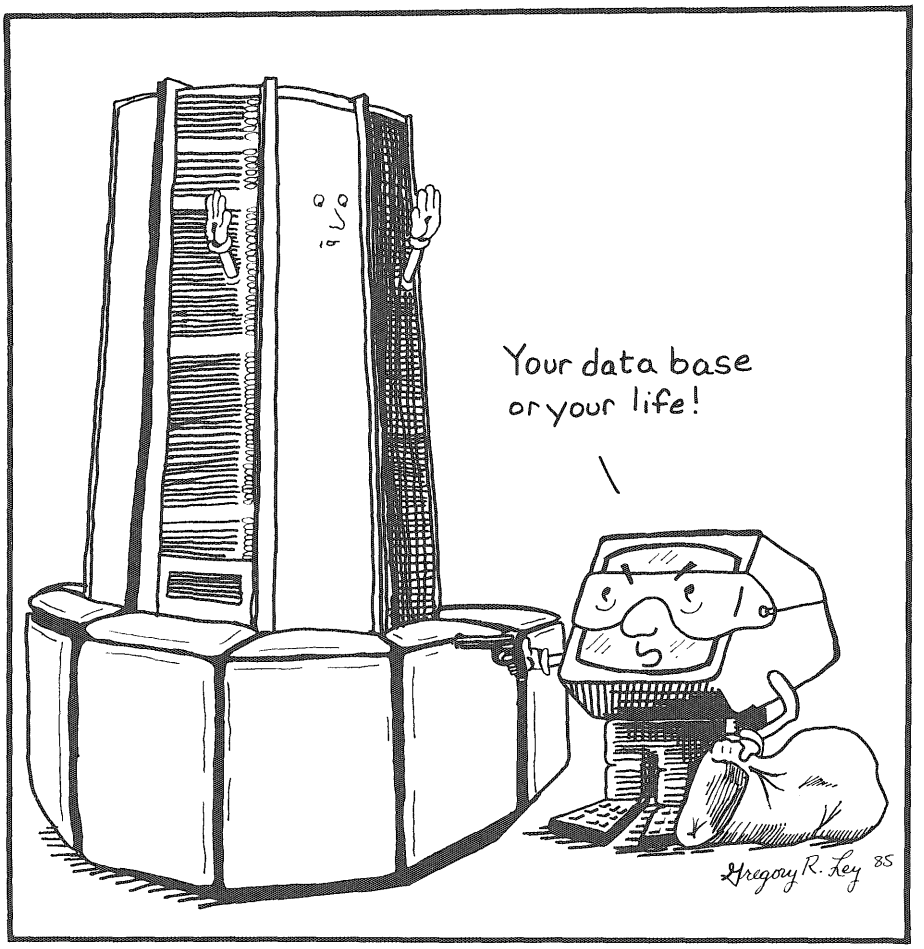
New laws specifically geared to crimes on and against computers are starting to appear.

The growing problem of computer abuse is not going unnoticed by legislators. New laws specifically geared to crimes on and against computers are starting to appear. For example, Massachusetts is considering a law that would allow a $5,000 fine and a year in jail for breaking into a computer. The punishment is triple if they can prove malicious intent. Many other states are also considering stiffer laws. A major problem is to formulate laws that are properly worded, since computer usage is different from using other forms of property. For example, some proposed laws made it illegal to extract any information from a computer without the owner's consent. Such wording would make it

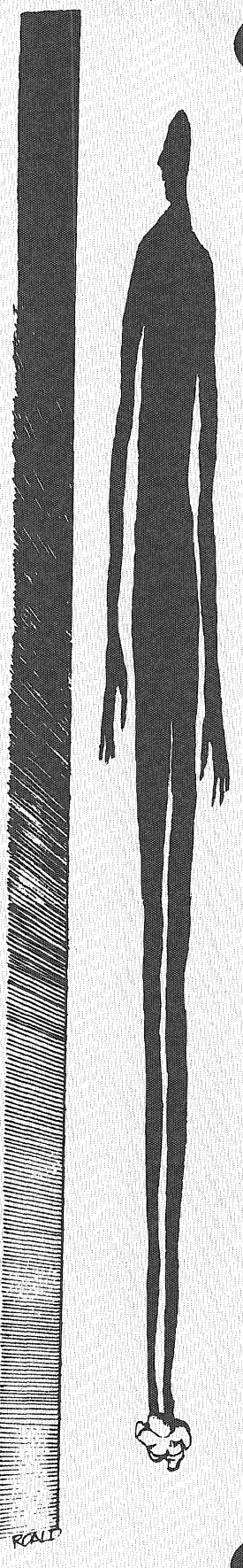
a crime to look at another person's digital wrist watch without permission.

New laws are starting to catch up with computer criminals. A recent example was Ronald Austin, a 20 year old UCLA student who confessed to cracking a Defense Department computer. He was also caught with $1600 worth of illegal airline tickets. He might have been released with a slap on the wrist a few years ago. Instead he was charged with 12 counts of maliciiously accessing a computer and faces a maximum punishment *per count* of $10,000 in fines and 8 years in jail.

Attitudes are changing and the laws are changing with them. Today, occasional trespassers are a nuisance and represent a threat to a computer system. People and organizations rely heavily on the information in their computers; the information is expensive to create and maintain and its loss could cause disaster. Legislators are working on new laws that reflect these concerns without needlessly hampering computer use. Victims of computer abuse are less willing to tolerate and ignore trespass.★



Science Fiction and Essay CONTEST



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Faculty Profile

Professor Starr refers to himself as a systems *engineer. In this context,* system *represents an interacting complex of people, resources and technology.*

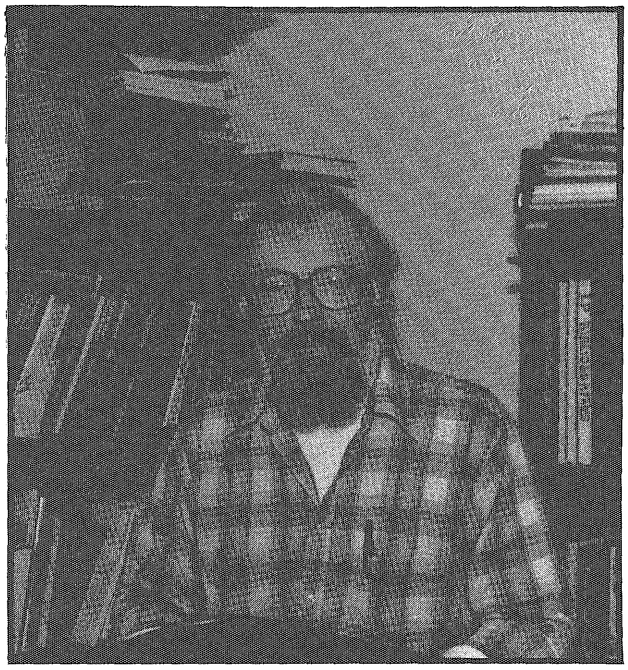


Photo By Mike McGee

By Debby Latimer

Professor Starr's students should consider themselves lucky for two reasons. First, they have the opportunity to take a class from a very well-educated and polished professor. Second, if fate had taken a different twist, the name Starr might have been associated with a famous racecar driver or designer. Throughout his high school years, Patrick Starr studied and read everything he could to fuel his strong interest in cars. Eventually, he built a racecar, and describes the experience with stinging, but subtle humor, "It took me two years to build it. The year that I put on the finishing touches, it was obsolete. Technology had passed me by."

As a college student, he became very interested in design and imagined building cars one day. Suddenly, and without much warning, an important realization occurred: a job should be kept separate from a hobby. Professor Starr received a Bachelor of Science degree in mechanical engineering in 1962, and worked for several years at Honeywell before receiving a Ph.D. in 1970. He began teaching an *operations research* course at the University of Minnesota in 1971 as a visiting professor. Convinced that the term Industrial Engineer underestimates the scope of his profession, Professor Starr refers to himself as a *systems engineer,* implying a much broader view of industry. In this context, *system* is best defined as an interacting complex of people, resources and technology. Beyond teaching *operations research,* a course in *design* and an *introduction to management* class, Professor Starr and a graduate student are currently involved in a fascinating research project with a local corporation. The project involves working with manufacturing people that are unfamiliar with formal analysis tools used to describe what manufacturing does. According to Professor Starr, "you do not manage a physical system. You manage the system that you believe to be out there."

He begins by interviewing people from various levels in the corporation in order to record their narratives as to how things work. Quite frequently,

there are incongruities or variances from one person's conception of things to another. From these descriptions, a series of prototype models of the manufacturing system are built using diagrams coupled with explanatory narratives. The next step is to give a presentation of the system incorporating criticism and revision into the existing model. This process is repeated several times until one model, with all its narratives, graphs and mathematics used to describe the system is agreed upon by everyone as a unified representation of their manufacturing system.

Two important things happen from this sort of approach: a dialogue among the workers is stimulated that had not existed before, and they see the totality of the system described as well as everyone else's perceived connections to it. "I call this a neutral format and refer to myself as a concept broker." Therefore, the end result is a description of the perceived system. The model can then be subjected to changes. It can be questioned and explored. For example, a question such as the following might arise: could we use this kind of robot in manufacturing? If so, would a different materials handling scheme be called for. The final step of such a process is to build a computer simulation model called a decision support system. Designers and floor managers would have a terminal that they could log on and play with by asking questions.

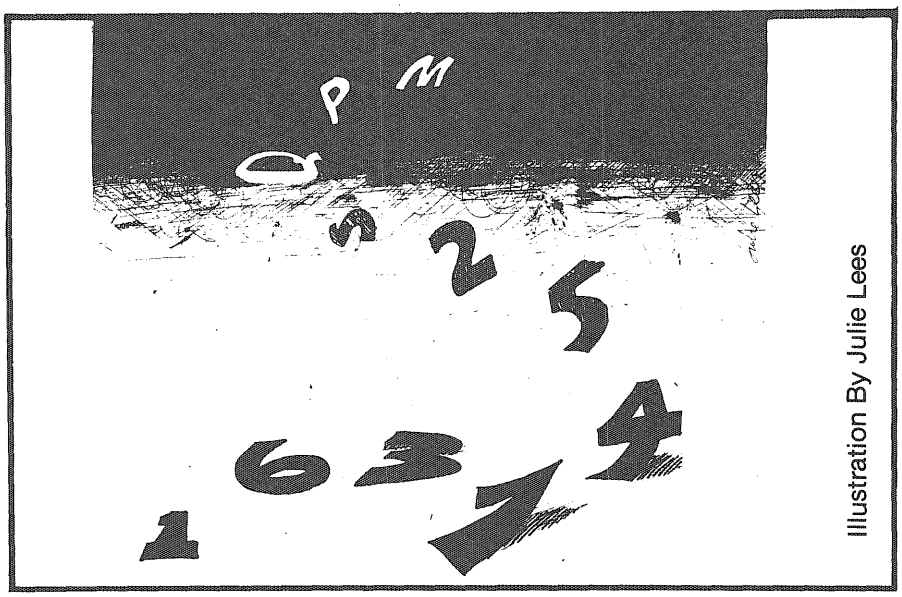


Illustration By Julie Lees

Professor Starr is interested in how things work. In descriptions that involve processes, resources and people. Whether it is a manufacturing system or an international grain market. He believes that they are all sort of the same in the way you think about them. Searching out places where decisions are made, interactions, whether information is available, who has it, how is it organized. Those are the sorts of questions that are independent of the contents.

Professor Starr has an interesting teaching style. He is extremely well-organized for each class. What is written on the board is very clear, and hand-outs are distributed to avoid unnecessary drawing of tables or charts. The use of a computer in his classroom has become essential. The first year that he taught *operations research* he did not use a computer. However, according to Professor Starr, many of the math operations that are described can apply for what is called an iterative solution technique. This can be best described as a person with a blindfold walking up a hill with a cane trying to find the top. If the ground feels higher in one place than another, he goes that way. Every step he takes is an iteration. He explores, decides and goes. The computer program does essentially the same thing. The solution is analogous to getting to the top. When all the land is downward, he concludes that he must be at the top. This represents a stopping point. Trial and error implies that you know something about your error that will help you on your next trial. Most of these math techniques require a lot of repetitive calculation. The numbers change each time but the cycle, decision go-that-way- is repeated. The next year, a computer was used in the *operations research* class.

In many ways, Professor Starr views the use of the computer in his course as a way to free the student from repetitive tasks, thus allowing more imaginative projects. But, in no way does the computer replace any part of a student's education. At various points in the tutorial, the student can do a problem by hand and see that the steps are exactly the same as what the computer is doing. Then, the student tries a more difficult problem and writes a narrative explaining why it is doing what it is doing. So, the student must understand how and why a problem is done. If you become a student in Professor Starr's class, the following represents a typical assignment: The math for a particular model is gone over by hand, then using a computer. The students will then design a decision-making situation where they invent a context by narratives, or numbers and use the program to evaluate three or four alternative courses of action. It is not just a question of defining the problem. It is a decision situation with alternatives, each having unknown consequences. The program is used to find the consequences. The final step is judging which is the best solution. For example, just because something has the lowest cost, the control may not be cost in that particular context. The students are asked to change the data and write narratives on why they have changed it as well as make observations about how a solution is changing. This all takes place in the beginning *operations research* course.

Professor Starr is a thinker. When asked to describe, with a symbol, the problem solving skills necessary in his classes, he immediately responded by saying, a cloud. Boundaries are difficult to define. Professor Starr is less interested in the pieces than how they fit together and where they stop. "The essence of life lies in balancing the ambiquities with the detail." ★

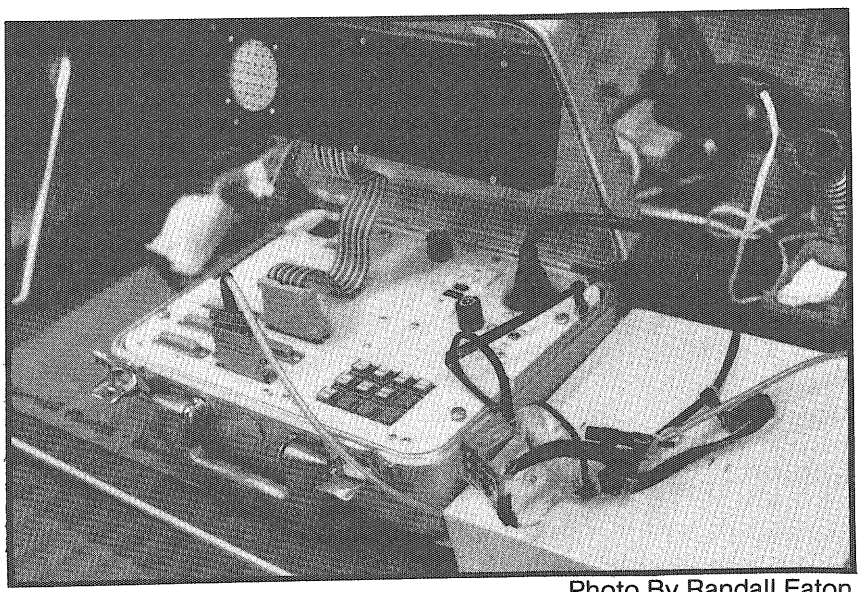
Rehabilitation Engineering

The goal of engineers working with the disabled is to maximize the potentials of the individuals involved so that they can function as well as possible in society.

By Debby Latimer

The Courage Center is a remarkable organization. One could even say that it is the personification of hope for many mentally and physically disabled people. They offer a variety of educational programs and activities while maintaining a client-services program oriented toward the application of technology for the disabled. In a sense, they are "machine tailors", engineering devices and software to fit the individual needs of the disabled.

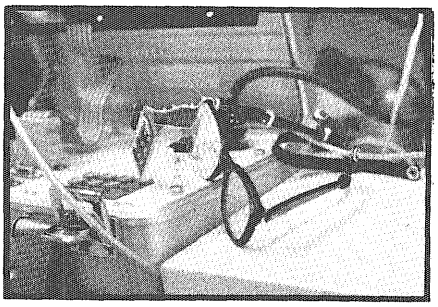
On a recent visit to the center, I spoke with Ray Fulford, chief engineer, about a new device that will soon be available at the facility. It consists of a pair of glasses with a sensing element attached to the arm of the eyeglass that feeds back into a computer. This allows the wearer of



Eyecom

Photo By Randall Eaton

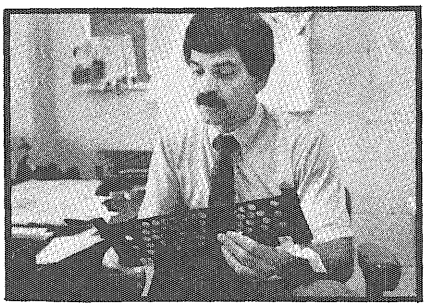
Rehabilitation from 27



the glasses to look at a display which is contained on a panel just in front of the glasses. By looking in certain areas of that display, the individual can choose letters or characters and have them printed out in a message on the screen. The mechanism operates by tracking the user's eye movement. This device will be used by people who cannot speak or have limited function and cannot use a keyboard. Currently, the software for this device does not have the capability to operate as an alternate keyboard for a computer. The system will be modified so that the characters selected will be dumped into a microcomputer, giving the individual full access to all the various functions. This is just one example of the technology used by the Courage Center. It is important to note that the Courage Center offers an engineering program oriented more toward the applications of technology as opposed to basic research and development. They have a large population base at the center and therefore, they identify individuals who can take advantage of the technology.

The goal of the engineers working in this environment serves as a common thread running throughout the Courage Center as well as other rehabilitation centers: to maximize the potentials of the individuals involved so that they can function as well as possible in society whether they are significantly mentally or physically disabled.

There is a lot of technology and equipment that does allow them to function in an enhanced situation. For example, to move into an apartment or become vocationally independent. The contrast between what Dr. Max Donath is doing at the University of Minnesota in the area of gait analysis (see *Minnesota Technolog*, Winter Two, 1985) and what is done at the Courage Center is based on the notion that the Courage Center is involved in the mainstream of individuals, injecting technology at a variety of points along the rehabilitation process as opposed to sitting down and looking at a particular problem such as gait. They look at how the disabled individual can interact with technology.

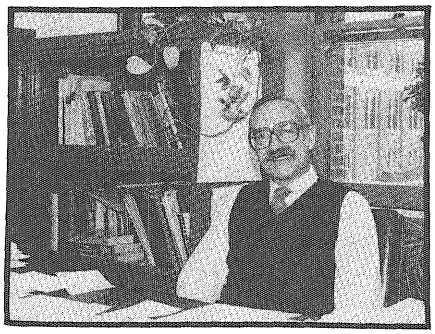


Fitting over a standard keyboard, this device serves as support to inhibit random movements.

Another device created at the Courage Center is a less sophisticated instrument, but without it, many disabled people with a lot of spasticity in their hands who cannot use a standard keyboard, would not have access to a microcomputer. The device, as shown in figure 2, fits over a standard keyboard and serves as support to inhibit random movements.

Many people that come to the Courage Center have cognitive difficulty or visual defects that interfere with the operation of a piece of software. Stroke victims often have what is called "field cuts" where only one half of their visual field is functioning. The Courage Center has modified programs that force the person to compensate for their problem, therapeutically reinforcing this compensation in their daily activities.

It is interesting to note that Mr. Fulford did not initially have a medical background. He graduated with a degree in mechanical engineering and immediately took a job in engineering rehabilitation. At first, most of his work concentrated on mechanical design of artificial limb parts. While returning to university to finish his Masters Degree, part of the course work involved a stint in medical school. There were a certain number of projects that exposed students to medical jargon. According to Mr. Fulford, engineering rehabilitation is a job that offers a lot of personal feedback that is not always available to engineers. There is also an enormous variety of projects on the go at any one given time. In the past, Mr. Fulford has worked very closely with Dr. Frohrib in the medical engineering department at the University of Minnesota. I had the opportunity to speak with Dr. Frohrib who has been working with students in the senior level design program on rehabilitation projects for the last five years. His students have been developing prototype devices for the St. Paul school district. A whole range of instruments have been designed and built; however, the difficulties have often been associated with patent



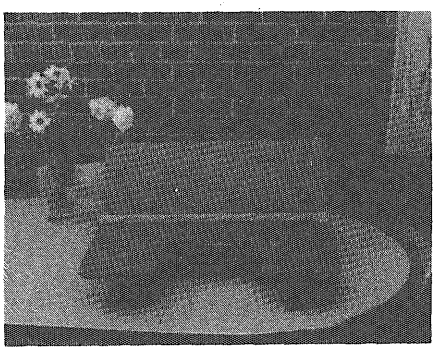
Dr. Frohr ib

rights, product liability and continuity—given that it is almost impossible to develop a device in ten weeks. Obviously, some special legal strategies are needed in the institutional setting. There have been many good designs produced but the university can only make *one* prototype. Unless the questions of product liability are settled and a manufacturer is found, a very good device needed by numerous students will be shelved. Traditionally, universities farm out their patents to satellite companies in the area. In the case of rehabilitation devices, the profit margin and demand are not motivating factors for company participation.

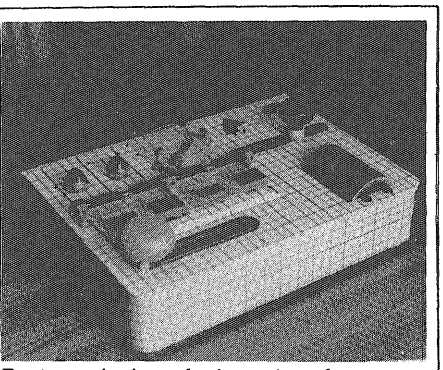
Dr. Frohrib's students have been developing prototype devices for the St. Paul school district.

Dr. Frohrib is certainly the professor to speak to if you have an interest in engineering rehabilitation. With a degree in mechanical engineering as well as biomedical engineering, his interest in engineering rehabilitation was present even before his departure from MIT in 1953. At that time, biomedical engineering, which encompasses all the disciplines that relate to the phenomenology of the human body in relationship to the engineering disciplines, was not a true field. One was more of a medic trained in engineering. For Dr. Frohrib, engineering rehabilitation is truly a passion. He describes rehabilitation as a stimulating field made up of special ingredients: intimacy, personal rewards and frustration. Dr. Frohrib often tells the students in his *creativity in engineering course* that before coming to Minnesota, he was in the aerospace field and never saw one of his designs. They all went into a hopper of larger scaled efforts.

For more information on engineering rehabilitation, contact the volunteer number of the Courage Center. It could be just the job for you. ★



Prototype device of an adjustable wheelchair tray. Designed by Cindy Dreier, Sue Witchraft and Nhue Duong.



Protype device of a busy box for severely handicapped children. Designed by Julie Schweitz, Robert Fluhrer and Bruce Olson.

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Alumni Profile

Photo By Mike McGee

Timothy Salo received a Bachelor of Science degree in Computer Science from the University of Minnesota in 1978.

By Timothy Salo

I was recently asked to make some brief comments about how my experiences at the University relate to my career in industry. In this article I will share my reflections on my transition from academia to industry and offer a few free tips to Institute of Technology students who will soon seek their first job.

The most valuable part of my University experience was the opportunity to work as an Undergraduate Research Assistant for the University Computer Center (UCC). This student job provided real-world programming experience which nicely complimented my course work. As a result, I left the University with a solid theoretical background from the Computer Science Department as well as extensive practical experience programming operating systems. In fact, I enjoyed work at the Computer Center much more than class attendance, a state of affairs which extended my tenure at the University by several years. I received a B.S. in Computer Science in 1978 while working full-time as a systems programmer at the Computer Center. This job provided my first exposure to data communications software. I worked on the medium-speed (SUPIO at the time) and the high-speed (EXPORT) remote batch subsystems under the NOS operating system.

In 1979 I moved to NCR Comten as a Systems Programmer. (NCR Comten develops and markets communications processors which enable computers and terminals to communicate, typically via telephone circuits.) My initial assignment was on a team developing systems software which enables NCR Comten processors to connect to X.25 packet-switched networks. (X.25 is an international standard which specifies protocols to be used when connecting to packet-switched data networks.) I was lucky to work with X.25 because the major use of X.25 at the time was in Europe. This enabled me to spend five weeks in Paris testing the product, as well as sightseeing. (Unfortunately, I had neglected to learn any French at the University; on the other hand, years of University exams fully prepared me to proceed coolly in the face of inadequate knowledge.) I have also worked at Comten as a Systems Engineer responsible for the high-level design of X.25 software and as the Manager of the C compiler development team. I am currently the Senior Product Manager responsible for Comten's X.25 products. This position is particularly exciting because I am responsible for recommending and selecting the new products which Comten must develop in order to remain at the forefront of its market.

I have observed two major differences between life at the University and my responsibilities in industry. First, my focus at the University was on learning; I had little opportunity to apply what I was learning. In industry my focus has been on doing. I find it thrilling to apply my education in the creation of tangible results, such as the development of new products. Second, while at the University I had a very narrow perception of the opportunities in industry for which my education was preparing me. Once in industry, I quickly found that there was a much wider range of opportunities to apply my Computer Science degree than I had imagined as a student. My education prepared me for these opportunities because it taught me more than the basics of a specific technology; it developed my ability to think critically and analytically. The University continues to contribute to my formal education through courses in Computer Science, Electrical Engineering, and more recently, Business.

I offer you a few tips based upon my review of hundreds of resumes. The most important thing to understand about a resume is its purpose: **The purpose of a good resume, and the associated cover letter, is to get you the right job interviews.** Many managers find interviewing candidates time consuming, even dull. Therefore, most managers limit the number of people they interview for a position. You want your resume to ensure that you are one of those interviewed. Some managers sort resumes into three piles: a few resumes in which the manager has no interest, a very few outstanding resumes which the manager will definitely interview, and the rest, usually the largest number, which look no different than most resumes from recent graduates. This sort is often performed very quickly; your resume may have only a minute of the manager's time to show that you are a candidate who must be interviewed. Your resume should immediately place itself in the "must interview" pile. There should be something on your resume which differentiates you from the other recent graduates. One of the best sources of attention is a student job related to your career goal. Other good attention-getters include a good academic record, leadership activities, or clearly-stated career goals. If you lack these, list interesting achievements, even if they are not directly related to the job for which you are applying. If you have flown the space shuttle or discovered a new planet, say so. The manager reading your resume may interview you just to see what sort of student flies for NASA. Once your resume has done its job you will have an opportunity to sell yourself in person to your prospective employer.

Good Luck! I wish all of you well in your studies and hope that your experiences after graduation will be as exciting and challenging as mine have been. I hope that you find and take advantage of the breadth of opportunity which industry can offer you.

Assigned Reading

Quantum Physics And Reality

By Renee Bergstrom

***In Search of Schrodinger's Cat,* John Gribbon, Bantam Books, 1984, paperback, 302 pages.**

In Search of Schrodinger's Cat is a book about quantum physics and reality. Author John Gribbon has set about detailing the developments in quantum theory from its inception to the present.

Introducing quantum theory, Gribbon sketches out the classical theory's reaches and difficulties. From this starting point quantum is developed with interesting biographical notes on the men responsible for the revolutionary ideas.

Schrodinger's Cat spends half its time developing quantum theory and the other half arguing quantum mechanical reality. Of the two halves, reading about the development of quantum was intensely more interesting, although the reality debate of quantum theory opens doors for interesting topics such as parallel worlds and time travel.

The book has its merits and demerits. The historical overview of the development of quantum theory with all of the scientific bickering between scientists yielded a more human characteristic to quantum theory along with a better appreciation for and understanding of the scientists themselves. The book in this respect succeeds in demystifying scientists such as Bohr, Schrodinger, Einstein and Dirac among others. Such an accomplishment should be applauded since it makes quantum theory at least feel more approachable.

On a more downward note, the book does not introduce the actual equations and formulas but the basic ideas involved with quantum. Since the book moves fairly rapidly over the developing theory, understanding and grasping what the author is referring to often requires some background in quantum itself. This is unfortunate because the language of the book would suit a layman but the concepts are glossed over too quickly for a quantum novice to glean much useful information. For an individual somewhat familiar with the theories, the book serves as a fairly good refresher and review.

In Schrodinger's Cat, the author spends half the time developing quantum theory and the other half arguing quantum mechanical reality.

Another point involves the author's reality arguments. The points seem to be hashed over and over with very little progress in any one direction or the other. This made much of the later material dry and uninteresting.

Despite the drier moments, Gribbon has conjured up images of "quantum cookery" and the benefits that quantum theory has produced as well as describing experimental reality situations encountered by physicists, "In the quantum world, what you see is what you get, and nothing is real; the best you can hope for is a set of delusions that agree with one another."

If you're interested in quantum theory and would like to get a better biographical picture of what has been going on, this book will captivate you.

***Chapterhouse: Dune,* Frank Herbert, G.P. Putnam's Sons, 1985, hardcover, 464 pages, $17.95.**

Frank Herbert continues his Dune saga in *Chapterhouse: Dune,* the sixth of such novels. *Chapterhouse* picks up the story a few years after *Heretics of Dune* leaves off. Many of the same characters have returned and the problem facing the Bene Gesserit order, the Honored Matres, still remains and has begun a program against the Bene Gesserit Sisterhood. The Sisterhood is forced into desperate measures as a sign of the times and the plot revolves around the decisions and actions taken to preserve the Sisterhood.

Despite the fact that this is the sixth novel in a series, the topic is still fresh and holds enough secrets that the material comes across as surprising while remaining familiar. Herbert is certainly the master and *Chapterhouse: Dune* reflects this.

Piece by piece Chapterhouse is a success. The characters are interesting, each one with his/her own thoughts, viewpoints, goals, etc., instead of merely presenting different aspects of the writer. The only real problem that exists in the characters involves Sheeana. This character has a bigger importance than what Herbert wrote.

The pacing of the story is rapid. Though the characters do spend time in internal reflection, the events transpire quickly, almost tumbling out on the page. With this pace however, the flow of time is unsteady in the book. There are a few flat references to the passage of time that Herbert could have worked into the text more effectively than he did.

Overall, the story is compelling. The characters are sensitive and sensitize the reader to their dilemmas, pain and problems. This novel is a definite *must* for Dune fans. ★

Practical Pointers For Living On Your Own

By John Krumm

Living on your own can be a trying experience at first. Away from your parents, you may be startled to realize that you can't even muster the ability to prepare toast, much less dress yourself every day. Without thoroughly knowledgeable assistance, minor difficulties can grow, turning your life into an ugly circus of never-ending horror. (I hate it when that happens.) Having lived on my own for what seems like weeks now, I have acquired the skills necessary for such an existence. This discussion is intended for those of you just starting out away from home, and also those of you have have been living that way for a long time, but have yet to get the hang of it. I'll concentrate on some of the more mundane skills like eating and cleaning and leave the important items like throwing parties and watching television to you.

Eating, you will soon discover, becomes a chore for the most part when there isn't someone around to cook for you. This means you should put as little effort into nutrition as possible. Eating out is, of course, the best alternative. To save money, you may want to stick to some of the many fine hamburger outlets in our city. Short-sighted detractors of this practice may argue that hamburgers every night can become a dreary dance of banal tedium. Well, they're right. But you can vitalize this routine by exploiting the near-infinite variety of various ingredients on your burger. The Big Mac alone lends itself to 255 different variations.* Order one without meat or a bun, and you've got a uniquely delicious chef salad. For a healthy vegetable side dish, take only the onions and pickles.

There may be times, however, when it's best to make something yourself. If you're paying rent on a kitchen, you should at least learn how to turn on the stove. Here at home, your best bet is some sort of T.V. dinner or perhaps a boil-in-the-bag main course. The instructions on these foolproof delicacies usually consist of little more than a time and a temperature, but read carefully just to make sure. Some T.V. dinners require that you painstakingly remove the foil cover from the hearty dessert module. If you have any questions, your grocer will be happy to help. Don't be afraid to let yourself get creative, either. Smear some Mexican Delight on your Swiss Steak for a cross-cultural gala of culinary ecstacy.

Cleaning can be broken into two categories: doing it or not doing it. The natural progression is to start with the latter and then move to the former after you develop respiratory trouble. When it finally comes down to you and the roaches, there are some shortcuts to remember. Camouflage is as effective in the home as it is one the battlefield or on those channel 2 wildlife shows. If you have the opportunity to choose new carpet, spend some time beforehand estimating the approximate size and color of your most common dirt. An intelligent choice here can save time and money on your vacuuming expenses.

Although no one spends much time in the bathroom (unless they're sick), it seems to exemplify the worst cleaning problems. Bathtub scum, although not pretty, should be left alone. It provides an important no-slip feature that could prevent an embarrassing mishap as you try to do the shower version of one of Pete Townshend's famous windmill guitar solos. Anyway, black scum is a lot nicer to look at than "Festive Bathtub Traction Daisies." Don't worry about cleaning up all the hair that seems to accumulate in the bathroom, either. Given a few weeks, all hair will migrate to the edge of the sink (to spawn, I suppose) where you can elimiate it with one fell swoop.

The question of which cleaning chemicals to use has boggled some of the best cleaning experts of this

*Big Macs, according to the old commercial, have eight ingredients, counting the twoallbeefpatties separately. You may eliminate any number of these eight in any combination, leading to the equation

$$n = C(_8^1) + C(_8^2) + C(_8^3) + \ldots + C(_8^8) = \sum_{i=1}^{8} C(_8^i) = 255$$

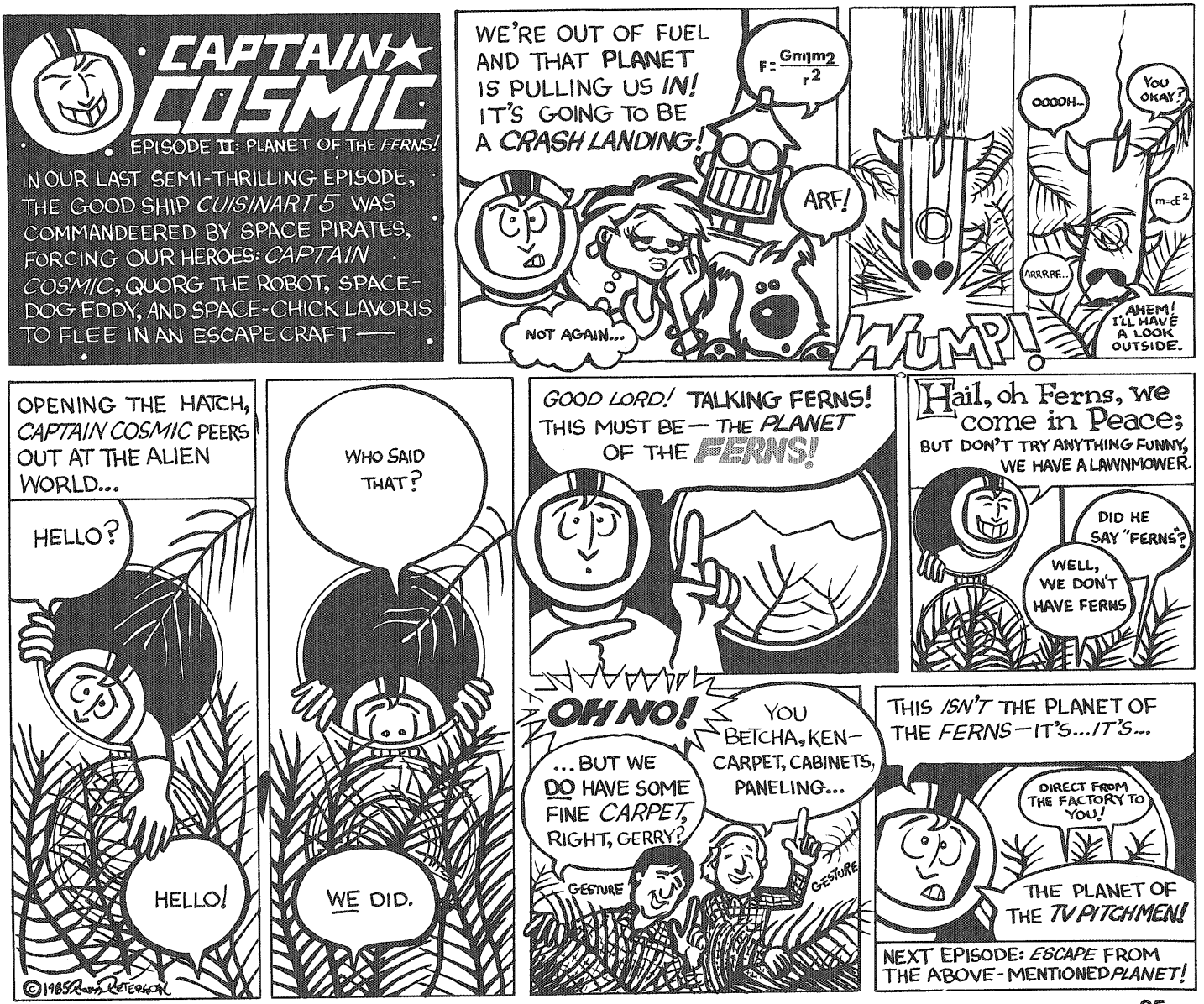
where n is the number of possible Big Macs. When you consider all the different hamburger stores with all their different hamburgers with all their different ingredients, the number of combinations would astound even Carl Sagan.

century. A friend of mine has answered the question once and for all: Easy-Off and Lime-Away. Yes, these two simple words (well, actually four fairly simple words plus one simple word "and", or, really a pair of moderately simple hyphenated pairs separated by one very simple word) are your keys to cleanliness. The great thing about Easy-Off Oven Cleaner is that it works on everything from sinks to shelves, from pots to pets. What Easy-Off can't do, Lime-Away can. They are both convenient in that you apply them once and let them do the work. After a light misting of Easy-Off in the morning, I can actually feel the dirt being lifted from my body as I ride the bus to school.

Getting along with your roommate, if you have one, is an important component of living away from home. The key here is tolerance and togetherness. If you find your roommate sitting around burning beaver dung incense and listening to the Mutant Surf Punks, go grab your stamp collection and rap about the highly prized 1926 White Plains souvenir sheet. The sign of a true friend is one who is not afraid of giving unsolicited constructive criticism or helpful advice. Examples include "We might have better luck with our fish if you wouldn't wash your feet in the aquarium," or "Sunglasses could divert attention away from your festering eye wound."

Finally, it's important to keep in close contact with home. Remember, if you call, they'll call, and if you write, they'll write. This is important when you realize how much easier it is to send money through the mail than over the phone. Your mother can provide valuable advice on how to fold a sweater, when to blow your nose, and what to do if you're sick. If you are sick, you should take your temperature before you call home. As far as the thermometer itself goes, I recommend the mouth kind unless you have a very outgoing roommate.

I hope these hints will help you in your life away from home. Just remember these few words of wisdom: "When in doubt, save it for later in Tupperware," and "When it starts to move, it's O.K. to throw it away." ★



THE

Art by N.B. Read

By John Bremer and Sallie Sjerslee

Mei Ling gave the flask a final twist, nodded to Dr. Tzu, and stepped back. Her eyes glanced up and followed the curvature of the huge electromagnet. From the windings of the coil she followed the arch up, over and down to where it terminated at the surface of a quartzite sphere two meters in diameter. The whole apparatus was the work of Dr. Tzu, who formulated the core material that enabled incredibly dense magnetic fields to be generated. Mei Ling's eyes came to rest on the flask she had just attached to the sphere. Following Dr. Tzu's instructions she had taken the flask from the cryogenic vault where dozens of similar containers were stored. Frost-covered, it now clung wart-like to the side of the crystal sphere.

"Composition, Mei Ling?" called the voice of Dr. Tzu.

She stepped forward and brushing the condensation from the identification plate and replied, "Carbon—10 units, hydrogen—40 units, nitrogen—30 units, oxygen—20 units, trace element mixture—7837."

Dr. Tzu stepped to the desk-sized computer, a HAL 2000 model, and punched in the parameters via a keyboard. The console lights flashed and paper rustled as the operations were recorded.

"Prepare to energize," came the command.

Mei Ling turned to a console and depressed several switches. After a moment she noted several readings on meters and recorded them on a notepad.

When her notetaking was

UNIVERSE MAKERS

Science Fiction Contest Winner From *Minnesota Technolog* 1977

completed, she approached the sphere and peered intently into its interior. The lights in the room faded and only a few panel indicators and the console lights furnished illumination.

"10 seconds to energization."

Mei Ling's skin prickled as she imagined the tremendous currents starting to flow through the windings of the electromagnet. Soon, the very air near the magnet seemed to pulse and throb in response to the magnetic fields forming and building between the poles.

Mei Ling turned her attention to the sphincter valve to which she had earlier secured the flask. It pulsed and a small puff of gas entered the sphere where it was immediately gathered in by the magnetic fields and compressed into the center. Rhythmically, the valve pulsed again and again. Each time another wisp of gas was seized by the intense fields. The tiny ball of gas at the sphere's center began to glow. The valve stopped operating and paper rattled as the computer spat out several pages of data.

The gaseous ball started behaving differently. The ball was flattened and compressed, kneaded and twisted. It writhed and glowed even brighter. And then "the transformation" occurred.

Mei Ling uttered a gasp of surprise and awe. Where there had been a writhing twisting gaseous mass, there was now a slowly expanding mass of pinpoint-sized lights. So intense were these tightly packed points that in the darkened room it hurt her eyes to look at them. As the pulsations from the electromagnet slowed, so did the expansion of the mass of lights.

Mei Ling stepped back from the sphere as Dr. Tzu wheeled over an electron camera and directed it against the surface of the sphere. Moving to the rear of the camera Mei Ling looked into the viewer. On a relatively low magnification, the points of light grew larger and were transformed into spirals. Fascinated, Mei Ling watched as they slowly came into focus and then drifted out, only to be replaced by others. She increased the magnification even further and the spiral, slowly coming into focus, resolved itself into millions of tiny light points, a miniature galaxy. It blurred and another took its place, this one edgewise. Reluctantly stepping back, Mei Ling surrendered the instrument to Dr. Tzu who made the final adjustments.

Soon the camera started an erratic, subdued clicking as the computer controlled the photographic device at the critical time when an object was in focus. Several hours passed during which the camera continued its clicking while the computer output data on its printer.

"Prepare to deactivate."

Dr. Tzu's voice broke Mei Ling's concentration. She quickly assumed her place at the console and prepared to record readings.

Dr. Tzu once again made adjustments at the computer's console and the fields generated by the electromagnet again seemed to cause the room to vibrate.

Mei Ling's instruments monitored the size and growth rates, field densities and emanations generated inside the sphere. The readings now showed that the growth of the universe had ceased and the final phase, the decay period, would begin.

"Growth has stabilized, Dr. Tzu," Mei Ling reported.

"Good," responded Dr. Tzu. "I can handle the rest by myself."

"I'd like to stay awhile and watch the decay," said Mei Ling. Returning to the sphere, she became completely absorbed in the scene before her eyes. She adjusted the viewer and brought a galaxy into focus. Raising the magnification, she watched. The tiny pinpoints of light composing the spiral now in focus shone coldly. Now and then one would flare with increasing brilliance and then slowly die out.

While Mei Ling was watching the decay, Dr. Tzu stopped the camera momentarily and retrieved the pictures that had been taken during the experiment. Then he reset the camera, making additional adjustment settings for the final phase just beginning. Dr. Tzu handed Mei Ling the stack of photos.

"See any you like?" he asked, taking a seat near her so they could look over the pictures together.

Mei Ling nodded in approval as she observed the pictures, each seemingly more breathtaking than the previous one. The pictures unveiled galaxies, nebulas, star clusters, single stars, binaries and occasionally, a planet.

"Look," exclaimed Mei Ling. The photo she held showed a distant yellow sun and in the foreground was a planet with rings. "Isn't it beautiful."

"Like Saturn," remarked Dr. Tzu, suddenly caught up in the beauty of the photographic exhibition.

They looked at the next picture, a planet. Wreathed in feathery clouds, its watery surface gleamed, broken by continental outlines. Mei Ling gasped when she saw the planet.

"No . . . no!" stammered Dr. Tzu as he ran to the console. "We've got to reverse the decay!"

Mei Ling did not respond as she helplessly looked up at the evening sky through the window above her. Her throat constricted in terror as one by one the stars winked out. ★

TechnoTrivia

By John Krumm

Questions

1) When you change altitude, you can often feel pressure in your ears. Why is it that you can relieve this pressure by yawning?

2) Which state posted the highest overall SAT scores in 1985?

3) At what time are people most likely to make an error in judgment?

4) Why do White Castle hamburger patties have those little holes in them? (fabulous bonus if you can give two reasons)

5) Believe it or not, you can make a quickly rotating object seem to stop by humming at the right frequency. Why?

6) How many Calories must you use up to lose a pound?

7) True or false: Leonard Nimoy, who played Spock on Star Trek, has the largest nose hair collection in the nation.

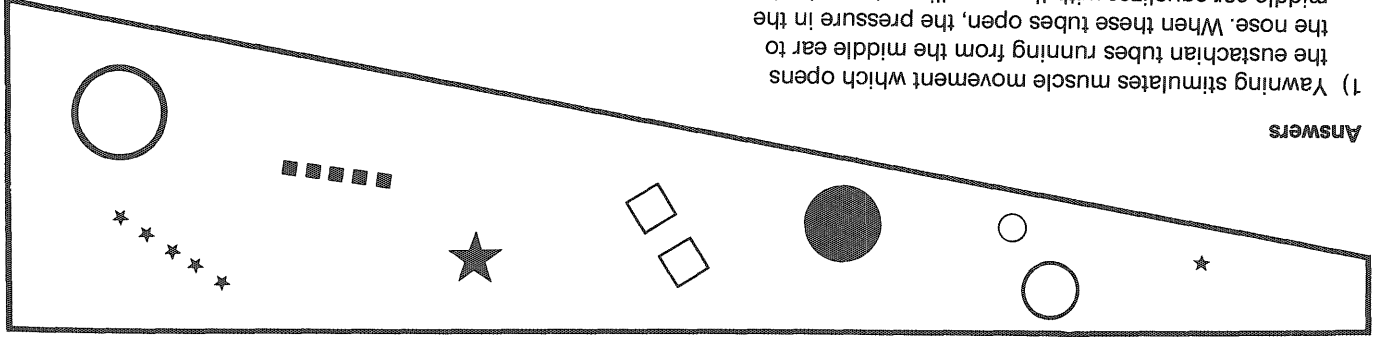
8) Within 10, what's the largest prime number ever found? (no calculators, please)

9) Why are women so fat all the time? No, let me rephrase that .... Why do humans of the female persuasion often have a more difficult time of losing weight than their counterparts of the opposite gender?

10) What's the fastest lane to run in on a curved track?

Scoring

0-1 You have the mind of a D cell.
2-4 Are you sure you understood all the questions?
5-7 Incogitably, untenably, implausibly fair
8-10 You boot-licking liar, oh, you milk-livered fibster



Answers

1) Yawning stimulates muscle movement which opens the eustachian tubes running from the middle ear to the nose. When these tubes open, the pressure in the middle ear equalizes with the prevailing atmospheric pressure.

2) South Dakota ranked first with 1,109. Minnesota came in tenth with 1,018. The sole Iowan planning to take the test was disqualified for not bringing two sharpened #2 pencils along.

3) Chronopsychologists say the highest risk comes between 4 a.m. and 6 a.m., so be on guard the next time you're having complicated dental bridge work during this period.

4) One reason is that the holes allow steam to come through the patty to the bun which sits on top while the burger is cooking. They also allow even heat distribution so the patty doesn't need to be turned while frying. If you knew both reasons, your bonus is the satisfaction of knowing that you knew. Congratulations.

5) Humming vibrates your eyeballs through your facial muscles. At the proper frequency, your retinas shift such that the image appears to stop. It's sort of like how a wagon wheel seems to stop spinning when a wagon slows down in a film.

6) 3,500 Calories. Take credit for 3,000-4,000.

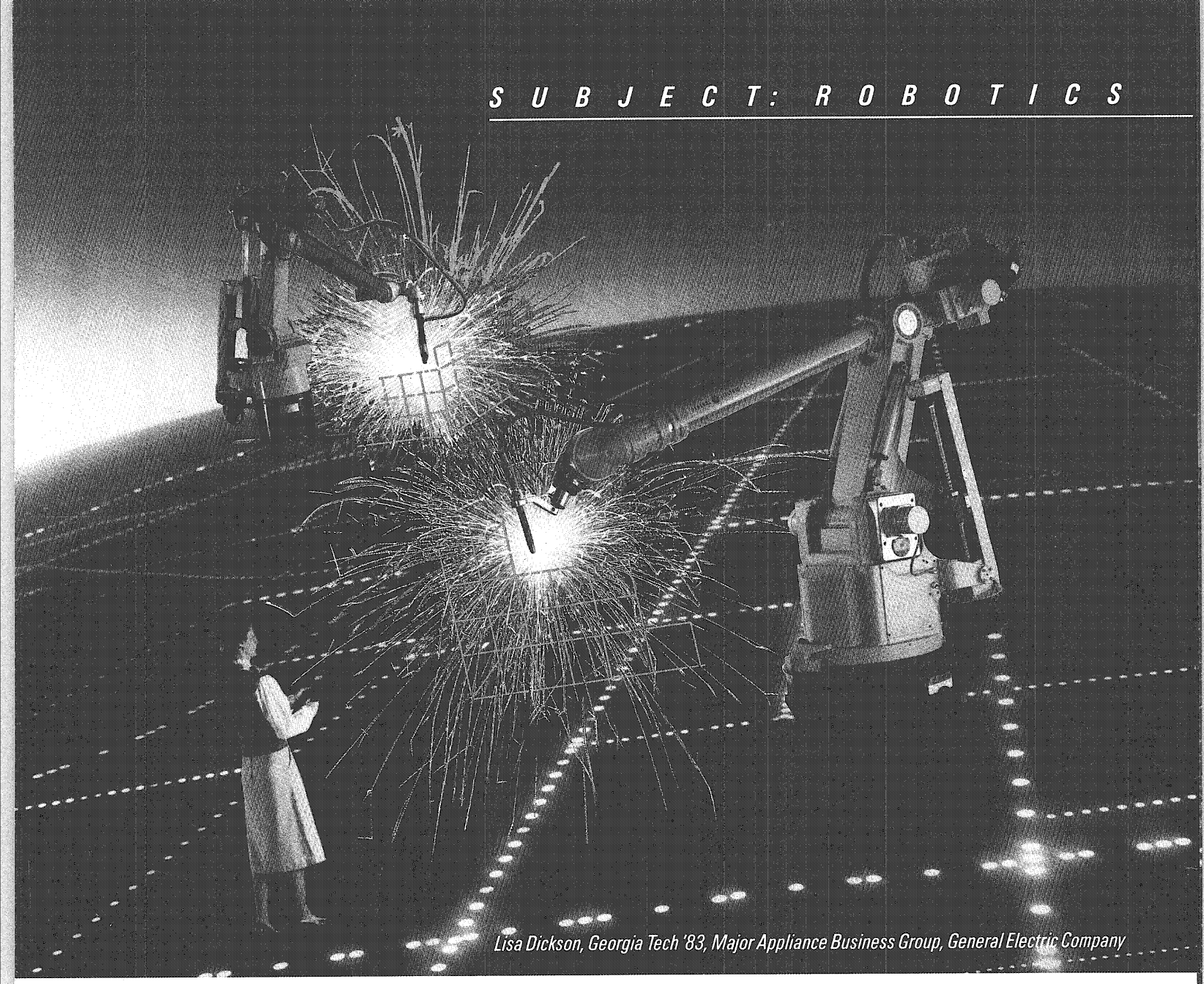
7) False. His earwax collection, however, is unrivaled in the Western Hemisphere.

8) You're right if you guessed 2216,091 - 1. Yes it has 65,050 digits and took over three hours to calculate on a Cray X-MP computer. It was found in early September by Chevron scientists in Houston. Oh heck, take credit if you were within 15.

9) Women normally have a higher percentage of body fat, while men have more muscle (me, for example). Fat is metabolically less active than muscle, so women burn fewer calories.

10) The outside lane is fastest because it requires the least amount of ankle effort to maintain centripetal acceleration around the curves.

S U B J E C T : R O B O T I C S



Lisa Dickson, Georgia Tech '83, Major Appliance Business Group, General Electric Company

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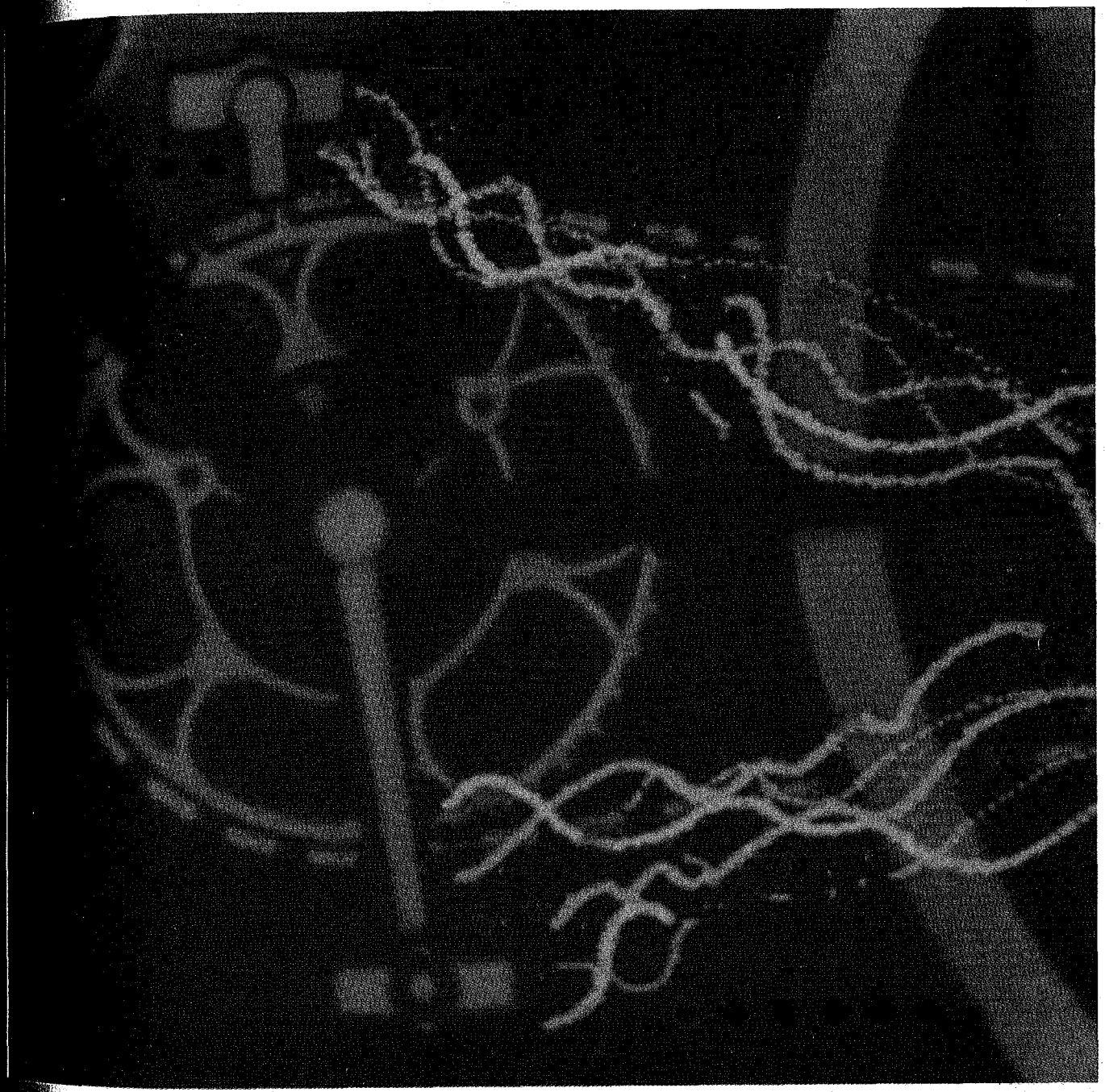

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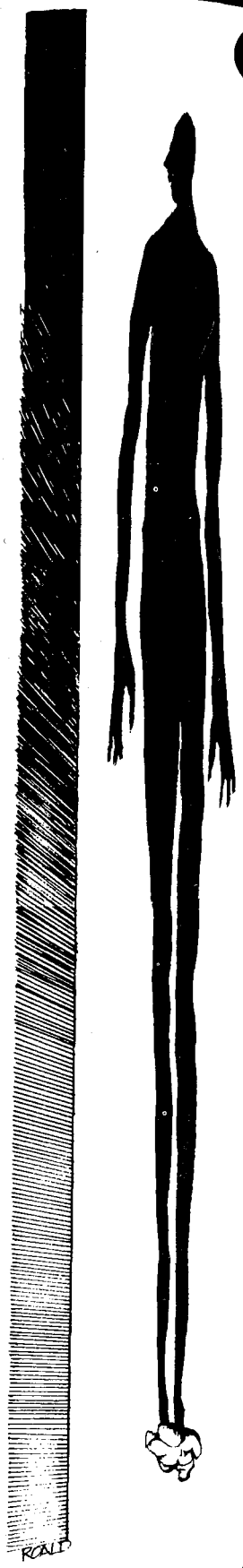


see this issue for details!

Editorial

THOSE PRIVATE LITTLE CHANGES

1986. Has anything really changed? It seems as though the notion of change is on everyone's mind at the start of a new year. Resolutions run rampant. We have heard of them before: "I'm going to quit smoking," "no more last minute cramming for exams," "I'm going to eat less junk food."

December 31st transforms into a gigantic lens; magnifying and focusing in on the procrastinations that have accumulated during the past twelve months. There is a feeling of expectation in the air; that each individual should initiate some private little changes that would, in turn, make him or her a better person.

Without a doubt, a resolution is a powerful symbol of commitment to change; one that should not necessarily be confined to the personal sphere of everyday activities. Have you considered adding another dimension to your intimate resolutions? A commitment that would migrate towards a social context?

This does not imply that anyone is obligated to spend a Saturday morning at the corner of Lake and Hennepin picketing the manufacture of fur coats, or sitting at the Honeywell gates waiting to be dragged into the back of a police wagon while protesting nuclear war. There are, of course, many ways to inject change into the mainstream of social activities, most depend upon your interpretation of the word *action*. What sort of participation constitutes an *active* involvement? Perhaps one of the most ignored methods of instigating change at this university is the written word. Words, thoughts and ideas, when presented to a public, represent a very powerful form of action.

Most successful magazines have a column titled: "Letters To The Editor. The purposes of such a column center around one very important fact: letters link the readers to the content of the magazine and visa versa. They also serve as a navigational tool; keeping the magazines in touch with what you are thinking about and bring into the limelight ideas, conflicts and observations that will have an impact upon the direction of this publication in the future. I.T. students are a part of the sweeping technologies and new scientific ideas of our times. Your ideas, opinions and projections about future technology should be a guiding force for this publication.

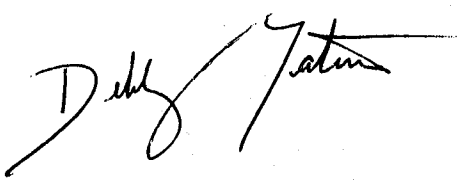
Letters To The Editor will help this magazine function as an interaction medium. (They will also assure myself and the staff that the *Minnesota Technologs* are not just disappearing into a *magazine absorption unit* never to be seen or heard from again.)

Each academic year, *Minnesota Technolog* has a new editor and staff, providing an opportunity for students to work with communication processes while furnishing fresh perspectives and input. This sort of change from year to year has its advantages. Yet, a more powerful, goal-oriented imagery is possible. With your resolution to participation, this publication will be able to develop *continuity* from issue to issue and year to year. Using these letters as a constant source of ideas and innovation, this magazine can be much more than it is today. To paraphrase Dr. Otto Schmitt of Biophysical Sciences, let's look up on our ideas and concepts as having a *genetics*. Ideas that begin with simple introductions and then grow to become influential forces in future social and scientific patterns.

Pick up your pen and comment about what's happening. We need to introduce new ideas and finish half spoken sentences such as: someone should...,wouldn't it be great if...,what I.T. really needs...,students should....

Dialogue is the key to the future of this publication. Minnesota Technolog has no magical motor. It's a human powered vehicle!

Happy New Year!



Debby Latimer
Editor

Bulletin Board

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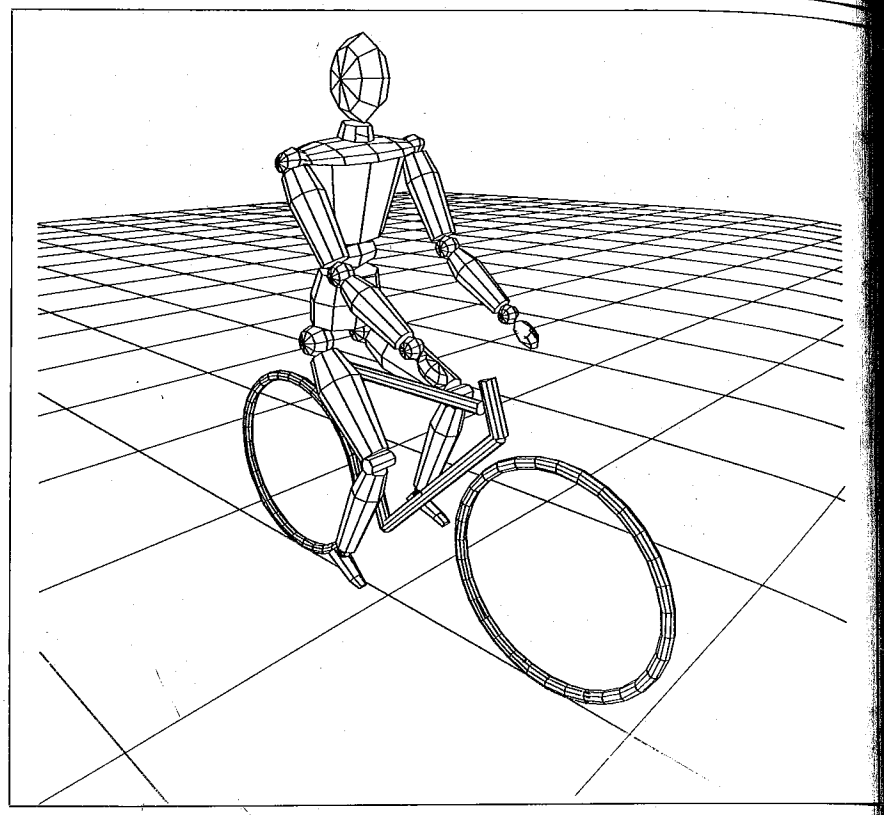

By Glen Larsen and Ted Morris

THE FUTURE OF SPACE

Meet the experts that will make the future of America's space program happen in a series of lectures for families and individuals Saturday afternoons at the Science Museum of Minnesota, 10th and Wabasha, in downtown St. Paul. The first presentation, full of slides and information, will be about the possibility of space travel by non-astronauts. Cost is $3, and Science Museum members receive a discount. For more information, call 612/221-9438.

HALLEY'S COMET LECTURES

Rod Nerdahl, director of the Minneapolis Planetarium, will use the starball in the the Science Museum of Minnesota's Omnitheater to illustrate a lecture about Halley's Comet Wednesday and Thursday, February 19 and 20, 5:30 to 7 p.m. Cost for the lecture is $4, $3 for Science Museum members. For more information, call 612/221-9438.

ARTIFICIAL INTELLIGENCE SYMPOSIA

Overview of AI January 15, 1986 (Dinner Meeting), Tutorials: AI Programming Tools and Techniques February 15, 1986, Expert Systems March 15, 1986, Vision/Image Processing April 12, 1986, and Natural Languages & Man-Machine Interface May 10, 1986. Radisson University Hotel. Minneapolis, Minnesota. Contact Dr. Alicja Ellis, Honeywell, Inc., MN14-2C20, 12001 State Highway 55, Plymouth, Minnesota, 55441, (612)541-2063 or Michael Kramer, 2825 Fairview Avenue North, P.O. Box 12828, St. Paul, Minnesota 55122, (612) 631-3175. Student discounts will be offered.

WOULD YOU LIKE TO STUDY ABROAD?

U of M- Twin Cities campus students are eligible to go to more than 70 foreign universities for the 1986-87 academic year under U of M student exchange agreements. Students interested in studying in the United Kingdom, Western Europe, Africa, Latin America, or Asia are encouraging to pick up a "Trading Places" brochure from ISTC (44 Coffman Union-next to the MSA Store for an overview of what is available. In all cases, participation costs are based on U of M tuition, fees, and room & board. Scholarship support is available for some programs, particularly those going to Third World countries. Application deadline for the ISEP, Essex, and Lancaster exchange programs is early February. Further information is available from ISTC advisors.

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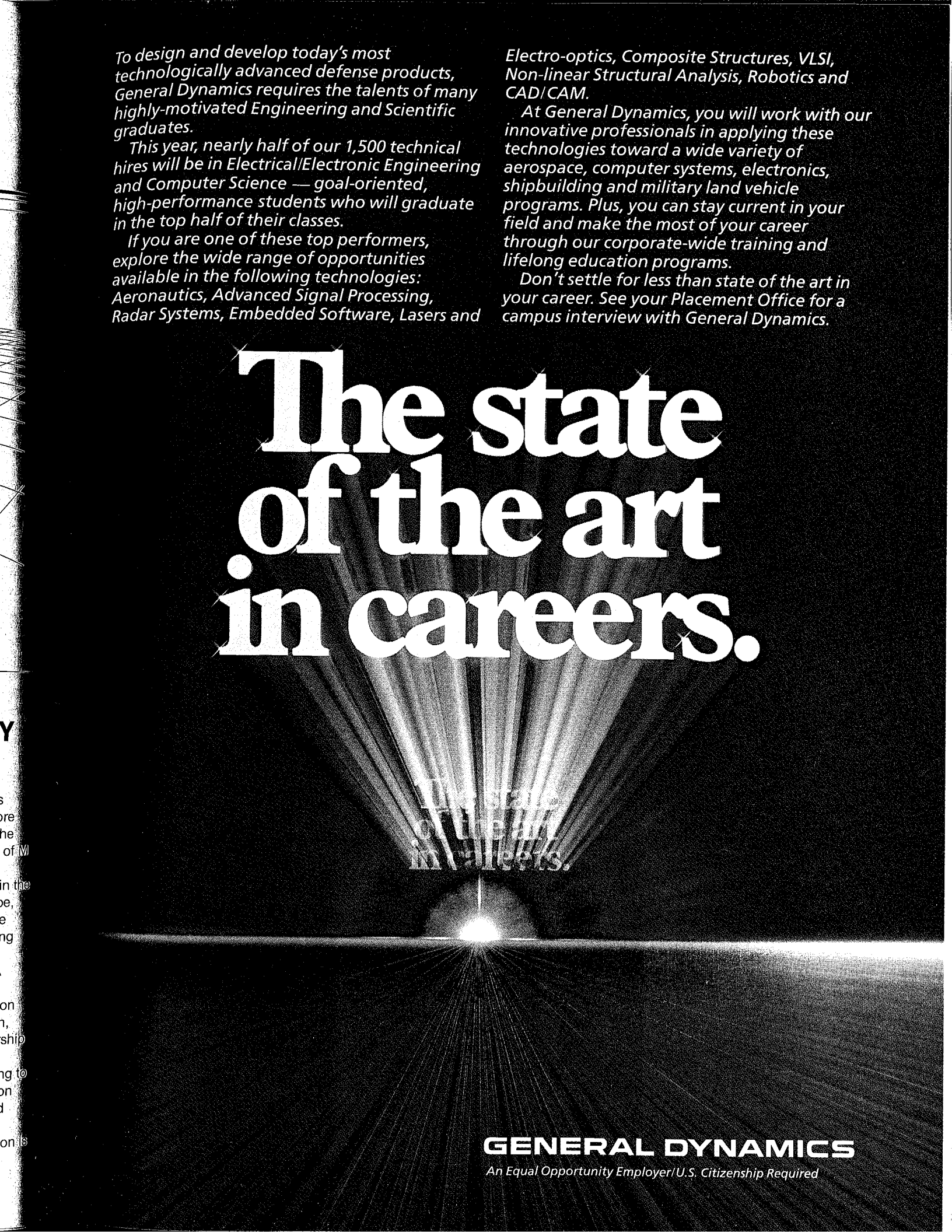

GENERAL DYNAMICS

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Bicycle Technology

Cecil Behringer's bicycles are not cheap at $10,000 each. They are among the lightest and strongest in the world. All of his bicycle frames are made of pure titanium and specially treated by a process called ion nitriding.

By Phil Decker

What could possibly hold anyone's attention to a supposedly low-tech subject that has been around since before my great-great grandfather ever rode across the Great Atlantic Spit. Two wheels, a bunch of spokes—who wants to read about something that makes you sweat? That's what I thought before I met Behringer.

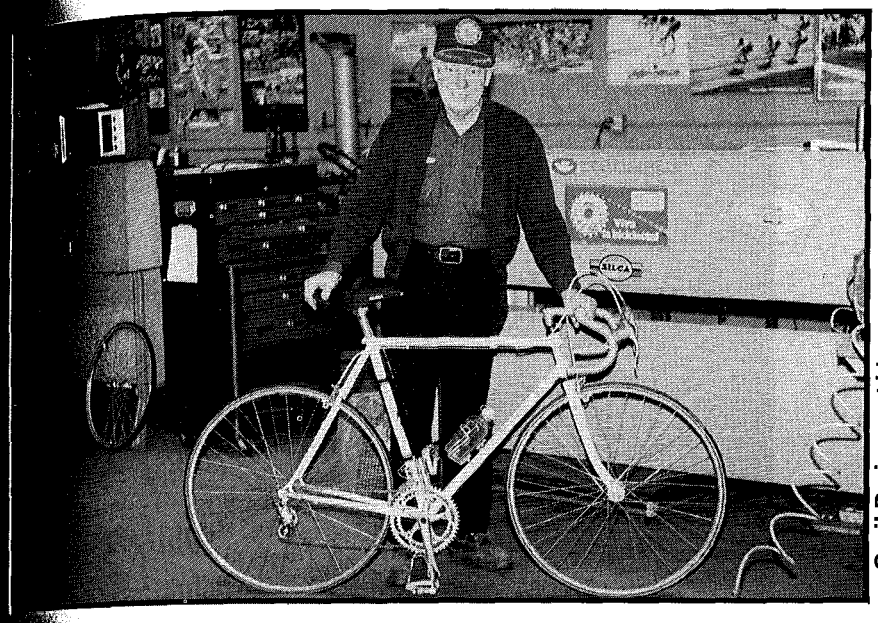
Academia, I found, does not hold the monopoly on genius and thank God the Pentagon doesn't either. You have to look beyond where you would expect to find it. Inventors hide in their skunk-works and shops and play with ideas. Sometimes, you have to get away from town to find these people and sometimes you have to go all the way to Shakopee to meet one.

Cecil Behringer's shop is a pre-fab aluminum affair on a light-industrial block just a stroll through the corn field away from Canterbury Downs. Non-descript is the word, I think. Small. There's a partly-dismantled velodrome off to one side, looking abandoned. Inside, works a retired professor on a ten thousand dollar bike he's building that is already two years behind schedule. He's in no hurry. Behringer has Ph.D.'s in Physics and Metallurgy—latter day alchemy, in this reporter's opinion.

Most of the bikes you see locked to the rack outside the *Minnesota Technolog* office are made of steel, and many companies today are saving weight by using aluminum frames. There have been many advances in the use of aluminum for frames recently, and they are making the bike manufacturers a lot of money. Cecil Behringer's claim to fame is his work with all-titanium frames. Titanium is very light and strong, but it is also very expensive. Few frame builders have used it because of the side effects that occur when one tries to weld the frame together. You get weak areas at the critical junctions. Thus, all of his frames are lugged and brazed.

But that's not enough for Behringer. He uses an old process called **"ion nitriding"** on the titanium tubes. Ion nitriding is basically the process of heating the metal in the presence of nitrogen, impregnating the metal inside and out with nitrogen atoms. Many have done it for other applications, but no one thought of putting an electric potential on it and using it on bicycle frames. The result is a very smooth, gold-colored metal approximately twice as strong as the original material. The process was "discovered" as a result of an accident while using a brazing oven.

"Can other industries benefit from this technology?" this reporter queried. Of course, and as an



Cecil Beringer at his stop.

example, Behringer determined that if the impellers in the helicopters used on that ill-fated rescue mission in Iran had been ion-nitrided, they would not have failed. The fact is that those impellers have to remove all the sand out of 650 cubic feet of air per second before it gets to the engine. The impellers used in the mission lasted ten seconds. If they had been ion-nitrided, they would have lasted for two hours.

The bicycles he makes are not cheap at $10,000 apiece. Why would someone spend that kind of money on a bicycle? "Psychological", is his one-word answer. His bikes are among the lightest and strongest in the world. Where most top-name racing bikes weight between twenty and twenty-five pounds, his weigh in at 15½ complete. The frame itself weighs only 2½ pounds. But, unless one is in the top one-half of one percent of bicycle racers, weight makes no difference at all, he admits.

"I've always said that 100% of the bicycles are better than 90% of the riders. Boy, they get madder than hell. But, unless you're in the world championship classification, the poundage doesn't mean a damn thing," says Behringer. "But they can afford it."

Some frame builders try to incorporate high strength and low weight by using nine millimeter S-L tubing. But then you get low cycle fatigue, he says. "You're exceeding the yield strength of its material—you're going to limit its life. But they (the professional racers) don't care, because they're only going to ride it one day. Most of the bikes ridden in the Tour de France are brought over here and sold as new."

Aficionados of the sport place a lot of importance on the rigidity of the bike, claiming it makes them more responsive. "It's like a waterbed versus a two-by-four," says Behringer. "You sleep on a two-by-four, you get tired. Do you want a comfortable ride or rigidity?"

temperature of about 80 million degrees Farenheit. What happens if it leaks? "Please don't ask that," he responded.

He is in great demand because he is one of the twelve people in the world who can bond metal to ceramic. The great difficulty, he says, is in matching the coefficients of expansion of the various materials. Companies are calling for him all the time for consulting work. "I charge them $25 as soon as I pick up the phone. If it goes over a half hour, it's $55," he says. "No school in the country has this in their curriculum..."

Behringer became involved in aircraft companies like Pratt & Whitney and Rolls Royce after he left a position at General Mills, Mechanical Division. At General *Mills*, he was on the team that made Alvin, still the deepest-going manned submersible. That's General Mills, the Cheerio's people. "That's General Mills, the Mechanical Division," he explained. "Fifteen hundred of the best engineers I've ever worked with." Alvin, built for Woods Hole Oceanographic Institute, is credited for rescuing two H-bombs that fell off of a B-52 in deep water off the coast of Spain some years ago. It can dive

Ion nitriding is the process of heating the metal in the presence of nitrogen, impregnating the metal inside and out with nitrogen atoms.

Behringer, 69, has been building bikes for fifty years. His interest in them started during the Depression, when he rode for Western Union for sixteen cents an hour. "Those were hard times," he says. "You had to put food on the table somehow." He had started a good bike racing career up to the start of WWII, when he joined the Navy.

He has taught at the University of Minnesota, Arizona State University, and Ohio State. As a consultant, he has worked for NASA, Boeing, GTE, Rolls Royce, and Pratt & Whitney. Behringer was also one of the scientists who put together Princeton's forty-eight inch fusion reactor. It takes a donut of gas forty-eight inches thick and using superconducting magnets, compresses it down to three-eighths of an inch. This achieves a

to a depth of 16,500 feet. Needless to say, Alvin can withstand tremendous pressures.

On the side, Behringer sometimes makes gold-plated golf balls. He uses a sputtering technique, puts 25,000 volts on the golf ball, with a gold anode. It's like electroplating, he explained, except the solution is a gas. The process is done under vacuum. The result is a layer of gold about 1500 angstroms thick, or about ten dollars worth. It will not wear off, either. It will, however, gash and wear like any other ball in regular use.

Someday, he may coat a pair of contact lenses with gold to be used during a bike race. The racer would wear sun glasses until the last mile. Then he would take them off and stare at his opponents. "That's psychological," he says.✦

The International Human Powered Vehicle Association

The first few meetings of the Minneapolis chapter of the Human Powered Vehicle Association met with an overwhelming response. This is symbolic of a growing interest in HPV all over the country.

By David Krafft

The human powered vehicle has been used by man for many centuries. The wheelbarrow is one of the earliest designs. Canoes, rowboats, carts, rickshaws, and more recently, the bicycle, have all been built by man to allow him to move himself or his posessions farther and faster then he could by merely walking. As technology began producing materials lighter and stronger than wood and mild steel, the design of human powered vehicles evolved into what we see today.

The standard bicycle is an excellent example of a relatively modern human powered vehicle. The diamond frame that is used in a bicycle was standardized in the 1890's and has not seen any significant change since that time. The design originated in the early eighteenth century as a foot-propelled toy. Over the next two hundred years, it experienced many different configurations and innovations, finally arriving at the relatively efficient machine we now know. Unfortunately the design was frozen by the mass production of the automobile and restrictions in design by sanctioned bicycle racing organizations.

A new organization was needed that would promote innovation in the design and construction of human powered vehicles and provide them with a way to demonstrate their advantages. The International Human Powered Vehicle Association was born. It's goal: to help advance human powered vehicles in the air, on land, and on the water. The IHPVA holds annual meets for land vehicles where the most recent single rider land vehicle record was set at 59.081 mph. They have been instrumental in finding sponsors to provide prizes for accomplishments in the field. The Kremer prizes, won by Dr. Paul MacCready Jr. with his Gossamer Condor and Gossamer Albatross, are prime examples of how a prize can become the catalyst to improved design. The Dupont Corporation has put up a $15,000 prize for the first single rider vehicle to exceed 65 mph. From where the current record stands, we may see this speed

exceeded in the very near future.

But the IHPVA is not only concerned with speed. A number of individuals are building commuter vehicles and an event has been designed to test their practicality. The one most important accomplishment of the IHPVA to advance the future of the HPV is to eliminate limits on design or construction, as long as it is considered safe. The results of this have been sweeping in scope. The "funny bikes" of the 1984 Olympics were designed with the new technology being developed by members of the IHPVA.

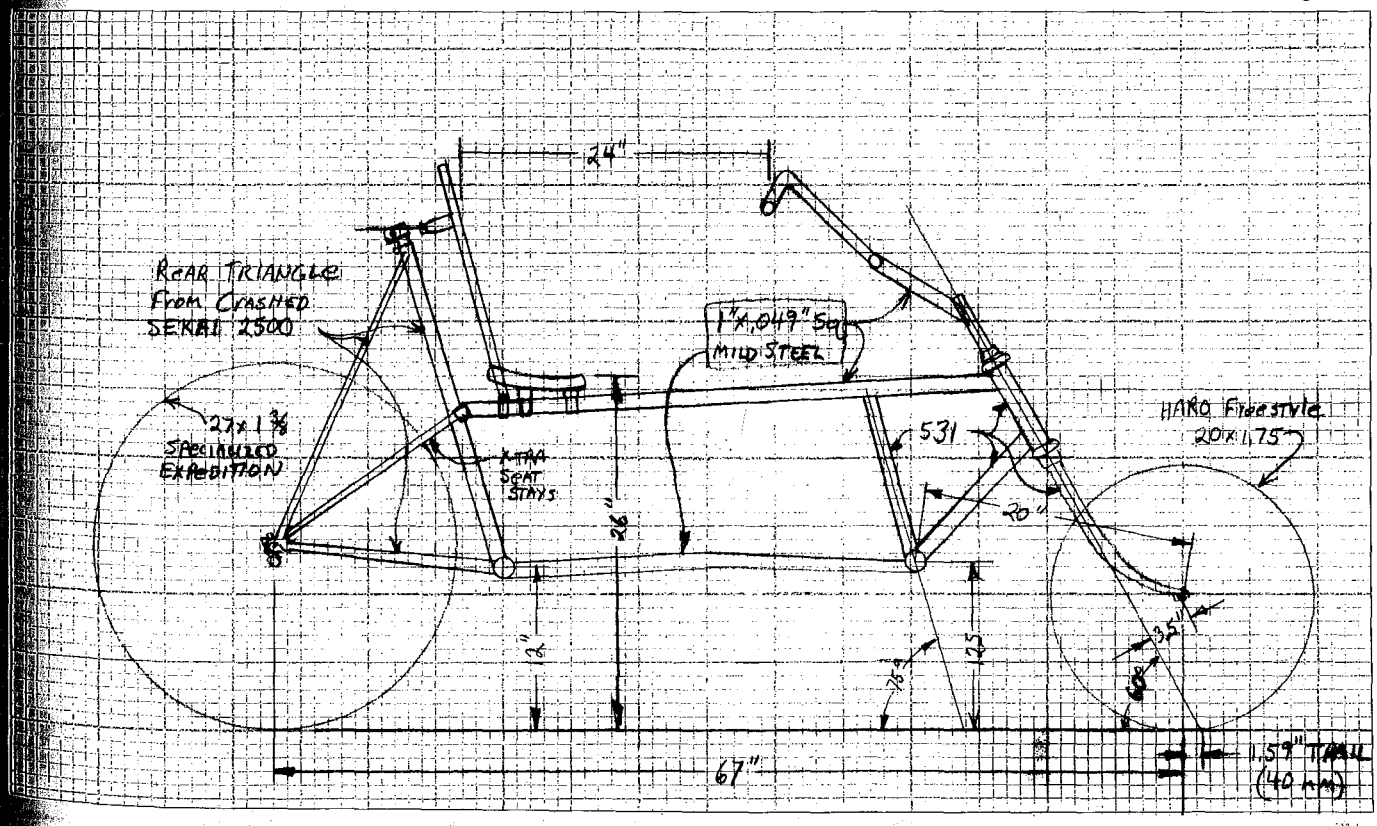
The IHPVA also produces a monthly newsletter called the HPV NEWS for it's members. This format allows the dissemination of information to more than 2,500 interested individuals world wide. The newsletter provides valuable design considerations but is not able to provide local resource information to people who are interested in building HPV's. In August of 1985, a group of IHPVA members and others interested in HPV's met in Minneapolis to try to overcome this problem. By setting up a local support group that holds regular meetings and has a newsletter devoted more towards local resources and available skills, they hope to make it easier to build HPV's in Minnesota. The first few meetings have been a great success with over 25 people attending. Topics ranged from an analysis of a newly built recumbent bicycle to a slide review of the recent 11th Speed Championship held at Indy Speedway in September.

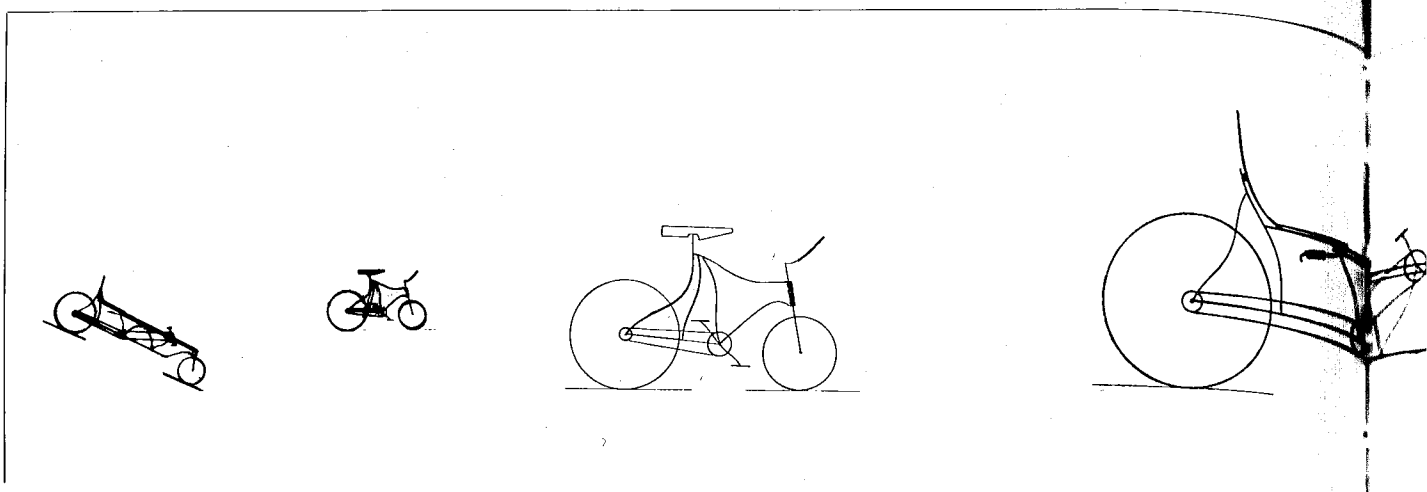
The IHPVA helps advance human powered vehicles in the air, on land, and in the water.

On October 13th, 17 different human powered vehicles participated in an HPV rally and 12 mile ride to Hyland Lake Park. The greatest number of vehicles present were what are referred to as recumbents. Figure 1 illustrates a bike built by Mark Stonich of Minneapolis. This was built by cutting parts of old bicycles and rearranging the geometry from that of a standard bicycle. This type of design has a number of distinct advantages over a traditional bike. The recumbent seating position is more comfortable than a standard bicycle seat, but, unfortunately, is accompanied by a loss in muscular efficiency of approximately 6%. The decreased aerodynamic drag that results from the recumbent position more than compensates for this with a realized loss of 23-25%. The center of gravity is lower giving greater stability in turns and stopping. It also allows the rider to put his feet down more easily if necessary. Many who ride this type of vehicle for the first time are amazed at the comfort and fun that riding an HPV can be.

Another of the vehicles present was the short wheelbase linear drive design of Calvin Hulbert. This bike uses a linear drive system that replaces the standard circular pedal motion. As yet, linear drives are not as efficient in use of muscle power as the circular drive but the design does show promise. This bicycle is also designed with hub center steering from a handlebar system below the

Mark Stonich's recumbent design **Figure 1**



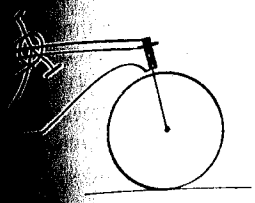


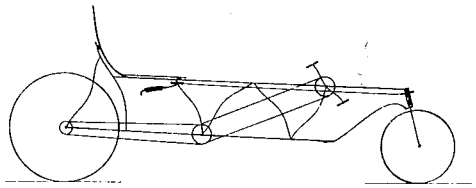
seat. The short wheelbase gives this bike a smaller turning radius then the recumbent bike.

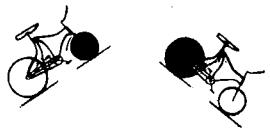
The bike built by Dave Krafft is an example of compound gearing. The double set of chainrings allows for a considerable step up in gear ratio from a normal bike with a total of 20 gear steps. To allow for this same increase with a standard arrangement would necessitate the use of front chainrings of almost twice the size. They wouldn't fit between the bike and the ground. The theoretical top speed for this type of gearing is limited only by muscular strength and wind resistance.

A radical departure from the traditional bicycle is the Row Cycle, designed and produced by Mark Ellefson of Chaska Minnesota. This vehicle is a tricycle design with two steering wheels in front. It uses a sliding seat rowing action that allows the rider to use both arms and legs to propel it down the road. The rowing action is transmitted by a cable to a 5 speed gear set that allows the rider to adjust to terrain and speed. Steering is accomplished with the feet. Ellefson Engineering is currently marketing this vehicle.

Mark Tessmer's infinity recumbent







is another production bicycle built of aircraft grade aluminum. This is a considerable weight savings over steel frames. It also uses beneath the seat steering and a long wheelbase design. The aluminum provides a very soft ride as the frame is able to flex in the verticle plane. It is probably the most comfortable of the designs represented at the ride.

Next summer there will be a number of organized rides for human powered vehicles in Minnesota, and perhaps a race. The Minnesota Chapter of the IHPVA is in the process of developing a resource file that will be available to all it's members. It will contain information on all the vehicles mentioned as well as local parts suppliers and sources from outside our area for materials not available in Minnesota.

The human powered vehicle has a definite place in the future of transportation. The designs and ideas of today may lead to the cost effective, non fossil fuel consuming vehicles that we will all be using in the future. If you are interested in finding out more about what the MNCIHPVA is doing, feel free to contact Dave Krafft at (612) 929-2978 for further information.★

Faculty Profile

Professor Otto Schmitt of Biophysical Sciences is truly a multidisciplinary scholar.

Otto and Viola Schmitt

By Debby Latimer

Interviewing Dr. Otto Schmitt is like inscribing oneself into the dominant forces of history. Within minutes upon arrival at this office, a polaroid picture along with my name were added to a special book. It contains the photos of many of the people that have visited Professor Schmitt in the past thirty odd years. Some, I was assured, have gone on to become prominent members of their field. If this wasn't enough excitement, the whole procedure was momentarily interrupted by a talking clock confirming, "the time is 11:05."

The Music Education building is an unusual spot for the Biophysical Sciences. Yet, since the destruction of the experimental engineering building, it is here that Dr. Schmitt and his wife, Viola, carry out their research. They are a team in the true sense of the word. Both St. Louisians, Mrs. Schmitt graduated from Washington University with a degree in Latin and M.A. in mathematics. Professor Schmitt finished graduate school with the unique honor of completing a triple Ph.D.. Since high school, he has had a dream: developing a new scientific discipline, a life-based algorhythmic hard science. Convinced that the life sciences had been using laundered ideas from physics, engineering and chemistry, Professor Schmitt envisioned research in the language of the life sciences themselves. After three years of high school, he had the opportunity to study in Berlin at the Kaiser Wilhelm Institute of Biology amidst four nobel prize winners. (His older brother, a professor at MIT was doing research in Berlin at that time.)

Upon his return to Washington University, he more then compensated for the last year missed at high school by passing the entrance exams and beginning as a sophomore.

Professor Schmitt is a true believer in multidisciplinary learning. He describes his triple Ph.D. in terms of a

delicate balance: Biology- representing the life-sciences. Mathematics- adding theory, and Physics- representing the physical sciences. His Ph.D. thesis, completed in 1937, consisted of a computer simulation of a living nerve. This led to the invention of the Schmitt trigger: an electrical circuit that simulates nerves and is now sold and used in computers.

Dr. Schmitt and his wife have traveled all over the world working with famous scientists such as A.V. Hill and Ernst Rutherford. They have regularly attended meetings at the Royal Society of London. Very early on in their partnership, Mrs. Schmitt became a meticulous data-taker. Thus becoming an invaluable and integral part of her husband's research. The important thing to remember about Dr. Schmitt is that you don't try to define him. He is a non-stop sources of ideas, inventions and systems and is involved in more types of activities than one would think humanly possible. When I inquired about his research and activities outside of teaching biophysics, I was handed a three page description of over fifty activities in which he is currently involved. The following represent just a few of his commitments:

1) Inductee and newly reelected President of Minnesota Inventors' Hall of Fame
2) Development of Interpenetrating Domain Topology techniques for Biomimetic Brain and AI Computer modeling.
3) Development of system and module designs to establish Family Participating Computer Aided Health Care in the home.
4) Establishment of an Innovative Higher Brain-Mind investigative program in cooperation with F.O. Schmitt, Institute Professor, M.I.T.
5) Member and recently elected president of Minnesota Inventors and Technology Transfer Corporation.
6) Historian for IEEE Engineering in Medicine and Biology Society.
7) Mentor to selected especially promising U of M students.
8) Consultant to 3M Medical Products division.
9) Consultant to Honeywell Biomimetic Sensors Program.
10) International Chronobiological Society-participant and planner.
11) Extension of the theory of Invention study and its pragmatic application.

The list is overwhelming! Having already over 70 patents to his name, Professor Schmitt is a man of ideas and has a philosophy about what it takes to disseminate these ideas to a public. When asked what kinds of ideas occupied his immediate attention, he smiled and said, "would you like to see a list?" While hunting through a large, hardbound black three-ringed binder, he calmly stated that longterm ideas cannot be sold. It takes an idea about fifteen years to reach general acceptance. It's all related to the theory of gradualness: little by little, beginning with a simple introduction of an idea repeated over and over again, people grow accustomed to it and start to think about it as a realistic possibility. In order to get ideas into a community, the scientist must also become a salesman. This involves learning about how a scientist can use the press and the media. Professor Schmitt wants to get ideas to people, and is not a for egocentric reasons. He gives ideas to students who want to develop them. In fact, I was shown his, "shopping list of inventions ready for marketing" for those who wish to pursue a particular idea all the way to production. The list covers everything from self-cooling beverages to highly specialized people-beneficial technology. For Professor Schmitt, this is all quite natural; one idea simply rises out of another.

In order to get ideas into a community, the scientist must also become a salesman Multidisciplinary thinking is an imagery that should begin at a very young age.

Why don't you invent some mathematic representations?

Multidisciplinary thinking is his hallmark. You might be saying to yourself that this perspective is fine if you have a triple Ph.D., but, that it would be impossible to most. It is precisely this sort of limitation that Professor Schmitt wants to eliminate. There is a flaw in the imagery in our educational system. We are taught to have one major. People ask, "what is your invention?," as if it is only possible to invent one in a lifetime. According to Dr. Schmitt, we need to present ideas of initiative and invention early in a child's education. There is a theory that there are "windows of opportunity" that open up at various stages in the career of a child's learning. At ages two, three, five, seven, etc, information seems to be processed with greater ease. (It is a commonly accepted phenomena that children learn foreign languages with greater ease than older adults.)

Multidisciplinary thinking is an imagery that should begin at a very young age. Part of Dr. Schmitt's philosophy lies in the belief that being a specialist never makes you an authority in a particular field. The concept of a plurality of sciences that builds it's own mathematics is symbolized in the strategy of not letting the Biophysical Sciences become a department. Such terminology would already be a distortion of the multidisciplinary imagery. According to Professor Schmitt, the difficulty with many professors is that they become too established. They have an investment in their expertise. Dr. Schmitt feels that we need to promote the assumption that "your students will be brighter than you." "If I can't teach my students in two years what took

me three, than I'm not doing a good job. Youthful people can invent not only devices and systems, but, also cultural patterns." He has tried this on his students by saying, "Why don't you invest some mathematical representations."

Professor Schmitt has developed some major ideas for health care. For example, the personal, portable, whole-life medical history. Using laser technology, one strip on a regular card the size of a credit card will hold 800 pages of numeric text, pictured included. A doctor anywhere in the world would be able to read the card and in seconds have all the current information about your health situation. This would be a portable private medical history, avoiding needless repetition of various analysis and tests.

Professor Schmitt is also trying to create personalized health care through the use of a personal computer. Each person will have a programmed, tailored set of rules corresponding to his or her particular illness. The person would then work at home, with the help of a friend or spouse. This would provide lower cost personalized health care.

Yet, health maintenance is only the first step of Dr. Schmitt's overall vision. We need to go farther to reach a concept of life-enhancement, where each person would participate in the planning of optimal lives. There would be centers where healthy people would go in order to build in targets for the prevention of many of the serious health problems. This concept is totally different from the present philosophy that relies heavily upon repair as opposed to prevention.

Professor Schmitt is a fascinating person. Anyone who speaks to him is sure to be caught up in his enthusiasm for life and learning. He has a curious way about him: he doesn't make you stop and think; he makes you start to think.★

Minnesota Technolog

Writing Contest

1) SCIENCE FICTION

2) ESSAY CONTEST

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You find yourself mysteriously stranded on a deserted island. What three scientific or mathematical principles would you want to have with you? Why?

PRIZES WILL BE AWARDED FOR BOTH CONTESTS

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CONTEST RULES

The contest is open to all registered U of M students of amateur status (persons never having published a work of fiction for monetary payment), except *Technolog* staff and I.T. Board of Publication members, past or present. Entries must be typed, double spaced, with one inch margins on 8½ x 11 paper and be no longer than 3,500 words. Each entry must be accompanied by three photocopies of the manuscript and must bear an attached cover page with the story title, author's name, home address, and telephone number. DO NOT PUT AUTHOR'S NAME ANYWHERE ELSE ON THE MANUSCRIPT! *Minnesota Technolog* retains first publication rights to all winning manuscripts. If you have any questions, call 373-5863.

DEADLINE: February 20, 1986

Rowing Ergometer Performance: A Computerized Measurement

As athletic competition continues to intensify, athletes are utilizing technology to make their training techniques more sophisticated than ever before. The sport of rowing is no exception.

By Gary Meyers, Chris Anton and Scott Hill

As athletic competition continues to intensify, athletes are utilizing technology to make their training techniques more sophisticated than ever before. The sport of rowing is no exception to this trend; many ergometers have been developed which permit rowers to train throughout the year and depending on the machine, obtain various measurements of their rowing performance. In many cases, however, the displayed values are only rough approximations of the measurements which they supposedly represent. The objective of this project was to develop an instrumentation system capable of accurately measuring work expenditure and rowing technique on a rowing ergometer while conveying real-time feedback to the athlete.

Work on this project began in a Mechanical Engineering design course at the University of Minnesota in the fall of 1984 and continued through winter 1985. The system had undergone considerable development by that time, and it was approved for further study as a UROP (Undergraduate Research Opportunities Program) project in the spring of 1985. In cooperation with Physical Education graduate students Heather Nelson, Leslie Ruff and Dr. Robert Serfass, Director of the Human Performance Laboratory, the system was tested for its ability to ensure that an athlete on a rowing ergometer could attain reproducible levels of work output and physiological response.

In its present form, the instrumentation system has been adapted to a machine known as the Concept II rowing ergometer. In a manner analogous to actual rowing shells, the rower's feet are strapped in place and the ergometer seat is free to slide back and forth during each stroke. A chain connects the Concept II's handle to a rotating flywheel which is outfitted with several air vanes for additional resistance.

In order to obtain a measurement of the work exerted by an athlete on the ergometer, two sensors have been attached to it: a strain-gage load cell and a tachometer. The load cell is

Inserted into the Concept II's chain so that its output voltage is proportional to the amount of force being placed on the handle at any given time. The tachometer is driven by the chain via a gear and sprocket arrangement, thereby measuring the velocity at which the Concept II's handle is being pulled. The output voltages from these two sensors are sent through a signal processing circuit and then to an A/D (analog-to-digital) converter interfaced with a Commodore 64 computer. Several assembly language subroutines have been written which read the load cell and tachometer channels of the A/D converter and save these values for subsequent data processing. A color monitor conveys visual and audible feedback to the athlete during an ergometer workout and displays the data processing results.

The voltage information from the load cell and the tachometer may be combined to calculate the instantaneous power being expended on the ergometer according to the equation:

$$P = F \cdot r \cdot w$$

where **P** = instantaneous power
F = pulliing force on the ergometer handle
r = radius of the tachometer sprocket
w = angular velocity of the tachometer

By integrating these instantaneous power values over a period of time, the athlete's total work output in that time may be calculated by:

$$W = \int_{t_1}^{t_2} P \cdot dt$$

where **W** = work done from t_1 to time t_2
P = the instantaneous power values from t_1 to t_2
dt = increment time difference between each power value

The fundamental purpose of the signal processing circuit is to provide clean transmission of the two analog voltages when they are sent from the ergometer to the computer. Quality components and techniques which minimize the signal distortion are key factors that influence the computer's ability to measure a rower's performance on the ergometer. The A/D converter which was used in this project has a specified input voltage range of zero to five volts per channel. In order to take full advantage of the converter's resolution, the signals from the sensors are transformed from their original levels into this voltage range. Because the unprocessed signal from the load cell is only on the order of millivolts, high-gain operational amplifier circuitry is employed to boost this voltage to the proper level. In addition, filtering techniques are implemented to minimize distortion of the signal due to amplification of electrical noise from the surroundings (e.g., lights and other components). The signal from the tachometer is processed through a voltage divider which ensures that this signal is also within the converter's specified input voltage range.

Depending on each rower's body type, he or she is capable of expending work on an ergometer in certain manner.

To make the instrumentation system flexible for a variety of rowing abilities, each channel of the circuit has been provided with an adjustable dial. By varying the settings of these dials, an athlete may independently adjust the amplification or reduction of the signals from the ergometer according to his or her strength and technique, thereby making optimum use of the system's numeric resolution. The sensors were calibrated at several different settings of the load cell and tachometer dials by applying known forces and angular velocities to the sensors and observing the corresponding

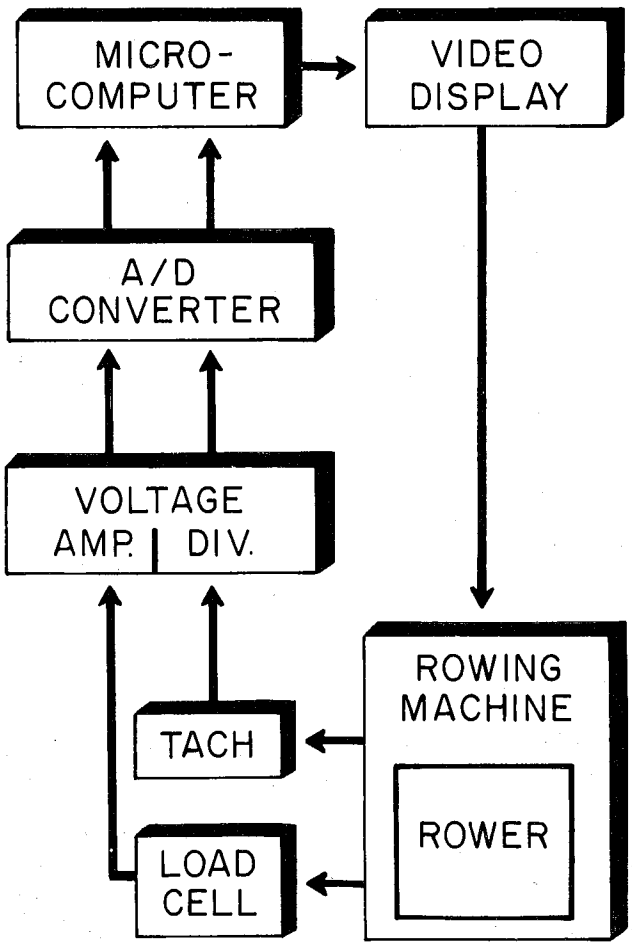
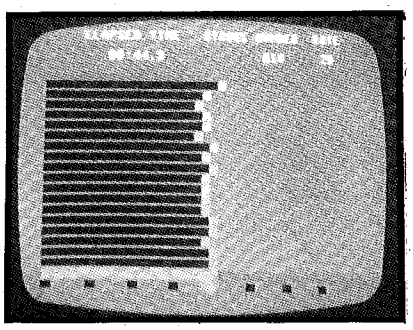


Illustration By Nan Gehrig



Horizontal total work bar graphs

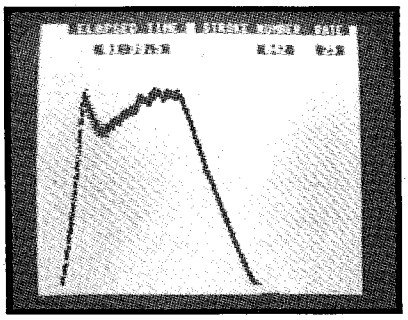
A color monitor conveys visual and audible feedback to the athlete during an ergometer workout and displays the data processing results.

numbers generated by the A/D converter. A least-squares linear regression analysis was performed on the calibration data and conversion factors were calculated for each dial setting. In the data processing section of the computer program, these factors are applied to the load cell and tachometer readings from the A/D converter in order to express these quantities in meaningful units of force and velocity, respectively. The above equations are then used to calculate the instantaneous power values throughout each stroke which are numerically integrated over time to determine the amount of work done on the ergometer.

The computer software is comprised of three BASIC programs and approximately four thousand bytes of assembly language subroutines which are used by the BASIC programs. Assembly language programming techniques make it possible to achieve a high sampling rate of the A/D converter and simultaneously issue feedback to the athlete about his or her performance. These subroutines also significantly reduce the time necessary to complete the data processing section of the program, especially the high-resolution plotting.

The main BASIC program is divided into three sections: circuit dial adjustment, data collection, and data processing. The user selects a particular option by pressing one of the computer's function keys in response to questions asked at each level of the command menu.

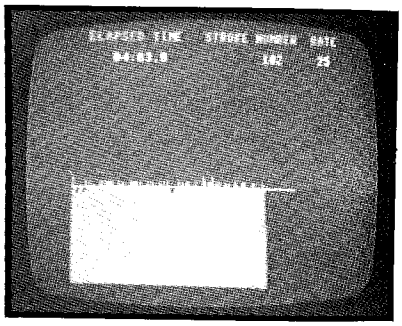
One form of feedback available during a rowing session consists of horizontal bar graphs, one per stroke, where the length of each graph is



Several velocity plots superimposed

directly proportional to the stroke's total work, peak force, peak velocity, or peak power. In the circuit dial adjustment section of the program, the athlete exercises on the ergometer while observing the stroke bar graphs that he or she is creating on the monitor. If the dial settings are too low to make the most efficient use of the system's resolution, the bar graphs will be shorter than the desired length. If the dials are set so high that the A/D converter becomes overloaded, the color of the bar graph changes to indicate which setting needs to be decreased. Once the athlete has determined the dial settings which are appropriate for his or her rowing ability, data collection may begin.

There are a variety of feedback options available for a rowing session. With each option, the elapsed time, stroke number, and calculated stroke rate appear at the top of the monitor screen, and an audible and visual metronome may be adjusted to the desired pitch and cadence. One mode of feedback consists of up to nineteen of the previously-mentioned bar graphs, whereupon the screen is cleared for the display of subsequent bar graphs. To better gauge a rower's performance, several scale markings appear on the line immediately below the current bar graph, with one bight goal position which may be preset anywhere along the width of the screen. By using this goal position to attain a particular length of each stroke's bar graph, the athlete is able to regulate the intensity and consistency of his or her ergometer workout. The second feedback mode is a high-resolution plot of the force, velocity, or instantaneoous power



Total work verticle bar graphs

values throughout each stroke. This option provides real-time information which may be used by athletes and coaches for the analysis and development of proper rowing technique.

A major distinction which must be made for every rowing session is whether the program will simply display a particular feedback option or whether it will issue feedback and also store the values from the load cell and tachometer into the computer's memory. If the first alternative is chosen, an unlimited amount of time may be spent on the ergometer for a training session. With the latter choice, approximately ten minutes of rowing data may be collected in memory and subsequently saved on a floppy disk for future reference.

Overall system commodore 64, circuits box sensors

Many data processing alternatives have been developed to examine a rowing session which has been saved to disk. With every data processing option, the stroke number, stroke rate, and elapsed time at which each stroke was completed appear at the top of the monitor screen. In the program's numerical analysis section, the conversion factors for the dial settings which were used during the ergometer workout are applied to the collected load cell and tachometer values. This makes possible the calculation, in either metric or English units, of such quantities as work per stroke; average work per stroke; total work; peak force, velocity, or power per stroke and per workout, and average power per stroke.

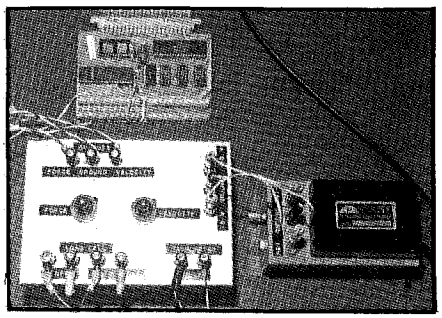
The remainder of the data processing options are of a graphical nature. One selection is a re-creation of the horizontal bar graphs of the rowing session, with the length of each graph dependent upon any of the four possible values (work, force, velocity, or power), whether or not that value was chosen for feedback during the workout. A second option displays these stroke graphs in a vertical, high-resolution representation so that over one hundred strokes may be viewed at one time. The bar graph goal position which was used during the session is drawn as a horizontal line on this screen, permitting analysis of the athlete's overall success in attaining this level of exertion. The third graphical selection consists of high-resolution plots of force, velocity, or instantaneous power throughout each stroke. These plots may be based upon the data from the individual strokes or they may represent a cumulative average stroke which is calculated and plotted. Any number of consecutive strokes may be superimposed upon each other in order to examine the consistency of the athlete's rowing technique.

This instrumentation system was recently put to its first test in the Human Performance Laboratory in Cooke Hall. Sixteen female volunteers who were experienced rowers between eighteen and thirty years old performed submaximal workouts on the Concept II ergometer while observing bar graph feedback on a video screen. On three separate days, each athlete exercised at three distinct total-work-per-stroke bar graph goal positions, for a total of nine ergometer sessions per person. Each session was four minutes in duration with a recovery period of three to five minutes, and the stroke rate metronome was set at twenty-five strokes per minute. The heart rates of the athletes were recorded with an ECG monitor and their expired air was collected for gas analysis.

The second feedback mode is a high-resolution plot of the force, velocity, or instantaneous power values throughout each stroke.

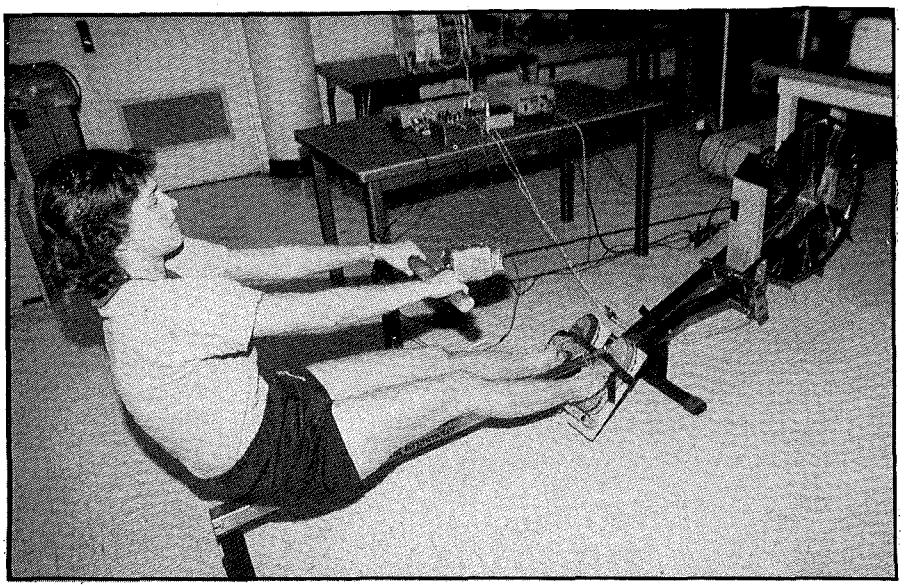
Of the several factors which could have been varied to produce distinct levels of exertion on the ergometer, the bar graph goal position was chosen because it could be accurately administered to a diverse population of athletes. Depending on each rower's body type, he or she is capable of expending work on an ergometer in a certain manner. For example, a shorter rower has a smaller amount of distance in which to produce work during a stroke than a taller rower, so the shorter rower's instantaneous power values must be higher in order for both rowers to produce the same amount of work per stroke. This meant that the shorter rowers in the study might sometimes overload the load cell and/or tachometer channels of the A/D converter when they attempted to reach a certain goal position on the screen.

In contrast to how the system would be used by any one rower, it was desired to maintain the load cell and tachometer dials at constant settings throughout the study. If the circuit dials had been varied to make them optimum for each rower, the length of the bar graphs would have been altered in such a way that new goal positions could not entirely compensate for the modified settings; therefore, unequal amounts of work exerted by different rowers could be displayed on the screen as identical bar graphs. Because the study's primary objective was to examine the reproducibility of work output and physiological response, this disparity in bar graph feedback between rowers was not acceptable. As a result, the dial settings were held constant for the duration of the study and three distinct goal positions were used in an attempt to have all sixteen athletes expend the same amount of work in each rowing session.



Ergometer with stain-gage load cell

Although the analysis of the test data has not yet been completed, some preliminary observations may be made. It appears that the instrumentation system was successful in ensuring that uniform amounts of work were attained by the rowers at each exertion level and that the work output was consistently reproduced from day to day. Most of the physiological variables (oxygen consumption, VO_2, R, and VE) measured in each rowing session seem to have been duplicated in proportion to the external work measured by the system, but the heart rates appear to be less conclusive than expected. The majority of the rowers became more successful in attaining the bar graph goal positions as the study progressed, indicating that some



learning took place over the three days. It is hoped that with repeated use of the system, an athlete would become increasingly aware of his or her performance and the factors which maximize the amount of work put into the ergometer during each stroke.

The prospective implications of this project include the possibility of rowing being used more frequently as a method of evaluating and improving cardiovascular fitness and the utilization of the system for crew team selection and development.★

Photo By Gary Meyers

The I.T. Board of Publications is looking for interested students to fill the following positions for the 1986/87 school year:

Editor
of the Minnesota Technolog
Business Manager
for the Minnesota Technolog
Editor
of the I.T. Connection

Applicants must be full-time students at the University of Minnesota. Preference will be given to I.T. students. Selected applicants will have the opportunity to train with *Minnesota Technolog* and *I.T. Connection* staff during Spring Quarter. This is an excellent way to gain practical experience—impressive to a prospective employer.

For more information call, 373-3298. Salaries for the current year are posted in room 2, ME.

In Quest Of Perpetual Motion

A perpetual motion machine would be a solution to the world's energy problems. What exactly is a perpetual motion machine and why do scientists say that they are impossible to create?

By Renee Bergstrom

For centuries man has dreamed of perpetual motion that would solve the world's energy problems. Time and time again, con men and hustlers have hoodwinked the public and perhaps even the patent office with false hope. Now hustlers and scientists alike have been busy trying to get a good definition of the properties involved in perpetual motion. But what exactly is a perpetual motion machine?

There are two types of perpetual motion machines, both of which are impossible. The first kind of perpetual motion machine violates the first law of thermodynamics, providing work without any input of energy.[1] Professor Kreevoy, University of Minnesota chemistry department, stated that a perpetual motion machine of the first kind has never been observed. Also, the definition of energy had to be changed to be consistent with the first law of thermodynamics.

The second law of thermodynamics states that it is "impossible to build a cyclic machine that converts heat into work with 100 percent efficiency."[2] The second type of perpetual motion involves withdrawing energy from a thermal bath without having any lower temperature reservoir in which to dump energy. To summarize the entire argument, the first law of thermodynamics "says you can't win; the second law says you can't even break even."[3]

Despite the fact that scientists state perpetual motion machines are impossible, many inventors have sought to create or sell perpetual motion machines. Artists such as Escher, in his work, *Windmill* captured the idea of perpetual motion in an artform.

Inventors have been seeking perpetual motion for years. Arthur Ord-Hume in his book *Perpetual Motion* quotes Preston, "The alchemists in chemistry have been somewhat like the perpetual motionists in natural philosophy. Both, by seeking after the impossible, have led up to discoveries of the greatest importance and practical value."[4] This side effect has been good for science. But the fact that these discoveries haven't been

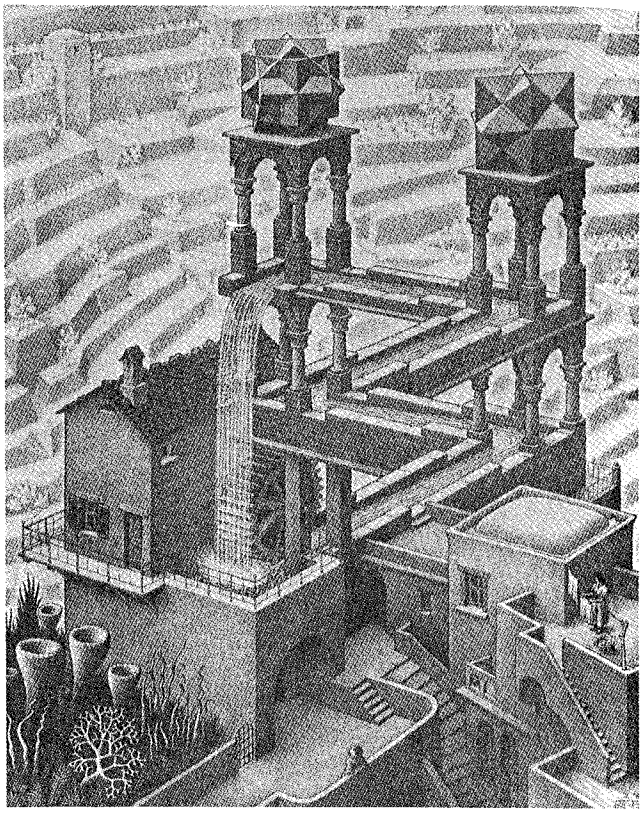
perpetual motion hasn't stopped the inventors.

These inventors have been in existence for centuries. An old Sanscrit manuscript *Siddhanta Ciromani* outlines a wheel with holes half filled with mercury arranged in such a way that once set in motion, it would rotate by itself. This document is about 1,550 years old.[5] Other hopeful inventors included Mark Antony Zimara (Italy, 1460), Robert Fludd (1574-1637), Bishop John Wilkins (1614-72) and the Marquis of Worchester among others. At the time these inventors lived, energy conservation was not understood, so, some inventions weren't "real" perpetual motion machines.[6] The following is a summary of some of the written inventions:

1618 Fludd described closed-cycle mill
1625 Zimara described his self-blowing windmill
1648 Wilkins evaluated Archimedean-screw closed=cycle pump
1686 Bockler's self-moving mills

Among the types of perpetual motion machines are the self-moving wheels and overbalancing weights. Also, there were the perpetual motion machines using electricity or magnets, and capillary attraction. Some famous scientists were caught up in the fever of this last category. John Bernoulli and Robert Boyle both had ideas for perpetual motion machines using capillary attraction.

Of the notable perpetual motion machines, Cox's perpetual motion machine must be included. Cox built a clock that derived its power from changes in atmospheric pressure. This clock used a barometer to wind it, taking into account overwinding. The clock actually worked but unfortunately, it was moved and damage to the mechanism occurred.[7]



Waterfall, By M.C. Escher (Lithograph, 1961)

Besides the inventors, confidence men have also been interested and involved in perpetual motion. Free energy and perpetual motion have been used synonomously in these cons. Most cons do not actually involve free perpetual motion machines. According to Professor Kreevoy, these cons involve free energy where some magic juice is put into a machine and the efficiencies produced are remarkable.

One such con involved Keely's energy machine. In 1872 John E.W. Keely presented his hydro-pneumatic-pulsating vacuum machine which used a quart of plain tap water for fuel. Keely sold thousands of dollars in stocks, then pocketed the money. The machine was a farce. The real source of power was a hidden compressed air assembly.

There are two types of perpetual motion machines, both of which are impossible.

As a result of all the attempts at perpetual motion, in 1836, the U.S. Patent Office estimated that about ten patents for perpetual motion machines had been granted. The next step the U.S. Patent Office took was to require a working model. (The Parisian Academy of Sciences had refused to accept perpetual motion schemes in 1775.[9]) Now, no patent applications are being accepted for perpetual motion machines.

What it all comes down to is the fact that thermodynamics is based on

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Second Law Perpetual Motion Machine

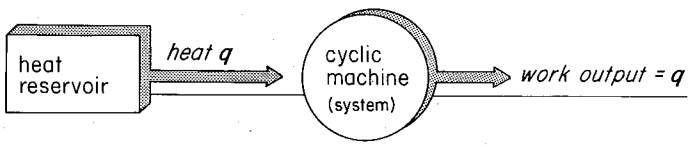

Illustration By Nan Gehrig

Alumni Profile

Britt Norton

Britt Norton received a Bachelor of Science degree in Chemical Engineering and now works at Promeon, a division of Medtronic.

By Britt Norton

In every graduating class, in every degree program, it seems like there are one or two graduates with 'classic' success stories. Four (or less) years to graduate, high-paying, low-effort summer jobs, unbelievable GPA's, no student loans, and at least five job offers to choose from *before* graduation. Then there are the rest of us, or so it seems. For those readers who fit the first description, great—take it and run with it. For the rest, who have to struggle through school like I did, take heart—it can be done. As the proud owner of a piecemeal path to success (or at least a job), I'll try to describe my experiences from high school graduation to finally landing the engineering job I was so sure I was prepared for.

After graduating with honors from Chisago Lakes Area High School in 1978, I found that being a good student didn't mean very much to the cashiers in Williamson Hall. Not wanting to sink into debt before I had even reached legal voting age, I decided to attend a less expensive school, Anoka-Ramsey Community College (ARCC).

Although my education at ARCC was more than adequate, it did not prepare me for the intense competition of my first IT hardcore 'weed-out' class, Principles of Chemical Engineering. Fortunately, the culture shock I experienced produced only a minor 'blip' in my GPA, but I found I had little time for such frivolous, non-essential activities such as eating or sleeping.

Financial matters also changed after transferring to the U of M. My bills at ARCC were paid from part-time and summer jobs as a janitor, an assembler, and a highly-respected, highly-paid convenience store night manager. I earned my room and board by washing dishes and taking out the dog at my parent's house. Although I still lived at home while attending the U of M, I found I needed more money because of rising tuition (remember the 'temporary surcharge'?). Recognizing this as a fine opportunity to establish a credit line, I opted for easy money via the bank and the GSL program. I can honestly say that if Guaranteed Student Loans had not been available to me, the State of Minnesota would now have one less gainfully employed engineer helping to finance mega-mall feasibility studies and pot-hole repairs.

My career in industry began at the end of my third year, when I was hired by Medtronic to study various

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derivations from predictions about the real world that turn out to be true. The non-observation of perpetual motion is one such example though there have been some "kooky" attempts to observe perpetual motion. There are theories about the universe which would make the universe a perpetual motion machine.

Although the quest for perpetual motion has been deemed impossible, there are still a few die-hard inventors out there still searching for their dream though their numbers are dwindling. Let's hope these inventors and dreamers are the alchemists of tomorrow, benefiting science and mankind with their discoveries.★

The oldest fallacy of all is the perpetual motion wheel. The sum of the weights and their moments about the center is always constant and no motion can result.

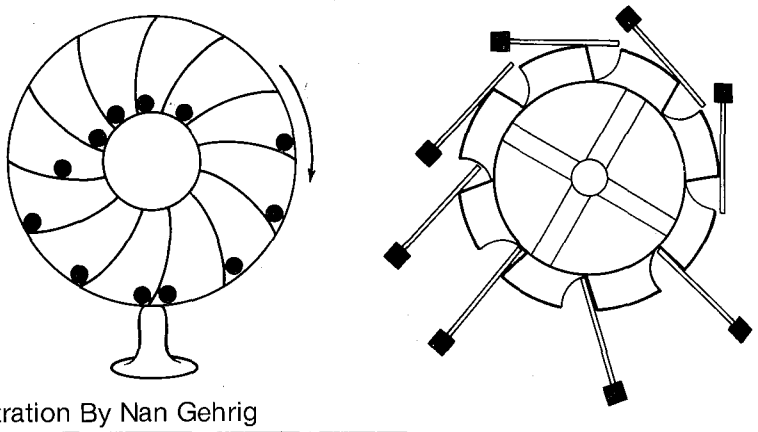


Illustration By Nan Gehrig

Great Discovery!

JUST arrived from the UNITED STATES of AMERICA, and is now open for the inspection of the NOBILITY of London and Public in general, at

No. 156, FLEET STREET,

(OPPOSITE BOUVERIE STREET,)

One of the Grandest PIECES of MECHANISM that was ever presented to the World,—the

Perpetual Motion

[1]Ira LeVine, *Physical Chemistry,* 2nd ed., (New York: McGraw Hill, 1983, p. 75).
[2]Ibid
[3]Ibid
[4]Arthur Ord-Hume, *Perpetual Motion,* (New York: St. Martin's Press, 1977, p. 32).
[5]Ord-Hume, p. 41.
[6]Ord-Hume, pp. 46-47.
[7]Ord-Hume, pp. 110-124.
[8]Jay Robert Nash, *Hustlers & Con Men,* (New York: M. Evans and Company Inc., 1976, pp. 164-65).
[9]Ord-Hume, p. 179.

Alumni from 25

My tenure at Medtronic went on to include a total of two summer internships, three twelve-week temporary extensions, and a six-month temporary extension before they decided they couldn't get rid of me, and offered me a full-time position as an engineer. This time span included my graduation with a Bachelors degree in Chemical Engineering (BSChE), and over eleven months of job searching with almost twenty interviews.

My work at Promeon, a division of Medtronic, includes everything from setting raw material requirements and writing operating procedures to large scale process development and capital equipment design. Most of my time is spent on projects involving conductive hydrogels for biomedical applications. I find that I use only a small fraction of the actual knowledge that I gained during school, yet I know that if I hadn't been taught to think as an engineer, I couldn't do my job. *Could my instructors have known what they were doing, after all?*

They don't teach subjects like that in the Chemical Engineering program.

I'm currently polishing off my education with an MBA from St. Thomas, to be complete in another two years (not wanting to hinder any emerging careers, I'll be more than willing to move up and let a new engineer have my old job). An evening MBA will fit right in with my polymers for possible use in their implantable drug pump. The experience that summer was invaluable. I was given the freedom to organize the studies, set up the equipment, collect the data, and interpret and publish the results with only minimal input from my boss. To an industry neophyte, as I was, the organizational and political workings of a larger company were almost as fascinating as they were confusing. They don't teach subjects like that in the Chemical Engineering program. patchwork background.

If I've learned anything from having to piece my degree together bit-by-bit, it would be that there's truth to the ancient saying "It'll all work out in the end". In spite of itself.★

Assigned Reading

Criminal Adventures

By Renee Bergstrom

***A Stainless Steel Rat Is Born,* Harry Harrison, Bantom Books, 1985, paperback, pp. 219, $3.5O.**

Harry Harrison's creation, a stainless steel rat, has been a lively humorous and welcome relief to the regular onslaught of science fiction. The main protagonist, James di Griz, is an accomplished 25th century criminal who finally got caught and currently works for a secret service agency assigned to catching serious lawbreakers. The series of books has James di Griz, The Stainless Steel Rat, hopping around on many universal adventures. In this latest addition to the collection, **A Stainless Steel Rat Is Born,** Harry Harrison sketches the humble beginnings of the shoplifting little tyke that will become the illustrious Stainless Steel Rat.

The book is easy reading and quite enjoyable. The careful plotting, action and humorous outlook of James di Griz is refreshing and fun. An example of the humorous and descriptive nature of the book is outlined in di Griz's impression of a police officer who caught him. " 'Gotcha!' he said. With a dirty, wide, evil law-enforcing smile."

The main interaction between characters in the book occurs between The Bishop, a well-established criminal, and James di Griz, a man wanting to become a well-established criminal. The Bishop calls crooks and criminals Citizens of the Outside, who have rejected society's simple and regimented life and substituted it for their own superior one. Criminals are industrious while society is lazy, society is immoral while criminals are moral. Criminals keep law enforcement working as well as provide entertainment for the common people. The Bishop added, "But in order for us to accomplish all this good for them, we must operate outside their barriers and well outside their rules. We must be stealthy as rats in the wainscotting of their society . . . Now that society is all ferroconcrete and stainless steel there are fewer gaps between the joints. It takes a very smart rat indeed to find these openings. Only a stainless steel rat can be at home in this environment." Hence, a stainless steel rat is born.

The book is easy reading and quite enjoyable.

The book is enjoyable, the careful planning and plotting is fascinating. However, this book resembles another book by Harry Harrison, **The Deathworld Trilogy**. Once such similarity lies in the main characters. In **Deathworld**, the main character's name is Jason din Alt, a professional gambler who doesn't like to be outdone by anyone. **Stainless Steel Rat** has James di Griz, professional criminal, as the main protagonist. The similarity in the names and the professions as well as the character mentality is worth noting.

Both books use a planet where the native language is esperanto.

A second point of similarities involves the settings of the stories. The major portion of **Stainless Steel Rat** takes place on a planet that enslaves people. Also, there's a feudal system, each side enlisting mercenaries to fight the other feudal lords. This planet also has each feudal lord possessing certain technologies that the other feudal lords do not possess. The second story in **Deathworld** also has a system where people are enslaved. The feudal system of exclusive technologies is also present. The settings for these stories are similar as well as the solutions offered by the main characters. A final point, both books use a planet who's native language is Esperanto.

Although the stories have an amazing amount of similarities, **Stainless Steel Rat** seems to have a more interesting format with James di Griz. **A Stainless Steel Rat Is Born** is several hours of inexpensive entertainment.

If this book sounds like something you might enjoy reading, also look into the other Stainless Steel Rat books.★

Helpful Tips For Getting A Job

By John Krumm

Let's be honest with each other here for a minute. We all know why you're in IT: you got a B or better in high school algebra, and now you want to turn that talent into some obscenely enormous yearly salary so you can buy that Porsche and live in a neighborhood with one bathroom per capita. Well, that's why I'm here anyway. Knowledge for it's own sake is a factor, of course, albeit a small one. Let's face it, how many parties do you think Newton got invited to? ("Hey Isaac! Take off that lampshade and do that one limit theorem thing for us again!") In light of your goals, then, I have taken it upon myself to teach you how to turn that algebra grade into a life style of materialistic hedonism. This, of course, means finding a job. We'll cover the art of writing an effective resume and the skills of surviving a typical interview.

A resume is to a job-hunter what a foot is to a door-to-door salesman; that is, they should both be about 11.5 inches long. At the top of your resume should be your name. However, you may want to leave this section blank depending on how the rest of it turns out. After your personal data (address, height, weight, sleep habits, grooming practices, moles, warts, birthmarks, recent romantic relationships), you should indicate your immediate career goals. If, like me, you want to earn $100,000/year for eating peeled grapes from bikini-clad beach girls, you should say so. Of course, it's always best to tailor these statements for the potential reader. You may want to say something like, "I would like to earn a subsistence income studying the flora and fauna of America's untamed shore areas." Some people call this artistic license; others call it lying.

The most important parts of your resume are those that deal with your education and experience. Start with the most recent in each of these categories and work back. This scheme is effective because it allows some of the older and less flattering incidents in your past to roll off the resume as you learn and do more. For instance, I was relieved last fall when I could finally eliminate the recounting of my three-week job as eraser-cleaner in second grade.

If your education or experience consists of a long list of disjointed happenings, you should try to combine them into a concise whole. Experts call this *"strategic data grouping."* If, on the other hand, you find yourself short on education or experience, you may want to employ a technique the experts call *"Strategic data borrowing."*

Your resume should be on a heavy, white paper. Some experts recommend 16 pound bond, while others prefer 20 pound. In general, the heavier the material, the better. I have been using white cardboard for years now, but I'll soon be moving up to a sort of cream-colored Formica. Above all, your resume should be eye-catching. The personnel in personnel go through piles of resumes each day, and you must give them a reason to stop and take a close look at yours. For instance, at the top of my resume, I have a picture of Ed McMahon saying, "You may already be a winner."

Your first interview with a company is perhaps the most critical time in the job-search process. It is here that a potential employer can set you on your way to a blissful cloud of job opportunity, surrounded by lavish gifts and caring co-workers with interesting new ideas, or else leave you in a terrifying abyss of

Illustration By Julie Lees

unemployment, full of ravenous jackals and demonic misfits with, like, those pliers things that they used to tag cattle with. If you're like me, you'd pick the first one. Given the extreme consequences of an interview, one might wish one could draw on the years of experience of a well-worn interviewee. I am this person. I began interviewing halfway through my senior year, vowing to stay in school and keep interviewing until I got a job. Now, approaching a Master's three years later, I have developed an impeccable strategy.

A successful interview starts at home, and this means looking nice. As a general rule, dress as if you were going to a funeral. This is appropriate because 1) both are about equally fun, and 2) at both, you'll probably never again talk to the person you came to see. It goes without saying that paper clips through the nose and comical fun-blood dripping from the mouth are not recommended (unless you're CLA).

First impressions are lasting impressions, so be prepared when it's time to meet the recruiter. It's important to show confidence at this point, and the handshake is the key. Whatever you do, don't extend an anemic, sweaty, lifeless appendage. (Remember how yucky it was to get a square dancing partner like this in gym class?) You need to grab that hand and let them know who's boss. Many interviewing experts recommend the four-and-quarter pound King Swenson handshake with the Ortegian wrist pulse (perfected by Tony Ortega, the Mexican handshaking genius). I tend to go with the more hearty six pound Alpine Hand Lock with a quick ⅛ revolution wrist flick. If you feel inadequate at this point, it's important to regain the high ground. I've had success with the Indian Death Grip and the Atomic Pile Driver.

Most interviews start off with some sort of small talk. This is a clever ploy by the recruiter to get back on the right track. The recruiter may say, "My youngest girl turned two yesterday," to which you should reply, "I hate all children. Let's talk about me." If you follow this rule, you will exude a confidence and seriousness unmatched by virtually all your competition.

I tend to go with the more hearty six pound Alpine Hand Lock with a quick ⅛ revolution wrist flick.

It's at this point that the real interview starts. The interviewer will rattle off a set of stock questions to which the interviewee should rattle off a set of stock answers. That the answers have to follow the questions is only an ancient tradition that comes from a barbarian time when much of an interview was not carefully planned out beforehand. Your answers don't really matter, as long as you seem thoughtful and calm. I like to throw in a little humor here and there just to be pleasant. Here are some common questions followed by suitable answers.

Q. "Tell me about yourself."

A. "My name is Bambi. I dig water skiing, watching *Miami Vice*, guys with big shoulders, and David Hume's criticism of the theological argument for God's existence." (I got this great answer from a magazine one of my roommates had.)

Q. "What do you know about our company?"

A. "What do you know about my blood sugar level?"

Q. "What's the most embarrassing thing that's ever happened to you?"

A. "My neighbor saw me watching him drop stray cats onto his car's spinning engine-cooling fan."

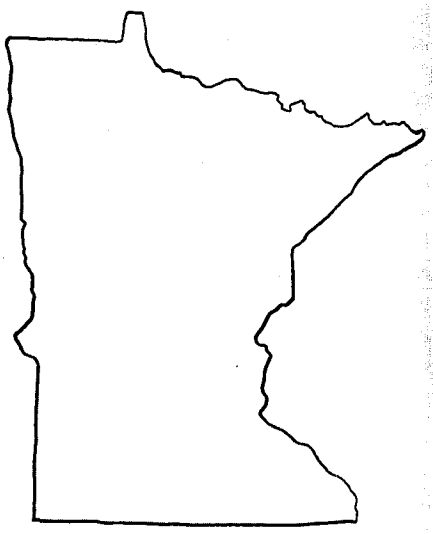
Some interviewers, in an effort to get you flustered, like to play little games. The most common and annoying game is the you've-got-something-in-your-nose game. Do you remember when your family had company, and how the older ones would try to get Grandpa to wipe his mouth or you to wipe your nose? They would look right at the person and wipe their own mouth or nose. The recruiter will begin this hideous free-for-all with a seemingly innocent scratching of his upper lip. You, fearing the worst, give your upper lip a more vigorous scratch. He repeats his first gesture. You go for the nose, inhaling heavily as your finger moves across your nostrils. He gives the innocent scratch again. You search for a tissue. Finding none, you ask the recruiter. All he can offer is a stiff page from the company brochure with a picture of a woman running a laser experiment on it. You accept, and, not noticing the dangling staple, proceed to plow your nose. Nothing comes out at first but a loud honk. Then, as you begin to settle down, you feel a warm drop hit your hand. You look down. It's not pretty. The staple has lacerated your delicate inner nose tissues, and now you have a nosebleed. The recruiter bursts into sinister laughter as you rush out. You

Continued on page 32

Minnesota Dons A Dome

***Minnesota Technolog* 1976**

By Jack Rink and Jeff Osborne



Proposed site of dome

Minnesota's on/off sport stadium may soon be a reality thanks to the efforts of a University of Minnesota professor. Hiram Q. Snaveley (pronounced "Smith"), Professor Emeritus of the School of Architecture, has recently completed a three-year study which he feels will permanently solve the sports stadium controversy. Snaveley's plan calls for the installation of a plastic dome over the entire state of Minnesota.

Although the idea sounds a bit grandiose, Snaveley nevertheless feels it is a practical solution to a perplexing problem. As Snaveley says, "Although the idea sounds a bit grandiose, I nevertheless feel it is a practical solution to a perplexing problem."

Snaveley's idea, although timely, was no sudden inspiration. In fact, Snaveley began his search for a radically new stadium design several years ago. Since that time, his work has been funded by local businessmen through the resale of Gopher basketball season tickets. But even with this substantial support the perfect solution Snaveley sought was elusive and the first 8,000 tickets and two years of research failed to produce a satisfactory design.

At one time Snaveley was so discouraged that he was about to abandon his project as insolvable. Fortunately, the paper airplane incident, a classic example of scientific procedure, provided a long-awaited break. "I was sitting at my desk one morning, absentmindedly making paper airplanes out of a student's master thesis," explains Snaveley, "when the plane I was working on, a really neato keen one, slipped from my hands. As I reached down to pick it up, I cracked my head against the side of the desk. You can still see the marks it left," continued Snaveley, pointing to matching dents in his desk and forehead.

As Snaveley looked up, among the objects he noted floating about his office was the state of Minnesota encased in a plastic dome. Groggy but inspired, Snaveley realized that he had found the perfect solution to his dilemma.

The next few months were spent in frenzied research as Snaveley consulted with some of the nation's foremost construction firms to determine if such a dome was

feasible. Seven different firms originally expressed interest in the project, however serious negotiation was soon narrowed to two companies.

The Colgate-Palmolive Corporation, maker of Baggies, has proposed a thin film dome supported by compressed air and sealed with specially designed wire "twistees." An important selling point in the Colgate proposal is that food spoilage in the state will be cut by 78 per cent after the dorm is installed. Furthermore, Colgate claims that the state-wide incidence of stale sandwiches will also be cut dramatically.

A second plan for the dome has been introduced by Tupperware Incorporated. The Tupperware dome would be somewhat thick and opaque in comparison to the Colgate version and would also need to be periodically "burped." One major advantage of the Tupperware dome is that it could be purchased at a remarkedly low price if Minnesotans agree to hold a Tupperware Party to sell similar domes to other states. (Editors note: This Tupperware Party has no relation to the political organization with the same name.

Snaveley feels that either of the two domes would be quite acceptable and the state legislature should make the final choice. Choosing between the proposals should be easy because once the entire state is domed most of the complex political issues that blocked other stadium proposals will disappear. In Professor Snaveley's own words, "Choosing between the proposals should be easy because once the entire state is domed most of the complex political issues that blocked other stadium proposals will disappear."

For Minnesota's sports teams the dome is a dream come true. The Vikings can look forward to playing in the most futuristic stadium in the National Football League. In fact, the only minor modification the Vikings have suggested is that the dome be extended slightly to the south — to Memphis, Tennessee. The Twins would no longer be confined to the Twin Cities and could attract larger crowds by playing their games on fields throughout the state. A couple hundred folding chairs would be used to accommodate spectators. In addition, the Gopher football and baseball teams would also play in the world's most spectacular stadium.

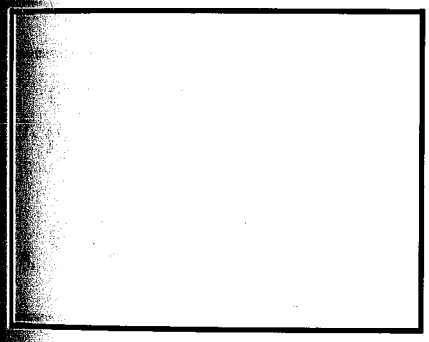
The proposed dome would be financed primarily by a special long term tax. According to Snaveley study, a two per cent tax on liquor, cigarettes, gasoline and pay toilets will pay for the dome in just over 3,200 years. In addition, since the Gophers would also use the facility, the University of Minnesota will pay a token charge. This money would come from a $800 increase in quarterly student fees.

Reaction to the planned dome has been swift. Governor Wendell Anderson came out strongly neutral on the subject stating, "I might support the proposal, assuming of course that I decide not to oppose it." The University of Minnesota Board of Regents wholeheartedly endorses the $800 student fee increase although they seem indifferent to the dome itself.

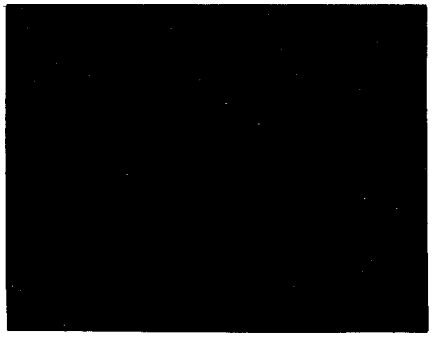
There are some serious objections to the plan, however. Professor Harlem Merblitz points out that the proposed dome is, "undoubtedly the most stupid thing I have ever heard in my life." The Sierra Club and other environmental groups have also voiced opposition to the plan and the Minnesota Pollution Control Agency announced that it will fight a legal battle to prevent the Reserve Mining Plant from being included under the dome. Meanwhile, Reserve Mining is already seeking a court order to block the project. When reached for comment, a Reserve spokesman said, "This action does not mean that we oppose the dome in any way. It is simply a company policy to seek an injunction against everything we can."

Professor Snaveley responds to criticism of his proposed dome with thoughtful rebuttal: "Anyone who doesn't like the idea is a big ninny and you can tell them I said so." Furthermore, when asked about a fine point of his plan, how fresh air would be circulated, Snaveley had a ready answer. "Shut up," he explained.

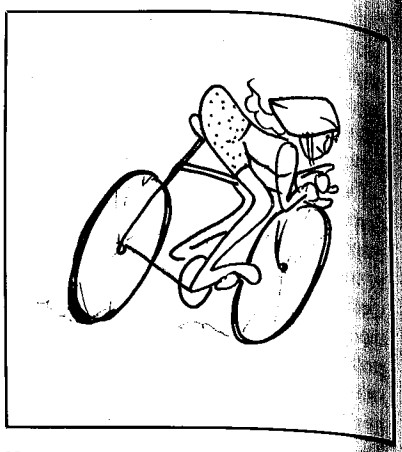
If Snaveley's proposal for a dome is accepted by this session of the state legislature (as he is confident it will be) the project could be completed by early 1993. This would make Minnesota the world's undisputed leader in innovative architecture in just 17 short years. As Professor Snavely sums up, "If my proposal for a dome is accepted by this session of the state legislature, as I'm confident it will be, the project could be completed by early 1993. This would make Minnesota the world's undisputed leader in innovative architecture in just 17 short years." Snaveley paused and added, "Boy will I be famous. Maybe then I can get out of this dump." ★



Interior of dome as it would appear during the day



Interior of dome as it would appear at night



Essay from 29

leave behind nothing but a bad impression and a warm puddle of blood, sweat, and tears.

It doesn't have to be this way. At the first sign of the you've-got-something-in-your-nose game, I put a forefinger on my front teeth and start quickly nodding my head while pointing to my mouth with my other forefinger. I call this the you've-got-a-piece-of-cabbage-lodged-between-your-front-teeth game.

Fortunately this circus of pandemonium can't last forever, and it comes time to end the interview.

Fortunately this circus of pandemonium can't last forever, and it comes time to end the interview. You will be thanked for your time, after which you should do the same. It's important here to remain pleasant and to indicate your satisfaction with the interviewer. Another handshake is O.K., but I like to try something a little more... like the old mock sparring thing. Recruiters love it. Be sure to end with a few playful blows to the jaw.

These, then, are the basic elements in securing stable employment. The key is to be persistent. I have vowed to stay in school until I get a job, and I know one will be coming along soon. Then again, I'm also looking around for some good Ph.D. programs.★

TechnoTrivia

By John Krumm

Questions

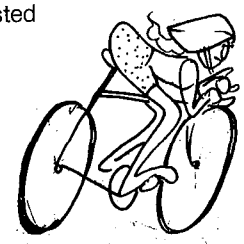
1. How come there's no channel one on TV?
2. How many trees does it take to produce the *New York Times* for one Sunday?
3. At age 10, a certain famous mathematician supposedly figured out a quick way to find the sum of the first 100 positive integers when his teacher gave him the assignment to keep him busy. Who was this person? Hint: Later in life, he came up with a slick law relating electrical flux to enclosed charge.
4. How come when you round a turn with a helium balloon in the car, the balloon moves toward the inside of the turn?
5. On which continent haven't they found any dinosaur fossils?
6. True or false: Ever since a freak accident in Cogswell, ND at age 18, 50-year-old Arnold Feedbag has lived his life with the rear axle of a 1951 Ford lodged in his head.
7. Which part of your face should you shave last? (I guess this question kind of favors the male readers, but, then again, I've seen some women around here with...well, anyway.)
8. On what day of the week are you most likely to have a fatal heart attack? (Not including when midterms are handed back.)
9. Within 50, how many homemade chocolate chip cookies would you have to eat to gain 10 pounds?
10. Why do gravel roads develop sections of "washboard" ripples?

Answers

1. When the FCC decided to make the move from amateur and experimental televisión to commercial TV, it kept channel one reserved for experimentation.
2. It takes 75,000 trees, or about 17 newspapers per tree. Take credit for 20,000 to 130,000. The *Technolog* in a conspicuous display of environmental concern, strives to use less than 75,000 trees per issue.
3. He was Carl Gauss. In case you're wondering, the sum of the first 100 positive integers is 5050.
4. Because air has more mass and thus more inertia than the helium-filled balloon, it "moves" to the outside of the turn, thus displacing the balloon. Similarly, as you stop the car from moving forward, the balloon will move toward the rear.
5. Antarctica. Evidently dinosaurs had more travel sense than certain present-day scientists.
6. False. The part was actually a muffler. Old Smokey, as Mr. Feedbag's friends call him, continues to delight children by emitting whiffs of carbon dioxide while emphasizing the importance of a proper driving posture.
7. You're right if you said the chin or mustache areas. This is where the beard is coarsest and needs the most time to soften by soaking up water.
8. According to the Mayo Clinic, Saturday is the riskiest day because of traditionally indulgent eating and drinking and drinking. Sunday and Monday are second and third.
9. 240.
10. When a vehicle encounters a single bump, its suspension begins bouncing, thus pounding out a pattern of ripples.

Scoring

0-1 Haev yoursfle chcked for dyslxeai.
2-4 Abysmal, but not that abysmal
5-7 Inside, you are a madcap melee of mediocrity.
8-10 If only there was a Nobel Prize for wasted brain storage.



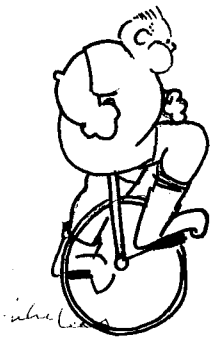
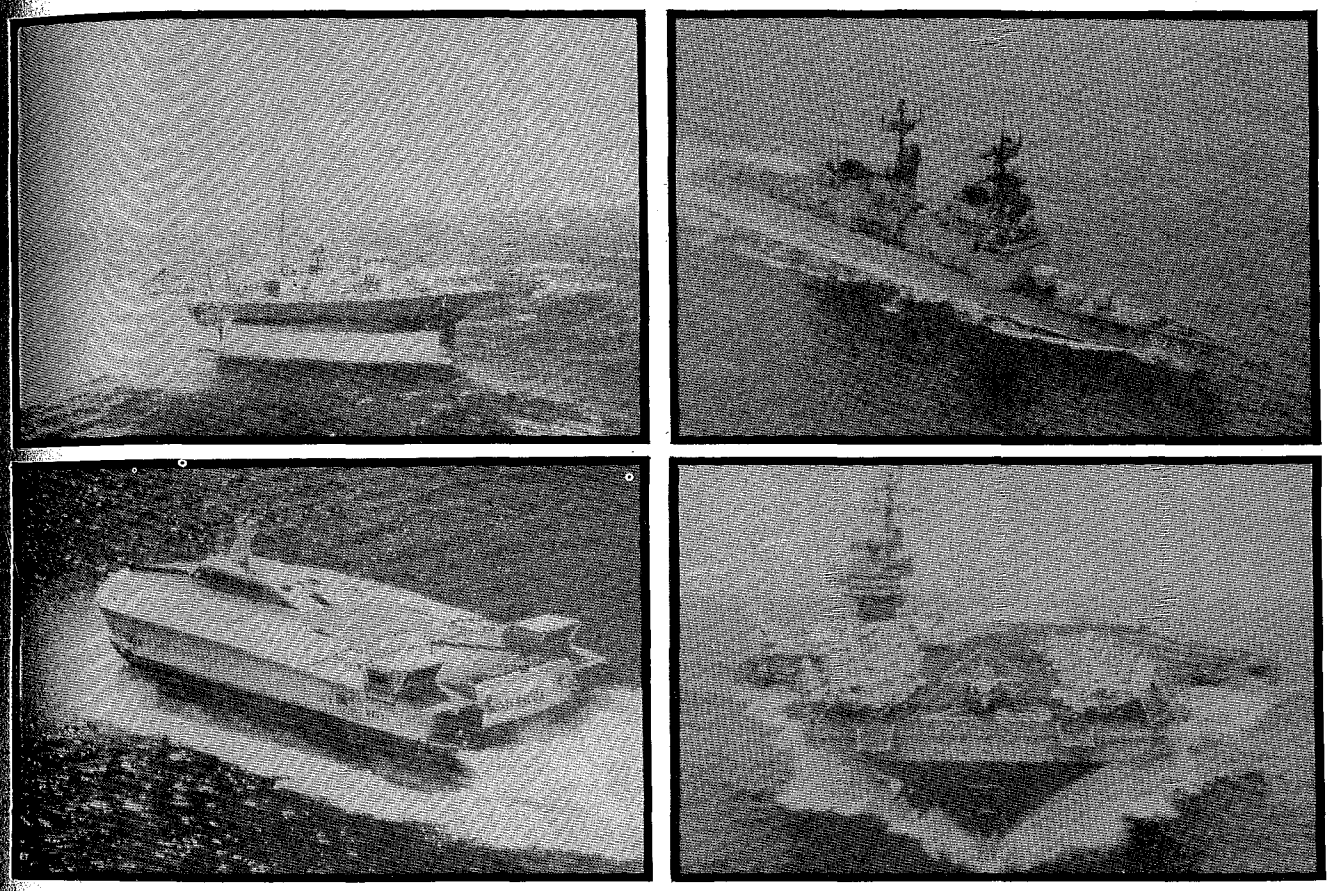


Illustration By Julie Lees

NEW NAVY ENGINEERING INTERN PROGRAM

WE CALL IT NAVY ROTC



Naval ROTC pays off in a number of ways. First, of course, it leads to a commission as an Ensign in the Navy.

It can also help pay your way through college. After two years in the Naval ROTC College Program, every student receives $100 a month living allowance for ten months each year, during his junior and senior years. In addition, he has the opportunity to qualify for a full scholarship—tuition, fees, books, plus expenses—up to a total of $10,000.

For more information, speak to the Professor of Naval Science on campus.

Give us a call, or just stop by

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U of M
Mpls., MN 55455
373-2230

THE NAVY

minnesota
TECHNOLOG

Winter Two, 1986

Perspectives and Illusions

Transcend the Edge of High-Tech Knowledge

Knowledge. At NCR Comten we've built a solid base of knowledge from which we draw our high-tech excellence. Yet, as technology advances, we constantly strive to gain new knowledge, new ideas and new technology.

As a leader in the design, manufacture and support of sophisticated data communications processing systems, we depend on our employees to transcend industry knowledge. Currently, we're seeking **University of Minnesota computer science and electrical engineering graduates** to do just that. After graduation, you can help us build on our wealth of knowledge.

In return for your commitment, we'll offer you an environment of challenge, high visibility, ongoing advancement potential, recognition for your expertise, an extensive compensation package, and a chance to work on your career, not just your job. If you would like more detailed information about how you can put your knowledge to excellent use, sign up at the Placement Office to see us on campus, Feb. 26th.

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Cover Art By
Miriam Edwards

minnesota
TECHNOLOG

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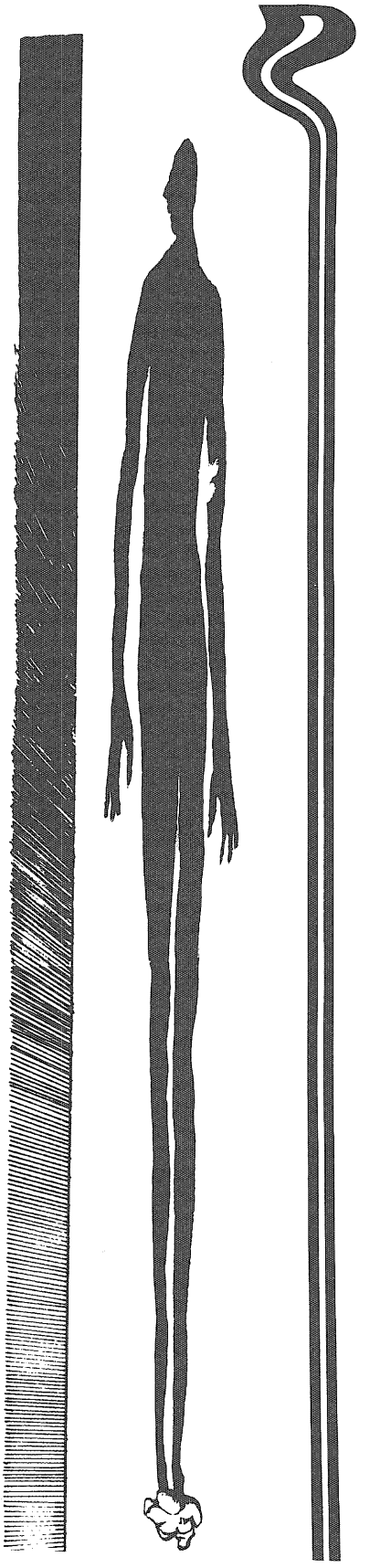
Minnesota Technolog

Writing Contest



1) SCIENCE FICTION

2) ESSAY CONTEST

SITUATION:

You find yourself mysteriously stranded on a deserted island. What three scientific or mathematical principles would you want to have with you? Why?

PRIZES WILL BE AWARDED FOR BOTH CONTESTS

FIRST PLACE: $150.00
SECOND PLACE: $75.00
THIRD PLACE: $50.00

CONTEST RULES

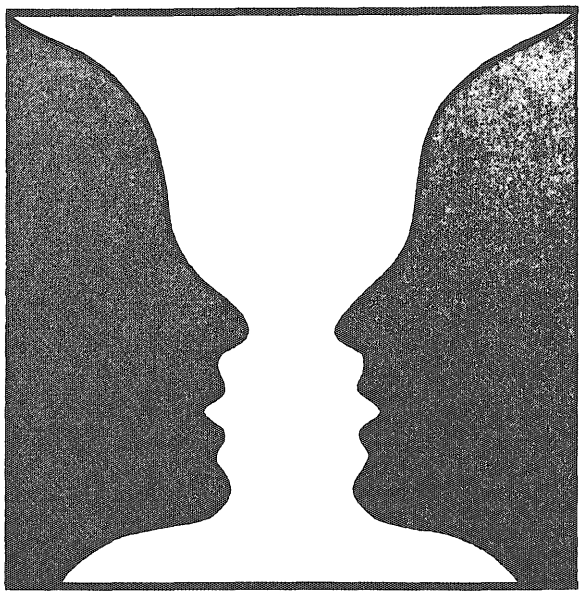
The contest is open to all registered U of M students of amateur status (persons never having published a work of fiction for monetary payment), except *Technolog* staff and I.T. Board of Publication members, past or present. Entries must be typed, double spaced, with one inch margins on 8½ x 11 paper and be no longer than 3,500 words. Each entry must be accompanied by three photocopies of the manuscript and must bear an attached cover page with the story title, author's name, home address, and telephone number. DO NOT PUT AUTHOR'S NAME ANYWHERE ELSE ON THE MANUSCRIPT! *Minnesota Technolog* retains first publication rights to all winning manuscripts. If you have any questions, call 373-5863.

DEADLINE: February 20, 1986

Editorial

The Kaleidoscope

When the brain begins to query, the image starts to fade
the concepts of the lines and space
form a bizarre and strange parade
ideas spring from emptiness,
patterns coalesce shapes
of thought emerge...
How to control the urge?
To believe what you see is real,
when logic says no,
but, the visual has such a
strong appeal...
Perhaps an illusion is something you feel?
Where are you now, you've lost your place,
the memory is becoming weary,
look at the image again,
is it true that...



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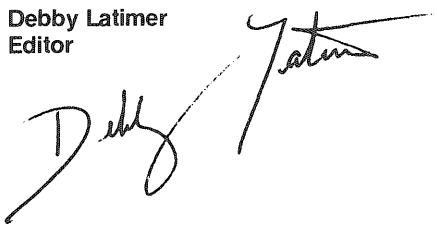
Debby Latimer
Editor



Bulletin Board

LETTERS TO THE EDITOR

Dear Editor:

In regard to the Technotrivia answer scores, *Technolog* Magazine dated Winter One, 1986, page 33. Dyslexia is a class of learning disabilities that occurs in a measurable percent of the population. Like any other disorder that limits a person's ability to function, at exactly the same level as the normal population, it leaves the person affected handicapped.

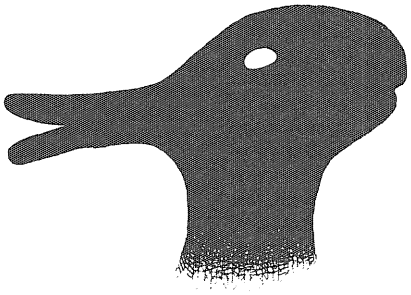
Unfortunately, for most dyslexics, their condition is never recognized, nor corrected. These people are branded as being "stupid", "slow" or having a "bad attitude" about school. The reality is that they, like a blind or deaf person, are as likely to be brilliant as they are to be retarded. Like the blind, the dyslexic has had a block put between him/her and the world of the unaffected.

For me, the choice to return to the University to finish my degree was a hard one. Because of my condition as a dyslexic I faced lower grades, due to my inability to spell without constant referral to a dictionary (a real drawback in an essay exam). And because of my slow reading speed my time spent studying is much greater. This is not new to me, I have always lived in the world of "normal" people, and in the future I will continue to compete in the world of "normal" people. I do not advertise my condition and I do not ask for special favors. I do however find it offensive when this false and degrading stereotype is perpetuated by a publication sponsored by the Science Department. Callous indifference and ignorance I have learned to live with, I do not feel that insult should be added.

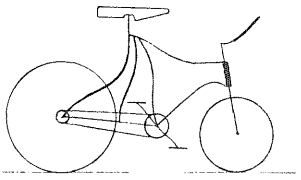
Thank you,
H. Davis
Student, University of Minnesota.

ASSOCIATION FOR CREATIVE ENGINEERING

The Association for Creative Engineering (ACE) is a student group of the Institute of Technology promoting invention, innovation and entrepreneurship. Each year ACE will sponsor an Innovation Fair, a competition for University students to create marketable products, and in addition will provide many support activities throughout the year to inventive engineering students such as business seminars and working facilities. For more information call 376-2769.



THANK YOU...



We would like to thank Bernard P. Smith for the bicycle illustrations that accompanied The International Human Powered Vehicle Association article in Winter One, 1986 of the *Minnesota Technolog*. Although his name did not appear with the drawings, it is not too late to give credit where credit is due. Excellent work!

INDEPENDENT STUDY PROGRAM

The Independent Study program at the University of Minnesota is offering two four credit electrical engineering courses.

EE 3351 Intro to Logic Design and microprocessors (2903)
EE 3352 Intro to Microprocessors (2904)

SEND LETTERS TO:

Room 2 Mechanical Engineering
111 Church Street, S.E.
University of Minnesota
Mpls., MN 55455

Believe It Or Not!

This *illusion* was demonstrated by Physics Professor Walter Johnson.

By Phil Decker

The illusion in these pictures starts with a vertical line placed with a hypodermic needle in a jar of fluid. The demonstrator turns the crank around and around until the solution appears as homogeneous as Golden Griddle syrup. Reverse the direction of the crank. When the demonstrator has wound the stuff back up to where he started, the same line will be there, just like when he started.

The apparatus consists of two concentric cylinders with glycerin between them. The dark line is glycerin with a dark-colored dye mixed into it. The demonstration is used, according to Professor Johnson, to demonstrate entropy—or the apparent lack of it. In ordinary fluid systems, the dark line would have been completely mixed into the surroundings. But using glycerin, the line is constricted to a very specific shear zone and does not mix. Hence, this mixing process is reversible, where most are not.★

Figure 1

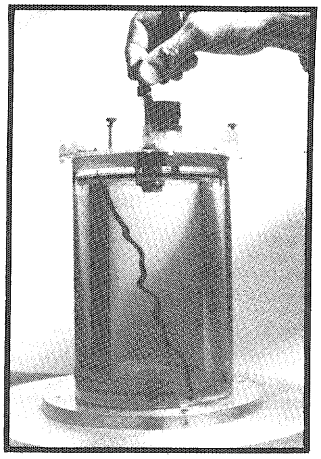


Figure 2

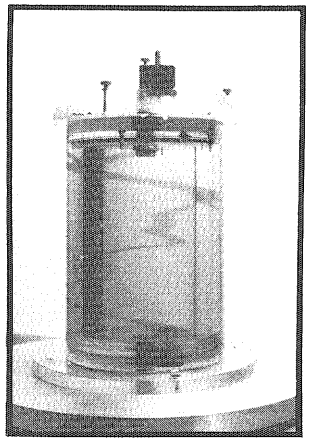
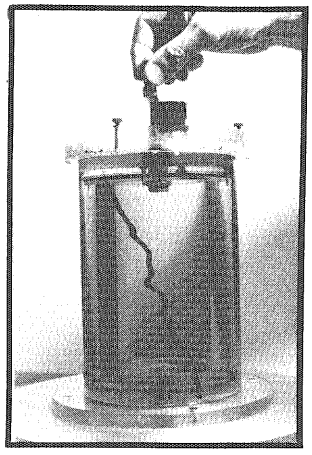


Figure 3



Photos By Randall Eaton

The Computerized Psychoanalyst

For many years ELIZA was an intriguing example of how a computer could carry on a conversation with a person. The program didn't really do psychoanalysis but, it came close enough to fool some of the people who helped create it.

By Rick Smith

The young woman sat uneasily in front of the terminal. The computer had typed "HELLO, I AM THE DOCTOR. PLEASE TELL ME ABOUT YOUR PROBLEM. TYPE IN COMPLETE SENTENCES AND ALWAYS END YOUR SENTENCE WITH A PERIOD." She typed cautiously, pausing to ponder the computer's replies.

my mother makes me so mad sometimes.

CAN YOU GIVE ME AN EXAMPLE

she phoned me and expected me to drop everything.

TELL ME ABOUT YOUR FAMILY

i hate my parents.

WHY DO YOU HATE YOUR PARENTS

they won't let me go.

IS IT IMPORTANT THAT THEY WON'T LET YOU GO

i'm suffocating.

GO ON

i need to get out on my own.

This is not a prediction of the future; this is a conversation with a computer program of twenty years ago. For many years ELIZA (or the DOCTOR, as it was also called) was an intriguing example of how a computer could carry on a conversation with a person.

It was in the early 1960s that Jerry Weizenbaum of MIT started experimenting with simple ways of making a computer carry on a

conversation. MIT was doing lots of work with interactive computers and timesharing systems. Computer terminals were appearing at offices and some people even had one at home. Weizenbaum developed a simple program that could answer trivial questions such as "What time is it" or "What date is Thursday". That first program wasn't very powerful and it was hard to improve its conversational skills.

Weizenbaum then met Kenneth Colby, a psychiatrist at Stanford who was interested in using the computer for psychotherapy. They worked together on the problem, Weizenbaum learning about conversation techniques in psychotherapy and Colby learning Weizenbaum's techniques for computer generated conversation. As the work progressed Weizenbaum and Colby found it hard to work together, partly because they disagreed on the ethical implications of the work. Weizenbaum continued working on his own version of the program which became known as ELIZA; Colby continued work on a version of the program that became known as DOCTOR.

People who tried the program were enthralled.

People who tried the program were enthralled. Weizenbaum's own secretary, who had watched him working on the program for many months, was not immune. Weizenbaum saw her in front his computer terminal and had her try it out. After a couple of minutes her conversation with ELIZA had gotten so personal that she had to ask Weizenbaum to leave the room! Later, the program was demonstrated to a noted Soviet computer scientist visiting the United States. After a few minutes the scientist was deeply involved in a conversation about how much he missed his family on his long trip from home.

The funniest example occurred at Bolt Beranek and Newman, an industrial research firm near MIT. Some of the researchers there had moved timesharing terminals into their homes so they could work at home. People at the office got used to the idea of 'talking' to a worker at home by typing at a terminal in the computer room.

One afternoon, a company vice president walked into the timesharing lab and was faced with a terminal that said, "TYPE YOUR MESSAGE AS A SENTENCE AND END IT WITH A PERIOD." The vice president thought the terminal was connected to the home of the scientist in charge of the timesharing system. He did not realize that the terminal was really running ELIZA, so he proceeded to type:

> do you think i can use the computer this morning.
>
> WHY DO YOU ASK
>
> i might be able to make some sales.
>
> DOES THIS MEAN VERY MUCH TO YOU
>
> of course it does.
>
> YOU SEEM VERY POSITIVE ABOUT THAT
>
> this is ridiculous.

The conversation continued until the vice president got mad and tried calling the scientist at home on the telephone instead. "Why are you being so snotty to me?" he yelled. The confused scientist replied, "What do you mean why am I being snotty to you?" They finally sorted out the mistaken identity.

Colby's own experiences with his DOCTOR program impressed him enough that he published a description of it in a journal of psychotherapy. This annoyed Weizenbaum, partly because his own article on ELIZA was delayed in publication and partly because of his ongoing disagreement with Colby on the ethics of computerized psychotherapy. Colby believed that a psychotherapist acted primarily as an *information processor*, listening to the patient and asking a few appropriate questions to direct the patient's words and thoughts. He figured that a computerized psychotherapist could do the same job, freeing human psychotherapists from much of their clinical work. Weizenbaum suspected, as do most clinical psychotherapists, that subtleties of human interaction were as important to therapy as any verbal information that was exchanged.

Weizenbaum was also unhappy because he knew that ELIZA (and DOCTOR) was not based on understanding what a patient said. Instead the programs relied on a bag of tricks to carry on a conversation. The basic trick was to look for specific words and match them to particular sentence forms. ELIZA's typed response was chosen according to the form of the patient's statement. For example, if the patient said "I hate you," ELIZA could reply by saying "Why do you hate me?" or "Is it important that you hate me?" ELIZA would recognize the words "I" and "you" in the pattern "I *** you," and knew that it could reply with a sentence like "Why do you *** me?" If the patient had said "I wipe the floor with you" instead, ELIZA might reply with "Why do you wipe the floor with me?" since the patient's statement matched the pattern. ELIZA had dozens of patterns it could recognize, each with one or more appropriate replies.

Part of the *ELIZA* illusion was the way people viewed computers in the 1960's.

To improve ELIZA's conversation, Weizenbaum added a few other words. If the patient mentioned "mother" or "father" or some other word for a family member, ELIZA could reply with "Tell me more about your family". ELIZA also remembered details of earlier statements so it could say things like "Earlier you said your mother makes you so mad sometimes. Could you tell me more about that?" When ELIZA was completely stumped for something to say it could fall back on the 'cocktail party principle' and reply with "That's interesting" or "Please go on." These tricks strenghened the illusion that ELIZA had purpose and understanding behind what it said.

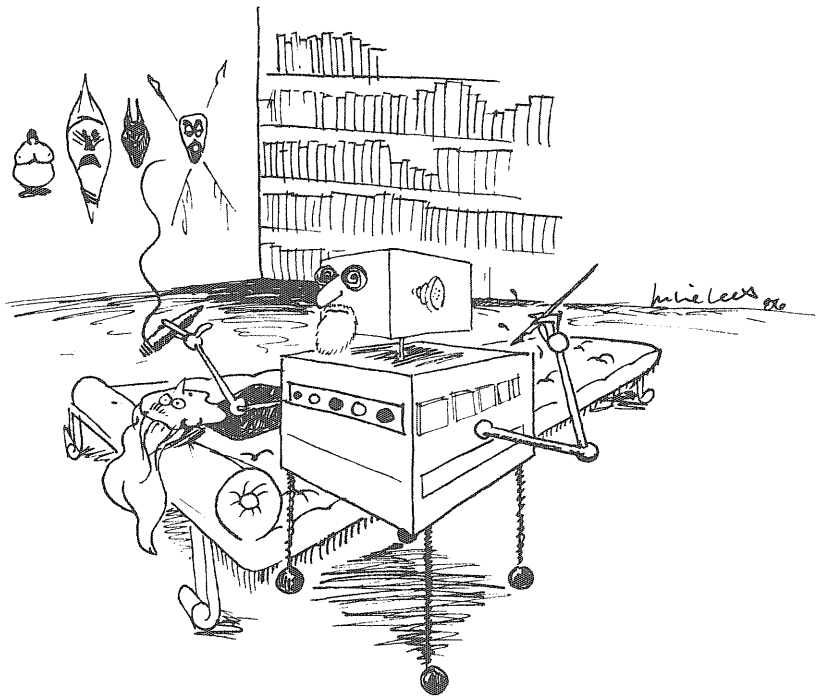


Illustration By Julie Lees

The very nature of psychotherapy conversations made it easy for ELIZA to sound reasonable. ELIZA's replies were modeled after the basic techniques of nondirective Rogerian psychotherapists. These techniques concentrated on asking questions based on the patient's own words. Patients understood this and wouldn't find it odd for a psychotherapist to say "Tell me about apples" if the patient mentioned apples. Questions like that might sound frivolous in normal conversation and still sound reasonable during psychotherapy.

Another aspect of the ELIZA illusion was the way people saw computers in the 1960s. Computer were expensive and rare, the handmaidens of only the most successful of scientists. Words spoken by a computer in the hands of a scientist were as impressive as the scientist's own. Computerized psychotherapy was as believable to most people as computer guided missiles or computerized accounting. Willingness to believe in ELIZA was an important part of its impact.

As the story of ELIZA and DOCTOR spread, Weizenbaum found himself in about the same place as Baron Frankenstein. To his horror he would get phone calls from people begging for ELIZA's "help" with their psychiatric problems. ELIZA's conversation was impressive enough that many psychotherapists seemed to think it really *understood* what was going on. Some, including Colby himself, spoke of using ELIZA for actual therapy after making "minor" improvements. Weizenbaum tried to clarify ELIZA's shortcomings through his article about it in *Communications of the ACM* and eventually by writing his book *Computer Power and Human Reason*. He tried to make it clear that ELIZA was an experiment in *language processing*, not in psychotherapy. Not everyone got the message. Ten years after Weizenbaum's article, Carl Sagan wrote an article that cited ELIZA as a forerunner of future systems to do automated psychotherapy.

The basic trick was to look for specific words and match them to particular sentence forms.

Today, ELIZA seems far less impressive than it was back then. More people know about computers now, and most realize how hard it is to make a computer handle a real conversation. Many people who use ELIZA today are more interested in watching how it manipulates their words than in psychotherapy:

TELL ME YOUR PROBLEM

i have flat feet.

COULD YOU PLEASE EXPLAIN MORE FULLY

my feet are planar on the bottom.

DOES IT BOTHER YOU THAT YOUR FEET ARE PLANAR ON THE BOTTOM

i was born that way.

IS THIS RELATED TO THE FACT THAT YOU HAVE FLAT FEET

i think so.

Another factor in ELIZA's fall from glory is that computers today are much more familiar objects. A personal computer running ELIZA just doesn't inspire the same awe as it did when it required a roomful of expensive hardware. ELIZA's success replied on people treating it as something more than it really was.★

A Visit To Cockington Green

Cockington Green represents an entire English village constructed in one-twelfth scale.

By Phil Decker

Just forty kilometers out of Canberra, the capitol city of Australia, is a tiny village like none other in the world. Its name is Cockington Green, an entire English village constructed in one-twelfth scale. The materials used in construction are the same as their full-size counterparts. The roads are real asphalt, the sidewalks are cement, and the houses are constructed out of

Thatched roofs are made of thatch. Even the grass is real.

small bricks and mortar. Thatched roofs are made of thatch. Even the grass is real. The owners have an experiment garden plot to the side of the village where they experiment with new types of grass to find which varieties can be cut to one-twelfth scale and still look real. The human figurines, however, are not real.

During the summer of 1984, this reporter travelled to Australia as part of a group from the Student Project for Amity among Nations (SPAN). The trip to Cockington Green was not part of his independent study program, but it was an educational visit nonetheless.★

A Handy Physics Refresher

By John Krumm

General Physics is not an easy set of classes for most people. Even Newton, who had a head for that sort of thing, admitted that his success was due to standing on the shoulders of giants. (One can imagine young Isaac naively pulling such a trick during a physics exam.) By the time you get to the quantum theory, you've pretty much forgotten about ropes and pulleys. With finals coming up, and for some of you, GRE's or MCAT's, a thorough refresher would really help. Oh sure, you can review Halliday and Resnick's tome *Physics,* but it's just not easy to squeeze that in during commercials on *Leave It To Beaver.* (*Physics,* isn't that kind of a pompous book title? What's next: *Science, Knowledge; Time, Space, and Being?*) What's needed is a concise yet comprehensive, an easy yet encyclopedic, a succinct yet sufficient summary of matter and energy. The *Technolog* set one of its best researchers to this task, but that person got sick, so I had to do it. Here, then, as a public service, is *A Handy Physics Refresher.*

All general physics books start with the metric system. In fact, almost every book I've had in college started with the metric system. (I remember the course I had in Colloquial American Poetry: "Oh metric system, you're so neat; I like you 'cause you ain't got feet.") Despite the best efforts of the book's author, not to mention practically the rest of the civilized world, we still like to think in English units. When we get an answer in metric, we can't relate to it until we know its English equivalent. It's like converting dog years to human years. "The answer is 13 centimeters. That's about 5 inches to you and me." We do seem to understand the standard units of time, however. This is because, instead of using bothersome factors of 10, time is expressed with more logical factors like 7, 24, 60, 52, and 365.

The first major topic in physics is usually kinematics. Here we are challenged with the mathematical concept of the derivative to describe velocity and acceleration. Velocity, for instance, is defined as

$$\mathbf{V} = \lim_{t \to 0} \frac{\mathbf{r}}{t}$$

where **r** is a displacement vector and t is time. This seems just a little fishy to me, and I blame it on the math folks. Who are they trying to fool with that limit stuff anyway? We all know something bad is going to happen when t gets to zero, so let's just admit it.

Considering the myriad of equations describing motion with constant acceleration, there must have been a contest on the back of a cereal box for physicists to think up new ones. I'm taking about equations like

$$x = x_0 + v_0t \times 1/2\, at^2$$

which reads "ex equals ex-not plus vee-not tee plus one-half a tee squared." Instead of remembering the equation, just memorize a simple mnemonic for how it reads. In this case, try "eeenpvntpohats" (rhymes with "Biff").

The topic of dynamics is dominated by Newton's three laws of motion. These laws are easy to remember because, although they all lend themselves to a strict mathematical interpretation, they can all be sensed in everyday, ordinary life. The first

As we progress through general physics, the topics become less and less intuitive.

law, for instance, says that 1) a body at rest tends to stay at rest (e.g. most professional Minnesota sports teams), and 2) a body in motion tends to stay in motion (e.g. your car as you approach a red stoplight on a snowy day).

One of the most illustrative applications of Newton's second law (F = ma) is the block on the inclined plane. The second law says that the block will slide down the plane (assuming, of course, an inertial reference frame, insufficient static and kinetic friction, and an adequately coinstantaneous alignment of Jupiter and Mars). Having learned my physics in eastern South Dakota, inclined planes were about as common in my neighborhood as New Orleans jazz musicians. Now in Minnesota, however, I am much more familiar with the topic ... not because Minnesota is so much hillier than South Dakota, but because of

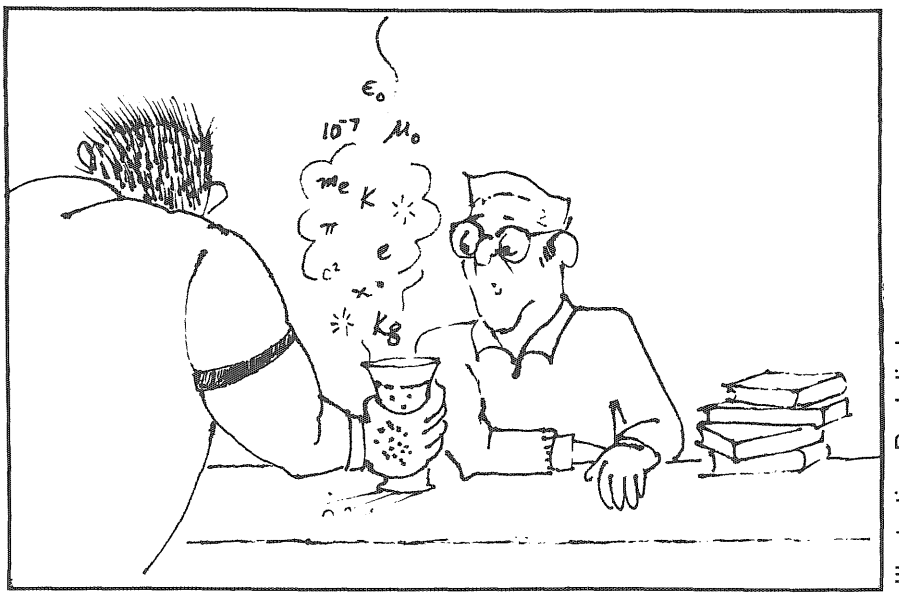


Illustration By Julie Lees

Minnesota's unique emphasis on wheelchair access.

Newton's third law concerns action and reaction, and it has many applications beyond the relatively self-contained atmosphere of physics. Not normally known for terse social commentary, Newton postulated that for every reaction (e.g. a request for a raise, a date, or some time to yourself) there is an equal and opposite reaction (e.g. "No way, buster."). Newton's third law was later generalized by Murphy.

To round out our discussion of dynamics, we consider rotational motion ("round out" "rotational motion" ... get it? It's a joke. Ha, ha, ha.) The classic problem here is "What's the minimum possible speed for a roller coaster at the top of a circular loop of radius r?" (I once challenged a rather gruff-looking carnival worker with this question and went away with grease all over my necktie.) If you think in terms of centripetal acceleration, you will no doubt realize that the speed must be sufficient to keep the vomit firmly pressed to the bottom of your stomach. As an aside, consider the path of the vomit should it indeed leave your stomach. A simple application of Murphy's law shows that it will travel toward the lap of the annoyingly temperamental Midway Murderer seated behind you.

A friend of mine pointed out that, as we progress through general physics, the topics become less and less intuitive, and frankly, I might add, their usefulness follows a similar trend. Take for instance temperature and thermodynamics (please). The standard fixed point for temperature is the triple point of water, that is, the temperature at which water exists as a vapor, liquid, and solid simultaneously. Let's be honest with ourselves here. Have you ever seen water in this condition? I sure haven't. And you'd think, living in the Land of 10,000 Lakes (lots of water), along with a fairly wide range of temperatures over a year, we'd see this phenomenon every once in a while. Even if you give the thermodymicists the benefit of the doubt, and say that the triple point of water can't occur at atmospheric pressure, which is, in fact true, so my suspicions are thoroughly ungrounded, but even then, they chose to call this temperature 273.16 degrees Kelvin. What is 273.16 ... a code for Kelvin's wife's birthday or something? The much more logical Celsius scale (for water at one atmosphere, 0.00° C is freezing and 100.00° is boiling) was invented, paradoxically, by a Swede (named Celsius).

Thermodynamics is characterized by three laws, numbered zero, one, and two. (Oops, did someone leave one out at the beginning? Or did the computer scientists, who like to start counting at zero, get their fingers in the pie?) The zeroeth law states, essentially, that if A and B are at the same temperature, and if B and C are at the same temperature, then A and C are also at the same temperature. In the words of Pee Wee Herman, "Well duuu." The thermodynamicists have cleverly restated a mathematical

principle that has been around since man could count. What's next . . . addition is commutative?

Solving most thermodynamics is quite easy. You first represent the problem as a reversible cycle on a Peavey diagram. (Who was Peavey anyway?) If this cycle has certain characteristics, it may be a Carnot cycle. (Whenever I see "Carnot," I always read it as "Carrot." Yes, it's the famous Carrot cycle.) Then, if you have too many unknowns, you can assume the process is adiabatic. If you still can't solve, you may assume it is isothermal. If the answer still won't come, you may assume the process violates the second law of thermodynamics and move on.

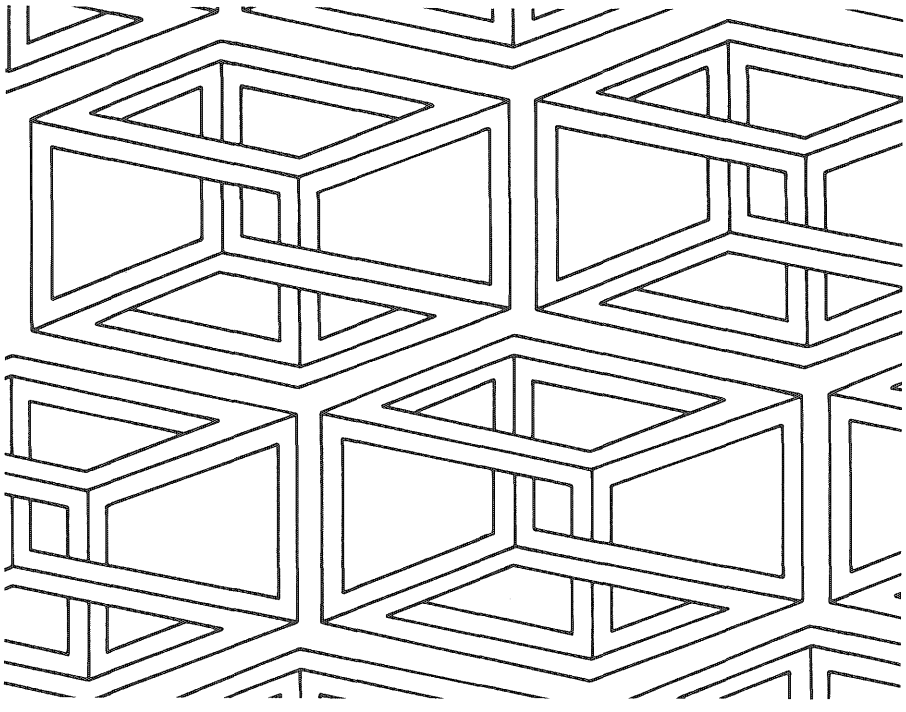
Electromagnetic theory is fundamentally the study of charge. This is why introductory electromagnetic theory labs are characterized by a virtual army of cat pelts. When rubbed on rods of certain materials, these skins of once-affectionate companions of withered, innocent, old ladies will induce a charge. You can do this yourself by wearing leather-soled shoes on carpet in the winter. (I never tired of demonstrating the principles of charge to my younger brother in this way. I was always careful to impress on him the potentially (ha, ha, yet another joke) painful consequences of uncharging to another human being.)

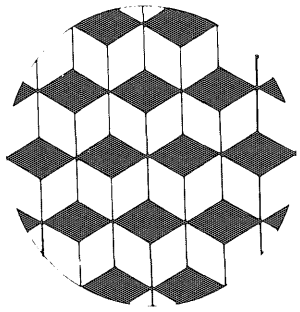
For the general physics student, electromagnetic theory can be a numbing orgy of baffling mathematics. One glance at Maxwell's equations will make you sincerely reconsider that job as a milkman. (I am perplexed by the fact that Maxwell did not actually write any of Maxwell's equations. Perhaps he brought them together and made a few changes here and there, but then shouldn't they be called "the equations that were edited by Maxwell?") The integrals are the scariest part, followed closely by the Greek letters. The book always presents the basic principles of electromagnetic theory in terms of amorphous, kidney-like objects to which any sane person's reaction is, "Boy, I'd sure hate to have to integrate that sucker." The problems at the end of the chapter seem relatively easy when the objects turn out to be merely thin rods and donuts.

When we get an answer in metric, we can't relate to it until we know its English equivalent. It's like converting dog years to human years.

After a frolic through optics, we find ourselves confronted with modern physics. (There is a problem here already. Old-fashioned physics was modern at one time. What are they going to call the physics they come up with 100 years from now, "New and improved physics?") All through optics it is shown beyond a doubt that light is a wave. It is at this point, just when we are getting comfortable with the idea, that the particle theory of light is thrust upon us. Now we long for the simpler times of Galileo, Newton, and foods which are naturally high in fiber. We are also inclined to ask a silly question: If light (which all along we thought was a particle) can be a wave? De Broglie also asked this question, and he found no reason why not. By now, we are willing to believe anything, including the supposition that everything is actually Jello, an idea introduced by Scandinavian immigrants early in this century. An appropriate end to this branch of physics is the Heisenburg uncertainty principle. It says that we can accurately calculate a particle's position or momentum, but not both.

Thus ends our journey through physics. We of the *Technolog* hope it was useful. Be sure to keep your eye on this space for another helpful guide, *A Handy Brain Surgery Refresher.*





The dark areas can be either the top of one set of cubes or the bottom of another set.

By Nan Gehrig

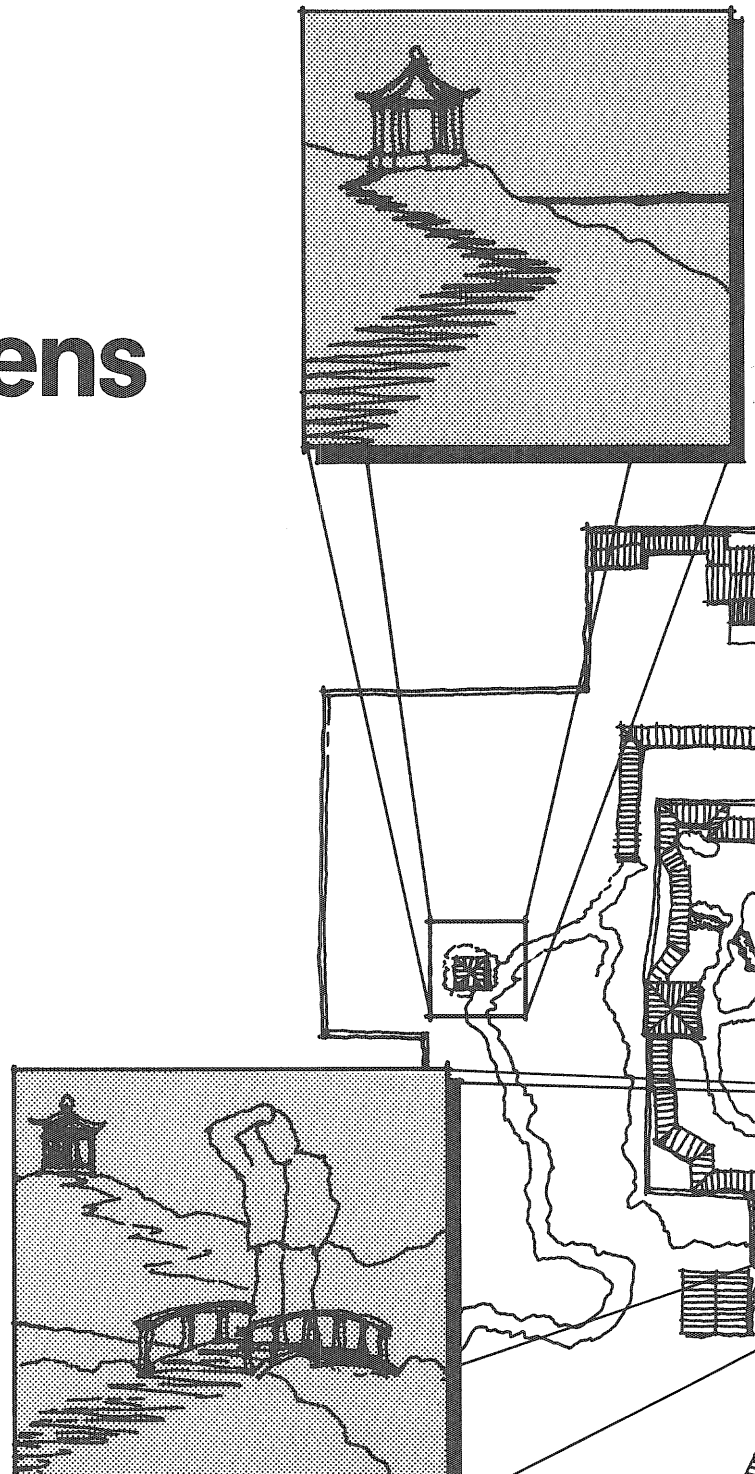
Perspective And Illusion In Chinese Gardens

By Robert Gerloff

China, the third largest nation in the world, is mostly desert. The bulk of its billion citizens are jammed into the bare 10% of its land mass that is arable. As much of the land as possible needs to be farmed. Land for houses is expensive. Space is precious. Chinese designers have, through the centuries, developed a series of tricks to manipulate perspective and illusion to make gardens feel larger than they actually were.

First, a word: Chinese gardens are not like western gardens, a plot of land that surrounds the house. The 'garden' is the entire plot of land, walled in on all sides. The 'house' is a series of pavilions sprinkled throughout the garden where the family did its eating, sleeping, bathing, and living. The house and garden are one.

The garden illustrated here, Liu Yuan (The Lingering Garden), is located in China's famous city of canals, Suzhou. The gardens in Suzhou, built by merchants and scholars, are now owned by the state, and are popular tourist attractions.

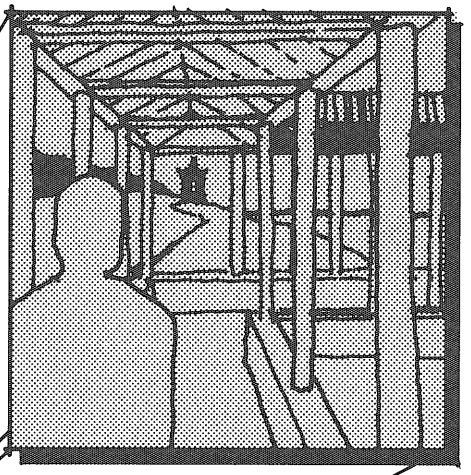


SCALE MANIPULATION

Objects in the distance appear to be smaller. The human mind knows this, and so did the Chinese designers, who would manipulate the scale of objects, making common objects smaller than usual, tricking the mind into believing they were further away than they actually were, making the garden seem larger.

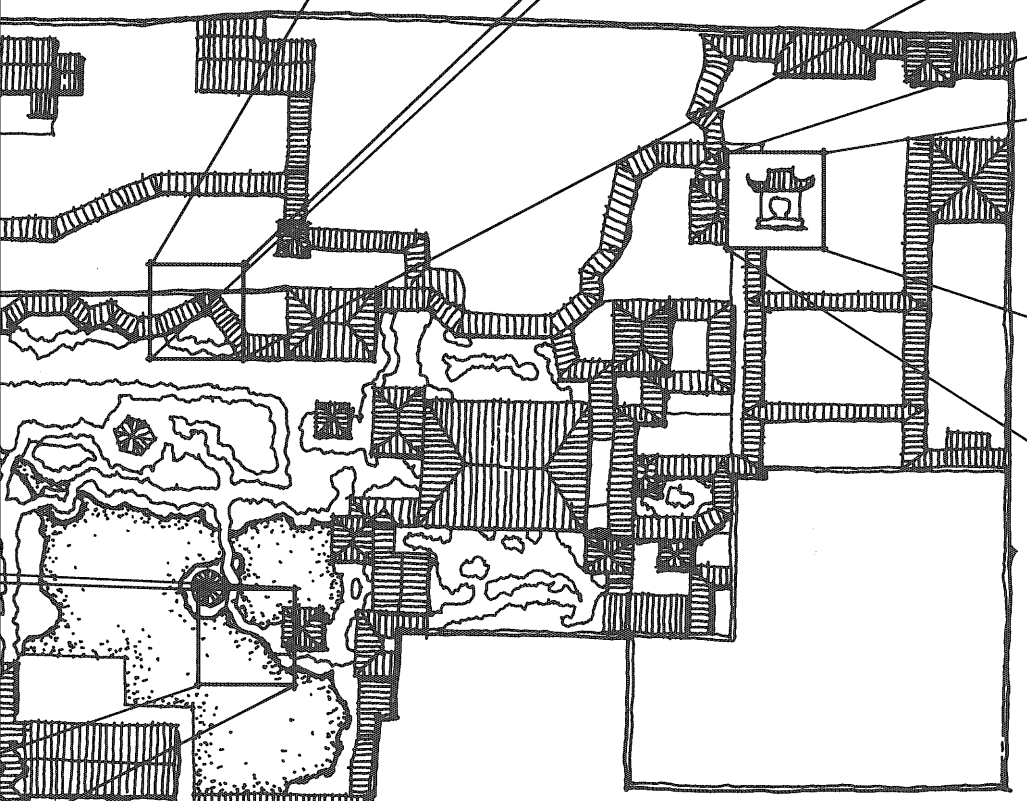
OBSERVING POINT

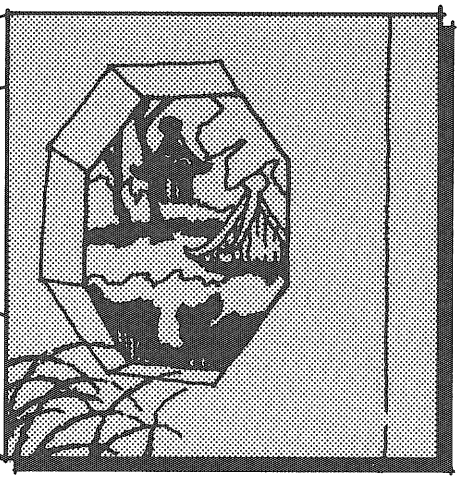
The designers built benches or pavilions at points in the garden where the views were closest to ideal. By providing several observing points in a garden, the designers could give people the feeling of having been in several distinctly different places—and thus make the garden feel large.



OBSERVING ROUTE

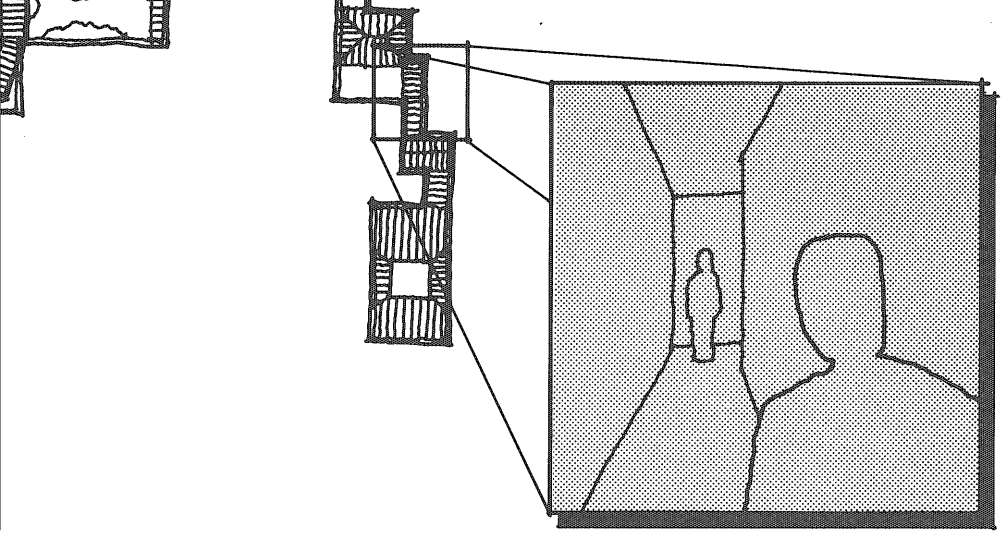
The garden designers carefully controlled how a visitor walked through the garden, constantly surprising him with views, sounds, forcing him to change directions, and generally providing more experiences than would seem possible in such a small area.





FRAMED VIEWS

Windows cut into pavilions or unexpectedly into corridor walls often frame 'ideal' views of the garden. Sometimes the view will be composed around a pagoda or other tower visible in the distance—the garden, tricking the laws of logic, will appear to extend clear to the distant pagoda.



RESTRICTIVE ENTRANCE

Lin Yuan Garden is entered through a series of tiny rooms, one after the other, which are narrow and restrictive, some only a few feet wide. Suddenly the visitor enters an open area with water and pavilions . . . and it seems so much larger because the entrance was so small.

Techniques For Three-Dimensional Computer Graphics

Flight simulation, television commercials and medical evaluation are but three examples of uses of computer graphics. Computer generated images of three-dimensional scenes are finding many artistic as well as technical applications.

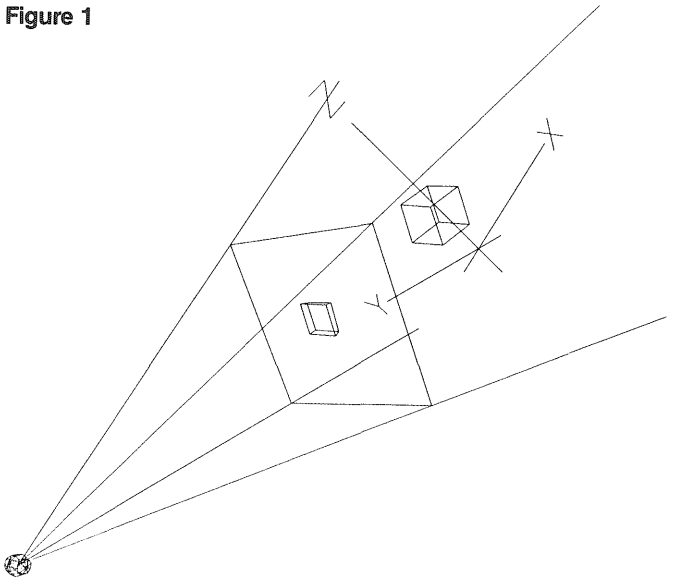
By Glen Larson

Use of the computer to create two-dimensional images of three-dimensional scenes is becoming more prevalent today in artistic and technical applications. Flight simulations, television commercials and medical evaluation are but three examples of how three-dimensional graphics are being used. As there are many applications, there have been many techniques and algorithms developed for three-d rendering with a wide variety of images produced and hardware required. This article will describe several approaches, their relative computing requirements and image quality, and what situations each might be appropriate for.

The most important factors in producing computer graphics are, of course, the computing hardware and graphics display employed. The main limitation of a given computer is usually the size of available memory as the data-base of even moderately detailed scenes, such as figures 5 and 8, often require mega-bytes of storage. The speed of the processor itself may be a secondary consideration as it affects only the time one has to wait for results. However, some techniques require immense amounts of computation, necessitating the use of large, powerful systems and increasingly supercomputers. The capabilities of the display used are the primary determinants of how the scene is eventually rendered. Current display technology can be divided into two classes: vector and raster. Vector displays are somewhat analogous to oscilloscopes and may produce only narrow lines on the screen. They therefore excel at line-drawings but cannot do the colored and shaded images which are the realm of raster displays.

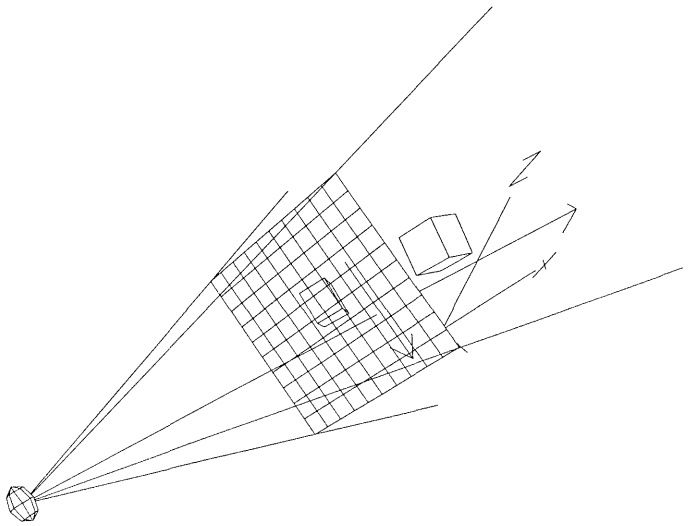
A raster display is essentially a high-quality television that can have its picture elements, or "pixels," colored by commands from a computer, (see figure 2). Typically, raster screens have a pixel count along the edges, or resolution, of from 350x450 to 1000x1000. The

Figure 1



This rendering illustrates the basic algorithm for wire-frame graphics. The objects are originally modelled as lines connecting points in three-space. The viewing perspective is established by setting the "eye-point," the direction of the sight, and the size of the viewing "window." The lines of the scene are then projected towards the eye-point with those lines or segments intersecting the window comprising the image. The lines running from the eye-point through the corners of the window are the corners of the visible volume.

Figure 2



This wire-frame graphic illustrates several graphics techniques. The eye-point and window are as in figure 1. The grid added to the window represents the pixels of a raster display. In this example, six squares making up a cube were projected to the window and used to remove hidden lines. The arrow going across the window implies the scan-line algorithm in which the rows of pixels are traversed looking for crossings with edges of projected polyhedra. The arrow going through the window is a ray-tracing vector which is sent from the eye-point through each pixel, checking for the first surface it hits.

most important ability is that of producing many colors simultaneously. This varies widely between models, from eight or less to over 16 million on the newest generation. This allows many more colors than pixels. Figure 8 was photographed off such a unit while that for figure 5 used about a thousand unique colors. The raster display can be used to present either line-drawings or more realistic colored pictures.

LINE DRAWINGS

Figure 1 shows some of the basic concepts common to most rendering methods. The first requirement in making any image is to create a data-base representing that scene in three-dimensions. What is seen on the screen is selected by positioning the eye point and viewing window as shown figures 1 and 2. After that an algorithm is applied to obtain a two-d rendering.

The simplest, and historically earlier, method for three-dimensional graphics is wire-frame rendering as in figure 3. The original representation of the scene was as a set of lines which were defined as connecting pairs of points in three-space. The image is made by projecting each line's end-points towards the eye point, through the window plane. Lines, or parts of lines, which do not fall within the window are discarded with the remaining lines constituting the image.

Compared with other methods, wire-frame images require a small amount of computer memory and take very little time to process which makes it attractive for quick review of scenes before more complex and costly rendering. It is also useful when one wants to actually see-through objects as in drafting or human-tissue modeling. An improvement on basic wire-frame rendering can be seen in the hidden-line removed image of figure 4. To accomplish this requires the scene data-base to be expanded to include a definition of the objects as physical solids. This is often done by representing each object not as a true solid but as a collection of planar exterior polyhedra, or "facets," that approximate the outside of the body. Typically, each polyhedron is defined as an ordered set of three-d points that lay in the same plane. To make a complex object or a curving surface requires many facets.

Hidden-line algorithms may be grouped into two general classes: object-space and image-space. Object-space approaches perform literal hidden-line removal.

The earliest method for three-dimensional graphics is wire frame rendering.

Obstructed segments are eliminated when a line, or in some cases facet edge, is covered by a surface when it is projected back towards the eye-point. The remaining visible lines are then projected to the viewing window as in basic wire-frame rendering.

Image-space algorithms are sometimes referred to as visible surface algorithms as the procedure emphasis is changed from identifying lines that are obstructed to finding

polyhedra that are not. The first step here is to determine which facets have a chance of being seen and projecting them into the viewing window. The polyhedra are then examined for overlapping conflicts which are resolved by the more distant facet being cut back, divided or removed altogether. When no more conflicts remain the resultant polyhedra edges constitute the drawing.

Hidden-line techniques are an efficient way of doing three-d depiction as the resulting image eliminates the clutter and confusion of basic wire-frame while not requiring the long computation time of actual surface rendering. These methods therefore, represent an efficient middle-ground between messy see-through drawings and costly full-color pictures.

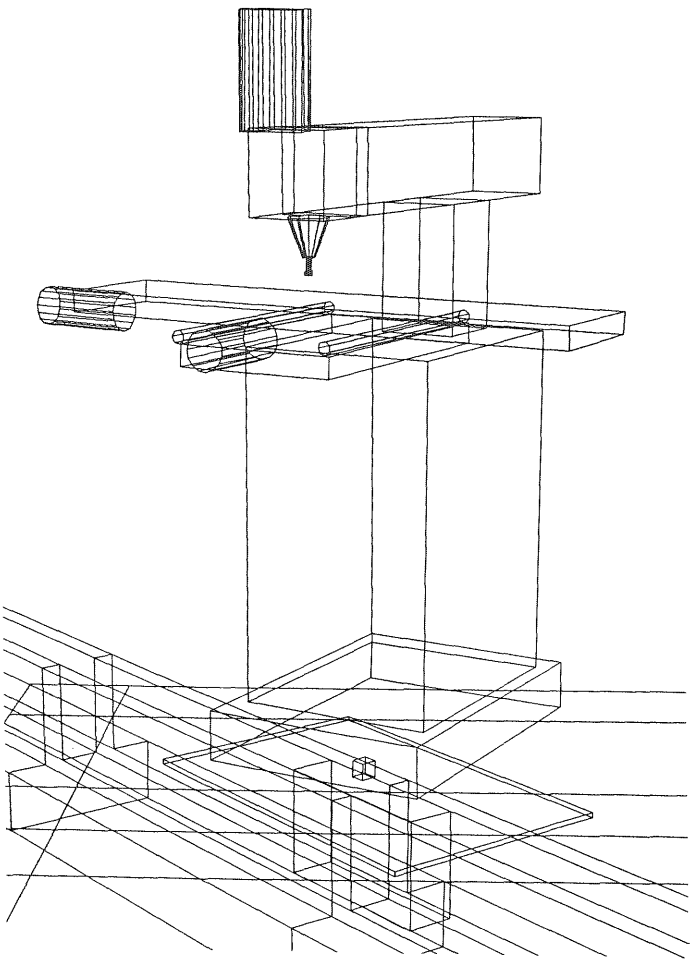
SURFACE RENDERINGS

Today's most advanced techniques produce full-color pictures instead of just line drawings. These attempt to mimic a real picture through simulated light sources, surface textures, reflections and other effects. There are again several current approaches here represented by figures 5, 7 and 8.

In scan-line methods the polyhedra are first projected to the screen as invisible surface hidden-line removal. The algorithm proceeds by searching across each pixel row in a "scan-line" for crossings with polyhedra edges. (see figure 3.) As edges are encountered, the horizontal row is broken into strips of pixels that are filled from the same facet. The strips are then colored using a variety of methods. Figure 8 was done using Gouraud shading which averages surface angle across neighboring facets, thus obtaining "bent" planes, before coloring evaluation to get a smoothly-shaded image.

In ray-tracing, a vector or ray is projected from the eye through each pixel to the first object it encounters, if any. The algorithm determines the color for that pixel by approximating the surface texture and lighting characteristics of the exact spot the ray hits. Ray-tracing achieves its realism by computing several things: the brightness of the spot hit due to direct lighting, whether light is bouncing directly into the eye and

Figure 3



Wire-frame rendering is the easiest method of three-dimensional computer graphics. However, as you can see, it can produce a messy, cluttered image. Figures 3, 4 and 5 were made using a software package developed by the author to simulate robotic workcells. This scene is one "frame" from a simulation where a robot is being used to service a milling machine with parts transported on an assembly line.

Figure 4

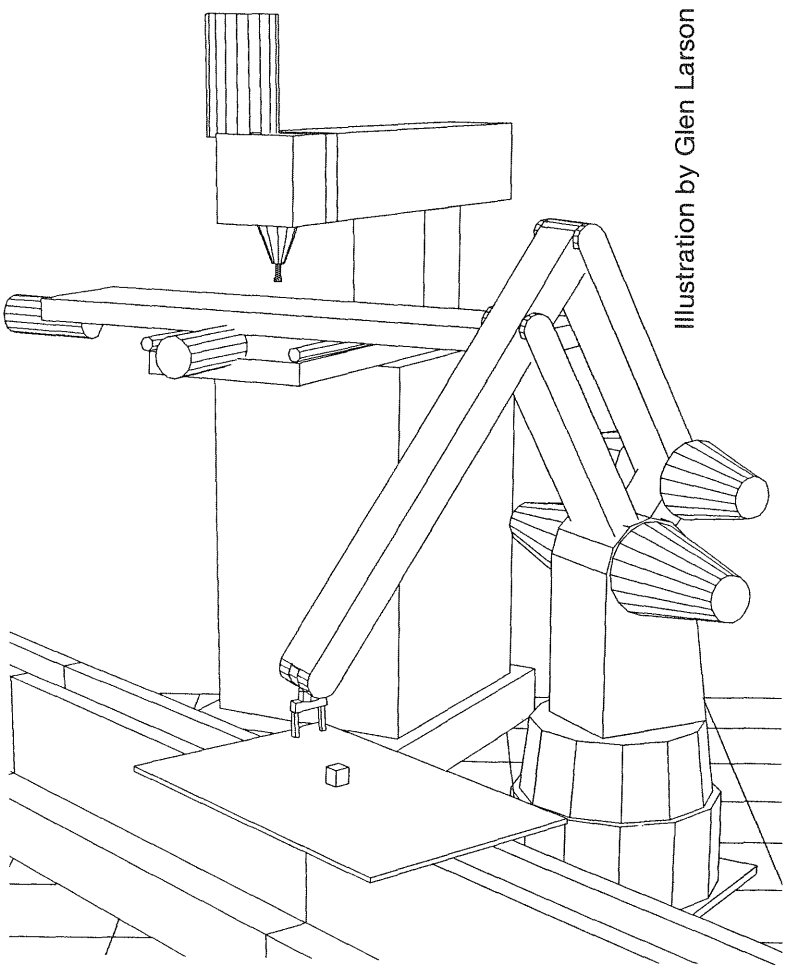
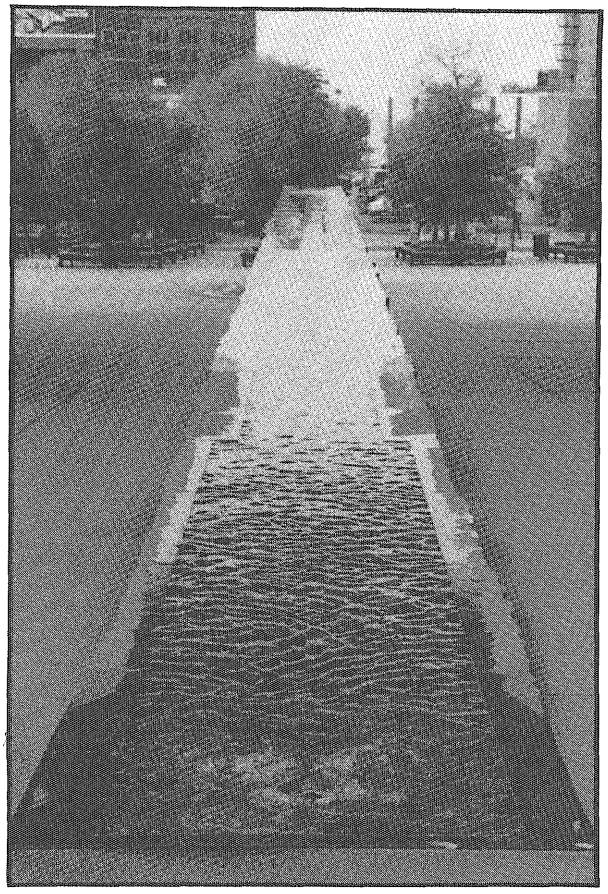
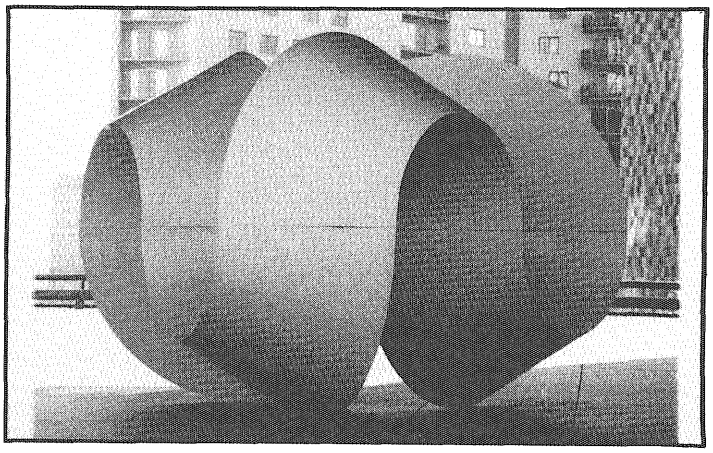


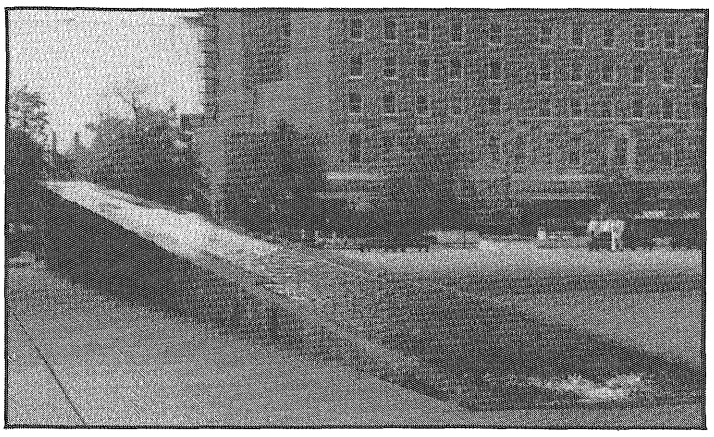
Illustration by Glen Larson

Hidden-line removal results in an image that is a vast improvement over basic wire-frame rendering. This rendering was made using the same scene as figures 3 and 5 to more clearly show the attributes of the three techniques. Other frames or steps from the simulation could be shown or the scene itself could be viewing differently.

Continued on page 22







A fountain going uphill in front of the Federal Reserve Building?

Photos by Tom Foy

Figure 5

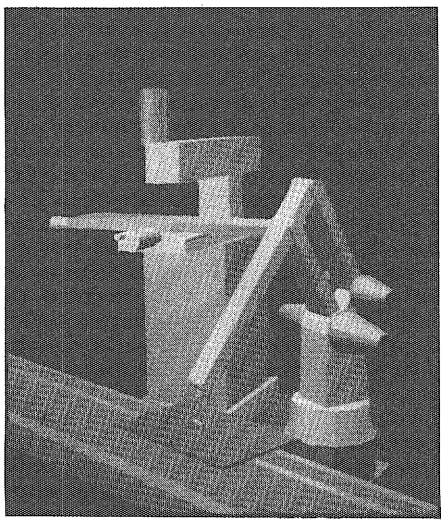


Illustration by Glen Larson

Surface rendering, in this case ray-tracing of polyhedra, produces the highest-quality computer graphics. The scene was lit by eight light sources, predominantly from the left, to get a well lit, distinguishable image. This figure illustrates "dithering" in which pixels of different colors are interspersed to produce another color. It is used here to make shading across a surface more gradual.

producing a high-light, and by spawning one or more secondary rays.

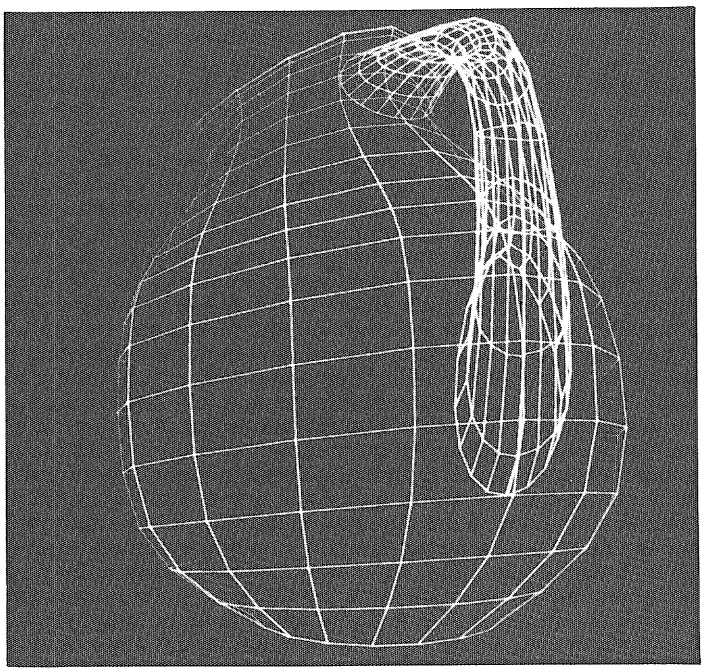
The secondary rays are sent in appropriate directions and are evaluated as the first ray with the results included in the pixel color according to surface type. Of course, one can do third and fourth rays but this is normally not done as the information added is most likely not worth the effort. For a clear surface, two rays are spawned with one in the reflected direction and one in the refracted direction. A translucent surface would include a surface color with the results of the two secondary rays. Figure 7 shows a simple ray-tracing that uses the positions and intensities, but not secondary rays, of the light sources to set the color.

Solid modeling is a three-dimensional modeling technique which allows for more accurate description, and hence rendering, of solid objects. More formally known as constructive solid geometry, the method defines solids as the result of set operations, such as AND, OR and NOT, on the volumes of simple shapes or "primitives" such as cubes, spheres and cones. This avoids the problem intrinsic to polyhedral modeling of using flat facets to approximate curved surfaces. However, complex objects and erpatic curves still require many primitives making solid modeling about equally useful for defining highly detailed scenes. Figure B demonstrates the capabilities of solid modelling combined with ray-tracing. Solid models may also be rendered as line-drawings.

A translucent surface would include a surface color with the results of the two secondary rays.

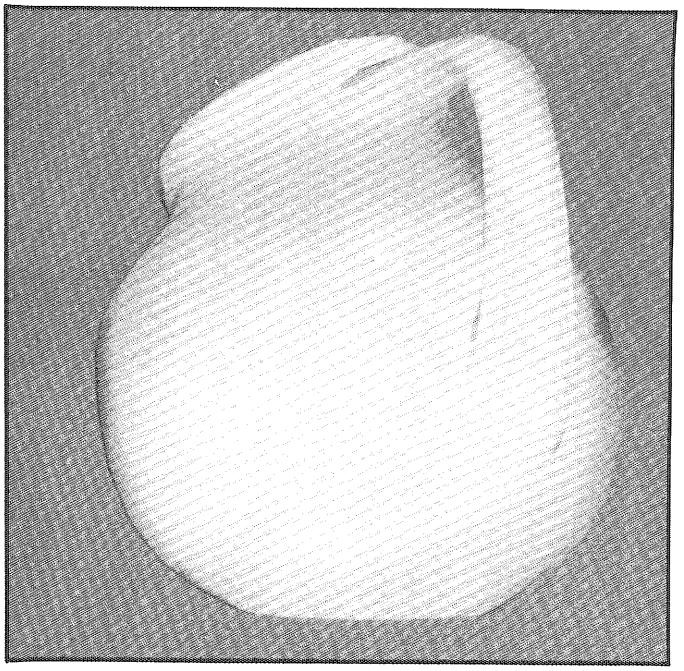
Another technique being used to obtain more realism is the broad category of surface texture mapping. While many graphics systems use mathematical models of surface color and texture, texture mapping utilizes information from pictures to include fine details. The pictures, which might be photographs, video signals or the results of two-dimensional "painting"

Figure 6

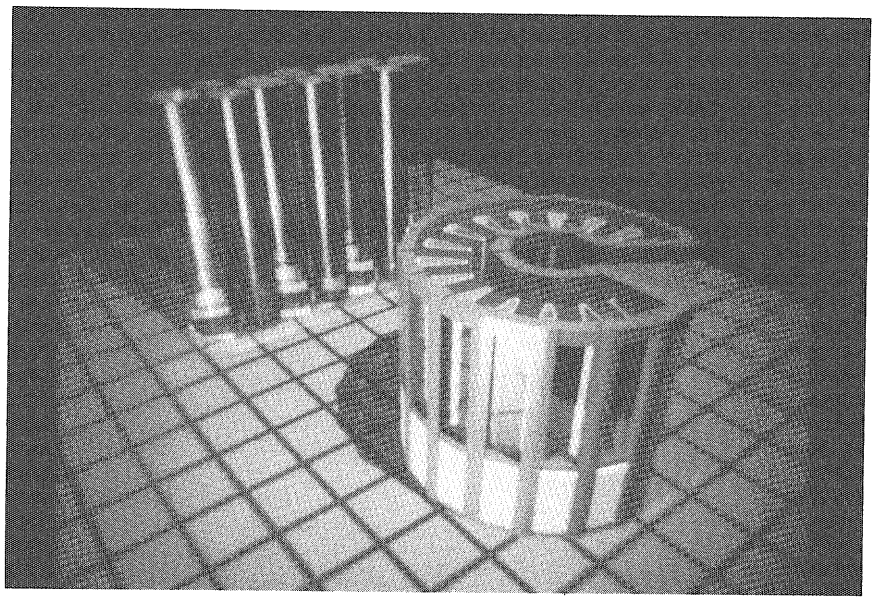


This is a wire-frame rendering of the polyhedra data-base for the vase also shown in figure 7. The surface facets here are all roughly rectangular. This image illustrates a method of adding some three-dimensional feel to standard wire-frame called shaded depth queing. Nearer lines are made brighter and farther lines are made dimmer to achieve this. In this image, the lines on the back have been reduced to black, not actually removed.

Figure 7



Gouraud shading is a method to obtain smooth shading of an object across polyhedra boundaries. This is done by modifying the surface angle at a given point based on the proximity of neighboring facets. A minor problem is that shaded objects still retain the straight edged silhouette of the polyhedra data-base. This image and figure 6 appear courtesy of Scott Gaff.



This ray-tracing on a constructive solid geometry data-base is an example of the current state-of-the-art in computer graphics. It shows a CRAY II computer and columns of coolant and was in fact created on a CRAY II making this sort of a "self-portrait." Reflection, refraction, high-lights and shadows are incorporated to produce an almost realistic rendering. This image courtesy of Gray Lorig and Cray Research, Inc.

software, are "digitized" into a numerical representation which is then mapped, or bent and stretched, onto the corresponding surface in the scene. This idea is compatible with most surface rendering algorithms and enables some fairly impressive results.

Currently, most of the advancement in computer graphics is occurring in hardware as special architectures are developed to specifically perform rendering operations and rapidly communicate the results. Areas of new technique development include modelling of fine textures such as cloth and motion blur. ★

SUGGESTED READING

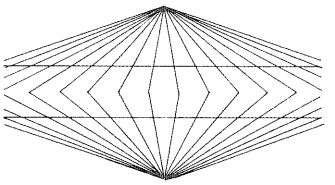
Device-Independent Graphics, Sproull, Sutherland and Ullner, McGraw-Hill, 1985.

Fundamentals of Interactive Computer Graphics, J. Foley and A. Van Dam, Addison-Wesley, 1982.

Procedural Elements for Computer Graphics. David F. Rogers. McGraw-Hill, 1985.

Linear Perspective In Early Renaissance

Linear perspective is the art and science of producing accurate and realistic spatial depth in drawing, painting, architecture and sculpture. The early Italian Renaissance is credited with the birth of this technical aspect of art.



By Michael Servatius

Linear perspective is the art and science of producing accurate and realistic spatial depth in drawing, painting, and to some extent architecture and sculpture. The Early Italian Renaissance is credited with the birth of this technical aspect of art. Prior to this period of time, many paintings appeared very awkward and unnatural in their presentation of figures, space, and depth. A series of events during the Early Renaissance changed this and enabled artists to produce paintings of great perspectival accuracy. It is due to the work of two great fifteenth century Italian artists that we now have a guaranteed geometric method of achieving accurate spatial depth in painting and drawing. In order to gain a clear understanding of this topic, we will focus our attention on the discovery and growth, of what was to become formally known as linear perspective.

Linear perspective was discovered in approximately the year 1425, by the Italian architect Filippo Brunelleschi, in Florence, Italy. Through the construction of two perspective experiments, Brunelleschi laid the groundwork for what would develop into the "science" of drawing. Much of the specific information concerning Brunelleschi's experiments is not positively known. This is true mainly for two reasons. One, the earliest accounts of these experiments were written fifty to sixty years after they took place. Secondly, the actual panels which Brunelleschi painted in the experiments have been lost. For these reasons, we rely on the very good approximations of scholars in the fields of art history and science, for data such as dimensions of the panels, and distances and visual angles used in the experiments. However, by reconstructing the experiments, in the absence of statistical data, we can still gain a clear background of Brunelleschi's original concepts.

The first of Brunelleschi's

Photo by Gary Lovelace

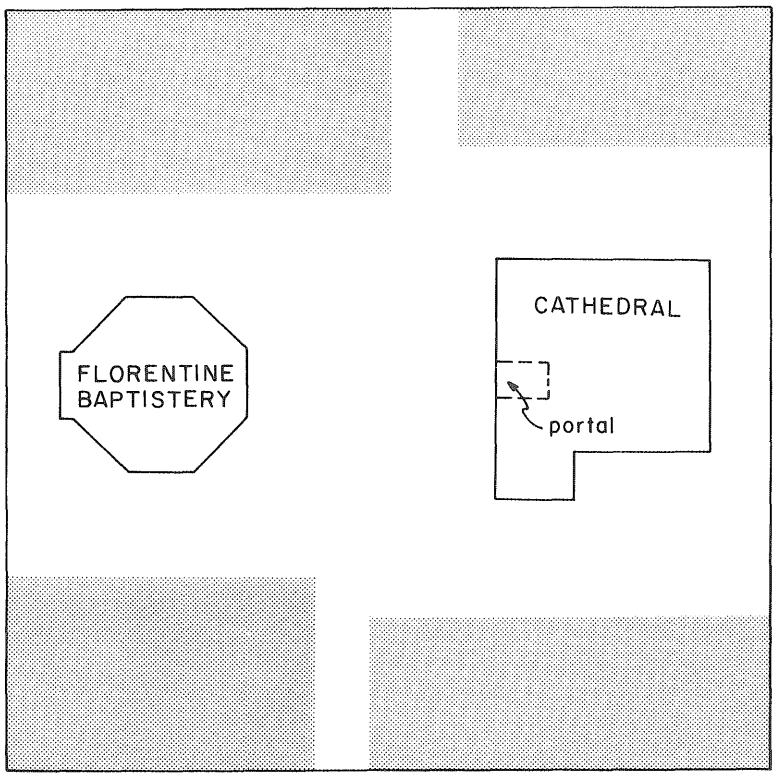
Diagram 1

experiments, and the one to have the greatest impact on future art, was a demonstration in frontal perspective. (The second experiment was a demonstration in oblique or angular perspective, which never received the amount of attention that the first experiment did. At this time, we will only concern ourselves with the first experiment.) The inherent value of this first experiment was Brunelleschi's notion of a central vanishing point. Brunelleschi, like many painters of the time, was fascinated by the apparent convergence of parallel lines seen in long roads and rooms. (See Diagram 1). We will assume that this fascination was a primary motivation behind the undertaking of this project. What follows is a very simplified explanation of this experiment in frontal perspective. We will only look at the format and process of the procedure, without examining specific mathematic data or details.

Brunelleschi wished to reproduce the natural illusion of convergence to a central vanishing point. He needed a concrete method of reproduction to prove his theory. As mirrors were receiving greater use during this time, Brunelleschi realized that by reconstructing the image seen in a mirror, he could accurately reproduce the spatial depth seen in nature. He chose as his subject for this visual essay, the Florentine Baptistery, which was then known as the Church of Santo Giovanni. Brunelleschi went to the Piazza del Duomo and stood in the portal of the Baptistery. (See Diagram 2). With his back to the Baptistery he set up an easel, on which he placed a mirror and a panel, each about twelve inches square. By looking only in the mirror, with his back to his subject the whole time, Brunelleschi proceeded to reconstruct the image in the mirror. The first step was to place a dot on the panel representing the vanishing point, at the same point it was located in his mirror. Then, presumably through the use of calipers, he transferred the dimensions and angles of the image in the mirror to his drawing on the panel. Brunelleschi's horizontal and vertical visual angles would have depended on his position in the portal and the inclination of the mirror, respectively. Since this information can only be estimated, we do not know what portion of the adjacent buildings or ground were visible from his viewing position. We take it that whatever surroundings were visible, were also drawn with this system. After he had geometrically reconstructed the image in this manner, he completed the panel by painting it.

For the second stage of this experiment, Brunelleschi needed a means of presenting his panel so as to enhance its perspectival qualities. He devised a very clever method of observation for this purpose. Brunelleschi first drilled a little hole in his completed panel. The viewer was then instructed to hold the panel close to one eye, with the painted surface facing away. In the other

Diagram 2



PIAZZA DEL DUOMO

Brunelleschi stood in the portal of the cathedral, with his back to the baptistery.

Illustration by Nan Gehrig

hand he was asked to hold a mirror, and then peek through the hole in the panel and look at the reflection of the painting in the mirror. By doing this, the mirror restored the painted image to its actual orientation. Brunelleschi originally reversed the image by painting it as seen in the mirror. Also, by looking at the image through one eye, the effects of binocular vision were removed from the experiment. Brunelleschi always required this observation to take place outdoors, so that the perspective painting could be compared to the Baptistery itself. When viewed side by side the painting must have looked startlingly realistic.

Brunelleschi was fascinated by the apparent convergence of parallel lines seen in long roads and rooms.

While Filippo Brunelleschi is given credit for discovering linear perspective, it was Leone Battista Alberti who was responsible for the increased growth and use of these principles. Alberti, also a fifteenth century Italian artist, was the first person to write down the rules of linear perspective and a method for executing this system in painting. In this treatise on painting, De pictura, Alberti wrote at length about his system of linear perspective. This text enabled many artists from all over the area, to make use of the principles in their own work.

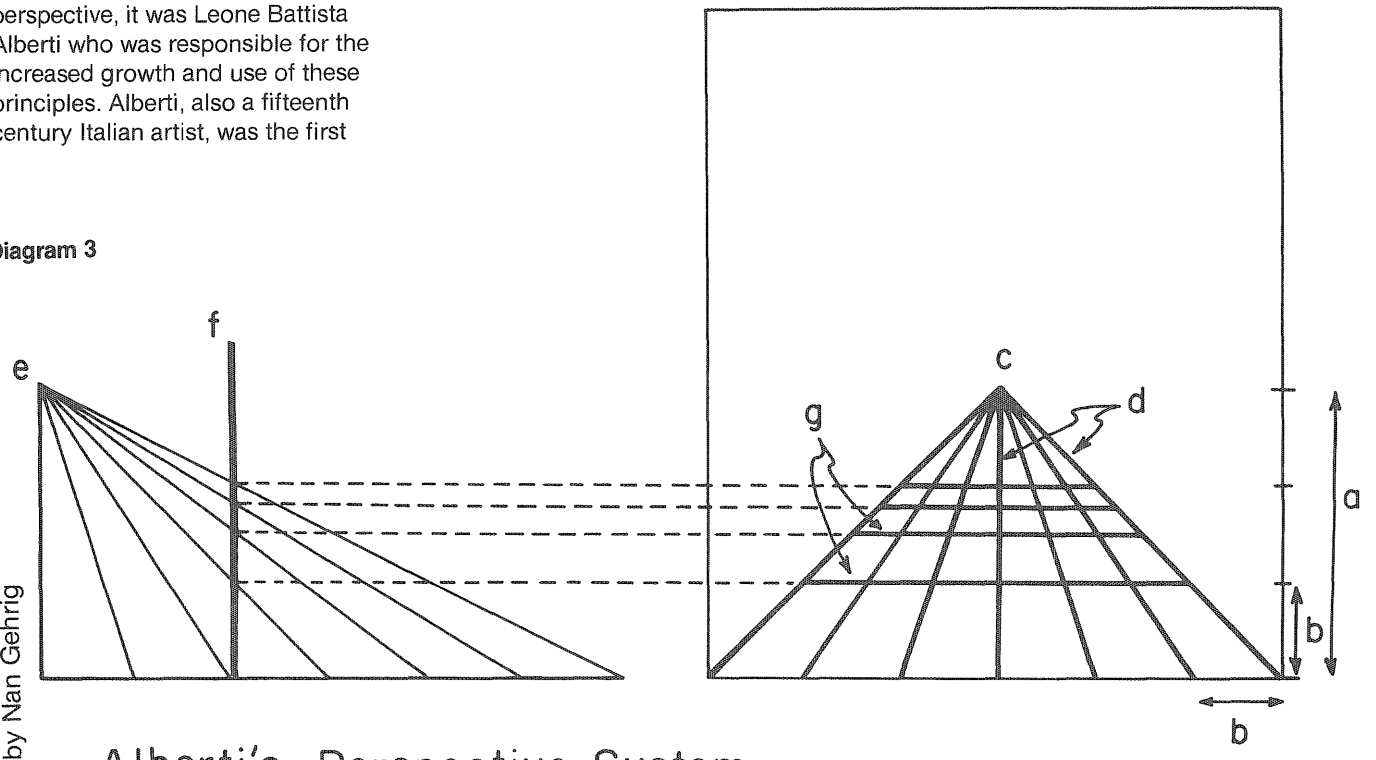
The basic method of linear perspective involves creating a system of perspective lines on a blank painting surface. These lines determine how an object or space should be drawn in order to convey accurate spatial depth. The lines are intended to be used only as a guide for composition, and are not visible in a completed painting. A perspective diagram can be constructed in the following manner, using Alberti's system. (Refer to Diagram 3).

The first step is to draw a rectangular box with any dimensions you desire, and determine the height of the human figures in the drawing (a). Divide this height into three equal sections and then divide the baseline of the box using this dimension (b). Next determine the location of the central vanishing point (anywhere

Alberti's system determines how to convey accurate spatial depth of an object.

you desire, but no higher than the height of the human figure) and draw a dot in this location (c). Now draw diagonals from the vanishing point to each of the divisions on the baseline. These converging lines are called orthoganals (d). The function of the orthogonals is to show how an object will appear to grow smaller and converge in the distance. Next draw a line to the left of, and directly in line with, the baseline of the box. Divide this line into sections of the same length as those on the baseline. Place a dot perpendicular to the end of the line at the same height as the central vanishing point (e). Now draw diagonals from this distance point to each division on the line. The last step is to draw a vertical line perpendicular to this second line so that it intersects each diagonal(f). Starting at the point

Diagram 3

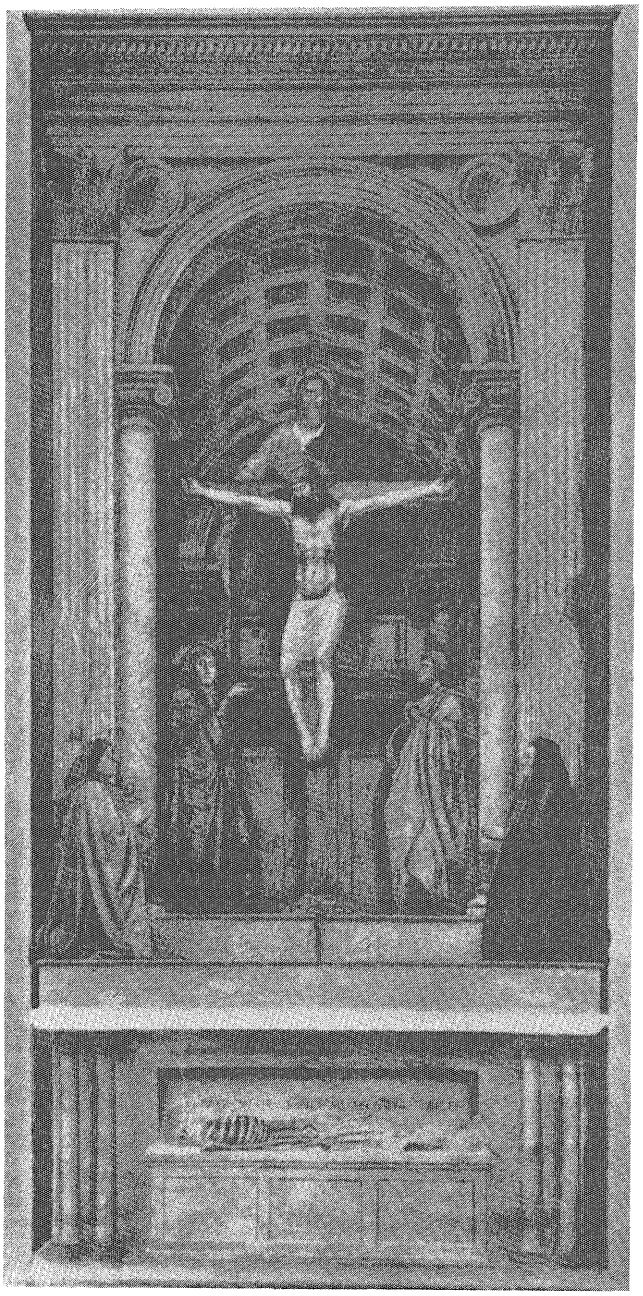


Alberti's Perspective System

a) height of human figures b) 1/3 height c) vanishing point
d) orthoganals e) distance point f) vertical line g) transversals

Illustration by Nan Gehrig

Diagram 4



Holy Trinity with The Virgin and St. John.

Diagram 5

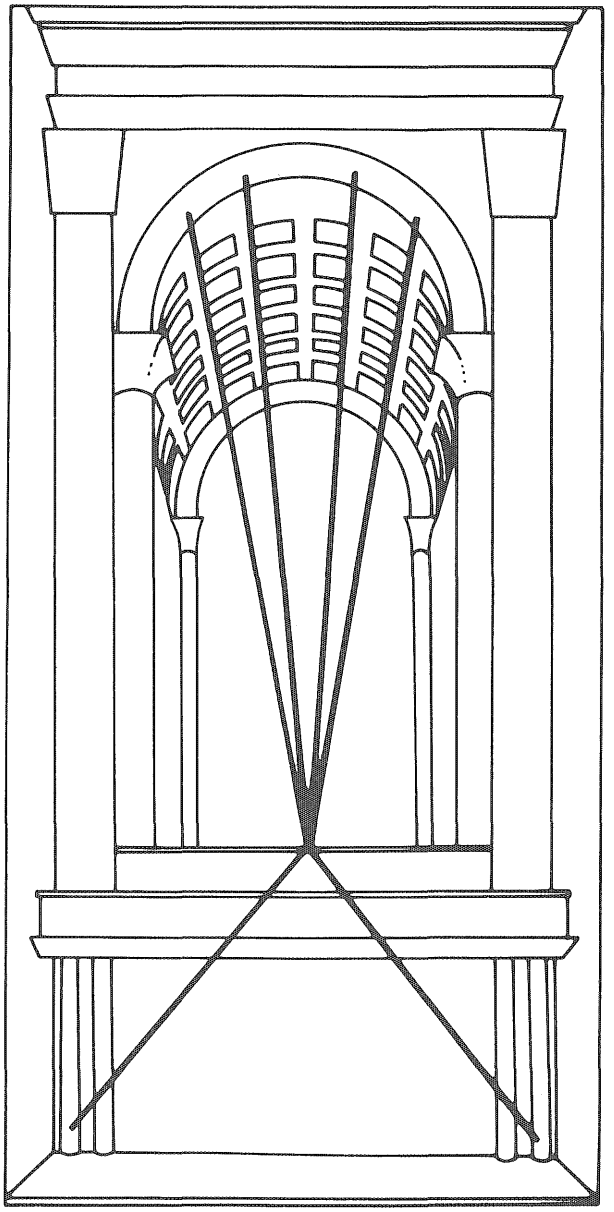


Illustration by Nan Gehrig

Parallels converge to a central vanishing point.

where this vertical line intersects each diagonal, draw lines parallel to the baseline intersecting the orthoganals. These parallel lines are called transversal (g), and serve to show how parallel lines which in reality are equidistant, appear to grow closer together in the distance. These rules can be manipulated to suit individual objectives. Many different effects can be achieved by altering the placement of the vanishing point, heights and the vertical intersector.

A very good example of the use of linear perspective is "The Trinity" by Masaccio. (See Diagram 4). This work was painted in the 1425, probably after hearing about Brunelleschi's perspective experiments. The architectural setting is magnificent. We can sense the great depth of this chamber behind the figures. The space is so realistic that you feel like you can walk into the picture. Masaccio used a system of perspective involving the principle of the vanishing point. As can be seen, the parallel lines converge to a point behind the foot of the Cross. (See Diagram 5).

Linear perspective developed into an essential part of the artistic process. Throughout the Early Renaissance and High Renaissance, almost every painter employed the principles which had been discovered by Brunelleschi and Alberti. The vast and complex subject of linear perspective is still an important aspect of painting, architecture and sculpture. This subject remains a fascinating area of study and application, even today.★

Assigned Reading

Identity Crisis

By Rene Bergstrom

***Killashandra,* Ann McCaffrey, Ballantine Books, 1985, pp. 303, hardcover, $16.95.**

Ann McCaffrey has recently released a new crystal singer novel. This new novel, *Killashandra,* revolves around a crystal singer on Ballybran. Killashandra, the title character, finds herself in a no win situation when she must leave the man she loves. Her assignment is to repair a sensory organ on Optheria as well as covertly find out if the Optherian government is holding its citizens on the planet against their will. Her assignment leads her into danger from both the Optherian government and the Optherian people while she makes some important discoveries.

Killashandra begins the novel as a spoiled girl and grows throughout the story. In the end she is a feeling and caring individual who no longer thinks only of herself. Her character is well developed and the reader can develop empathy for Killashandra and her predicaments.

The secondary characters weren't as well defined as Killashandra. Despite the lack of definition, the other crystal singers have consistent reactions. The elders of Optheria however, were a problem in terms of definition and consistency. Their personalities were defined through the other characters and never really existed on their own.

The plot takes some unexpected twists and turns in the process of getting the sensory organ fixed. Some of the twists are somewhat insignificant and could have been added to pad the action in the novel. Despite these episodes, the plot is entertaining and engrossing and the ending is a surprise.

The earth is attacked by creatures who can alter what the mind perceives.

The plot is difficult to outguess which makes the reading enjoyable and the sequel doesn't require an understanding of *The Crystal Singer* to be readable. Further, while reading the jacket of the book doesn't give a good first impression the book is much better than the jacket leads one to believe.

Although it is somewhat steamy for a science fiction novel, the book would make good reading for a weekend study break.

***End As A Hero,* Keith Laumer, Ace Science Fiction Books, 1985, paperback, pp. 150, $2.95.**

End As A Hero is the new effort by Keith Laumer. Earth finds itself under attack from a gestalt of creatures who can bend and alter what the mind perceives. To combat the situation, earth sends a psychodynamicist, Dr. Peter Granthan, to study the phenomena. Granthan discovers some of the Gool's secrets which will help the earth defeat the Gool but, earth no longer trusts him after a psychological attack on an earth space ship. Granthan must somehow get to earth and stop the Gool.

One glance at Maxwell's equations will make you sincerely reconsider that job as a milkman.

Much of the book revolves around Granthan's inner conflict and thoughts. This is adequate to keep the plot moving and intensity building through most of the novel. However, once on earth, Granthan's actions and inner conflict are predictable and the intensity of the book drops off. Also, the climax of the novel wasn't as intense as some of the earlier parts of the story.

The character Dr. Peter Granthan is also a point of interest. His incredible physical prowess wasn't mentioned when he was introduced so it made his dispatch of broken bones and pain almost unbelievable. Further still, his questionable ethics were never given more than a casual mention when he started using Gool mind probe techniques on his fellow human beings.

Laumer used only one main protagonist which allowed him more control over the novel than if he had added other characters. Despite the advantage, Laumer did not write with the control that could have been expected. Even if more time was spent on the novel, the outcome would not change much. At best, this book would be a good basis for a late night suspense movie. I'd wait for the next edition.

TIME MACHINE

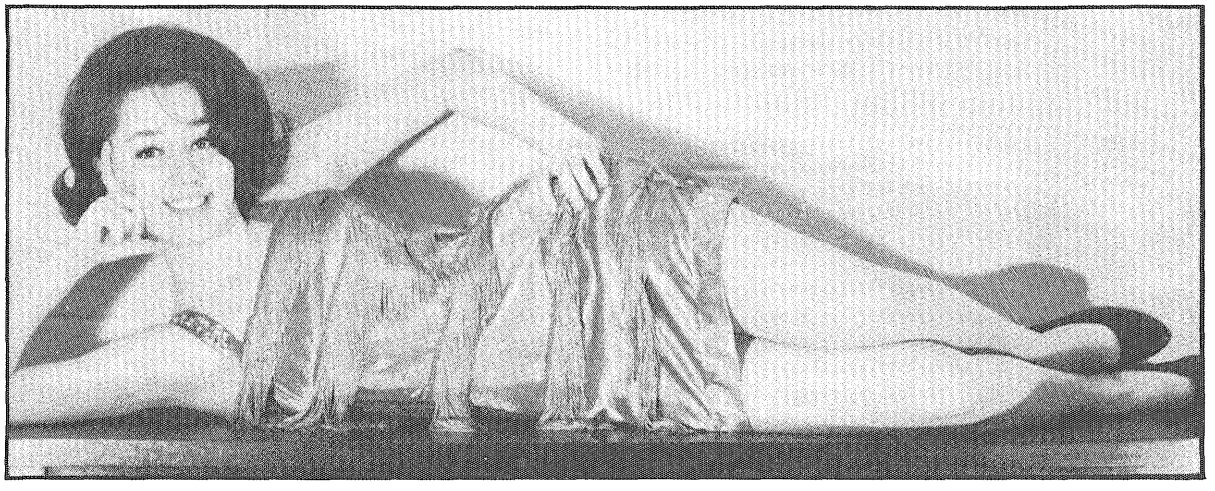
For several years, the *Minnesota Technolog* featured a Pin-up of the month. In this special issue of Perspectives and Illusions, it seems appropriate to highlight this aspect of "60's thinking." Increasing social awareness makes this sort of advertising a thing of the past. It's fun to look back! It's also important to recognize social progress.

Miss February 1965

Kathy Bina

Every engineer with a good memory might recall last year's E-day. If you do you'll surely remember Miss Kathy Bina, one of the queen candidates. That was a good year. Another good year occurred two decades ago when the stork brought the Bina household a baby girl. She must have been a beautiful baby, 'cause boy look at her now.

Some of Miss Bina's interests include ice skating, water skiing, and shalet skiing. She has also done some modeling for Powers. Kathy is majoring in elementary education with a Spanish minor. She is a member of the Greek system and is quite good in the Roman: XXXV-XXIII-XXXVI.



TechnoTrivia

By John Krumm

Questions

1) Within two million, how many Americans drink Coke for breakfast?

2) Why do cars get poorer gas mileage in winter?

3) We've all heard of eigenvalues and eigenvectors. What does the German prefix "eigen" mean?

4) Within two hours either way, at what time of day are you most likely to have a heart attack?

5) Firewood is sold in cords. Is a cord a length, volume, weight, or circumference?

6) What state has the highest incidence of athlete's foot per capita?

7) Say you put a laser in a lighthouse and rotate the laser very quickly. If the spot of light is projected on a distant screen, could the spot cross the screen faster than c, the speed of light?

8) How many feet of tape are there in a 90-minute cassette (within 50 feet)?

9) True or false: Undergraduates with low G.P.A.'s are subconsciously encouraged to go into forestry. engineering.

10) What accounts for the lightness and darkness of bird meat?

Scoring

0-1 Have yourself checked for telltale signs of a brain.
2-4 Below average. Have you thought about forestry? (just kidding)
5-7 You are justified in retaining the will to live.
8-10 Why are you even bothering to check this category?

Answers

1) 965,000 Americans drink Coke for breakfast. Surely they are twisted creeps.

2) When the engine is cold, only about 10% of the gasoline vaporizes before combustion. The remainder stays liquid and is blown out the exhaust pipe. Also, there is increased internal friction due to the high viscosities of cold lubricants. Take credit for either answer.

3) "eigen" means proper, one's own, or characteristic. This sort of makes sense when you think about it.

4) The number of heart attacks peaks at 9 a.m. Doctors say this peak is likely triggered by the stress of waking up (especially if you've only gone to bed three hours ago).

5) A cord is a volume of wood 16 inches wide, 4 feet high, and 24 feet long.

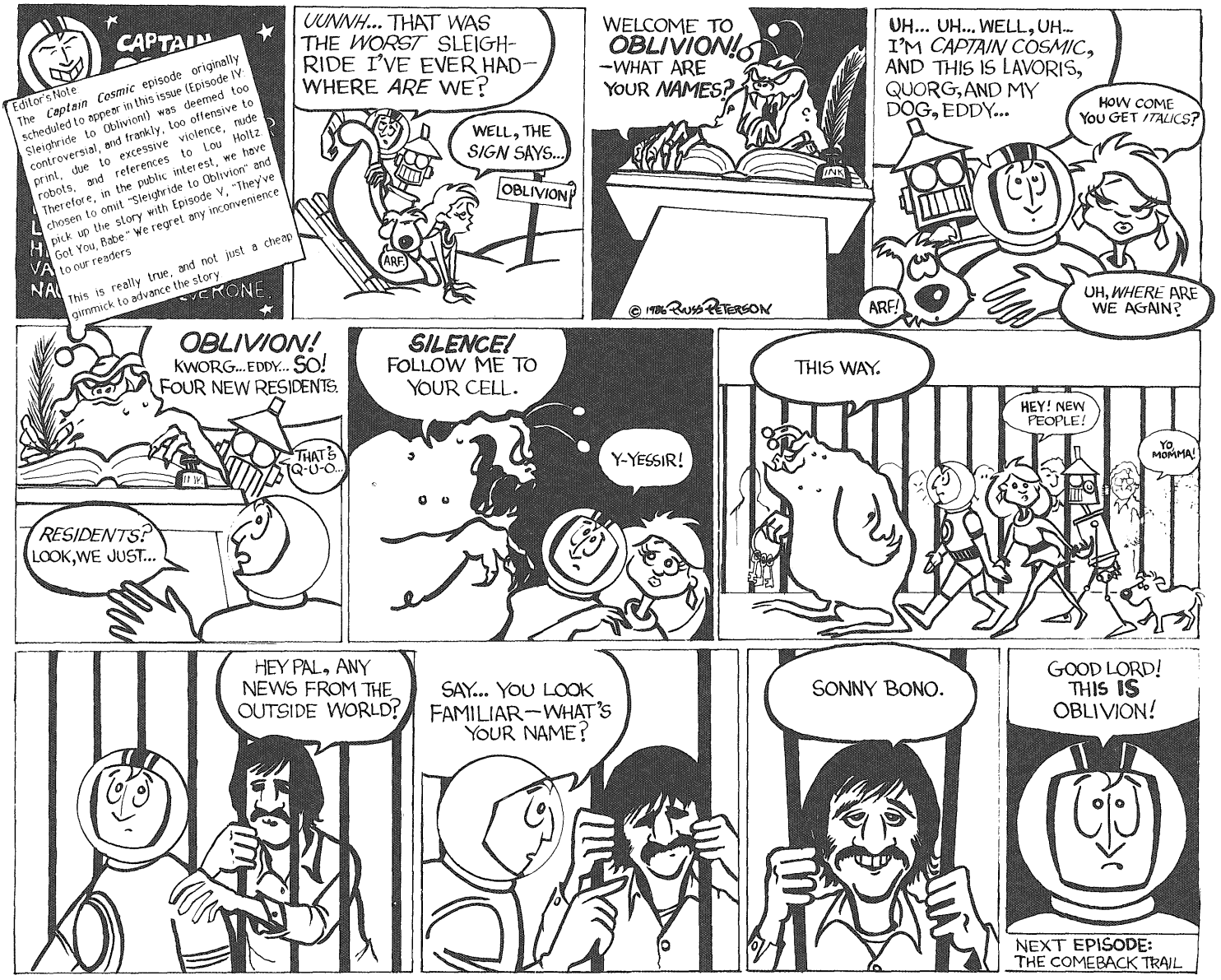
6) California has the highest incidence, probably because of its outdoor life style. (Soon Dayton's will be promoting athlete's foot as the latest in summer fashion.)

7) Yes. This does not violate the laws of relativity because the photons don't exceed c; only the intersection of the beam and the screen exceed c. Similarly, shadows can travel faster than c.

8) A 90-minute cassette has about 420 feet of tape.
60 sec. 1-7/8 in.1 ft.
(45 min. x ----- x ----- x ----- = 422 ft.)
1 min. 1 sec. 12 in.

9) False. This is a vicious rumor which is, for the most part, untrue.

10) Muscles which are more active get more blood, and blood darkens the meat. Since farm turkeys and chickens don't fly much, their breast meat is white, while that of wild ducks is darker.



How to recognize a quack when you see one.

Quack medical products. They're everything from baldness remedies to cancer cures. All eventually prove to be a waste of money; many actually pose a serious threat to your health.

How do you distinguish a quack medical product from the real thing? For a start—if it sounds too good to be true, it probably is. Quack medical products usually claim simple solutions, miracle cures, or amazing scientific breakthroughs. Many flaunt testimonials from satisfied users. To be sure whether a medical product is a quack, check with your doctor or pharmacist first. Because the next dead duck could be you.

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minnesota

Spring One, 1986

TECHNOLOG

Science Fiction Issue

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The official undergraduate publication of the Institute of Technology

Features:

Departments:

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"Mickelson danced on a rock"

Epiphany Illustration by Julie Lees

Editorial

The Waiting Room

They wanted to wait faster, but, they couldn't. Simple everyday movements such as walking, talking, eating and watching were, of course, the same..... Yet, the pace of these activities was perceived as something external—foreign, yet, routine. The real notion of time was lodged inside their minds; like a pea rolling weightlessly around a seemingly infinite expanse of chalky, cloud-like nothingness. This nebulous surreal space is called, The Waiting Room.

There was nothing that could pierce the regular evenness of its presence. Yet they had expected the wait. They knew that by doing what they did there would be a long and tedious wait ahead. Yes, they knew.

To others, they have become known as courageous, bold and important members of the scientific community. Some refer to them as the clairvoyants of scientific progress. They have been known to imagine mental concepts that have preceded technology by years and years. They have created fictitious scenarios that draw imaginatively on scientific knowledge and speculation only to finish by predicting actual future events.

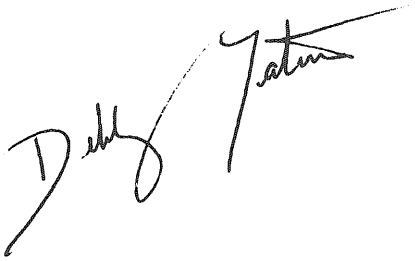
They are still waiting.... After all, if they can't reach the public with their ideas what will become of them? The wait will be even longer...

The connection between their imaginations and society is peculiar. Their work has often been categorized along with "things-that-you-take-on-your-vacation." The pedagogical value of their efforts is all too frequently removed from the problem solving process associated with a traditional class. Wouldn't it be interesting, even important, to write a narrative (some science fiction) at the end of a class such as: linear circuits, thermodynamics and kinetics, heat transfer or topics in partial differential equations? To just imagine a different world and toy with principles in a way that doesn't even remotely resemble the typical result-oriented situations confronted on a daily basis by students and professionals. Depart from the assumed! What would happen if you just let your imagination weave itself around the factual side of the information? Playing with ideas is entertaining. Yet, what might become of it? A new idea or combination?

Science fiction is perhaps the most obvious confluence of literature and science. But even more, it is often founded on present day scientific principles which are then projected towards a future that is grasped mentally, before its technological birth. Science fiction is a preparation for tomorrow.

They don't have to wait anymore! The seemingly infinite cloud-like expanse of nothingness whirls and compresses into one vivid electric spec on the page... the tip of a letter, the beginning of a word, a name... their names.

Congratulations to the winners of the 1986 Minnesota Technolog Science Fiction Contest! First place: Michael A. Popham. Second place: Joyce Roberts. Third place: Duncan C. Connel. ★



Debby Latimer
Editor

Bulletin Board

LETTERS TO THE EDITOR

Dear Editor:

Though not an entrant in your "desert island" contest, I would like to share my thoughts on the three least dispensible scientific/mathematical axioms.

A. "1+1=2" serves as a constant reminder that great complexity and achievement can result from humble beginnings.
B. "Entropy increases" illuminates the constant struggle which will be necessary to combat the ill effects of time on body and mind.
C. "Murphy's Law" points to the most critical element for survival—sense of humor.

Sincerely,
Lawrence Rudnick
Associate Professor, Astronomy Department

CONTEST JUDGES

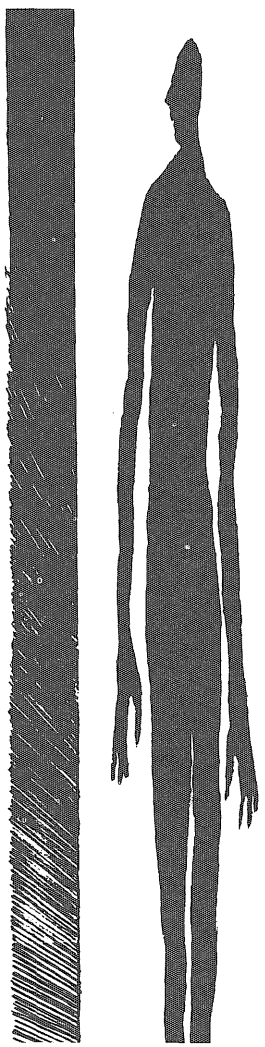
The three judges for the 1986 Minnesota Technolog Science Fiction Contest were chosen because of their involvement with science fiction literature. The 1986 judges are: Assenka Oksiloff, Lauren Pacelli and Bernard P. Smith. Thank you.

I.T. WEEK

I.T. Week will begin the second week of May, 1986. Due to the success of the Technology Fair, there will be the addition of a Microcomputer Fair this year. The Spring Two issue of Minnesota Technolog will feature schedules as well as a history of I.T. Week for those of you who may be wondering where all the traditions came from.

CORRECTIONS

Brad Mares has been an active member of the I.T. Board of Publications since Fall quarter, 1985. Through an oversight, his name has not appeared along with the other board members. Thank you for your participation.



M.E. CO-OP PROGRAM

"It's harder. It's a rigid program. It takes a little better student than the average. You can't slip-up. It takes away some of your freedom." That was the worst criticism this reporter has heard about the Mechanical Engineering Co-op Program (MECP). Before mentioning all the benefits a student can expect from participating in it, a description of what it is should be presented.

The MECP is a program that places mechanical engineering students with participating companies for the purpose of working and learning about what engineers do for a living after they graduate. Starting sometimes within days after their sophomore year, students spend a quarter working full-time and then coming back to school and studying full-time. After every work quarter, the student is expected to write a technical report on what he has done. This report is worth two credits for each quarter during the junior year, and four credits for each one during the senior year. Progress reports from the field are expected monthly. In their final two years, the student spends a total of four quarters with the company. "We like to emphasize the educationai aspects," says Prof. Virgil Marple, director of the MECP, "not so much the work itself." While in the MECP, Prof. Marple is the students' advisor.

Now for more bad stuff. Still reading? Good. It's worth it.

What is first required of the student, before any serious co-op words are spoken, is that he or she be a sophomore who has been accepted into the M.E. Upper Division Program. Then, to be eligible this year, the student must have applied before January 15, 1986. The application covers mostly academic stuff, with

some blanks for work experience and preferences. It's probably there to show that you're a serious applicant and won't leave egg on anyone's face.

Assuming the student has made it this far, he or she looks over the company list—those companies that are in the market for interns/co-ops and that will be coming to campus to look you over. This is where it gets better.

There are typically 40 to 50 companies coming, which will be offering around 120 jobs to approximately 80 to 90 applicants. This makes the odds of being selected for one of them just slightly better than the odds for getting a cup of coffee in exchange for 30 cents in the basement of the M.E. building.

The companies all have reps on campus for three days of interviewing. Those are the only three days they are on campus all year. But the companies that come are some of the cornerstones of engineering in America. A typical list would include companies like General Dynamics, Honeywell, 3M, ITT Thermotech, IBM, MTS, Boise Cascade, and Pillsbury. Some are large and some are small. They all offer an extremely valuable educational opportunity to the student. The student typically works in as many different areas of the company as possible and winds up knowing more about it than employees who have been working there for ten years. And you can put that on your resume.

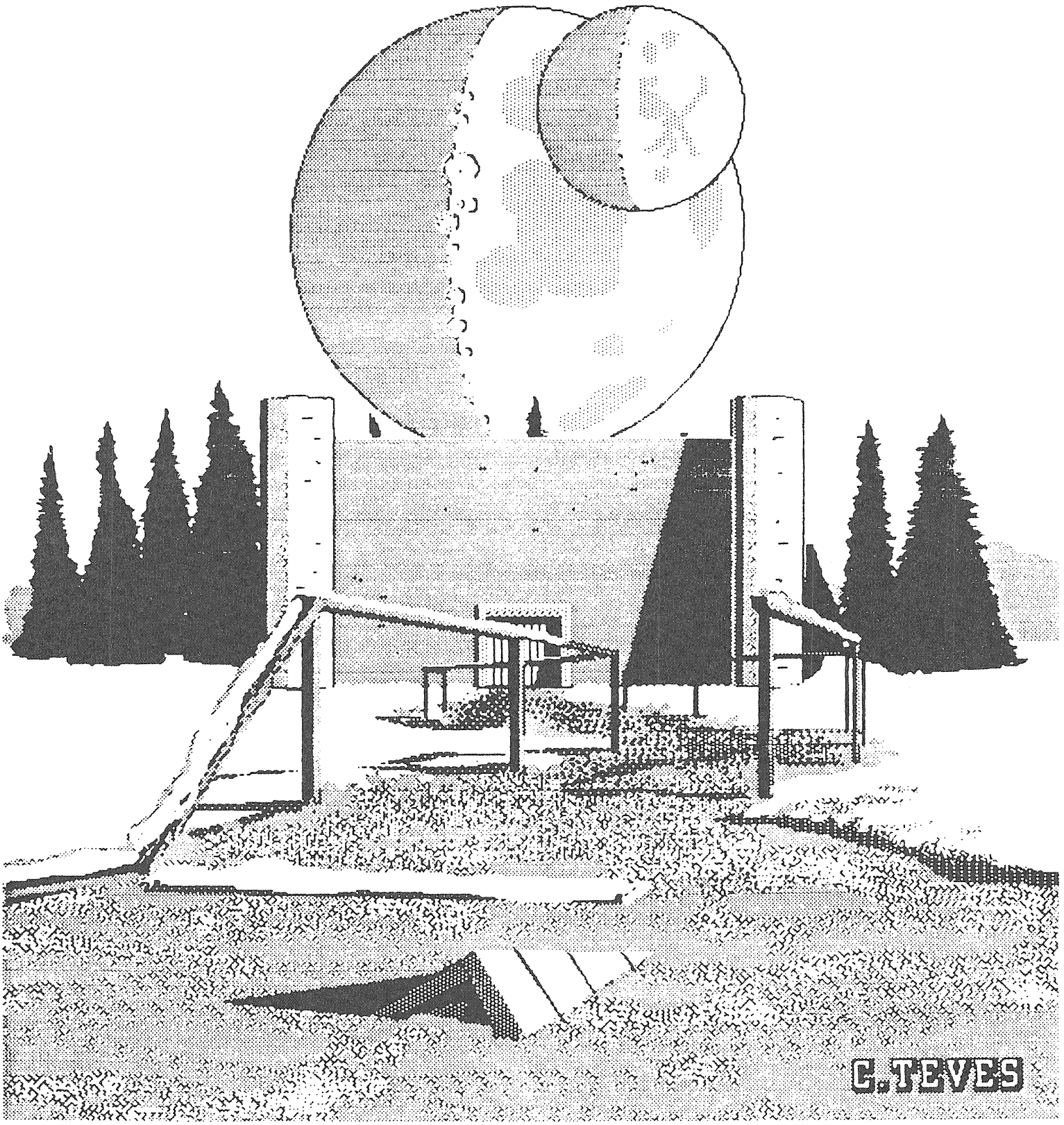
Now for the really good part. You get paid for it. According to the 1985 Engineering Co-op Program Salary Survey, the the average *monthly* salary is $1400. Aren't you glad you're an engineer? The scale goes from $1040 to $1865 per month. In other words, the student will not starve.

In addition, when hired full-time after graduation, the co-op veteran can expect to be paid $1500 to $2000 per year more than his or her non-co-op counterpart. This figure is regardless of whether the student went with the company of co-operation or not.

Prof. Marple in fact also started a co-op at the U. of M. with John Deere, between 1960 and 1961. He spoke in glowing terms of the program. Deere considered him an employee even during his quarters of school. They also remembered his Christmas bonus of $400. Deere started him in the foundry, then the machine shop, and had him literally work a machine a day. He next moved to assembly, then inspection. One of his favorite positions was driving tractors off the assembly line. Towards the end of his stay, he worked with the designers at the drafting boards. When he finally reached the drafting boards, he already knew the entire company from the bolts on up. That is a rare ability for any undergraduate. That is what makes the Co-op Program worthwhile. ★

By Phil Decker

VOICES FROM



THE FUTURE

In celebration of National Technology Month, the Minnesota Alliance for Science, Minnesota High Technology Council and the Governor's Office of Science and Technology sponsored a writing contest for Minnesota students in grades one through twelve. The four winners received an award from Governor Perpich and a $500.00 savings bond.

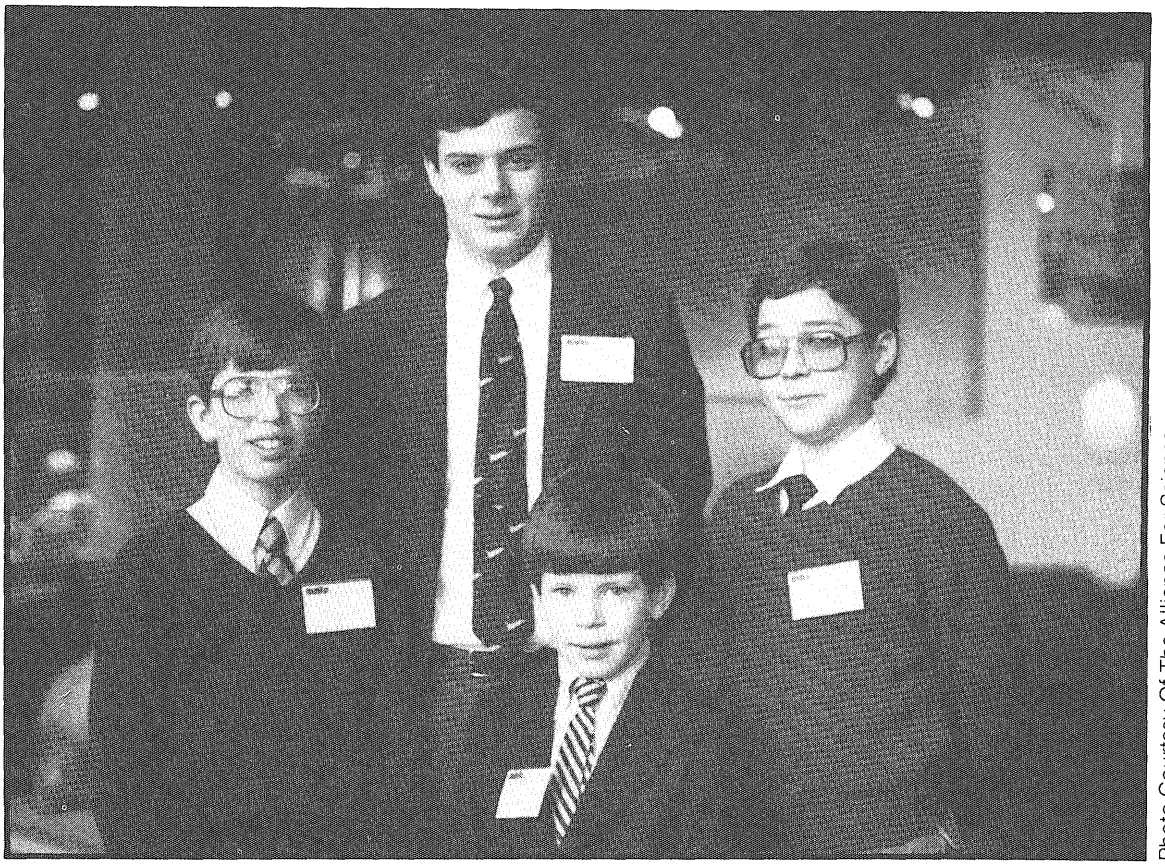


Photo Courtesy Of The Alliance For Science

From left to right: Mark Purves, Andy Harrod, Nick Ogura, and in front, Tim Kelley

Voices From The Future is designed to focus public recognition on the excellence of Minnesota students and teachers. The contest invited participants to envision the future by responding to questions that stimulated them to employ an imaginative understanding of science while demonstrating proficiency in written communication skills. The four winning authors recorded their entries for transmission from the studio of Minnesota Public Radio to West Star IV, a communications satellite in an orbit 23,000 miles from the earth.

Journal Entry: December 31, 2010

By Tim Kelley, age 8, grade 3
Elaine Salek, teacher

First Place, Grades 1-3

Writing Topic
Grades 1-3: It is the year 2010. You have just invented a fantastic new machine. What is it? What will it do?

We did it! Today we placed our peace machine in the last country on Earth. When the peace machine was activated, peace on Earth came true.

The peace machines were such a simple idea. We just took a sample of every school child's blood and a couple of tears from each student, mixed them together in a high speed blender, cooked them with mega-lasers, freeze dried the results and put the product in an unbreakable plastic heart.

The mixture of the blood and tears gives off a gas which makes people wish for peace and fun times. We put the hearts in America and Russia during our first experiment.

Within a few days the Russians and Americans started to help each other with their problems. They helped us get grasshoppers out of our wheat crops and we showed them how to dress in flashier clothes.

East Germany and West Germany soon became friends. The Germans helped each other take their nuclear bombs apart. They decided to help each other instead of hating each other.

Pretty soon all the countries wanted peace machines. We made them as fast as we could. Kids volunteered to give the blood, but because everybody was peaceful we did have a hard time getting the tears. A few peeled onions helped us there.

So tomorrow a new day starts. A new world begins, too. A world of peace and fun. Hooray for tomorrow! ★

Two Minds Are Better Than One

By Mark Purves, age 11, grade 6
Karen Hermanson, teacher

First Place, Grades 4-6

Writing Topic
Grades 4-6: You were chosen to ride on the space shuttle in the year 2010. On the third day of your mission, you receive a message from an unknown planet. You are asked to deliver this message. What is the message? To whom will you deliver it?

We have a lift-off!" I am pressed against my seat from the tremendous force needed to boost us out of earth's atmosphere.

I was selected to travel on the shuttle because of my research in telepathy and ESP. Another group aboard is attempting to solve one of earth's most baffling problems: disposal of nuclear waste. They are looking for possible sites in space.

The first days are relaxing as I adjust to the weightlessness. On the third day I feel as if someone or something is trying to eavesdrop on my mind. I switch on my decoder, a device I've developed that allows me to control who picks through my mind. An image flashes in my head! I see a person much like myself except each hand has four fingers. I picture his words: "I am monitoring your thoughts. They tell me of your concern with nuclear waste on Earth. Many years ago on my planet, Quamatapp, we learned about nuclear waste the hard way. We now live in protective domes that shield us from the radioactivity. We won't be free to enjoy our world for 25 more years.

"We now have developed the ultimate canister for holding nuclear waste and a process that speeds the waste's return to safe levels, taking 100 years instead of 10,000. We store the canisters on the planet Notox, which is uninhabited."

"Why are you telling me this?" I think to him.

"We will make Notox available to you in exchange for privileges on earth. We want our children to enjoy life for a few weeks on a planet with trees, wildlife and clean water."

I allow the Quamatappian to feel my excitement as we arrange to meet at the docking station. A computer prepares my report for officials on earth. I can hardly wait to tell my family. We surely will want to be the first ones to host Quamatappian children! ★

Terran Trade Authority: Civil and commercial file #B513: Space City ALPHA 912

By Nick Ogura, age 12, grade 7
Rebecca J. Hanson, teacher

First Place, Grades 7-9

Writing Topic

Grades 7-9: It is the year 2010. You are the city planner for the first "city in space." Describe your plan. What will the city be like?

ORIGIN: The ALPHA 912 came originally from earth, but some modifications have been approved by the TTA (Terran Trade Authority), which is of alien origin. The ALPHA 912 was originally designed for people who were to escape the pollution of the earth. The purpose was later changed when the mineral Forbidium was discovered in considerable amounts in the system of Sol.

POSITION: The A912 circles the sixth moon of Jupiter, the largest planet of the system Sol. It is from this moon that the inhabitants of A912 mine the mineral Forbidium, the fuel of most major spacecrafts.

CLIMATE: The A912 is basically kept at a climate common to the northern temperate region of Sol 3 (Earth).

ECOLOGY: The upper portion of the A912 is crowned by a massive 3 mile dome. The height of this dome gives adequate space for aircraft. The dome is made of a light-weight, plastic polymer which, by order of the TTA, cannot be detailed here. This dome acts as the ozone layer of Sol 3 (Earth). An ecosystem such as seen on Sol 3 (Earth) was taken into consideration by the contractors, and after three years of close observation they had a rough plan of what animals and plants would be needed. In the 314 mile circumference of the A912 there are currently about 275 species of birds, 210 species of mammals, 200 species of fish, 12 species of marsupials, 50 species of reptiles, 100 species of amphibians, 25 species of rodents, 300 species of insects, 278 species of shrubbery and trees, and 250 species of flowers, weeds and other plants.

The atmosphere is kept in good condition by the fact that all industrial pollutants are recycled. What is left over after recycling is then shot down to the surface of Sol (Jupiter) which is a gaseous, lifeless planet. Every earth week, ecological upkeep workers sail about on anti-grav skiffs and test the atmosphere for high levels of dangerous chemicals.

If test results are positive, workers bring out 'clouds-bombs' which are pollutant neutralizer bombs. These neutralize the dangerous chemicals. So far, these bombs have caused no harmful effects to the ecosystem, but there is a possibility that after continued exposure, harmful effects may surface. Because of this chance, the ecological upkeep workers keep a close surveillance on the usage and effects of these bombs. There is little chance of these effects surfacing since the bombs have been used only once since their installation.

Gravity is maintained on A912 by a system of massive magnets implanted under the ground. This system was at first scorned by scientists because they thought it would not work. The system works off one major fact: a magnet attracts an electric field. Since the human body produces an electric field, the "gravity" pulls down the people. Metal objects are made of a special alloy which is nonmagnetic but is treated with traces of iron. Nonliving objects such as plastic, wood and cloth are also treated with traces of iron.

TRANSPORTATION: The main source of transportation on A912 is the aerocar: a magnetic drive ACU C air cushion vehicle capable of speeds of 80 mph. These cars are rather efficient for they, depending on use, need only a charge-up every so often (about once per month with normal use). They do not pollute the environment, either. Another form of transportation is the aerobike which, in most respects, conforms to the aerocar but looks like a motorcycle with three horizontal discs for wheels in front and two in back.

Among other minor forms of transportation are the anti-grav skiff, the jet-copter and the ornohopper. The anti-grav skiff is an open-air platform-like vehicle which operates on a magnetic drive unit. These are about ten feet wide by twenty feet long and are used chiefly by the ecological up-keep center. The jet-copter is a stream-lined helicopter with a unique drive system: the laser fan propulsion system. This is basically a solar panel which is attached to a battery. The battery powers an argon laser. The laser fires on a compact composite solar cell which powers an electric motor, which in turn powers a propeller. The process is simple: the solar energy is converted to electricity which charges the battery: the battery drives the laser which boosts the cell: this gives the propeller a huge thrust potential. The ornohopper is a light aircraft which actually flaps wings instead of using jets. A laser fan system is attached to an axle which connects to two rods. These rods are connected to the wings.

TTA File #BJ13

★

P.E.A.C.E.

By Andy Harrod, age 16, grade 10
Joan Schultz, teacher

First Place, Grades 10-12

Writing Topic

Grades 10-12: It is the year 2010. You have been chosen to select five objects to be sent to another planet. Inhabitants there will learn, from the objects, about civilization on Earth. What will you send and why?

In the preceding century there have been many mobile displays capable of presenting not only the objects to be shown but also high degree of exposure. Some, such as the Great White Fleet of President Teddy Roosevelt's days, served to project power across the globe. Others, including Sputnik, which was launched under Premier Krushchev, displayed the technological advances of the time. Finally, several of these presentations have given an account of human history as did the American Freedom Train of 1976. During this year, however, in the first decade of the twenty-first century, the people of Earth shall see a project to dwarf them all; we will see P.E.A.C.E.

I, as Secretary General of the United Nations, have overseen the development of Peaceful Education and Communications Envoy (PEACE). Built through an international effort, PEACE began as a crash program to communicate with our new-found, extraterrestrial neighbors. Since our "neighbors" first visited Earth in the year 2002, they have requested five objects for scientific study on their home planet. By 2004, after considerable study over this request and exaggeration of the word "object," PEACE, man's most advanced spaceship, began to take form. With the aid of the U.S. Space Fleet, nine shuttles in all, the U.S.S.R.'s Red Star space station, and technical help from around the world, the "Envoy" became a reality in outer space. Now, six years after the first heat tiles were laid, PEACE will begin her lonely voyage.

Although no one will pilot her, the ship will carry the world's most precious cargo. Divided into five areas, PEACE contains items representing Earth's technology, geology, ecology, history, and culture. The entire project encompasses the cream of Earth's knowledge and effort.

To begin with, the first "object," two kilometers long and 500 meters wide, is the best ship ever devised. Complete with three fission-propelled engines, all automatic systems, and the first Computer Brain, PEACE has the ability to run herself. In addition to the exterior of the ship, all control, maintenance, and life support systems occupy the first section of the Penta-Bay as a tribute to Earth's achievements.

Immediately below lies the Geology Section. Here, in a circular, zero-gravity auditorium, a 250 meter wide model of the Earth floats. The model is a marvel of human accuracy, depicting every natural feature of the Earth. Since the model can be pulled apart, an observer can even glimpse under the Earth's crust to the planet's core. Temperature resistant windows on all sides peering into outer space complete this section and its representation of our home's place in the universe.

Among all the areas, though, the majority of observers find the Ecology section their favorite. The most advanced aquarium designed by man, representing the life of 80% of the Earth's surface, resides here. A wide variety of marine life lives in a completely natural environment. Vital elements such as oxygen are provided through compressed gas tanks; food exists in abundance inside the aquarium; and rotation of the aquarium on its axis provides gravity.

The Historical Section, directly below, has a much more somber feeling. Through a specially designed audio/visual microcassette player, an observer may view any part of man's past. By using the reference, any era of mankind's often horrible history becomes available. As many have noted, there exists much to be learned by both the aliens and by us in this section.

After seeing the advances of our technology, the uniqueness of Earth, the variety of life on our planet, and the chronicles of the past, any tour group may relax in the Culture Section. By simply instructing the compact disc player, anyone may observe a wide variety of music and art. The theater surrounds the viewer on all sides and embraces him with 3-D images and stereo sound. Hardly anyone will ever tire of visiting this area, and, when the audio novels are added, the entire library consists of over 1,000 playing hours of disc.

Now that the final preparations are complete, PEACE will soon leave for her meeting point with an alien escort. When PEACE's fuel tanks are exhausted, she will be towed to her final destination. Once there, many aliens will walk the corridors of the shop and see the objects we have given them. Hopefully, for the welfare of both earth and our neighbors, PEACE's message will be received. ★

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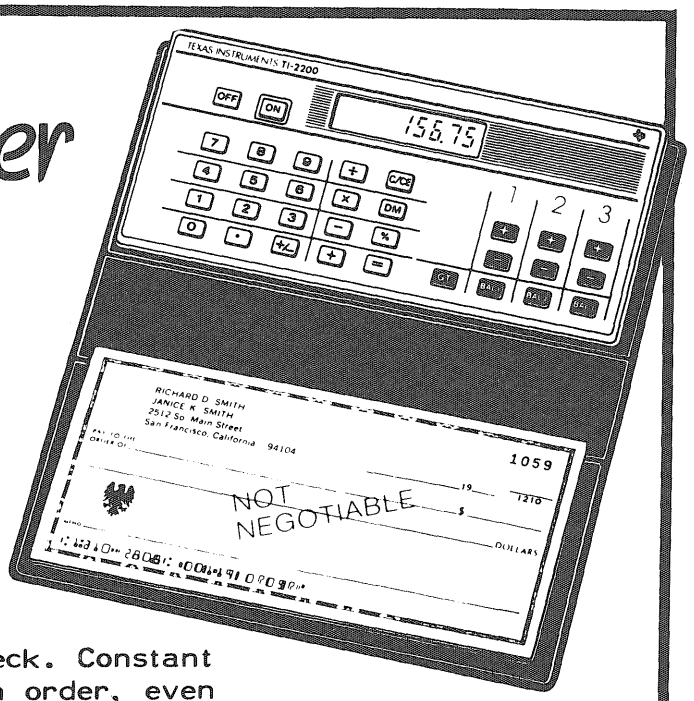

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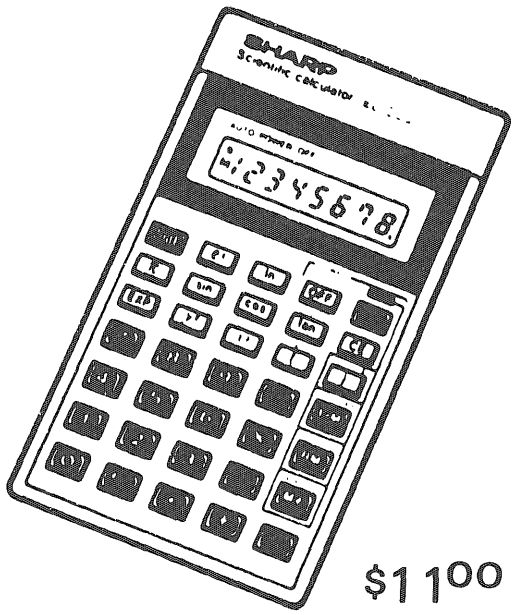

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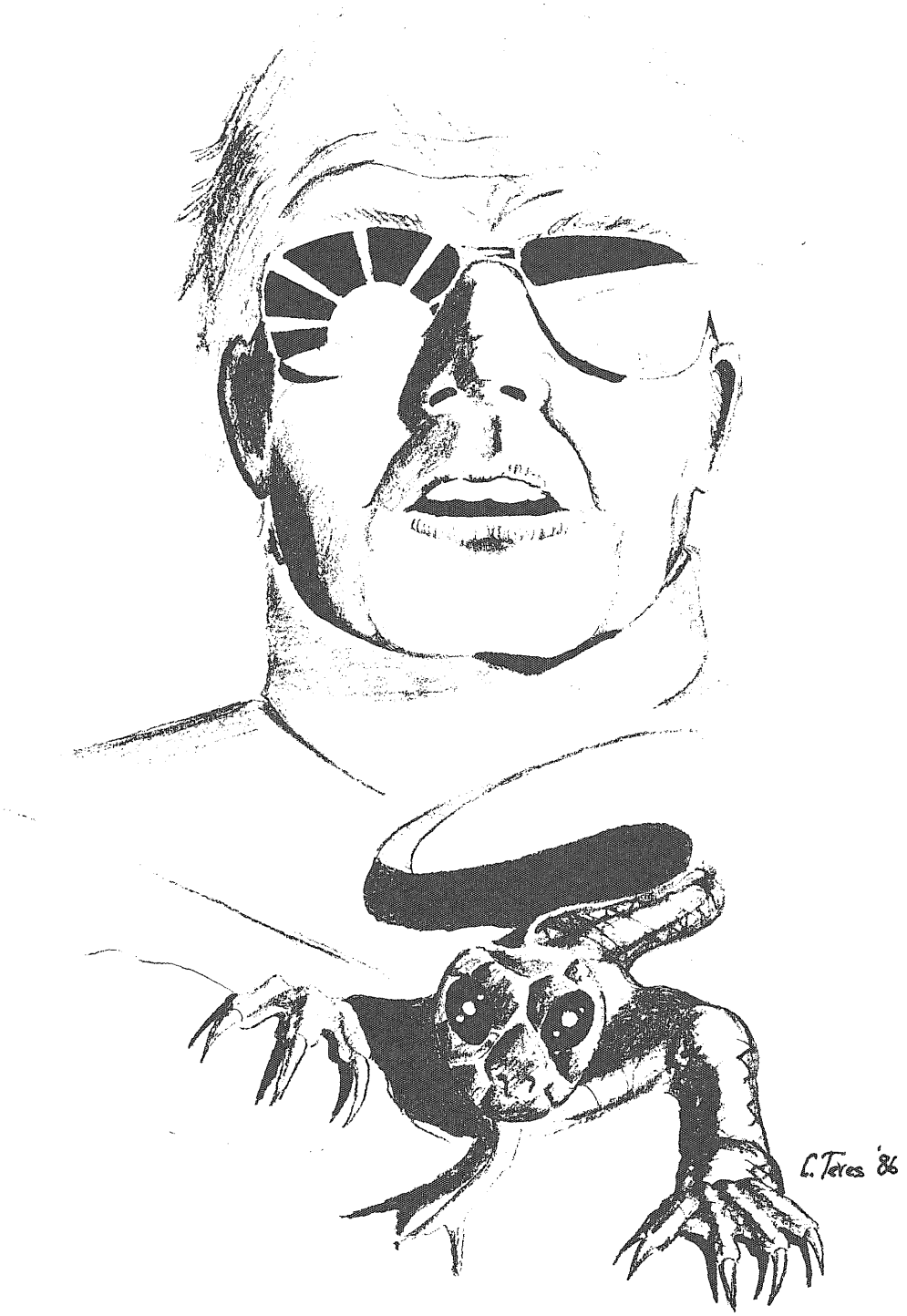
The Epiphany

By Michael A. Popham



FIRST PLACE

"Set now, sun," the general ordered, for the sun was threatening the horizon and required his permission to pass. The general lay on a blanket spread over a huge dolomite slab. He could not see the strange, white-colored sun, for he wore dark glasses, but he had felt its presence over him all day and now that presence was ebbing.

"Entropy," the general murmured. He tried to raise his arm but could not.

And there were his men close at hand, all of them; they were loyal to him and he knew he had chosen well from the volunteers at Messina. They peered into the depths of his black lenses, and saw nothing. That was the way leaders must remain, he thought. Inscrutable.

The general wore white robes, for he was a god. The realization had come to him soon after the Newmi had infected him, two years ago. He had been like the others, then: ignorant but willing to follow orders for the betterment of the Confederation. But an infected desert lizard had surprised him once while he was on patrol; their retinas exchanged reflected light and the Newmi were in him to stay.

The Confederation survival manuals had said that the Newmi were parasites, feeding off chemico-electrical charges from the body's central nervous system. The general had long ago concluded that the manuals were wrong. The Newmi fed off the body, true, but they traded energy for consciousness. He observed more now; his dreams could foretell the future and his hearing was more acute. He could hear the hearts of his men pumping constantly, though they were at the moment several feet away; three steady, reassuring lives clustered around him.

They knew he was a god. They had said so. It was a god, not a general, who ordered their survey scoutcraft destroyed in those first days. It was disciples, not subordinates, who carried that order out. Mickelson, tall, lanky and arrogant, had apologized to the general for mutinous deeds committed before the Newmi entered. Tecumseh now knelt and kissed the general's hand each time before he spoke to him. Baker renounced his Christianity in favor of the new messiah that emerged from the body of his elderly commander. It was Baker who was speaking into his ear now,

"My lord," he whispered.

"Speak, disciple."

"I beg my lord's permission to light a fire, for you have brought on the night, and it is cold now."

"You may, disciple. Wood is scarce, I know, and growing scarcer, but mind that you do not disturb the fruit tree near where I attained my transmigration; this tree is my hallowed place and it is not to be disturbed."

"My lord."

Baker went away and the general was alone again with the Newmi. He saw them clustering like a swarm of bees in midwinter along his neural causeways, for they had provided him with inner sight along with everything else. At this moment they were draining energy from him and multiplying, waiting for another host to come under their influence, that they might spread the True Word, that they might enlighten. It was their purpose, the general thought, their purpose.

The men had asked long ago not to be enlightened, for as they so correctly pointed out, every god must have disciples. So he allowed them their ignorance and wore the dark glasses, knowing that the time for the enlightenment of others would come eventually, without his stir. Patience is a discipline gods treasure above all others.

The Newmi fed off the body, true, but they traded energy for consciousness

One day, as the white star above burned in a green sky, the general told his disciples of the dream he had had the night before.

"The Newmi told me," he said, "in their own way." In my dream I saw a starfortress coming to this planet. I saw the ship's commander and read his thoughts. He is a man of action, but like all men of action his mind is riddled with chaos. He must be enlightened."

I saw the ship's commander and read his thoughts.

"Which ship?" the disciples asked eagerly. "Which starfortress?" for the Confederation and their Homeworlds had been reduced to a shallow memory for them until this moment.

"Starfortress *Phobos*." the general replied quietly. "Their commander is Heskin Thosk." He allowed them a moment to remember the names, the people associated with the names, the memories associated with the people. Then he said, "They will be here by tomorrow morning, and we must be prepared. You know what they will do. They will resist the enlightenment and uproot the sacrosanct tree. They will take me away and attempt to purge the Newmi from my body. They will force you to disavow my godhood and place you under the rule of chaotic minds. This we must not allow."

"Some of you believe that when they come you may be forced to kill them. But I say to you, to kill the unenlightened is to kill a child. They must be allowed to grow, these people of the starfortress. They must not die; the Newmi will regulate their behavior and cleanse them of their chaos. These are my words, as I am your general, and your god."

The general was tired; his instructions had drained him, he felt the Newmi within him drawing his life away, wringing him dry and still demanding more. *Soon, soon,* he thought then, before he was forced to sleep. *Yes, yes, yes.*

Mickelson danced on a rock.

The general had just ordered the white star to rise, and the day came suddenly, as if by the turning of a switch, and as the day began, Mickelson did his dance upon a rock. Since on this planet he was very light, he bent his knees and pushed himself far into the sky. He floated down, doing a double somersault, and landed on his feet on the rock again.

He was watching just above the horizon all the time, and when the shore party came in their tiny shuttlepod, he knew.

They saw him from far away, and approached. They wore uniforms of the Confederation: black tunics and boots, with a bold green cross stretched across each man's chest. Their faces were leaden and their skin was blanched from being too long away from sunlight and trees and grass. Each of the five carried a weapon and they pointed their weapons at the odd man on the rock.

When they stopped before him, Mickelson ended his dance and bowed to the new company.

"Welcome, gentlemen," and he bowed again. "I'm Thaddeus Mickelson."

"Are you from the *Bode*?" asked one of the men. He did not lower his gun. "We're here to take you home."

"What do you mean," said Mickelson, "by 'home'?"

"Why, your Homeworld," said another of the Phobos crew, a slight, red-haired man. "Whichever world that is. Procyon, if you like; that's

Mickelson danced on a rock

closest. Tau, Sol, Betelgeuse..."

"Are there any more?" demanded the first man. He was standing in an almost theatrical pose in front of the others; short gray hair, a cruel mouth and crooked nose.

"You gentlemen," said Mickelson, "You're from the Earth yourselves."

"Some of us," said the first man.

"You're from the *Phobos,* that I know. And you—you're commander Thosk?"

The first man nodded dumbly.

"All the *Bode* crew is alive," said Mickelson. "My general is a very resourceful man. He kept us alive, something we could never do for ourselves. But he's ill, now. He's very ill, he needs a physician."

"What's wrong with him?"

Mickelson shrugged. "Nervous breakdown, maybe," he said. "Maybe he's caught some sort of disease."

"We have a medic," said commander Thosk. "Lead us to him, we'll fix him up."

Mickelson spent a few moments standing on the rock, smiling down at them. Finally he just hopped off and began strolling calmly back toward the encampment. Thosk's men, one by one, put their weapons away.

"It's been quite a while," said Mickelson. "I haven't seen anyone from the Homeworlds in years."

"We're very curious as to what happened to your scoutcraft," Thosk replied. "Our orbital scans showed only small bits of debris scattered in a very limited area. We would have thought—I mean, considering all hands survived—"

"I like your uniforms," Mikelson said suddenly. "They're not like the ones we wore when we left Messina. Of course, that was six or seven years ago." He tugged at his own tattered uniform. "Nothing special, back then. Basic gray."

"Well," said Thosk. "Styles, tastes—they change, I suppose." Mickelson suddenly stopped and touched the large green cross that dominated Thosk's tunic. "This interests me," he murmured. "What's it for?"

"It's the Christian symbol."

"You're not with the Confederation, then?"

"We are. There've been...changes."

Mickelson pulled his hand back and listened to the wind for a moment. "Oh," he said quietly. They moved on.

From there it was not far from the general's encampment. Mickelson had been walking up front, but as the dark shapes of the makeshift dwellings came into view, Thosk crossed in front of him and strutted onward, a supreme commander supremely confident.

The encampment wasn't much; the general had wanted it that way. The shelters looked as if they were planned to be used for a single night only: two large, sheets of aluminum provided an A-frame over which was draped strip after strip of ragged black cloth, which waved frantically whenever the wind blew up and somehow made the shelter look that much more precarious. Far beyond it was what seemed a sturdier project: the *Bode*'s ablation shield, a massive black disc suspended a couple of meters above the sand by a crazyquilt pattern of aluminum support struts, large rocks and odd pieces of machinery. Beyond this second structure was the general with his attendants.

"Hallo!" shouted Heskin Thosk at the empty shelters. "Hallo!" He

I dreamed there was a war...or...another form of change

walked impatiently, finally catching sight of the other survivors.

Tecumseh and Baker drifted away from the general, staring as apes do from the insides of cages, hunched and wary, like the weird sisters minus one.

Commander Thosk strode forward and addressed the two. "We'll take you back to the starfortress," he said curtly. "I understand your survey leader is in need of medical attention. We've a class 7 med along—he'll do any emergency work that needs to be done. Anything beyond that'll have to be taken care of on board the *Phobos*—if we don't leave orbit in three hours we'll miss a valuable reconnaisasance opportunity elsewhere in this system.

"If you've anything to bring along, get it now and make sure it complies with the standard weight restrictions. Questions?"

"My general wishes to speak with you, commander," said Baker, stepping forward. "He says it's very important."

Thosk turned and motioned to two of his men, each of whom carried a heavy steel case with the green cross emblazoned on the front. The three of them followed Baker back to the exposed slab on which the general lay.

Baker knelt by the general's ear. The general seemed to assume with the black lenses a kind of unwavering intensity. Baker said, "General the rescue ship has arrived."

"This is known to me."

"I have brought commander Thosk to you."

"Let me speak with him, disciple."

Baker stood and looked at Thosk. "You may kneel," he said.

"I kneel to no man," Thosk returned stiffly, but as Baker retreated he realized that there was no other way to address the injured survey leader.

Thosk lowered himself carefully in a hopeless attempt to kneel and still leave dignity intact. "You wanted to speak with me?" he said coldly.

"I wanted to know about the changes in the Confederation," the general murmured.

"There are too many for you to worry about. You'll see them soon enough."

"I dreamed there was a war... or...another form of change. More subtle. The equation is labeled differently, but the results... are apparent and unchanged..."

"Your eyes," snapped the general, "are they damaged? Have you been injured? We have medics here, highly trained medics. They can help you."

"I need no help. But you have traded one form of chaos for another. There is a saying, a motto, which you have adopted..."

"Yes," said commander Thosk.

"I can almost read it."

The general's hand rose slowly, clutching at Thosk's tunic, feeling the cross that was raised slightly on the black material. Thosk stood quickly, angered at this impertinence. "I'll ask you not to—"

"I know it now," said the general slowly. "'By this sign you shall conquer. By this sign'—"

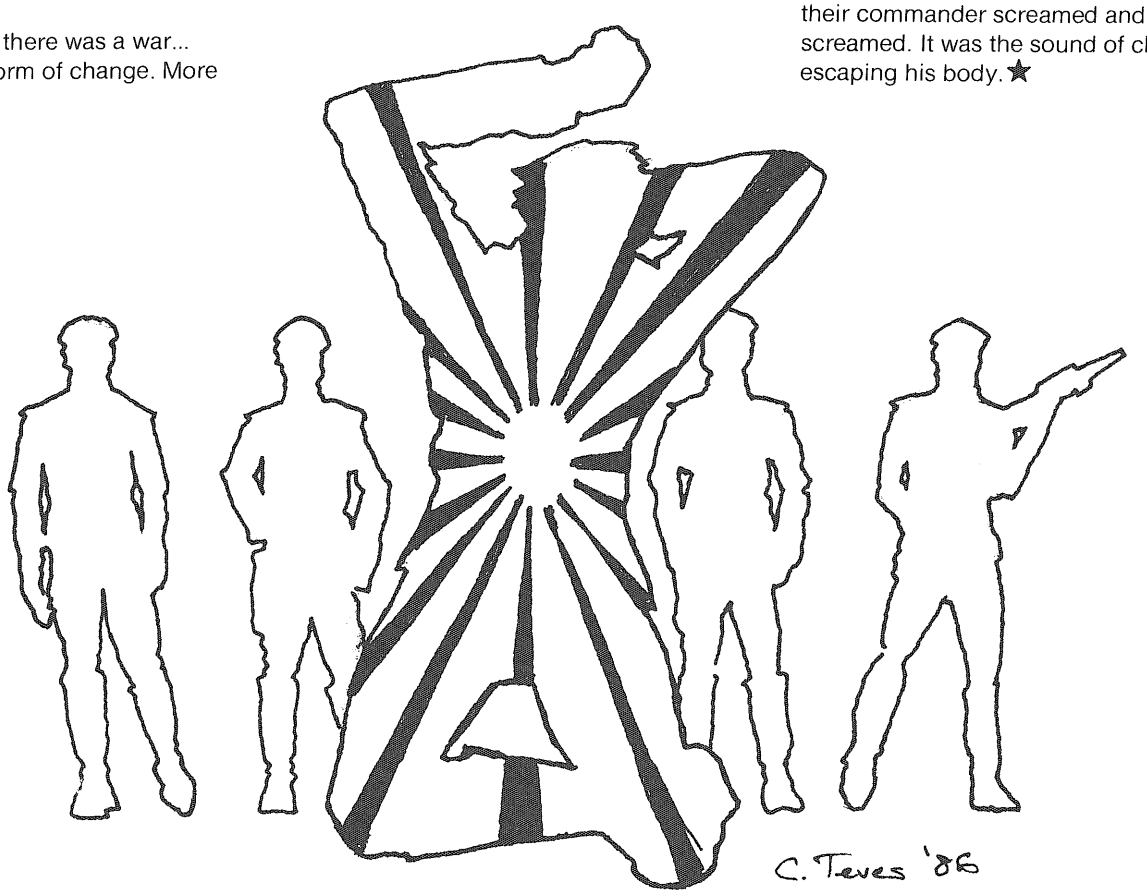
Thosk dropped to his knees again, astonished. How did you—how—" He looked at the general's face but the glasses hid the truth. "How could you have known that? You've been isolated... how..."

"By this sign," said the general again, smiling.

The hand that had touched the cross now came back and drew the dark glasses from the general's face. Thosk stared, not comprehending, until their eyes locked and the Newmi flowed, eager and invisible, into the starfortress commander's body.

Thosk shuddered. He wanted only to run away now. The onion-like layers of maturity and responsibility that had sheathed him from the very beginning of his life had suddenly vanished and he was a child again, defenseless against an onrush of enlightenment. He blinked and looked back down at the general, wanting an explanation in the cold linear terms he was accustomed to. But the general had fainted and Thosk was alone. Each question he formulated in his mind was knocked aside by reason and calm. He felt the panic rising in his chest and he found it hard to breathe. Leaning back, losing his balance, he screamed.

Thosk's crewmen grabbed at their weapons and waved them about, confused. They were trained to respond to direct, obvious threats, but they lacked the creative energy to assess the situation for themselves. They stood, waiting, alarmed, while their commander screamed and screamed. It was the sound of chaos escaping his body. ★



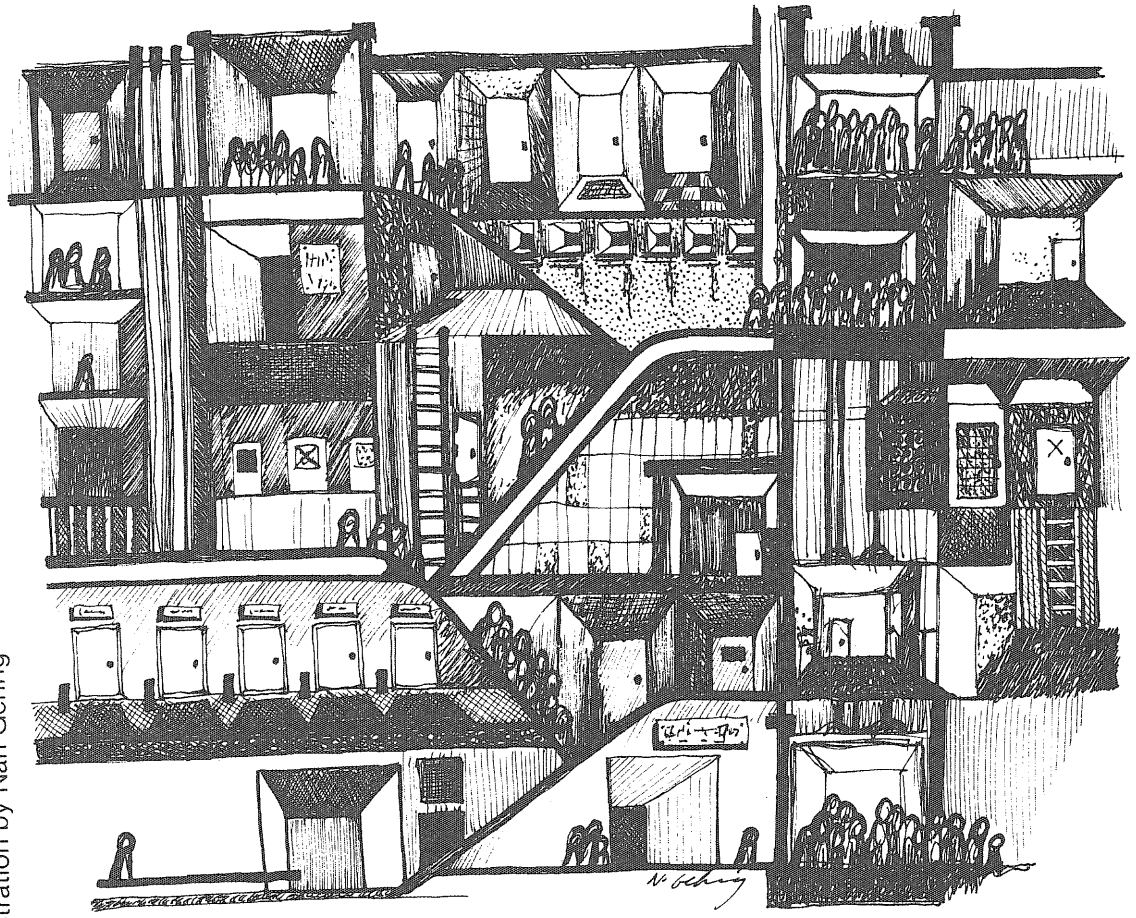


Illustration by Nan Gehrig

MOLE

By Joyce Roberts

SECOND PLACE

"Hold the elevator!" George shouted, running down the corridor. He reached the elevator in time to nearly crush his fingers as he tried to prevent the doors from closing the final half-inch.

"Damn!" He kicked the cold, gray metal. It would be at least half an hour before the elevator returned to his level again. Now he would have to take the cursed escalator up fifty levels.

George Franklin's day had started badly and was becoming worse. When he got up that morning, he had found a red notice waiting for him on his computer screen. It read, "DUE TO NON-PAYMENT OF YOUR AIR BILL, WE ARE FORCED TO CUT OFF YOUR AIR SUPPLY AS OF 12:01 A.M., NOVEMBER 14, 2219. IF THIS SHOULD OCCUR, WE ARE OBLIGATED BY LAW TO NOTIFY THE POLICE OF YOUR CHANGE IN STATUS."

The 14th of November was tomorrow. In disbelief, George had reread the terse note. Then he had read it again. He knew there had been a mistake. He had paid his air bill two weeks ago. Now he would be forced to miss work this morning and to fool around for hours in order to straighten things out with the air company. Sighing, he had pushed the button for a hard copy, shoved it in his pocket, and headed into the public corridors.

George was a descendant of the lucky twenty percent of the population who had moved underground at the beginning of the 21st century. At that time, both the United States and the Soviet Union, unable to reach an arms reduction agreement, had begun building subterranean cities designed to protect their citizenry from the effects of nuclear war. As construction progressed, both sides became increasingly trigger—happy. Each believed the other would annihilate the one who did not finish its project first. Inevitably, war broke out while the majority of the people on both sides still lived above ground. The world was bombed into extinction.

In the aftermath, one of the immediate problems facing the underground survivors had been to supply themselves with safe, clean, breathable air. Fortunately, politicians and governmental officials had been among the first to move beneath the surface. They moved swiftly to solve the problem. They levied an air tax to pay for breathable air in the corridors. Then they formed a public utility to supply air to private apartments. In response, the public formed protest groups. As Americans, the people considered air to be one of their inalienable, and free, rights, but the government stood firm. A law was passed, sentencing anyone living in the public corridors to be exiled above ground. Then the air supply to the apartments of all known dissidents was turned off.

By George's time all this was musty history, but the exile law was still in effect. Either he corrected the problem with the air company today or he became a fugitive corridor-bum tomorrow.

Inside the office of the air company, George paused, took a deep, slow breath and calmed himself. All he had to do was explain the problem to his service representative, punch in his bank records to prove payment, and the representative would reinstall his air service.

His service representative turned out to be fifty years old, at least. She was endowed with the figure of a stripper and the intelligence of an earthworm.

"The computer says you haven't paid it," she said when his records came on screen.

"I realize that," George said patiently, "but, if you will only check my bank records, you'll find that payment was made on November 1st."

"The computer says payment was *not* made," she replied firmly. "Would you like to pay now? Otherwise, your service will be cut off tomorrow, and the police will be notified that you have probably become a corridor-bum. It is illegal to breathe air that isn't paid for, you know."

Holding tightly to the arms of his chair, George said, "Please punch in my bank records. You will see that the payment was made by my bank. If the bank has transferred the funds, then the air company has been paid, but there has been an error in recording the payment. I work with computers myself. I know these things do happen, but they can easily be cleared up."

She sniffed. "Oh, all right. Give me your number."

When the bank records came up she examined them closely. "Yes," she said, "I see a payment listed here."

George smiled with relief. At last, he was getting somewhere.

"However," she went on, "*our* computer says you did not pay, and I see you don't have enough money in your account to cover your bill. We'll have to cut off your service."

Angrily, George leaned forward. "The bill is paid," he protested. "You can see that."

"Mr. Franklin," she replied sharply, "these records of yours may be phony. You could be one of those computer hackers that are always trying to cheat honest people. The air company will check this out, and the matter will be cleared up in two weeks. In the meantime, either pay your bill or suffer the consequences."

"But I can't pay my bill," he wailed.

"Then go to Oxycare," she snapped. "Good day."

The Oxycare office was on the other side of town and twenty levels down. An hour later, feeling ashamed and degraded, George sidled into its dingy lobby. He wondered how this could be happening to him. He was an honest, hard-working citizen. Now, suddenly, he was begging for a hand-out the same as the lazy, no-account bums slouching in the tacky chairs arranged along the walls. He took a number and sat down.

"Go up, young man, go up." Body odor and alcohol fumes surrounded George as an unshaven, ragged, old man sat down next to him. Ignoring him, George picked up an ancient magazine, opened it and began to read.

Undaunted, the old drunk nudged George with his elbow. "Yes, sir, if I was your age, young man, I wouldn't be hangin' around here. No, sir, I'd be goin' topside, I would. Land of milk-'n'-honey up there, I hear, just waitin' for young folks with pioneer spirit to claim it—free air, open space, no rules. Be your own man up there, you could." He nudged George again. "I hear tell there's some wild women up there. Whole tribes of 'em that lived through the war somehow. A man could have his own harem, he could."

George looked up. "That's ridiculous. They blasted it all to slag up there. No one can live there now."

The old man cackled. "Ain't so anymore. That was over two hundred years ago that that happened. All different now. They just want you to believe it ain't liveable so's they can keep you down here under their thumbs doin' what you're told to do. Go up, I say, go up."

Then they formed a public utility to supply air to private appartments

No one can live there now

"I've heard all that before. It's just an old wives' tale," George said. He moved to another chair and remained there, pretending to read his magazine, for the next three hours. Finally, a bald man called his number. The man led George back to his desk, where he pulled out a sheaf of forms and a pack of bubble gum.

"Want a Piece?" he offered.

George shook his head.

"Talking to people all day long makes my mouth dry," the man said. He stuffed two pieces of gum in his mouth and began chewing. Then he asked, "Do you have a place to stay?"

"Not after today," George replied.

"Evicted you, huh?"

"No," George said, "they're cutting off my air service tomorrow."

"But you have an apartment?" the bald man asked.

"Yes, but I can't stay there because I don't have any air."

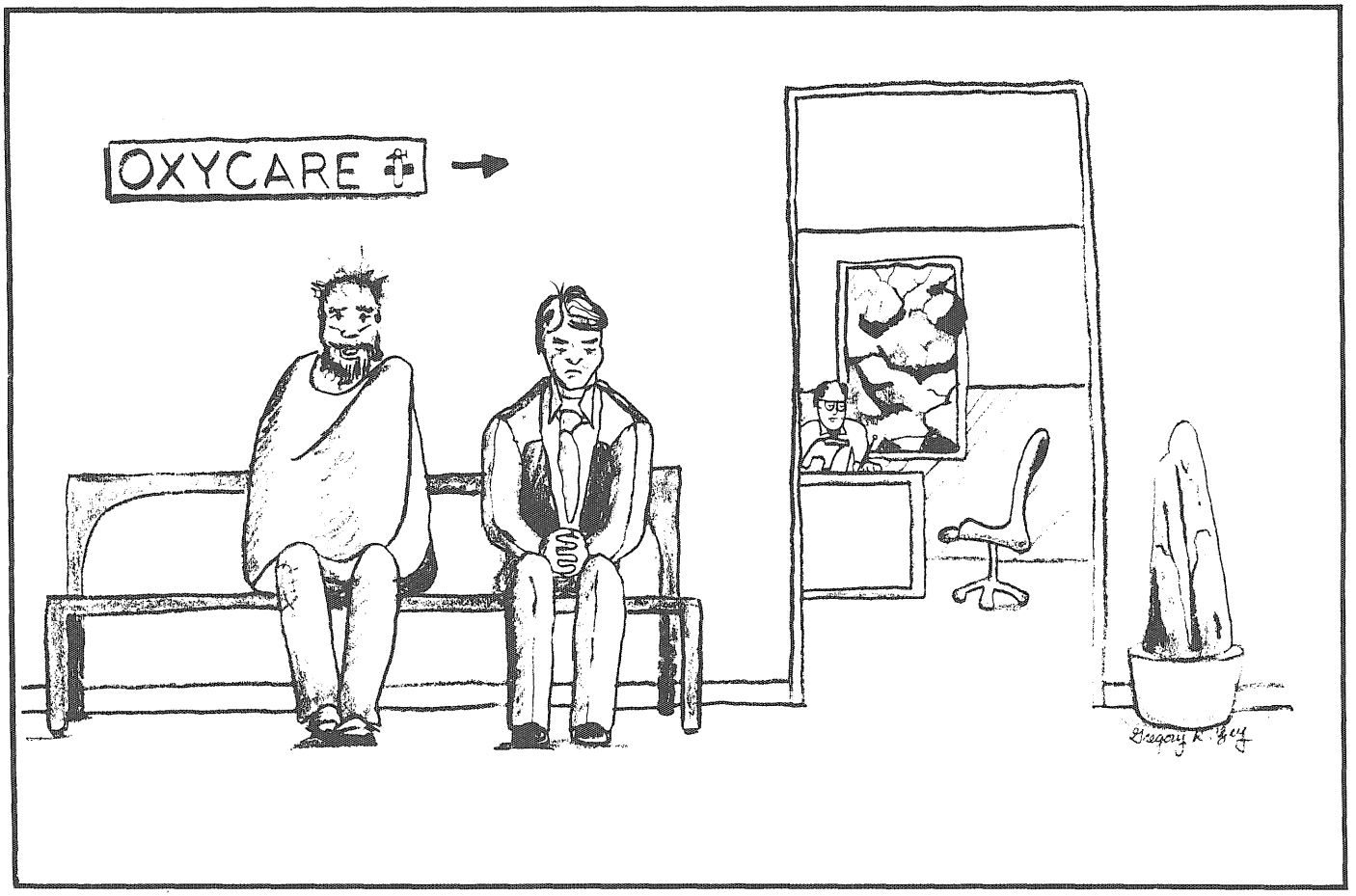


illustration by Greg Ley

"How long is the rent paid for?"

"It's paid until December 1st," George said.

The man blew an enormous bubble. George suppressed his urge to reach over the desk and pop it in the jerk's face.

"I see," the bald man said, leaning back in his chair. "Do you have a job?"

George sighed. "Yes."

The man put down his pen and looked George up and down disdainfully. "So what's your problem?"

Desperately George held on to the remains of his patience and explained the whole story of the unrecorded Payment and his trip to the air company. He emphasized that his air was to be cut off, and that he could not cover the bill to keep his service until the air company had finished its investigation. As he talked, he read indignance and anger on the man's face.

Suddenly the bald man interrupted him. "You have a job and an apartment, Mr. Franklin. Oxycare is here to help the indigent. We are not in the business of handing out cash to every Tom, Dick, and Harry who wastes his money and then can't pay his bills. I'm turning down your application "

Panicked, George burst out, "I didn't do that. I can prove what I say. I need help."

The man glared at him coldly. "Either leave quietly or I will call security," he said.

Despondent, George bought a bottle of gin and headed back to his apartment. There was only one course of action left to him. He would have a couple of drinks, relax, and wait until his girlfriend got home from work. Then he would call and ask her to let him stay at her place until his air problem was cleared up.

Alicia, however, didn't answer her phone until 10:00 p.m. By that time George was tipsy and had convinced himself she was out with another man.

"Where've you been?" he snapped, when he finally heard her voice.

"It's none of your business," she snapped back. "What do you want, George?"

Realizing he wasn't going to get anywhere like that, George tried again. "I'm sorry, honey. I didn't mean to talk to you that way. I've had a bad day, and, when you didn't answer your phone all evening, I got worried about you."

"I'm sorry I was so touchy, George," she apologized. I've been having a rotten day myself. There was a mix-up about my bill at the air company, and they're cutting off my service tomorrow. I've spent all evening moving my things over to my parents' place. I just came back now to make sure I hadn't forgotten anything."

George groaned and moved to

hang up. Then, as an idea seized him, he stopped. In less than two hours his air would be cut off and his name would be reported to the police. As soon as they caught up with him he would be exiled topside. What if it was true that the land and the air had recovered like the old man had said? Why not just go topside now?

"Alicia," he said tentatively, "remember how we've always talked about the old days and how it must have been to live above ground?"

"Of course. Honestly, George, I'm so fed up right now that I feel like going topside just to get away from this city. It's like living in a cage."

George felt a surge of hope. If Alicia came with him, it would make everything that had happened to him that day more bearable. "My air is being cut off tomorrow too," he said. "I have nowhere to go. So I'm going topside now. Come with me. We could be like Adam and Eve."

There was a long, long silence. Finally, she said, "No, I can't. Even if we could live up there, I couldn't bear all that open space. I'd feel like I was going to fly apart. I need walls around me. I'm sorry." She began to cry.

George felt like crying too. Instead he said, "If I survive, I'll come back some day and describe it all to you. Goodbye, Alicia."

"Wait, George," she cried. "Come stay at my parents' place. I know they would put you up. You're practically one of the family."

"No. I love you, Alicia, but I don't love the life I've been living. I've been a good little puppet long enough. I followed all the rules. I obeyed the law, paid my bills and filed my tax return every year, but my society threw me out because of a computer glitch. The hell with it! I'm going topside." He hung up.

George packed a bag and set out into the corridors to find his way up and out of the city. "Ready or not, world," he muttered to himself, "here I come." ★

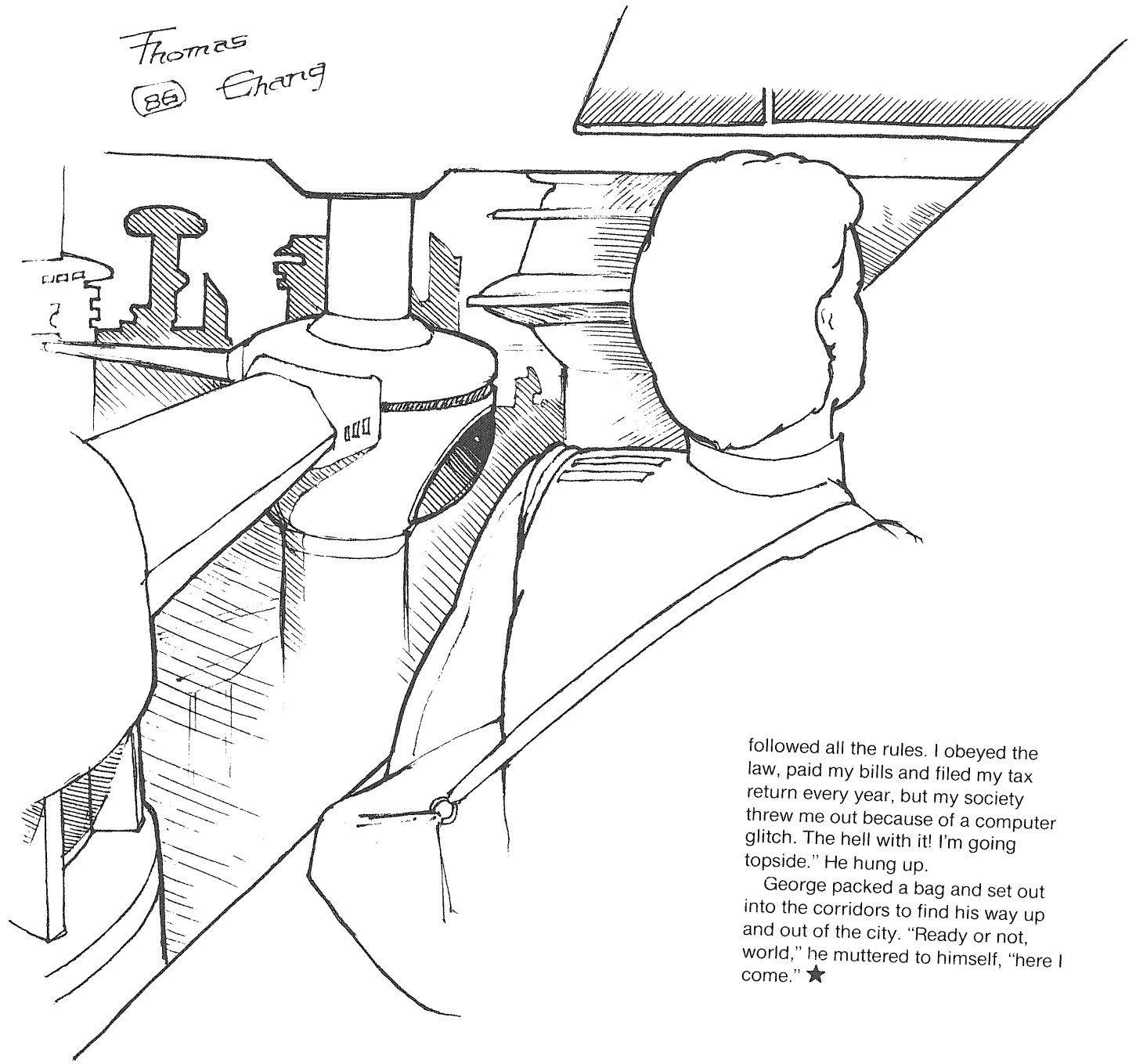
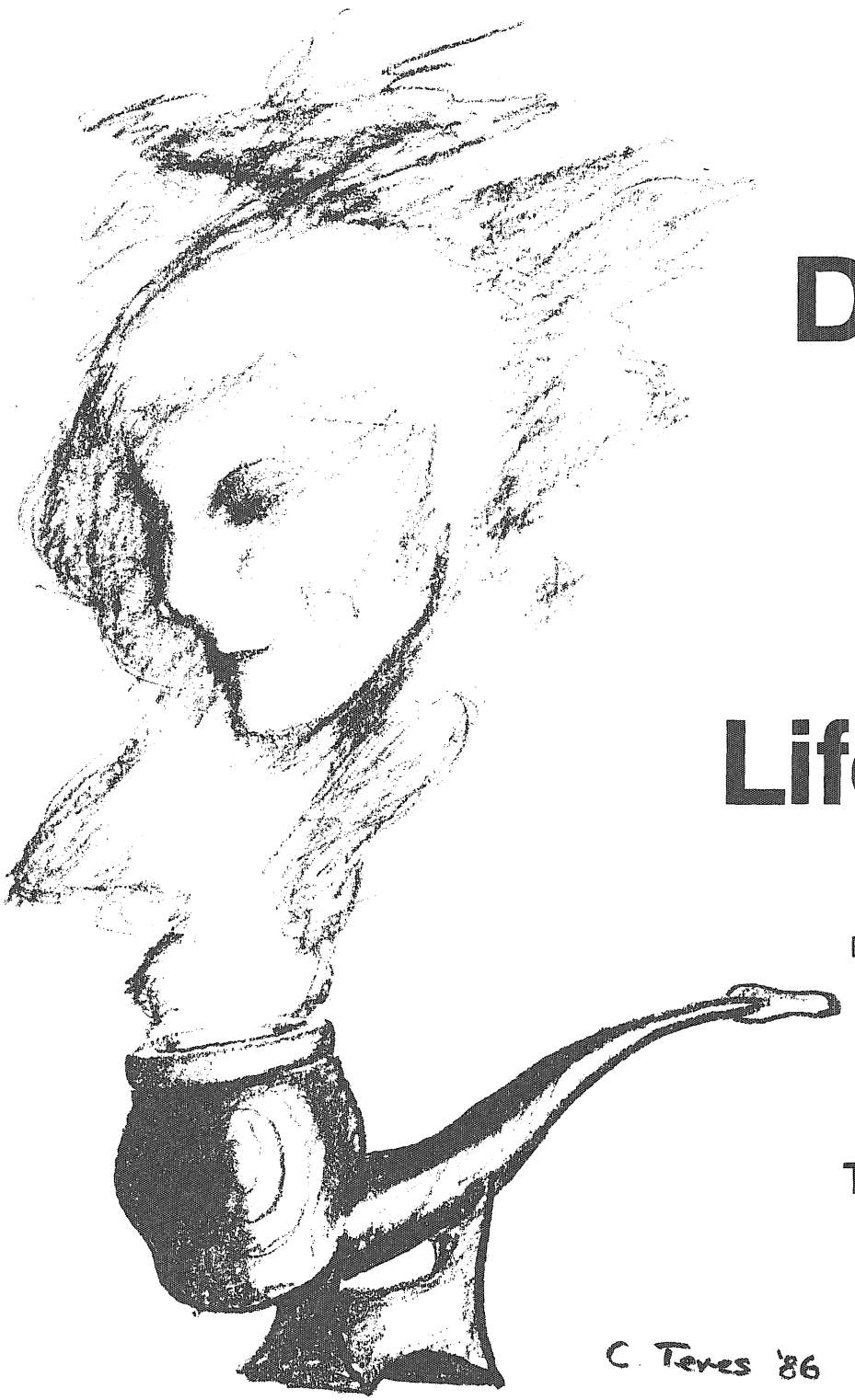


Illustration by Thomas Chang



The Dream Of A Lifetime

By Duncan C. Connel

THIRD PLACE

Nozick Dejamais had only just sat down in the psychologist's office for the first time when the tall suited man with too much hair strode in from behind him and said, "Not you again?"

Actually, Nozick had had some *dreams* where he was in a psychologist's office, but this office was nothing like the dream-office, and certainly this psychologist was nothing like *that one* either. But then again, Nozick's reason for being here now was, in part, because of his strange dreams.

Nozick considered the psychologist's statement carefully before trying to reply. "Not you again?"—what did it mean? Was it a test of some kind, to reveal any insecurities about dealing with things seemingly void of meaning, to detect any hostilities in his adolescent mind? Or was it just a simple mistake? *No mistakes in psychology*, Nozick remembered hearing once, *only slips.* Nozick realized he was thinking too much again, and that if this statement was in fact a test, he had best reply to it, and without undue hesitation.

"Ah, you must have me confused with someone else," Nozick said, "I've never been to see you before."

The psychologist looked puzzled for a moment. He put his hand into his mop of hair, as if to massage his brain to life. The deep crevices of his jowls gave his chin the look of a marionette or a ventriloquist's dummy. "Well," he said, "I was right then."

Nozick didn't understand. He managed to say what he thought the most normal reply: "W-what do you mean?"

"I was *right,* get it? It's *not* you again—because you've never been here before. It's a joke, see?"

Nozick took a long time to understand that he was referring to his first statement. Then Nozick tried to make a fake laugh about it. This psychologist was either a fool or else he had just proven Nozick a nut case.

"Well," the psychologist said, "getting to business here." He opened a file envelope and turned it around in order to read it. "It says here you've had feelings of anxiety, trouble sleeping, bad dreams, and hearing voices. Well, I suppose that sounds pretty bad to you when I say it, but believe me, I have the same problems sometimes."

Nozick was thrilled to have someone to empathize with him.

"Now, tell me, are you comfortable?"

"Yes, pretty much," Nozick said, "I'm glad I don't have to lie down."

"Really, why is that Nozick?" the psychologist asked.

The psychologist looked puzzled for a moment

"Oh it's just that I get nervous about going to bed and everything, because of the dreams." Nozick was sure he'd just made a mistake—that is, a slip.

"So your dreams disturb you to the degree that you don't want to go to bed at all, is that right?"

"Well, yes, but I do get some sleep. I just don't look forward to it in a certain way I guess." Nozick thought a moment. The smell of the leather chair was relaxing, and the seat very soft. He felt much more secure now, he realized. "You know, I feel like I could go to sleep right here. I should have a chair like this at home to sleep in, that way I wouldn't have to lie down."

"Well don't go to sleep just now," the psychologist chuckled, "we still have some work to do here." The psychologist then lit a pipe and said, "It seems to me that there is something important about your not wanting to lie down, but that can wait. First why don't you tell me about your last dream?"

"All right," Nozick said, quite relaxed now and getting the pleasant, dry, smoldering aroma of the pipe. "Let's see. Like it probably says in your file there, I work as an apprentice engineer at the Syntho-Meats plant, and I just moved into my own quarters a few weeks ago. I haven't heard anything from my family and all that because I'm so busy and I hardly get any calls from them anymore. And I can never get them on the phone at all. Anyway, the dream I had was so weird because it was just like my whole day. Everything happened just the same, like deja vu. Only, sometimes I thought I was an infant or something and I pictured my mother carrying me when I was really walking —"

"Wait now," the psychologist said. "Do you mean you were really sleep-walking, or what?"

"No, I mean I was, well, walking but than it turned out that I was being carried. But then I get torn away from my mother each time and it's like someone is trying to drown me a bath tub and I get submerged, but I still breathe somehow."

"Hmm. Very good," the psychologist mumbled.

"What? What's good?"

"Oh—I mean it's a good thing you could still breathe. A little, uh, joke, you see?" The psychologist looked flustered. Nozick did not feel so comfortable anymore.

The psychologist leaned back in his chair and put up his feet. He puffed on his pipe and absently launched a thick smoke ring in Nozick's direction. The ring moved very slowly but steadily, widening along the way. By the time it was half way to Nozick it had warped and twisted around so that it resembled the sign for infinity. It grew larger and came closer to Nozick who tried to blow it away, but, somehow, could not.

The smoke ring suddenly became a rope and wrapped itself around Nozick in his chair.

The smoke ring suddenly became a rope and wrapped itself around Nozick in his chair. He struggled and tried to call out and then . . .

And then he woke up.

The psychologist was standing over him, eyeing him like a dissected frog. "You're not telling me everything, are you? You're not even sure what reality is anymore. It must be frightening."

"How — how could you know that?" Nozick sank back in the soft chair.

"Oh, it's very common in young people your age." The psychologist disengaged and backed to his desk. "Becoming an adult is difficult for everyone, and for some it is a living hell."

"Living hell!?" Nozick knew he had just described him perfectly. But was this usual? Why use those words? But it was so true. Nozick woke up from dreams upon dreams, in which the awakening was only the start of other dreams within dreams. He had no idea where they had actually started, and there really seemed no end. "Doctor," Nozick said, "I'll level with you, but you've got to help me get straightened out, please!"

And so he did.

When the session was over, the psychologist appeared very pleased with Nozick, and said they were going to make good progress at the next one as well.

At home, Nozick felt lonely in his little efficiency apartment—he couldn't seem to get anyone on the phone as usual—but he wasn't quite so apprehensive about going to bed. The psychologist had prescribed some sleeping pills. The bottle said take two, Nozick took three and laid down in his bed to sleep. He felt the little pricklings all over his body like always, but soon he didn't care and he slept.

Next morning Nozick couldn't remember a single dream and he felt like a new man. The whole world seemed brighter, happier, fresh again. At work his supervisor complimented him on his bright-eyes-and-bushy-tail.

Nozick's job involved the contruction and placement of the skeletons that went into the meat synthesizer tanks. Using a type of plastic tubing, Nozick built approximations of beef, poultry and hog's skeletons, upon which the synthetic meat-forms would collect inside the dense fluid. This was the "fancy" meat production division, a more expensive kind than the regular block meats; it was old-fashioned, but popular, since there were the different "cuts" which still had something similar to the bones of real animal parts (which were truly expensive delicacies that hardly *anyone* could afford).

Rigging up a hog, Nozick was finally overcome, all at once, with a feeling of dread. He suddenly didn't want to go back to the psychologist. But that was silly—the psycholgist was the one who got him out of the seemingly infinite regress of dreams. It felt good to know he was awake for a change.—But that was just it: How do I *know* I really am awake? That was the scary thing now. But Nozick realized he should not consider himself cured at this early date.

Nozick immersed the Hog-frame into the tank. Immediately, dark nodules began to form on the white "bones." Soon this skeleton would be covered with synthesized pork, without a head or hooves or tail, but with the general form of a pig. Nozick thought the addition of ears and snout would be nice. But then he decided not—it would be so macabre. Nozick was prone to daydreams, and when he realized that this was exactly what he was doing, he checked himself. He shook his head vigorously and concentrated on his work, going down the line of big clear tanks to check the other meats and record their "fattenings."

After work Nozick went to the Syntho-Meats, Inc. office in the Multi-Vision tower to pick up his second paycheck. The M.V. tower was the tallest building in the city, and from the window, Nozick could see out to where the suburbs melted with the horizon in the hazy distance. The rectangular shapes of the city blocks were like micro-chips upon the vast circuitboard of the urban sprawl below. Nozick imagined the vehicles as electrons surging along the conductor avenues, and the telephone lines were the wiring of sub-circuit loops that fed the interconnected chips. Even the water towers, of which there were many more than Nozick had supposed, fit in as little transistors sticking up every here and there on that gigantic circuit-board below him.

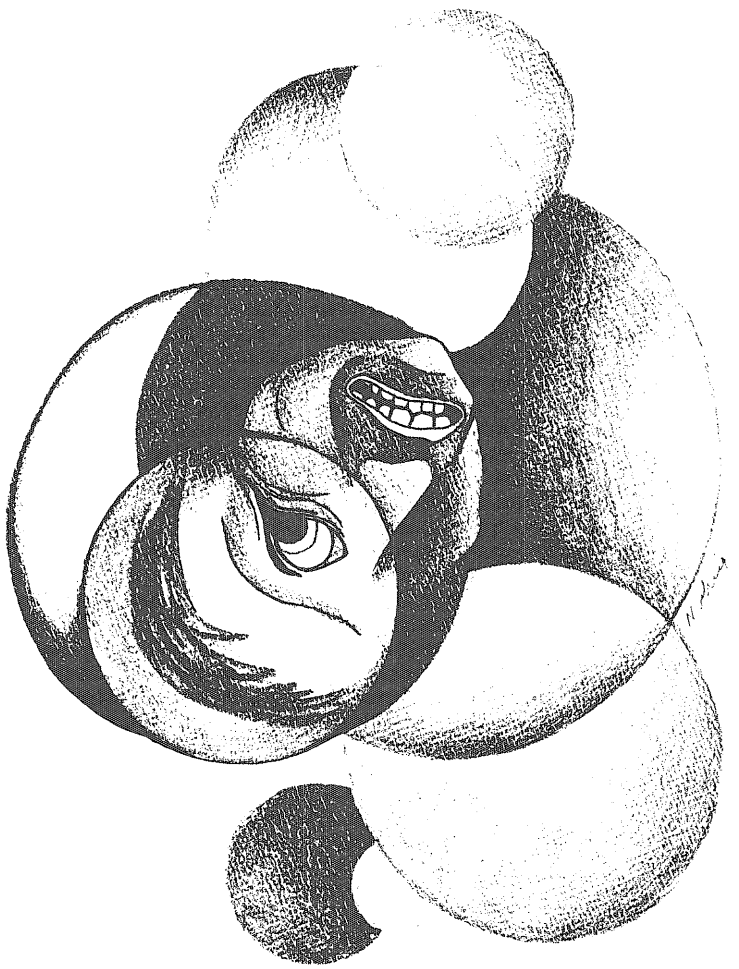


Illustration by Nan Gehrig

Just then, Nozick began to hear the voices again. It was like someone was commenting on him from some invisible, omniscient viewpoint. "Creative" they would say, or "a difficult case." They were like the snatches of sentences one might catch flipping through the radio dial, never complete but all with a certain common attitude . . . .

And then, of all things, Nozick woke up.

He was at home in his apartment, with a receipt from the deposit of his paycheck in his hand. The clock told him it was over an hour since he'd left work. Nozick was by no means cured, and now he was truly afraid.

And worst of all, it was time to go to go to his next session.

Nozick was scared, but he also tried to keep in mind that if anyone was going to help him, it was going to be the psychologist. Nozick told the psychologist all about the voices and the lapse of memory he'd just experienced. He felt, more or less, comfortable again in the psychologist's office.

"When you looked out the window," the psychologist asked, "did you have any suicidal ideas?"

"No."

"Well, that's good to hear. Did you have at any time before that a suicidal thought of any kind?"

"What's with this suicide stuff? You're coming out of left field, Doc."

The psychologist leaned forward. "You have then, haven't you?"

"Well, sure, I mean isn't it normal at my age for the idea to come up? You make it sound like I'm trying to hide it or something."

The psychologist shook his head, rising from his chair to sit on the front of his desk. "Nozick," he said, "Nozick, you don't have the first idea what's going on here, but I'm going to help you adjust. You'll just have to be patient because I have to do this gently."

"You worry me Doc." Nozick glanced at the door, toying with the idea of a quick getaway.

"That's all right Nozick, I just need you to keep an open mind."

"Okay, sure. What."

The psychologist put his hand in his hair again to stir up the brain. "What if I were to tell you that nothing is real?" Nozick could only glare back at him. "What if I told you I'm not real, I'm only an image projected on your mind. What if in fact your whole life up til now has been nothing but an induced dream?"

Nozick tried to get up. He couldn't. He tried to speak. Nothing. All he could do was *want* to get the hell out. The voices were there now: "It's genuine rebellion" they said of him, "reset now."

And Nozick woke up.

The psychologist was back in his desk, hands clasped upon it. "Don't you see Nozick? Childhood is a wasteful period. It costs so much time and money. If we can create an entire, normal, healthy childhood in the mind, and then release the person at the beginning of adulthood, then we have a ready-made model citizen, fully prepared for real life in a society free of crime, poverty, and so on. We have presented every sense perception you've ever had. But your thoughts are strictly your own. It's simply been found that, given all the right environmental conditions, a human being will develop normally and in good health. You're floating in a dense suspension fluid, Nozick. You are covered with thousands of electrodes. Your muscles are exercised by electro-stimulation —"

"It's no good," one of the voices said, "reset."

And then Nozick woke up—At home, in his parent's house.

His mother was there, holding him. "My dear God," she said, "I couldn't wake you up, Nozick. You were having some kind of nightmare. Are you all right honey?"

Nozick glared up into her eyes. "Yeah, I think so." Nozick really thought it was okay now. "I've been having dreams about dreams where I'm already in a dream and it was like it went on like that forever. And the weird psychologist was telling me that I was floating in a tank, plugged into some kind of machine —"

"Well, of course you were, Nozick," his mother said. "They took you out of the sensory development tank this morning, didn't they say that?"

"Wait—what are you saying!?" Nozick couldn't move.

"They decided that they would be damaging you if they kept you in any longer. We brought you back here to rest a few days."

"You're telling me that I really was in that tank, just like the psychologist said?"

"Of course, that's the way we all grew up—me, your father, and our parents before us. Oh, don't worry, the shock will wear off in a day or two, you'll see."

"But, but I want to get up, and I can't move!"

"Please dear, don't fuss so!"

"Like hell! I'm getting out if I have to kill myself!"

"Oh dear," his mother, or someone, said.

And Nozick, again, woke up.

He was in the hospital now, with casts on his legs and fat bandages on his head. He hurt like a truck had, quite literally, run him over, or even worse.

"Painful, wasn't it?" A voice came from behind the curtain. "You have to realize we can't let a suicidal teenager loose on society." The curtain drew back, and too much hair ducked under the curtain rod. Nozick tried to scream, to lash out. He could not.

Nozick tried to get up. He couldn't. He tried to speak. Nothing.

How do I *know* I really am awake?

"I want to prepare you, Nozick, that's all. Why not accept it?"

It's too late, that's why not. How can I go along now? I'll never really know when I might just wake up again. If I really am in some tank like you say, then I can never be sure that I'm really, *really* out—can I?"

The psychologist lowered his head. Suddenly his face became white, and his nose inflated like a little balloon.

He became a clown. "What's going on," a voice said. "We never gave him that." Nozick laughed.

And then he woke up. *How to commit suicide with no tools but the mind alone?* Nozick tried to concentrate on that—

And then he woke up. *No! I won't let them use that to break my thoughts apart.*

And he woke up again. *Damn you! If I can't manage to kill myself, I'll at least never let you win. Torture me if that's what you really wanted in the first place. You control my senses, but not my thoughts!*

And he woke up. *Don't they say a dream that lasts a lifetime is a reality? Well, if this is going to be my reality, I'm going to make use of it. I'll make you think again about what you're doing... I'll make you think . . .*

And then Nozick woke up,
And then he woke up again,
And again,
And again, ★

The Test

HONORABLE MENTION

Thomas Chang '86

By Randall M. Thompson

The darkness fades and the dizzy feeling recedes gradually. Smooth grey walls surround me on three sides. Walls that stretch above my head.

Part of me has been here before, I know. Still, I do not know this place. Where exactly is "here"?

I stretch upward futilely to try to see over the left-hand wall. It is much too high. I try to climb it, but it is far too smooth. Above the walls, I can see the sky. It is white, and the part of me that has been here before knows that it never changes.

Occasionally, vague white shapes can be seen gliding by above the walls.

I sniff about, wondering what to do. The place smells of fear. The fear left behind by others who were here before me.

I can see nothing to be afraid of. I have not been harmed. I am not afraid. But I *am* hungry. Very hungry.

I start out in the only direction possible, with the smooth grey wall stretching above me on both sides. Underfoot, the surface over which I walk is smooth and hard, yet different

It has a strange smell, like it is somehow...alive

from the walls. It is a lighter color, and it is scratched and stained in some places.

The corridor turns a corner and I soon come to an intersection of three passageways. I sniff. My nose tells me to take the left passageway. I smell food. I hurry down the hallway, toward the food. The path is straight and has no turns or branchings.

There's food at the end of the corridor! But wait! The food is separated from me by a curious narrow gridwork set into the floor. I cautiously smell the grid. It has a strange smell, like it is somehow...alive. I gaze longingly at the food. Examining the grating on the floor more carefully, I notice that a small section of it is of a slightly different color than the rest. Having made up my mind, I scamper across the grid, touching only the section which I have just discovered. I negotiate it safely and rush to the food. It is a savory treat, but not very filling.

I continue my search. I walk back to the intersection and take the other branch. I walk slowly down it, keeping my nose alert.

Suddenly I am falling, sliding through darkness. I have fallen through a hidden hole in the floor. I should have been more careful.

Soon I am deposited with a plop in a large room. The fear smell is very strong here. The walls are higher on three sides of the room, but on the fourth the wall is slightly less tall than those of the passageways. The white sky is still above me.

The room is empty, and the chute that dropped me here has disappeared.

I sniff around for awhile wondering what to do. I am beginning to get hungry again.

Then: **PAIN!** Pain in my feet! I leap into the air, but when I touch the ground again there is pain. I run frantically to the shortest of the walls and leap over with a tremendous jump.

On the other side of the wall is a room that is identical to the one I have just escaped from. Except that the floor does not give me pain.

But I have spoken too soon! The burning floor has followed me! What am I to do?

I squeal and jump back to the other side. It is no use! The pain from the floor is everywhere. Everywhere except...

I jump and grab at the top of the short wall. With much effort I am able to pull my body up and keep my balance on the top of the wall.

But now what do I do? I cannot cling here forever.

The question is answered for me when a door is opened in the far wall of the second room.

But will the floor still burn? I decide that I must take that chance and leave my perch before the door closes. I leap to the floor and run to the door without any further discomfort.

The pain from the floor is everywhere

I stop when I am safely in the corridor. My mind is beginning to harbor a small twinge of fear. Fear at what lies ahead, and at what lies behind. But my body is hungry, so I dismiss the fear. The fear seems to have come from the part of me that has been here before anyway.

I journey down the passage and soon come to a four-way intersection. I choose to go to the right. The corridor turns and then I come to a branching in the path. Further on, the hallway turns and forks, turns and forks again. Fighting down a panic of being lost, I keep my head and try to think. I methodically eliminate branches of the maze. Soon, after a few failures and some lucky guesses, I am free of the labyrinth.

I find myself in a small room where I also find my reward: a small portion of food.

I eat and continue on the way. I am curious now at what is ahead. I go through a door which has opened in one of the walls while I was eating. Once I'm through, the door closes again with a sliding noise.

A white shape drifts by in the white sky. The white shapes look familiar to me, but I can't remember why.

I walk down the corridor and find myself at the edge of a precipice. The corridor simply ends and drops off out of sight below, forming a wide chasm. A thin piece of rope connects this side of the passage to the other side. Without hesitation I start across

Suddenly a piece of food falls from the sky.

on the rope. When I get to the middle, I peer beneath me curiously, trying to discover what lies below. But the abyss is too dark towards the bottom, so I travel on.

On the other side, I begin to catch the scent of other bodies. I follow the odor. I come to a fork in the passage. I wrinkle my nose and take the path with the smell of the others.

I come to a large room. The room has two exits; one, I am standing in, and the other lies across the room from me. In the room with me are twenty or so others, all milling about. They seem as hungry as I, but no one is leaving the room in search of food. All of the others are males. I sniff to catch the scent of a female, but there are none.

Suddenly a piece of food falls from the sky. It falls in the center of the room and three of the others are on it immediately. Soon the whole group, including myself, has crowded close, wanting the food. I am about the same size as all the others, but I am fierce, determined, and hungry.

I muscle my way in among squeals of protest. With a few well-placed, savage bites, I gain control of what is left of the food. I run to a corner and protect the food between my arms and under my chest. Several of the bigger ones come to take the food from me, but I fend them off using claws and teeth, and I bloody a few ears and noses.

I wait to see if any of the others will try to challenge me. Eight or nine have been injured in the melee, and they are busy licking their wounds. The rest seem to be daunted by my ferociousness. I set about to eating my hard won dinner.

I finish, and I start to feel dizzy.

Soon the darkness takes over once again.

* * *

"Gentlemen," the well groomed executive addressed the group of ten seated at the boardroom table. "By now you are probably aware that our corporation has recently established a new method of testing potential employees."

Next to the executive stood a bewildered looking man in a business suit. He blinked often and seemed to have a preoccupation with the ceiling.

The executive continued. "I am here today to tell you all more about the program. The new testing program, in conjunction with already existing methods, enables us to find out with astounding accuracy what kind of person we are hiring." He paused. "The applicant in question is subjected to a variety of stimuli, and his reactions to the stimuli enable us to rate him or her in the areas of basal intelligence, creativity, competitiveness, perseverance, decision-making ability, and reactions under stressful situations.

"The stimuli are introduced to the potential employee through the use of a newly developed device, the Trans-entital synaptic transmitter, or **TEST** for short. Certain areas of the subject's brain, notably areas in the temporal lobe and the motor and sensory cortices, are connected to the **TEST** via electrodes. The **TEST** is then connected to an ordinary laboratory rat by the use of a small transducer which is implanted into the brain of the rat.

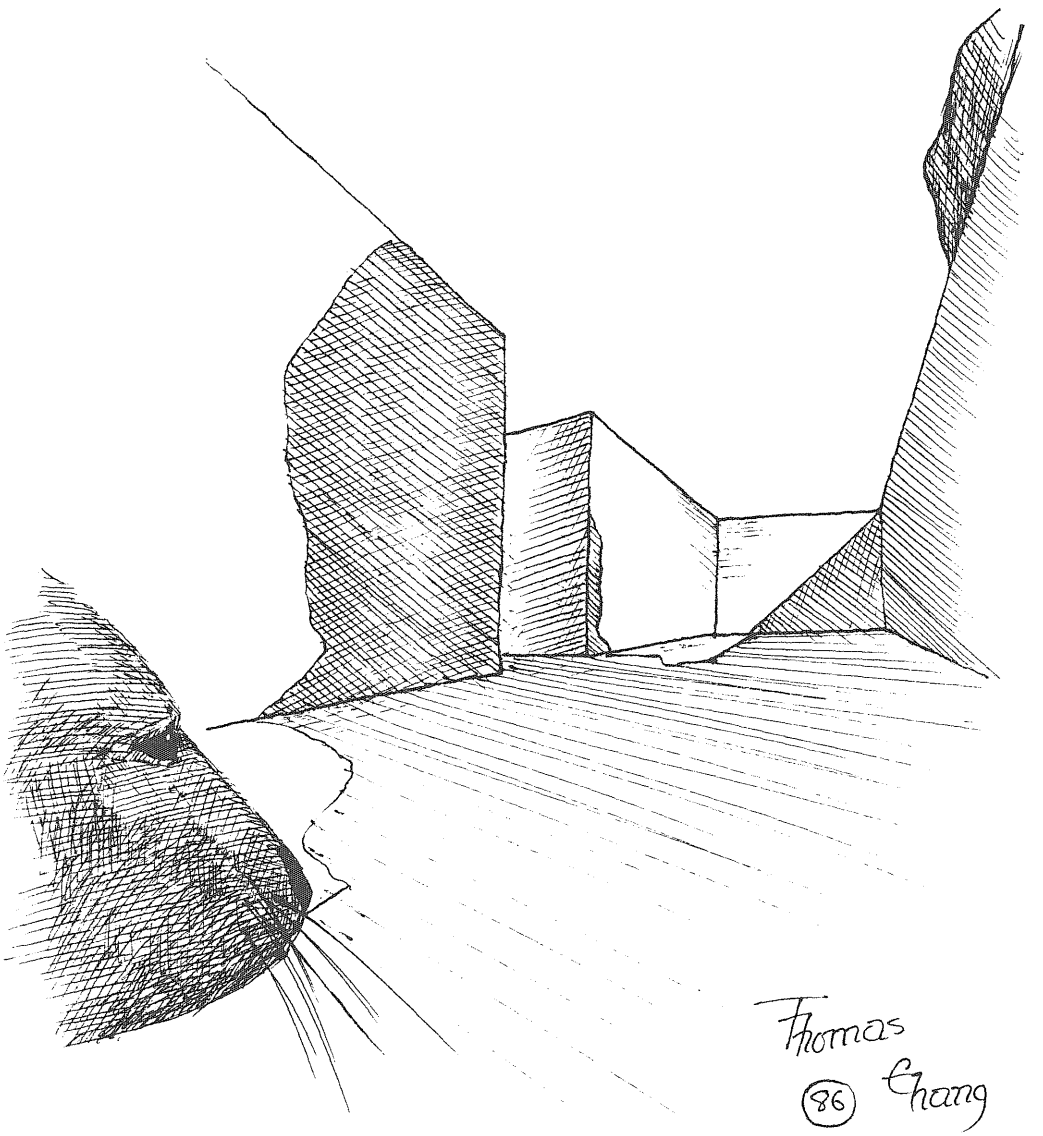
"Thus we are able to do rigorous testing on the rat without harm to the subject.

"In short, what the rat experiences, the subject experiences. Are there any questions?"

The group of men said nothing. They waited expectantly for the executive to continue.

The executive turned to the dazed man standing next to him. "Mr. Nelson, here has shown the highest of ratings in all areas of our testing. I think that he will be a welcome addition to our corporation in the position of Junior Vice President."

Mr. Nelson's nose twitched and he caught himself just as he was raising his left leg to scratch behind his ear. ★



Situation Essay

On behalf of the Minnesota Technolog I would like to thank Paul Rydeen for his courageous contribution to this new contest. In fact, Paul is the only student that entered. Although one entry does not constitute a contest, this essay is an excellent example of what can be done when a good imagination teams up with hard fast scientific principles.

Gilligan

By Paul Rydeen

Illustration by Julie Lees

Just sit right back and you'll hear a tale...

"Gil-li-GAN."

"Oh boy, the Skipper wants me. COMING, SKIPPER."

CRASH. HAHA HAHA hahaha...

"Watch where you're going, Gilligan."

"Sorry, Skipper."

"Now, Gilligan, it looks like we're stranded on this uncharted desert isle, and I think we'll be here for a long, long time. We'll have to make the best of things, and it won't be easy."

"Sounds like it's going to be an uphill climb, Skipper."

"That's right, little buddy. Now run along and ask the Professor what three scientific or mathematical principles we should use here on the island.

"OK, Skipper."

"OOF."

HA HA ha.

"Sorry, Skipper."

*****

I will use plate-techtonics to calculate how long it will be before our island comes within swimming distance of Hawaii.

"Ah, Gilligan, you're just in time to see my latest experiment. Now these coconuts contain...

*****

"Professor, the Skipper wants to know what three scientific or mathematical principles we should use. How about phones, lights, and motorcars?"

"No, Gilligan, not a single luxury. We're in a primitive environment, and the principles must be basic to survival."

"Kind of like Robinson Crusoe, eh, Professor?"

"Exactly. Since the first logical thing to do is attempt escape, I will use plate-tectonics to calculate how long it will be before our island comes within swimming distance of Hawaii. It will only take a minute; I'll figure it out in my head. Let's see, add and carry the one and, hmm... approximately another five billion years, with a little luck and a good wind."

"Oh boy. Wait till I tell Skipper."

"Gilligan. Wait."

HA HA HA HA...

*****

"Gilligan, you fool. We'll be dead in five billion years. Didn't the Professor have any other ideas ?"

"That's no way to talk to Gilligan, Skipper; he's doing his best to help."

"You're right, Mary Anne. I'm sorry, little buddy. Will you forgive me ?"

"That's all right, Skipper. I'll check with the Professor again. Bye, Mary Anne."

"Bye, Gilligan. And watch out for that...

KLUNK. HAHAHA.

...tree. Oh, Gilligan."

*****

"Gilligan, I have thought of a second, more practical principle with which to aid our survival on the island. Since we can't escape at the moment, we should turn our attention to survival. After all, it's up to you and the Skipper to make the others comfortable in this tropic-island nest."

"Yes, Professor, I'll do my very best."

"Good. The answer is genetics. Not only will it help grow an optimum crop of food, but it will determine the ultimate combination of the peculiar boy-girl ratio on the island."

"Professor, you can't talk about that on prime-time TV. This is the sixties, remember?"

"You are correct, of course, Gilligan. Perhaps I can get a guest spot on *Love, American Style.* Or *Laugh-In.* Or...

*****

"Ooh. I don't think the Professor was that far off, Gilligan. After all, that is the classic desert island dream, and I'm a girl, and you're a boy, and...

"Ginger, all I wanted was a piece of that banana cream pie that you and Mary Anne baked this morning, not a piece of...

"Gilligan."

*****

I have come up with the first practical application for Taylor's Theorem.

"Well, Gilligan, we're not going to escape and you're not having much luck at making the girls comfortable, so my third and final suggestion is to achieve immortality. That way, we can live on long after we're cancelled."

"Cancelled? What do you mean by that, Professor?"

"Never mind, Gilligan. Now I have an idea that will help Mr. Howell count his money, *and* assure that we live on in taped eternity. I have come up with the first practical application for Taylor's Theorem."

HAHA HAHA HAHA HAHA ha ha ha ha ha.

"What's that about, Professor?"

"Taylor's Theorem is about *infinite series*, Gilligan. Infinite series like our own. I know that reruns will guarantee our immortality in televisionland. And VCRs haven't even been invented yet. Just think of the possibilities."

"Gee, Professor, you've done it again."

"That's supposed to be my line, little buddy."

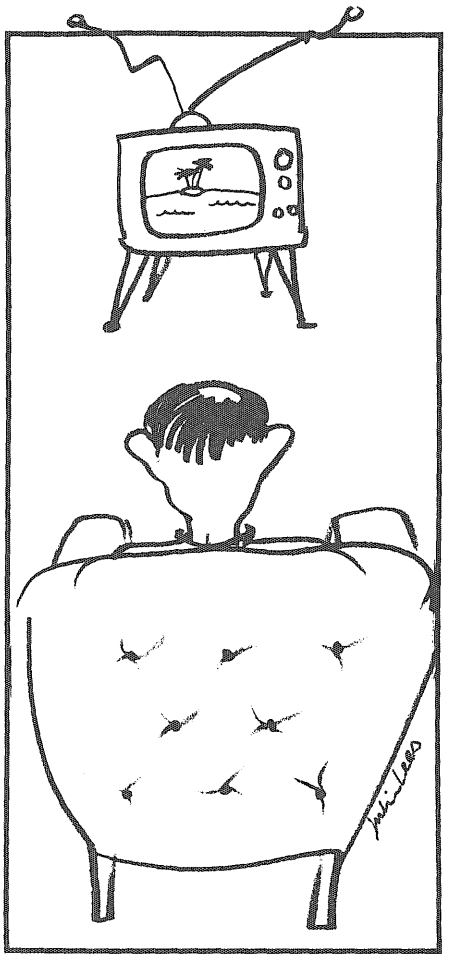
"Sorry, Skipper."

HAHAHA.

Now this is the fate of our castaways, they're here for a long, long time. They'll have to make the best of things, it's an uphill climb. The first mate and his skipper, too, will do their very best to make the others comfortable in their tropic-island nest. NO PHONES. NO LIGHTS. NO MOTORCARS. Not a single luxury. Like Robinson Crusoe, it's primitive as can be.

So join us here each week, my friends, you're sure to get a smile from seven stranded castaways HERE ON GILLIGAN'S ISLE. ★

Quoted from *Gilligan's Island* television show.



TechnoTrivia

Questions

1) What has a more profound effect on fatness, your environment or inherited traits?

2) True or false: Banana peels are an effective cure for scuffs on your shoes.

3) Sort these three famous constants from smallest to largest: e, π, $(\sqrt{5} - 1)/2$ (this is the golden mean).

4) Why were pistol duels usually held at dawn?

5) What element does Ga stand for?

6) Within 10%, what percentage of Americans say they never socialize at all?

7) Who has a keener sense of smell, men or women?

8) What famous constant was Buffon able to approximate by dropping a needle on a plane of equally spaced, parallel lines? (Hint: it is not e or the golden mean.)

9) True or false: Even as you read this, flying saucers are landing in Wyoming and absconding with that state's supply of *National Geographics*.

10) Toothpaste contains saccharin, the chemical that turned out to be carcinogenic for Canadian rats. Within one million, how many times per day would you have to brush your teeth to ingest the same amount of saccharin that the rats ate?

Scoring

0-1 If ignorance is bliss, you've reached the summit of happiness.
2-4 You could be worse, but so could *The Brady Bunch*.
5-7 You are a brown suit in the closet of trivia.
8-10 Oh yes, and I suppose a large invisible rabbit helped you with the tough ones.

Answers

1) According to a Danish study of 540 adults who were adopted as children, environment has little or nothing to do with weight, while fatness was strongly correlated with that of their biological parents.

2) True. According to the International Banana Association, polishing shoes with the inside of banana skins erases scuffs. Interestingly enough, the International Trout Association says that their fish makes an effective deodorant.

3) (5 - 1)/2 e, . Deduct two points if you used a calculator (sinister laugh, wa ha ha ha).

4) It is easier to treat abdominal wounds if the victim has not eaten recently. Imagine the difficulty of locating bullet fragments amidst a rainbow of Froot Loops and milk.

5) Ga stands for "gallium," not "gasoline" as you probably naively guessed.

6) Two percent of Americans say they never socialize at all. Let's see, if you add up all the computer science majors and divide by the population, you get . . .

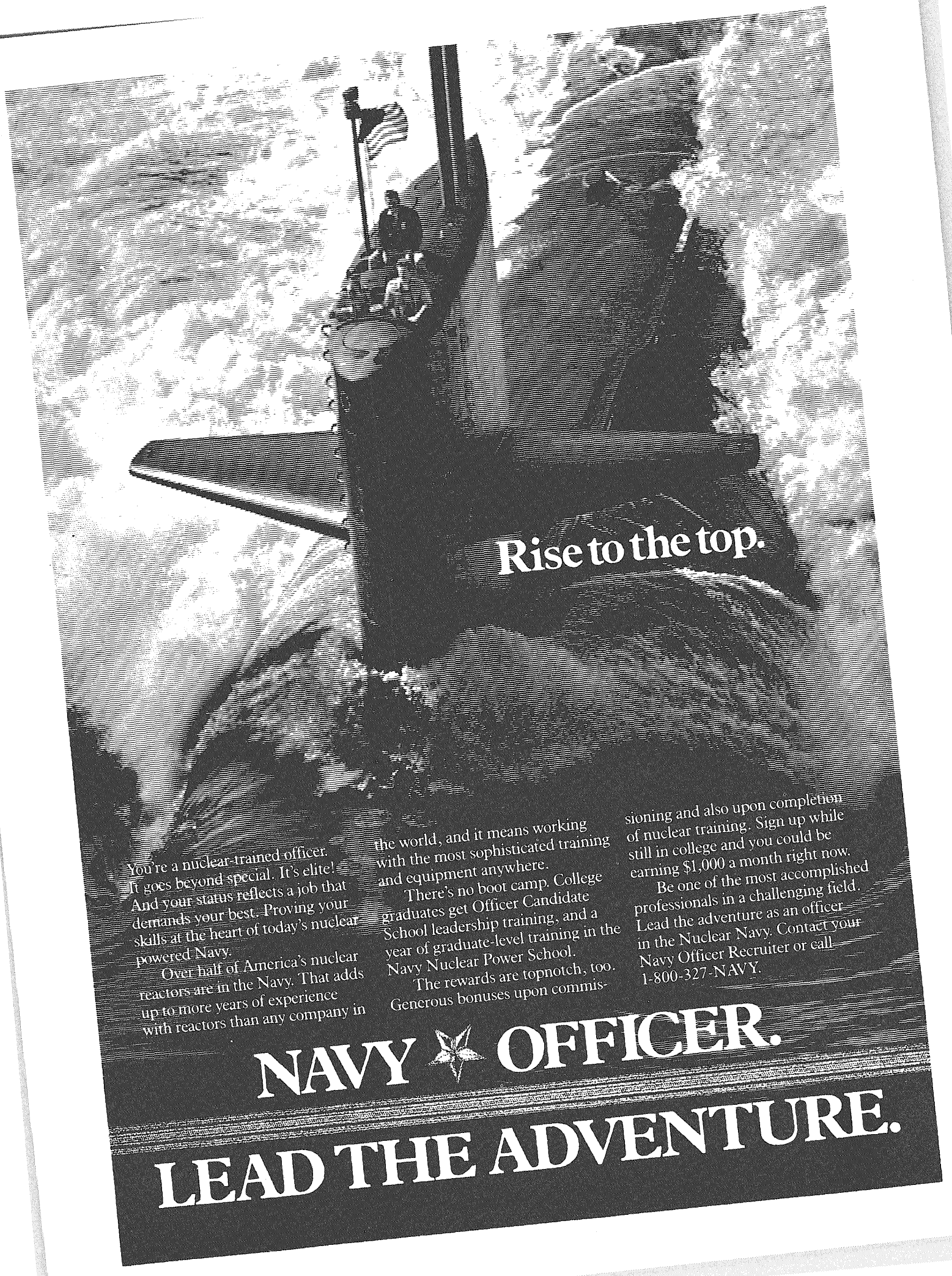
7) In general, women have more sensitive noses.

8) π

9) False. It is actually the CIA, and they are after back issues of the magazine *Motorcycle Wrestlemania*.

10) You would have to brush your teeth 1.25 million times per day. Besides being expensive, this would probably wear your entire skull away in one weekend.


CAPTAIN Cosmic
EPISODE VI: THE COMEBACK TRAIL
OBLIVION! A PRISON FOR THE FORGOTTEN— LIMBO FOR THE SUDDEN UNKNOWN, WHOM FAME HAS ABANDONED. IT IS A LAND BEYOND TIME... BEYOND SPACE... BEYOND THE FIFTH DIMENSION...
©1986 Russ Peterson
THE FIFTH DIMENSION— WHATEVER HAPPENED TO THEM?
THEY'RE IN CELL BLOCK #9 —LISTEN!
UP UP AND AWAY— YAY! IN MY SP
AND THERE'S HALEY MILLS, ALICE COOPER, BO DEREK, GARRET MORRIS AND...
BENJI?
...OOOOH! BOBBY SHERMAN!
WHAT IS THIS PLACE SONNY?
OBLIVION! MAN, DIDN'T YOU READ THE INTRODUCTION? IT'S LIKE THIS— ONE DAY YOU'RE ON THE COVER OF PEOPLE, YOUR OWN SITCOM, PEPSI COMMERCIALS— THEN POW! —AND HERE YOU ARE.
ARF.
...THE ONLY WAY OUT IS TO MAKE A COMEBACK. A HIT SONG, A REUNION SHOW, A GUEST SHOT ON LETTERMAN— BUT TO DO THAT YOU NEED...
AN AGENT! SWIFTY BIZARRE— AGENT TO THE STARS! LET'S TAKE LUNCH LET'S TALK TURKEY LET'S MAKE A DEAL!
YOU KIDS ARE GREAT! GREAT GREAT GREAT SOOOPAH! THE HELMET, THE ROBOT, THE POOCH, GREAT LOOK! I LOVE IT!
STAR QUALITY! I CAN SPOT IT A MILE AWAY! YOU'RE GOING STRAIGHT TO THE TOP KIDS, FRIDAY NIGHT VIDEOS, MTV, TOP 40 AM & FM— STEP UP TO THE MIKE, KID.
UH...
GREAT! TERRIFIC! FAAABULOUS! IT'S A WRAP!
ALL I SAID WAS "UH"!
JUST LEAVE THE REST TO ME, MATES.
THIS IS MICK INPUT. HE'S THE BEST PRODUCER IN THE BIZ! HE'S REALLY REALLY HOT RIGHT NOW.
ROIGHT, ROIGHT; LOOK, LUV, PRODUCTION VALUES IS WOT MAKES TODAY'S SOUND; A DRUM MACHINE HERE, BIT OF REVERB THERE... PRESTO! A NUMBER ONE 'IT.
A SINGLE, AN ALBUM A 12-INCH, EP, DANCE MIX, VIDEO AND A MAJOR U.S. TOUR
WE'LL DO IT ON ONE CONDITION...
...SONNY OPENS FOR US.
HMM...
O.....KAY, SIGN HERE.
NEXT: ON THE ROAD AGAIN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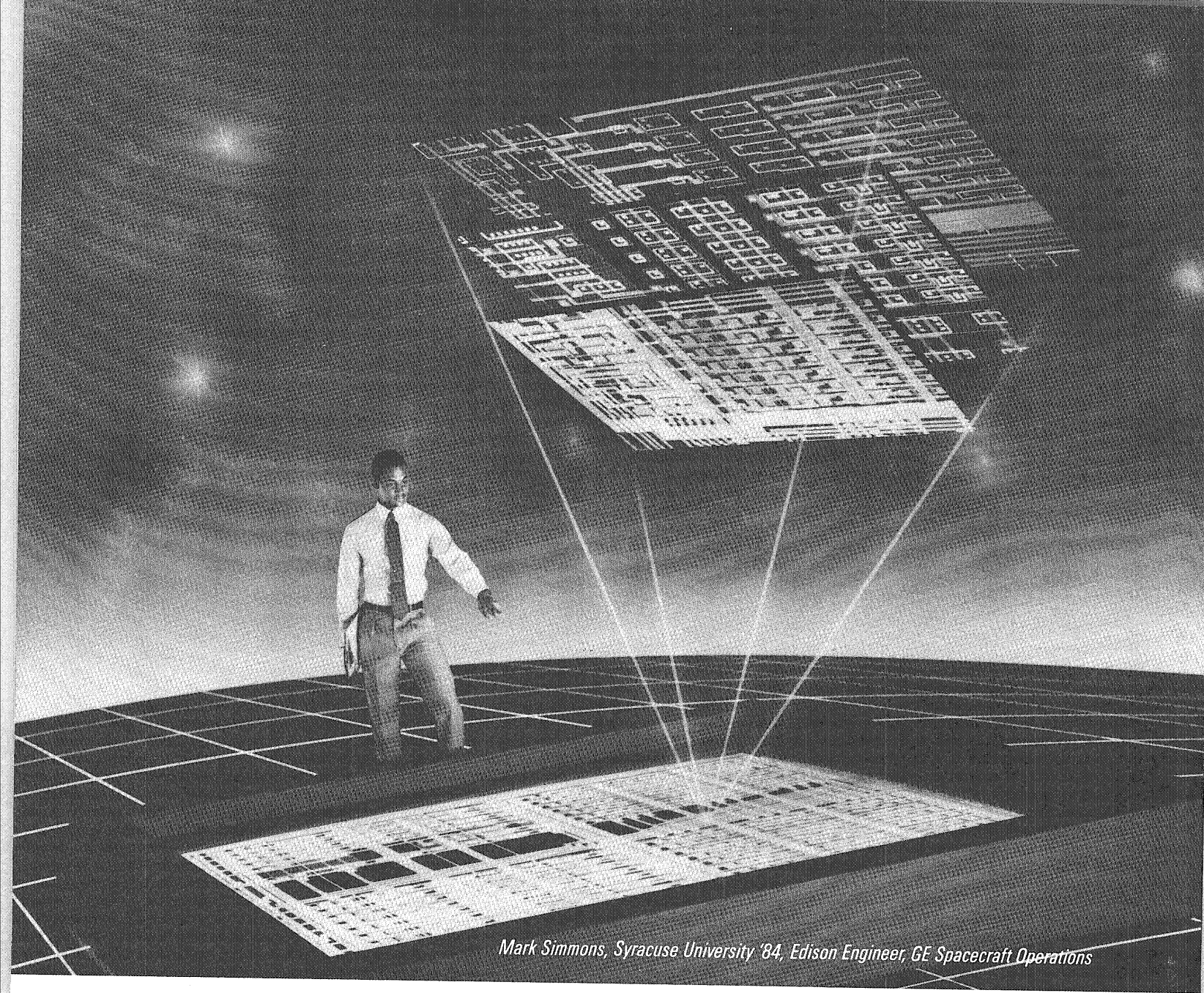

Mark Simmons, Syracuse University '84, Edison Engineer, GE Spacecraft Operations

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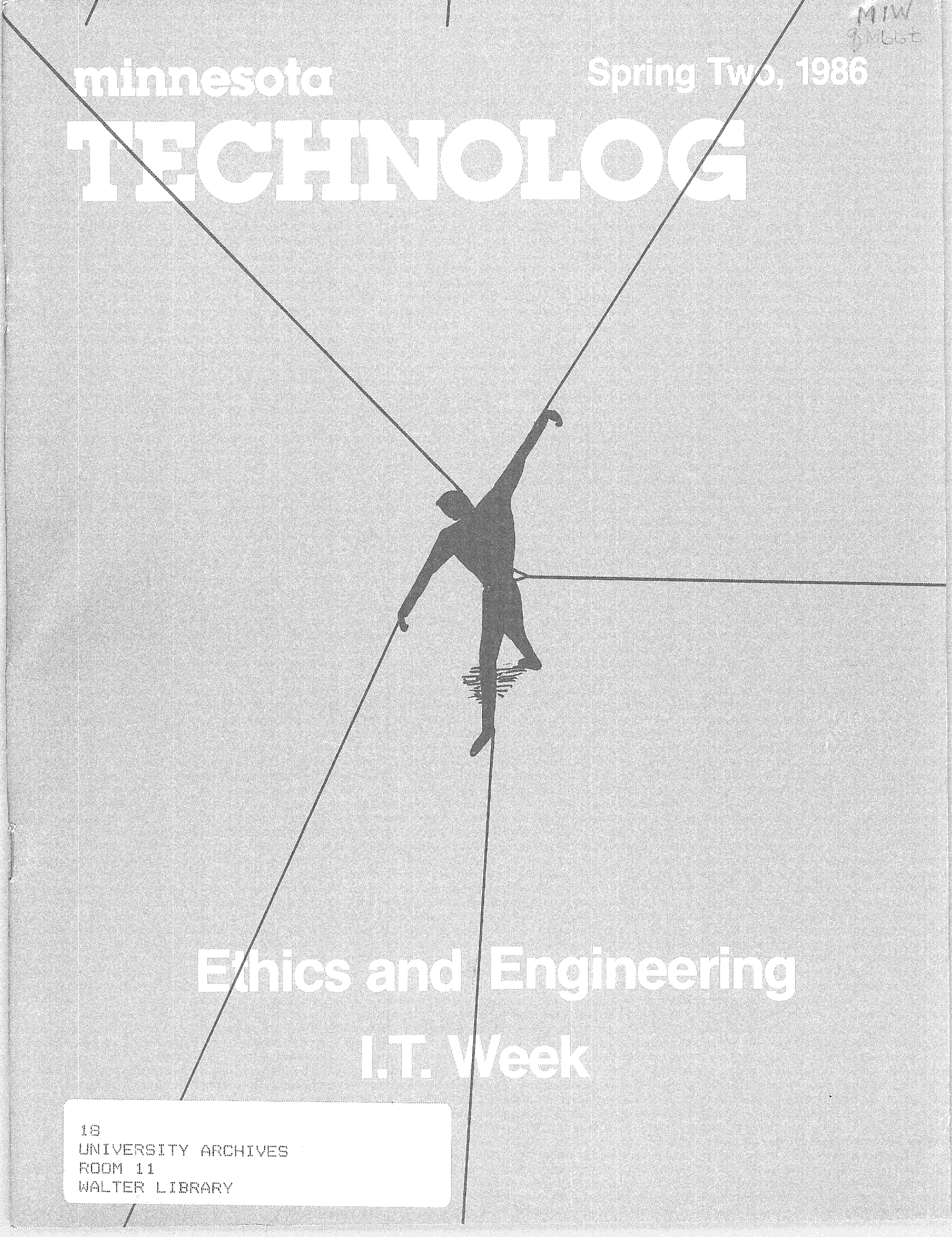

Ethics and Engineering

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Cover Art By Julie Lees

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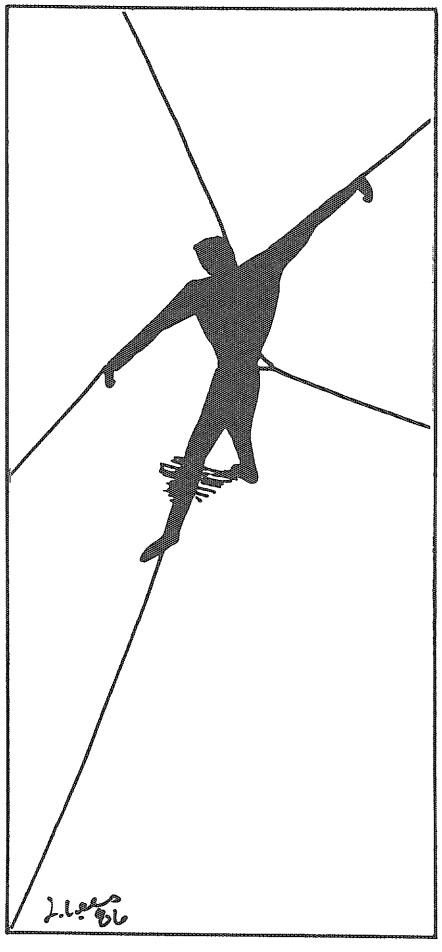
Editorial

The Art of Defensive Engineering

There have been many attempts made to create a hands-on approach to science and technology for the general public, such as, the Exploratorium in San Francisco, the Air and Space Museum in Washington, the Ontario Science Center in Toronto and the Museum of Science and Industry in Chicago, to mention but a few. These "environments" function as playgrounds for those who are not experts in the field, encouraging them to play with science in order to gain an understanding of the mechanics of particular technological applications. Through involvement, it becomes obvious that science affects and generates the basic fabric of our lifestyles. Yet, one of the greatest awarenesses that can be gleaned from such an experience often remains unnoticed: engineering is a social experiment. The designs and decisions of engineers influence the intricate relationships of our society as a whole. It comes as no surprise, therefore, that technically-oriented decisions of a seemingly harmless mathematical nature have another dimension to them: one with moral and ethical implications.



Until recent years, the study of ethics and engineering has been seriously neglected. Realizations of "ethics" and "engineering" have performed as the two struggling personalities of the schizophrenic professional. It is not clear whose ethical values should be followed and how they should be applied to particular situations. The current publicity that has focused attention on the moral responsibility of the engineer in disasters, such as the shuttle explosion, demonstrates the need to clarify the engineer's ethical obligations.

It follows that any working definition of engineering ethics will ultimately be linked with a definition of engineering. What is engineering? Let's begin with a definition from Webster's New Collegiate Dictionary. "Engineering: the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to man in structures, machines, products, systems and processes."

It is the practical work of the engineer that links this or any other theory of engineering to a social context. In the process of translating

theory into practice, a growing network of responsibilities to various individuals, groups, and companies will force the engineer to prioritize the ethical implications of his or her choices. Let's examine a very simple case. While working as an engineer for company A, you accept an offer to work for company B. After several months on the job, you discover that with some slight modifications, a procedure used at company A could be adapted to improve a process employed at company B. This would also result in a more cost efficient production of the product. As the engineer in question, what is the ethical choice to make? Should you forget the whole idea because company A's process is confidential? Or should you be loyal to your new employer and adapt the process?

It can be difficult to know what to do. When a crisis arises, we wonder how things reach such a critical point so quickly. It pays to view job activities with a critical "ethical-eye" before a decision point occurs. It is interesting to note that language itself can offer insight into the nature of a crisis. The Chinese ideagraph for "crisis" consists of the characters for (a) "danger" and (b) "chance" or "opportunity" which is also used for "machine." (Ethics in Engineering, Martin/Schinzinger)

a. 危　　b. 機

A person does not need to speak Chinese to benefit from this illustration. The characters furnish the components of the concept of a crisis. They provide ingredients to reflect upon, thereby stabilizing and structuring the idea of "crisis." You can use these or similar notions to develop a consistent viewpoint about crisis phenomenon. In this way, a disaster does not appear like a mass of indiscernable events but rather, a situation with a framework and you too have a structure from which you emerge in order to handle your involvement in any situation.

Since engineering is a social experiment, it is inevitable that risks will be taken. It is also a fact that absolute safety is not attainable. Every design has a purpose and uncertainties about materials or components and actual operating conditions will always require a "risk assessment" sort of decision. Testing is, perhaps, one scientific expression of ethical concerns. Testing not only determines if a system works but also if it is safe. Yet, not all systems or products can be tested to the point of destruction, which would be the ultimate test. So, simulations are created with hypothetical consequences. Fault-free analysis traces a possible system's failure back to the component level and represents another method of testing (of which there are many).

Ethical decisions must also submit to testing. Engineers need to follow an ethical code that is consistent from company to company. Engineers also have rights. Find out what they are and how you would articulate them within the company that you work for. If you need to take an ethical stand on an issue, how will you do it? Will you lose your job?

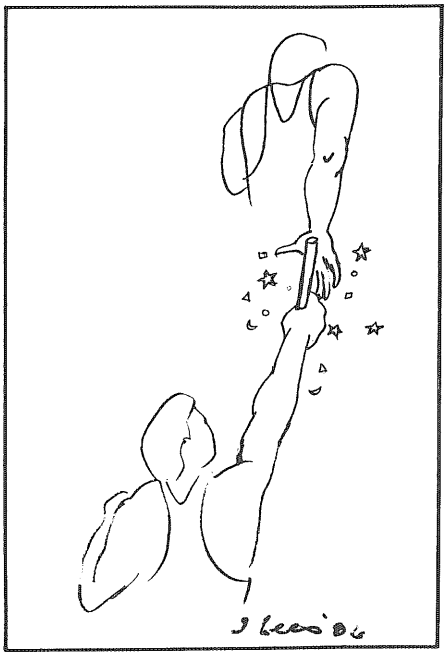
To make ethical decisions, it helps to have some exposure to the history of ethical thought. An understanding of ethics is a lifelong process that does not offer any "carry-out" solutions to problems. Educate yourself as to the kinds of ethical choices that you may face in your career. Anticipating possible points of crisis will be good training in the art of defensive engineering.★

Prestidigitation ..... Editor Magic

Actually, you can't make an editor appear or disappear with slight of hand. Yet, there is a sort of "editor magic" that continues from year to year in the *Minnesota Technolog.* The arrival and departure of an editor describes a path—a direction that maps an interval of time in the evolution of the magazine.

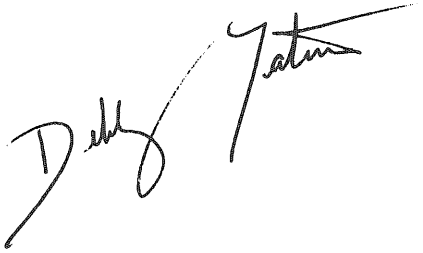
As this is my last editorial as the editor of the *Minnesota Technolog,* I would like to thank all the writers, artists, photographers, proof readers and countless other people who have helped with this publication over the past year.

Remember, it's not too late to become a part of next year's *Minnesota Technolog* staff. Just stop by room 2, Mechanical Engineering and express your interest to get involved.



If you are graduating this year, take the *Minnesota Technolog* with you! Stop by the office and fill out a subscription form.

Next year promises to be a very exciting year for the *Minnesota Technolog!* Become a part of it!



Debby Latimer
Editor

Bulletin Board

LETTERS TO THE EDITOR

"An Open Letter From Robert Plumb On Nerds, Foresters, and Holy Stones"

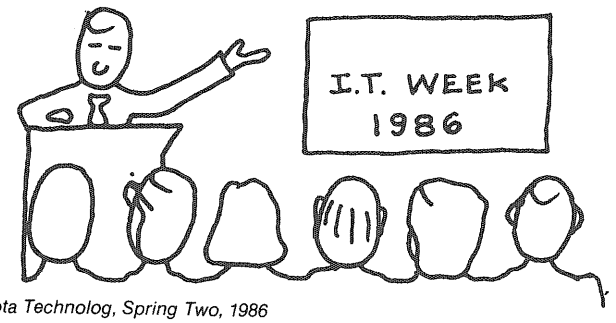
"Nerd!" It's a name often associated with engineers by those outside of the engineering (scientific) disciplines. Have you ever stopped to wonder why? Several theories have been developed to explain the origin and use of this ignoble term, but the fact remains that it is a result of jealousy. Now of course I don't mean to directly imply that all non-engineering students are in fact mental amoebas. On the contrary, I personally have met two or three non-techies that could hold a semi-intelligent conversation. They are not all as dumb as the classic forester. Nay, not even I would deign to place non-techies at such a low level.

What then, you may ask, do these people have to live for? I have often pondered that question myself, without much success. However, non-techies are often wont to claim they have prowess in athletic competition—the claim being that muscle-bodies means muscle-brains. Seeking to determine if in fact this claim is true, I have arranged a small competition to be held on Friday, May 9. In this "Nerds Against The World" olympic, teams from I.T. and from other schools will compete for the fabled Baby Blarney Trophy. The events start around 10 a.m. on Union Street and include: The Bed Race, The Trike Race, The Amoeba Race, The Blind Man's Wheelbarrow Race and The Tug-O-War. May the best group win!

Once again I find it's necessary to remind those of you who have fallen from the faith that the holy Blarney Stone only gives its faithful followers good luck and fortune. I have sent Pat the Wise to you to save the heathen and steer them on the true path to follow the stone. I also bring you great news. The beloved stone has sent to us the Baby Blarney, a stone of magic and wonder. The Holy Baby appeared to its followers form the depths of the excavation for the new Computer Science/Electrical Engineering building. they were awed and bowed down before it. Baby Blarney went to the stone temple and there helped prepare the members of Plumb Bob for the Holy magical week of stone worship—I.T. Week.

I have been told that preparations include an Opening Ceremony on Monday, a Technology Fair on Wednesday and Thursday, and all sorts of holy celebrations, competitions and fun on Friday. I am of course referring to that week of magic held on May 5th-9th, I.T. Week. Hope to see you all there. ★

Sincerely in the Stone,
Robert Plumb



EARLY REGISTRATION FOR NEXT YEAR

Beginning this year, students can register during spring quarter for the following fall. Queued registration for fall 1986 begins this May 22 and ends June 6. Open registration will extend through early July. Registration will reopen August 28 for cancel/add and late registration.

In early May, you will be receiving a Registration Status Notice showing your day and time of registration. Registration procedures will be very similar to the procedures you are accustomed to, with the following exceptions:

Because room scheduling may not be completed, the *Class Schedule* that you receive in May will list general campus locations (east bank, west bank, St. Paul), not buildings and room numbers.

If tuition and all fees have been approved and room assignments made by the beginning of registration, you will receive a complete fee statement. If, however, all tuition and fees have not been determined or room assignments have not been completed, your May fee statement will list courses and credits but not tuition or rooms. Then, during the first week of August, a *final* fee statement, showing your exact tuition and fees and the location of your classes for fall quarter, would be mailed to you. (Remember to notify the Office of Registration, Student Records, and Scheduling of any address changes to insure that you receive this document.)

Tuition (or your first installment) for fall quarter will be due around August 29. As in the past, late fees will be waived if you are waiting for financial aid.

The advantages of spring registration are numerous. The most obvious benefit, particularly if you live outside the Twin Cities area, is that you probably won't need to come to campus before fall quarter begins. You will also find it easier to meet with your adviser in May, when the academic year is still in session. You may wait until August to register if you wish, but May registration will give you the best selection of courses. If you're not absolutely sure what you want to take fall quarter, you may want to register in the spring anyway. You can always cancel/add later if necessary. If you wait until August to register, you may find many courses closed.★

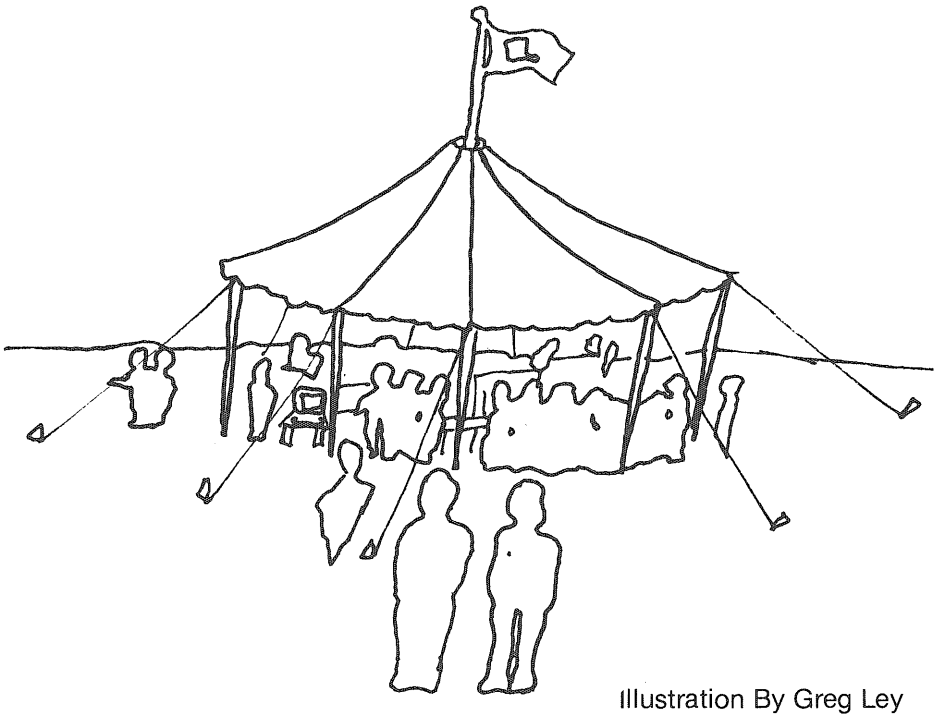


Illustration By Greg Ley

COURSE IN ETHICS AND ENGINEERING

Photo By Gary Lovelace

Professor Norman Dahl has taught Engineering and Ethics for the past three years. A faculty member of the Philosophy Department, Professor Dahl specializes in Ethics. The course, however, was developed out of a need expressed by the Institute of Technology. The business community appealed to the university stating that the graduates were excellent in their technical skills but that the students were totally unaware of the political and social conditions under which they were working. They wanted the students to have exposure to some of the ethical problems that they face as engineers.

The course touches upon many issues: an abridged history of ethical thought, case studies of ethical dilemmas, rights of the engineer and alternative sorts of action that an engineer can take within a company in regard to an ethical crisis. According to Professor Dahl, students have emerged from this class with a healthier respect for their jobs and a greater realization of what they will be getting into. Professor Dahl also acknowledges that fitting this course into the already 'overloaded' engineering curriculum is a logistics problem that has yet to be resolved.

If you have the opportunity, enroll in this class—it will be well worth the time. ★

PATENT IT YOURSELF

A patent attorney with 18 year's experience as a Patent Office Examiner, Mr. Pressman has authored what is possibly the best we have seen on this subject in 20 years. It simply crackles with information for amateur and professional alike.

In chapter after chapter, this excellent manual reveals exactly how to proceed in protecting, patenting and marketing your ideas. It also addresses the subject of trademarks, copyrights, international protection and additionally supplies all of the forms necessary for patent application at the Patent & Trademark office, Washington.

"PATENT IT YOURSELF"
by David Pressman
Nolo Self-Help Law Books
950 Parker St., Berkeley, CA 94710
U.S.A.
432 pp. $24.95

I.T. WEEK HIGHLIGHTS

Monday, May 5

Opening Ceremonies

Tuesday, May 6

Technology and Society Assessment Program (TSAP)

Wednesday, May 7

Tech Fair
Micro Computer Fair
Movie Tent
Department Tours

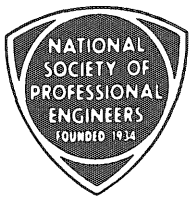
Thursday, May 8

Tech Fair
Micro Computer Fair
Movie Tent
Department Tours
Paper Airplane Contest
Textbook Stacking Contest

Friday (I.T. DAY), May 9

I.T. Olympics (Nerds Against the World)
I.T. Day Picnic
Volleyball Tournament
Forester Joke Contest
Nerd Beauty Contest
Bed Race
Calculator Toss
Death of an Auto
I.T. Recognition Banquet
I.T. Week Party

CODE OF ETHICS FOR ENGINEERS



This code serves as a general description of ethical guidelines for all engineers. How should it be applied to specifics is another question.

PREAMBLE

Engineering is an important and learned profession. The members of the profession recognize that their work has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairnes and equity, and must be dedicated to the protection of the public health, safety and welfare. In the practice of their profession, engineers must perform under a standard of professional behavior which requires adherence to the highest principles of ethical conduct on behalf of the public, clients, employers and the profession.

I. FUNDAMENTAL CANONS

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health and welfare of the public in the performance of their professional duties.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act in professional matters for each employer or client as faithful agents or trustees.
5. Avoid improper solicitation of professional employment.

II. RULES OF PRACTICE

1. Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.
   a. Engineers shall at all times recognize that their primary obligation is to protect the safety, health, property and welfare of the public. If their professional judgment is overruled under circumstances where the safety, health, property or welfare of the public are endangered, they shall notify their employer or client and such other authority as may be appropriate.
   b. Engineers shall approve only those engineering documents which are safe for public health, property and welfare in conformity with accepted standards.
   c. Engineers shall not reveal facts, data or information obtained in a professional capacity without the prior consent of the client or employer except as authorized or required by law or this Code.
   d. Engineers shall not permit the use of their name or firm name nor associate in business ventures with any person or firm which they have reason to believe is engaging in fraudulent or dishonest business or professional practices.
   e. Engineers having knowledge of any alleged violation of this Code shall cooperate with the proper authorities in furnishing such information or assistance as may be required.

2. Engineers shall perform services only in the areas of their competence.
   a. Engineers shall undertake assignments only when qualified by education or experience in the specific technical fields involved.
   b. Engineers shall not affix their signatures to any plans or documents dealing with subject matter in which they lack competence, nor to any plan or document not prepared under their direction and control.
   c. Engineers may accept an assignment outside of their fields of competence to the extent that their services are restricted to those phases of the project in which they are qualified, and to the extent that they are satisfied that all other phases of such project will be performed by registered or otherwise qualified associates, consultants, or employees, in which case they may then sign the documents for the total project.
3. Engineers shall issue public statements only in an objective and truthful manner.
   a. Engineers shall be objective and truthful in professional reports, statements or testimony. They shall include all relevant and pertinent information in such reports, statements or testimony.
   b. Engineers may express publicly a professional opinion on technical subjects only when that opinion is founded upon adequate knowledge of the facts and competence in the subject matter.
   c. Engineers shall issue no statements, criticisms or arguments on technical matters which are inspired or paid for by interested parties, unless they have prefaced their comments by explicitly identifying the interested parties on whose behalf they are speaking, and by revealing the existence of any interest the engineers may have in the matters.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees.
   a. Engineers shall disclose all known or potential conflicts of interest to their employees or clients by promptly informing them of any business association, interest, or other circumstances which could influence or appear to influcence their judgment or the quality of their services.
   b. Engineers shall not accept compensation, financial or otherwise, from more than one party for services on the same project, or for services pertaining to the same project, unless the circumstances are fully disclosed to, and agreed to, by all interested parties.
   c. Engineers shall not solicit or accept financial or other valuable consideration, directly or indirectly, from contractors, their agents, or other parties in connection with work for employers or clients for which they are responsible.
   d. Engineers in public service as members, advisors or employees of a governmental body or department shall not participate in decisions with respect to professional services solicited or provided by them or their organizations in private or public engineering practice.
   e. Engineers shall not solicit or accept a professional contract from a governmental body on which a principal or officer of their organization serves as a member.
5. Engineers shall avoid improper solicitation of professional employment.
   a. Engineers shall not falsify or permit misrepresentation of their, or their associates', academic or professional qualifications. They shall not misrepresent or exaggerate their degree of responsibility in or for the subject matter of prior assignments. Brochures or other presentations incident to the solicitation of employment shall not misrepresent pertinent facts concerning employers, employees, associates, joint venturers or past accomplishments with the intent and purpose of enhancing their qualifications and their work.
   b. Engineers shall not offer, give, solicit or receive, either directly or indirectly, any political contribution in an amount intended to influence the award of a contract by public authority, or which may be reasonably construed by the public of having the effect or intent to influence the award of a contract. They shall not offer any gift, or other valuable consideration in order to secure work. They shall not pay a commission, percentage or brokerage fee in order to secure work except to a bona fide employee or bona fide established commercial or marketing agencies retained by them.

III. PROFESSIONAL OBLIGATIONS

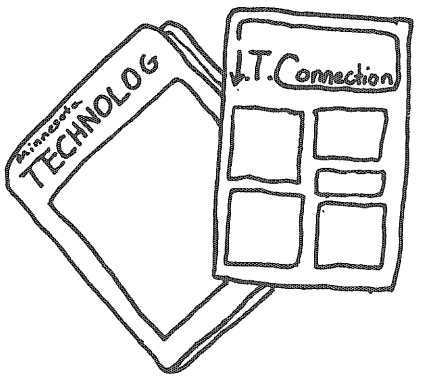
1. Engineers shall be guided in all their professional relations by the highest standards of integrity.
   a. Engineers shall admit and accept their own errors when proven wrong and refrain from distorting or alerting the facts in an attempt to justify their decision.
   b. Engineers shall advise their clients or employers when they believe a project will not be successful.
   c. Engineers shall not accept outside employment to the detriment of their regular work or interest. Before accepting any outside employment they will notify their employers.
   d. Engineers shall not attempt to attract an engineer from another employer by false or misleading pretenses.
   e. Engineers shall not actively participate in strikes, picket lines, or other collective coercive action.
   f. Engineers shall avoid any act tending to promote their own interest at the expense of the dignity and integrity of the profession.
2. Engineers shall at all times strive to serve the public interest.
   a. Engineers shall seek opportunities to be of constructive service in civic affairs and work for the advancement of the safety, health and well-being of their community.
   b. Engineers shall not complete, sign, or seal plans and/or specifications that are not of a design safe to the public health and welfare and in conformity with accepted engineering standards. If the client or employer insists on such unprofessional conduct, they shall notify the proper authorities and withdraw from further service on the project.
   c. Engineers shall endeavor to extend public knowledge and appreciation of engineering and its achievements and to protect the engineering profession from misrepresentation and misunderstanding.
3. Engineers shall avoid all conduct or practice which is likely to discredit the profession or deceive the public.
   a. Engineers shall avoid the use of statements containing a material misrepresentation of fact or omitting a material fact necessary to keep statements from being misleading; statements intended or likely to create an unjustified expectation; statements containing prediction of future success; statements containing an opinion as to the quality of the Engineers' services; or statments intended or likely to attract clients by the use of showmanship, puffery, or self-laudation, including the use of slogans, jingles, or sensational language or format.
   b. Consistent with the foregoing, Engineers may advertise for recruitment of personnel.

c. Consistent with the foregoing, Engineers may prepare articles for the lay or technical press, but such articles shall not imply credit to the author for work performed by others.

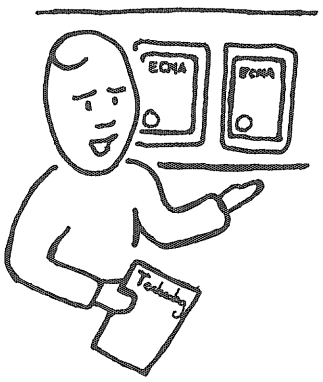
4. Engineers shall not disclose confidential information concerning the business affairs or technical processes of any present or former client or employer without his consent.
   a. Engineers in the employ of others shall not without the consent of all interested parties enter promotional efforts or negotiations for work or make arrangements for other employment as a principal or to practice in connection with a specific project for which the Engineer has gained particular and specialized knowledge.
   b. Engineers shall not, without the consent of all interested parties, participate in or represent an adversary interest in connection with a specific project or proceeding in which the Engineer has gained particular specialized knowledge on behalf of a former client or employer.
5. Engineers shall not be influenced in their professional duties by conflicting interests.
   a. Engineers shall not accept financial or other considerations, including free engineer designs, from material or equipment suppliers for specifying their product.
   b. Engineers shall not accept commissions or allowances, directly or indirectly, from contractors or other parties dealing with clients or employers of the Engineer in connection with work for which the Engineer is responsible.
6. Engineers shall uphold the principle of appropriate and adequate compensation for those engaged in engineering work.
   a. Engineers shall not accept remuneration from either an employee or employment agency for giving employment.
   b. Engineers, when employing other engineers, shall offer a salary according to professional qualifications and the recognized standards in the particular geographical area.
7. Engineers shall not compete unfairly with other engineers by attempting to obtain employment or advancement or professional engagements by taking advantage of a salaried position, by criticizing other engineers, or by other improper or questionable methods.
   a. Engineers shall not request, propose, or accept a professional commission on a contingent basis under circumstances in which their professional judgment may be compromised.
   b. Engineers in salaried positions shall accept part-time engineering work only at salaries not less than that recognized as standard in the area.
   c. Engineers shall not use equipment, supplies, laboratory, or office facilities of an employer to carry on outside private practice without consent.
8. Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputation, prospects, practice or employment of other engineers, nor indiscriminately criticize other engineers' work. Engineers who believe others are guilty of unethical or illegal practice shall present such information to the proper authority for action.
   a. Engineers in private practice shall not review the work of another engineer for the same client, except with the knowledge of such engineer, or unless the connection of such engineer with the work has been terminated.
   b. Engineers in governmental, industrial or educational employ are entitled to review and evaluate the work of other engineers when so required by their employment duties.
   c. Engineers in sales or industrial employ are entitled to make engineering comparisons of represented products with products of other suppliers.
9. Engineers shall accept personal responsibility for all professional activities.
   a. Engineers shall conform with state registration laws in the practice of engineering.
   b. Engineers shall not use association with a nonengineer, a corporation, or partnership, as a "cloak" for unethical acts, but must accept personal responsibility for all professional acts.
10. Engineers shall give credit for engineering work to those to whom credit is due, and will recognize the proprietary interest of others.
   a. Engineers shall, whenever possible, name the person or persons who may be individually responsible for designs, inventions, writings, or other accomplishments.
   b. Engineers using designs supplied by a client recognize that the designs remain the property of the client and may not be duplicated by the Engineer for others without express permission.
   c. Engineers, before undertaking work for others in connection with which the Engineer may make improvements, plans, designs, inventions, or other records which may justify copyrights or patents, should enter into a positive agreement regarding ownership.
   d. Engineers' designs, data, records, and notes referring exclusively to an employer's work are the employer's property.
11. Engineers shall cooperate in extending the effectiveness of the profession by interchanging information and experience with other engineers and students, and will endeavor to provide opportunity for the professional development and advancement of engineers under their supervision.
   a. Engineers shall encourage engineering employees' efforts to improve their education.
   b. Engineers shall encourage engineering employees to attend and present papers at professional and technical society meetings.
   c. Engineers shall urge engineering employees to become registered at the earliest possible date.
   d. Engineers shall assign a professional engineer duties of a nature to utilize full training and experience, insofar as possible, and delegate lesser functions to subprofessionals or to technicians.
   e. Engineers shall provide a prospective engineering employee with complete information on working conditions and proposed status of employment, and after employment will keep employees informed of any changes.

"By order of the United States District Court for the District of Columbia, former Section 11(c) of the NSPE Code of Ethics prohibiting competitive bidding, and all policy statements, opinions, rulings or other guidelines interpreting its scope, have been rescinded as unlawfully interfering with the legal right of engineers, protected under the antitrust laws, to provide price information to prospective clients; accordingly, nothing contained in the NSPE Code of Ethics, policy statements, opinions, rulings or other guidelines prohibits the submission of price quotations or competitive bids for engineering services at any time or in any amount."

COME TO THE OPEN HOUSE



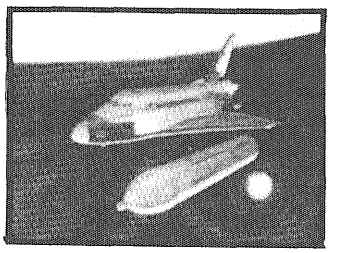
If you are interested in joining the *Minnesota Technolog* or Connection staff, participate in the open house on May 8 th, from 8:00-3:00. This will be an excellent opportunity to meet the editors and everyone else involved with the publications.

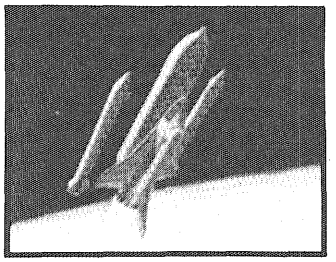


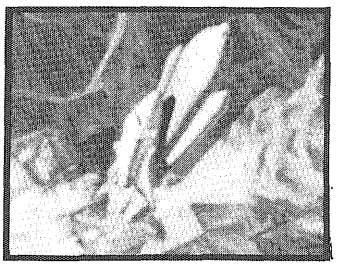
may 8

Heroes and Villains: A Report on the Shuttle Tragedy

Why did the disaster happen? Who will be held responsible? At what point did the decision to launch become an ethical one?







By Phil Decker

"With this pitch," said Charlie Brown, "I can be the hero, or I can be the goat." NASA, the Astronauts, and the myriad American corporations who have brought you the Mercury, Gemini, Apollo, and Shuttle flights have certainly had their share of heroes in the brief history of manned space flight. Except for the Apollo mission in which three astronauts perished on the launch pad, the story of Americans in space has been full of hard won and well-earned successes. As was President Kennedy's dream, we have indeed sent Americans to the moon, walked upon it, and returned them home safely. We take pride in engaging reusable spacecraft to perform scientific and commercial duties according to a schedule, albeit an adjustable one.

We have since suffered the worst space disaster in history, following the worst year in aircraft history. We lost seven American astronauts. As Dan Rather reported that night on CBS Evening News, "They came from all walks of life. Seven of America's finest. And even a man named Smith."

We are forced by our sense of morality to ask "Why did this happen? Who is responsible? How can this be prevented from ever happening again?" In this story, there are both heroes and villains. Their story is one of engineering ethics of the highest order. It is a matter of life or death in the outcome. The heroes are to be lauded because they risked their career and reputation for the cause of preserving human life. The villains are to be sought out and scorned for cowardice and subterfuge. Most of the players have been identified.

The game is still in play. Photographs of the launch found a smoking booster rocket. The press seems to have found the smoking gun.

The focus of the shuttle investigation has settled on the right solid rocket booster (SRB), designed and manufactured by Morton-Thiokol, Inc. (MTI) of Brigham City, Utah. Morton-Thiokol has years of experience in solid-fuel rockets, having built them for unmanned rocket boosters and missiles. Although other theories exist, the likeliest cause of the shuttle explosion was the failure of the O-ring seals joining sections of the booster. These rubber-like O-rings perform the job of keeping three million pounds of thrust inside the rocket so that the

nozzel can direct the exhaust in the desired direction. It usually works like that. However, in cold weather the seals contract and become brittle. That is why the Morton-Thiokol engineers specified that the rocket is safe for temperatures above 51° F.

Why, then, was the launch okayed on January 28th when the temperature at Cape Canaveral was in the mid 30's?

The Marshall Space Flight Center (MSFC) is the division of NASA in charge of the SRB program. They are located in Huntsville, Alabama. They performed extensive tests on the rockets and believed them to be safe to a temperature of 31 degrees.

After about fifty seconds into the flight, flames were seen escaping from the vicinity of the rings. This flame seems to have acted as a welding torch and severed a strut that holds the SRB a scant two feet away from the liquid-fuel booster. When the strut failed, the SRB careened into the orbiter, severed the right wing, and punctured the liquid-fuel booster. This ignited the 500,000 gallon liquid hydrogen and oxygen tank and caused the explosion. Most of the shuttle was vaporized instantly.

The launch did not take place without prior discussion.

NASA ostensibly has always held safety as their highest priority. At the Cape, any technician can press a button that would stop the launch. The manufacturers, contractors, and flight controllers must make a unanimous vote to launch, or else the flight will not take place. They realize that the shuttle was designed to work according to specifications, but that critical parts like O-rings must constantly be monitored for conditions under which they may not work.

On January 27, after already delaying the second shuttle flight of the year by one day, the engineers of Morton-Thiokol issued a recommendation not to launch, citing the O-ring problem. When Marshall heard of the note, one Marshall official called them and said, "I am appalled by your recommendation." Robert Mulloy, head of MSFC, phoned Morton-Thiokol and said, "My God, Thiokol. When do you want me to launch? In April?"

One unnamed Morton-Thiokol official was quoted as saying, "We were asked to prove that no launch should occur and the data were not black and white."

After twice refusing to recommend the launch, Vice President Joe Kilminster of Morton-Thiokol, overruled his engineers and signed a recommendation on the eve of the January 28 flight. NASA should not have even accepted it due to the wording of the text. It said, in effect, that the primary rings probably would not work, but that the secondary rings would. NASA policy is to require working primaries and back-ups of O-rings.

The presidential commission investigating the cause of the accident found out that a senior Morton-Thiokol official at the Cape had still refused to endorse the recommendation. One of the members of the commission said, "This shook us to the socks. We were unprepared for it... It changed the whole tone of the investigation."

Their story is one of engineering ethics of the highest order.

"We threw everybody out of the room," he said, "and decided we had to tell the President."

The presidential commission has been investigating the cause since the accident occurred. They have been hearing testimony from everyone who had anything to do with the decision to launch that day. With all of the arguments between Morton-Thiokol and Marshall, the top NASA officials at Cape Canaveral heard none of it. They knew that Marshall had certified the safety of the O-rings down to 31 degrees, and at launch time it was 38.

Although the evidence points to the rings that join two sections of the SRB's together, Marshall, in their testimony, is still trying to place blame on the liquid-fuel booster, which was not their responsibility. William P. Rogers, head of the presidential commission, is getting annoyed with them. "Each time representatives of Marshall testify, they put the tank as their number one suspect," said Rogers. "Ostensibly, it seems as if the joint seems to be the villain. I just don't understand."

One NASA official has aptly remarked that it is suspected that the "smoking gun is at Huntsville."

Judge for yourself. Is the Marshall Space Flight Center trying to hide something?

One hero stands out: Allan J. McDonald. McDonald has been a Morton-Thiokol engineer for twenty-six years. He lobbied for eight hours trying to get Marshall to delay the flight. He argued with Lawrence Mulloy, head of Marshall. He only stopped when he was overruled by his vice president, Mr. Kilminster.

Engineers must follow a code of ethics. They must respond to both their personal morality and the law. Very often, there are gray areas in engineering that almost every professional engineering society has endeavored to codify. They are not perfect formulae to follow—only a lighter shade of gray. But armed with a sense of civic responsibility, personal morality, and respect for the engineering profession, engineers can help correct technological problems before technology becomes a danger to the public.

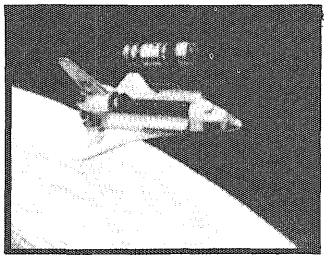
Many instances have occurred where an engineer has risked his or her job, career, and reputation to avert potential catastrophe. All too often, the engineer is heard too late. The highest awards given by professional societies are given to those engineers.

Is the Marshall Space Flight Center trying to hide something?

A model Code of Ethics has been presented by Stephen H. Unger, author of *Controlling Technology: Ethics and the Responsible Engineer.* This code is a generalization of the codes from many professional societies, primarily from the Institute of Electrical and Electronics Engineers (IEEE). If it had been followed by NASA engineers at Marshall, the shuttle *Challenger* and its seven crew members would be with us today. Here is the first part of it:

"Preamble:

In the pursuit of their professions, engineers and scien-

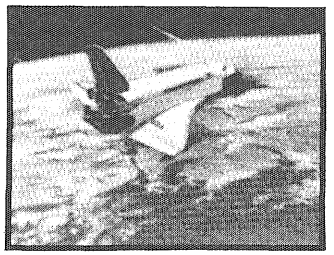


tists should use their skills and knowledge to enhance the quality of life for all and should conduct themselves in an honorable and ethical manner so as to merit confidence and respect. This code is a guide to the balanced discharge of their responsibilities to society, to their employers and clients, to their co-workers and subordinates, to their professional colleagues, and to themselves.

Article 1. Engineers shall regard their responsibility to society as paramount and shall:

1.1 Inform themselves and others, as appropriate, of the consequences, direct and indirect, immediate and remote, of projects they are involved in

1.2 Endeavor to direct their professional skills toward conscientiously chosen ends they deem, on balance, to be of positive

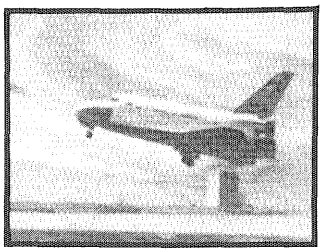


value to humanity; declining to use those skills for purposes they consider, on balance, to conflict with their moral values

1.3 Hold paramount the safety, health, and welfare of the public, speaking out against abuses of the public interest that they may encounter in the course of professional activities in whatever manner is best calculated to lead to a remedy

1.4 Help inform the public about technological developments, the alternatives they make feasible, and possible associated problems

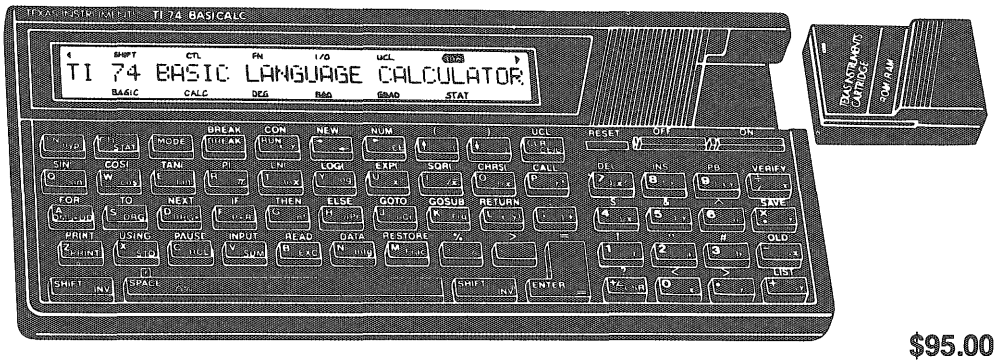
1.5 Be encouraged to contribute professional advice to worthy causes."



When the books and movies come out about the shuttle disaster, there will be heroes and there will be villains. McDonald will be one of the heroes.

Photos courtesy of the Space Division of Rockwell International

TI-74 CALCULATOR



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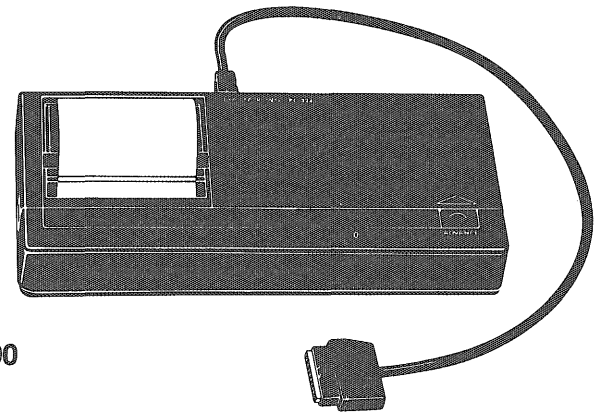

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Available at: Minnesota Book Center

Liability and the Engineer

Employer-Employee Relationships

By Lipman G. Feld

At the beginning of this century the basic responsibilities of the engineer to his or her employer were the traditional ones of obedience, loyalty, reliability, and competence in job performance. The engineer was seen as a professional, a member of an elite class with exceptional standards of integrity and conduct. He was not expected to be concerned with such things as working conditions, which were left solely to the employer's discretion. Regulatory laws were few and rudimentary. If an engineer became disenchanted with his job, the solution was simply to quit.

The situation in 1986 is not quite that simple. Although there are probably some engineers whose relationship with their employers is still based on the Protestant work ethic, for most the employer-employee relationship now differs drastically. New federal and state laws, court decisions, social and economic factors, and modifications of life goals and ideals have combined to create this new relationship.

CARELESSNESS

An engineer who is an independent contractor is legally liable for careless work under various types of negligence described by the courts. For the employed engineer, however, the situation is more complicated.

Suppose, for example, a highly paid aeronautical engineer is hired to test models, prototypes, and subassemblies of production aircraft and to evaluate the effects of stresses imposed during actual or simulated flight conditions. As a result of the engineer's bad judgment or lack of skill the employer suffers financial loss.

Or a transmission engineer is assigned to submit data on a proposed route to obtain necessary easements for a high-voltage power line. However, he carelessly assembles the data and his employer loses a profitable client.

The aeronautical engineer and the transmission engineer are both likely to be fired because of their carelessness. But the employer may have trouble getting any compensation. He can, of course, file suit for the financial loss sustained, but companies seldom do so: even if negligence can be proved, most employees cannot afford to pay for the large damages that result. At the high price of legal counsel, the costs to the company of bringing a suit might well be greater than any possible recovery.

Even if the employer does decide to sue, he is not sure of winning. A good defense attorney can argue—in or out of court—that there was improper supervision, support, or instruction. The employee's error, he might plead, lay with his supervisor, whose laxness

caused the employed engineer to misunderstand the standard operating procedures required for his job. Rather than defend against such difficult charges, the employer's best recourse if often to write up the story in his personnel files and forget it.

In fact, the employer would be wise to help his former employee get a new job. The reason? To prevent a rise in his unemployment insurance rates, which could result if too many of his ex-employees are out of work collecting state unemployment benefits.

The employee, of course, will always have the problem of explaining why he left his former job. In return for some type of restitution, the ex-employer will often agree to soften his reasons for firing the employee when questioned by prospective employers of the engineer.

Occasionally employers do press lawsuits and get financial restitution from incompetent or careless engineers, usually by financial settlements outside of court. These employers evidently feel that the problems that a lawsuit entails—and the damage it could cause to the employee's career—are outweighed by the necessity to set an example, in order to keep carelessness from spreading in the company or in the profession.

FRAUD

What if there is fraud, misrepresentation, embezzlement, or theft? A chemical engineer prepares false quality-control records and technical reports with the intent of delaying production, and is discovered to be secretly on the payroll of a competitor. This is a case of misrepresentation. Or suppose a civil engineer, located at a faraway project, appears to have embezzled funds over which he has check-writing control.

Companies get surprisingly little sympathy in such cases. First, it is difficult to get investigative cooperation from law enforcement agencies for suspected intra-company white collar crimes. Not only are police officials often reluctant to investigate such crimes because of what they see as more pressing business, but also, as they will often frankly inform management, they fear countersuits for defamation. In some instances the attorney for the local police will even tell the investigating police detective to go slow or halt the investigation in order to avoid personal legal liability.

INDUSTRIAL MISCONDUCT

Misconduct lies halfway between inefficiency and actual industrial crime. The employed engineer's legal liability is greater for misconduct than it is for negligence, but misconduct won't land an engineer in jail unless it involves malicious or willful destruction of property.

What constitutes industrial misconduct? An analytical chemist is given detailed written instructions to investigate the use of certain instruments for a new product test procedure. However, he decides that management really doesn't know what it needs and goes on a research frolic of his own to prove management's stupidity. This diversion causes an expensive delay in production.

The chemist has committed industrial misconduct. He will probably be discharged, in which case he cannot collect the unemployment insurance that he could collect had he been discharged for inefficiency. He can also be sued for damages resulting from his misconduct, but the obstacles facing an employer pressing such a civil suit are similar to those described earlier in carelessness suits.

DISCRIMINATION

Another aspect of misconduct involves discrimination, an issue that has received increasing attention during the past few years. Suppose an electrical engineer, despite repeated warnings, deliberately refuses to take applications for employment in his section from well-educated women engineers. This would be industrial misconduct. Employers are forbidden to indulge in discriminatory practices based upon age, sex, race, color, national origin, or religion. Discharge or mistreatment of employees related to such grounds can result in costly litigation for the employer.

Minority groups protected under federal law include blacks, Spanish-surnamed, and Asians, and the list is growing. A suit by a Jewish man based on anti-Semitic discrimination has been allowed against General Motors. If Jews can be protected against discriminatory employers (such cases often involve the refusal to work on Saturday, the Jewish sabbath), the same protection must apply to Italians, Greeks, and Central Europeans.

Companies are consequently becoming very cautious about their dealings with minorities. One company told the *Wall Street Journal* recently that it was tired of spending thousands of dollars preparing, defending, and losing discrimination cases and had told its middle managers, "If you don't comply with the law and promote women and minorities, you'll be fired."

Some white males are taking action against this "reverse discrimination" and have filed complaints with the Federal Equal Employment Opportunity Commission. James B. Webber, a director of Cambridge Research Institute, pointing out the peril to the white engineer, related that a divisional manager of one company he had studied advised his top engineer to go elsewhere because he didn't have a place for him.

The employer's control over his employee is restricted in other ways as well. For example, federal law prohibits firing an employed engineer who is garnisheed one or more times for the same indebtedness.

PRIVACY

An employed engineer cannot be subjected by his employer to unwarranted and undesired publicity. For example, the employer cannot post a notice on a bulletin board that the employee doesn't pay his debts. Whether the statement is true or not is immaterial—it is an invasion of privacy in any case. The courts, not bulletin boards, are the last recourse for collecting debts. However, it is all right for management to advertise in a newspaper that a certain engineer is no longer an officer or employee and that the plant is not responsible for contracts he makes after he has left.

Ordinarily, the employer has the right to photograph an employee without his consent if the purpose is

to increase the efficiency of plant operation or to promote industrial safety. However, he is prohibited from doing so if the photographs affect the engineer's health, welfare, or domestic situation. In one case, Dow Chemical Company was prevented from using a photograph (taken without consent) of a Louisiana man's deep and unsightly wound, which had been caused by an industrial accident. The photograph of the gaping hole in the unconscious man's thigh was intended to shock factory workers into following safety precautions. An injured employee must allow management to take photographs of his body for valid legal or medical reasons; in this case, however, the company was found to have invaded its employee's privacy.

If an employed engineer sues his employer for any reason, he may be questioned in detail on anything relevant to the incident giving rise to his claim. There is no invasion of privacy in this case, regardless of the distress or embarrassment involved.

WHISTLE BLOWING

How far can the employed engineer go in taking action against his employer? Can he move beyond the protection of his own interests, in cases where he is given express protection against discrimination by federal or state laws? Yes, but at some peril.

Several years ago a Fisher Body inspector turned over information to Ralph Nader on defective welding of Chevrolet bodies, even though his bosses had told him to "forget it." The worker did not lose his job, because he was protected by a strong union. However, had an engineer made the same type of protest, top management could have fired him without delay. Retaliation through litigation would have been unlikely—what engineer has the money to take on General Motors in court?

However, responsible whistle blowing—the right of the employee to inform upon his company on matters considered harmful to the public interest—may be the trend of the future. In fact, if a company is guilty of a criminal act, the employee involved can conceivably be punished for *not* speaking out. An engineer who is an officer of his company could be charged criminally and also face suits for huge civil damages from victims of the act, or by the federal government under securities laws for failure to disclose facts that are misleading to stockholders or investors.

For instance, suppose the press reports that an oil company has leased certain tremendously productive and valuable mineral rights. The result is a big jump for the oil company's stock on the New York Stock Exchange. It turns out that the company's public relations officer has been too imaginative and that the mineral rights are not as significant as he says. The engineering vice president who possesses the true facts but keeps his mouth shut can find himself in deep trouble for failure to disclose the facts to the stockholders, the board of directors, and the public.

Employees who report a violation of the Occupational Safety and Health Act by their employer are specifically protected from retaliation under that act. However, responsible whistle blowing is still a risky venture when the socially conscious engineer acts adversely to his management's interests. The employer can retaliate in more subtle ways against the employee who turned the company in, such as finding other "unrelated" grounds for firing him.

As a result, the employer must often resort to private investigators to build a case. In a case like the chemical engineer's, the employer could sue both the former employee and the competitor for ordinary and punitive damages (that is, he sues to recover his losses and seeks an extra amount of money as "punishment"). Again, because of the expenses of a suit, these matters are often settled out of court.

In the embezzlement case, if the employee does not sign a confession and agree to make restitution, the investigative services of the employer's bonding company may be brought into play. A bad record with a bonding company becomes a blight on an engineer's future. If the embezzlement is proved, the company will often require the employed engineer to sign a promissory note which he cannot disavow even if he goes into bankruptcy. If the case goes to court in a criminal action, such restitution is sometimes considered in mitigating punishment.

If he is brought to court, the employee can retaliate by suing for defamation of character. But such court battles can hardly help an engineer's career, win or lose.★

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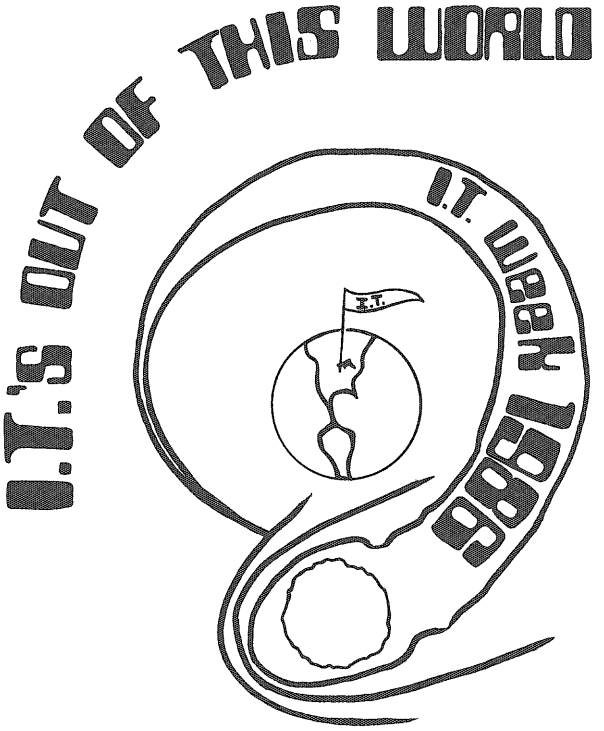
I.T. TECHNOLOGY FAIR



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What Would You Do?

Discover how you would react to situations where engineering ethics is applied to environmental problems.

Case Number One

By Herbert Popper and Roy V. Hughson

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You are the division manager of Sellwell Co.—a firm that has developed an inexpensive chemical specialty that you hope will find a huge market as a household product. You want to package this product in 1-gal. and ½-gal. sizes. A number of container materials would appear to be practical—glass, aluminum, treated paper, steel, and various types of plastic. A young engineer whom you hired recently and assigned to the packaging department has done a container-disposal study that shows that the disposal cost for 1-gal. containers can vary by a factor of three—depending on the weight of the container, whether it can be recycled, whether it is easy to incinerate, whether it has good landfill characteristics, etc.

Your company's marketing expert believes that the container material with the highest consumer appeal is the one that happens to present the biggest disposal problem and cost to communities. He estimates that the sales potential would be at least 10% less if the easiest-to-dispose-of, salvageable, container were used, because this container would be somewhat less distinctive and attractive.

Assuming that the actual costs of the containers were about the same, to what extent would you let the disposal problem influence your choice? Would you:

A. Choose the container strictly on its marketing appeal, on the premise that disposal is the community's problem, not yours (and also that some communities may not be ready to use the recycling approach yet, regardless of which container-material you select).

B. Choose the easiest-to-dispose of container, and either accept the sales penalty, or try to overcome it by stressing the "good citizenship" angle (even though the marketing department is skeptical about whether this will work).

C. Take the middle road, by accepting a 5% sales penalty to come up with a container that is midway on the disposability scale.

Case 1a:

Do you think the young engineer who made the container-disposal study (but who is not a marketing expert) has any moral obligation to make strong recommendations as to which container to use?

A. Yes. He should spare no effort in campaigning for what he believes to be socially desirable.

B. No. He should merely point out the disposal-cost differential, and not try to inject himself into decisions that also involve marketing considerations about which he may be naive. ★

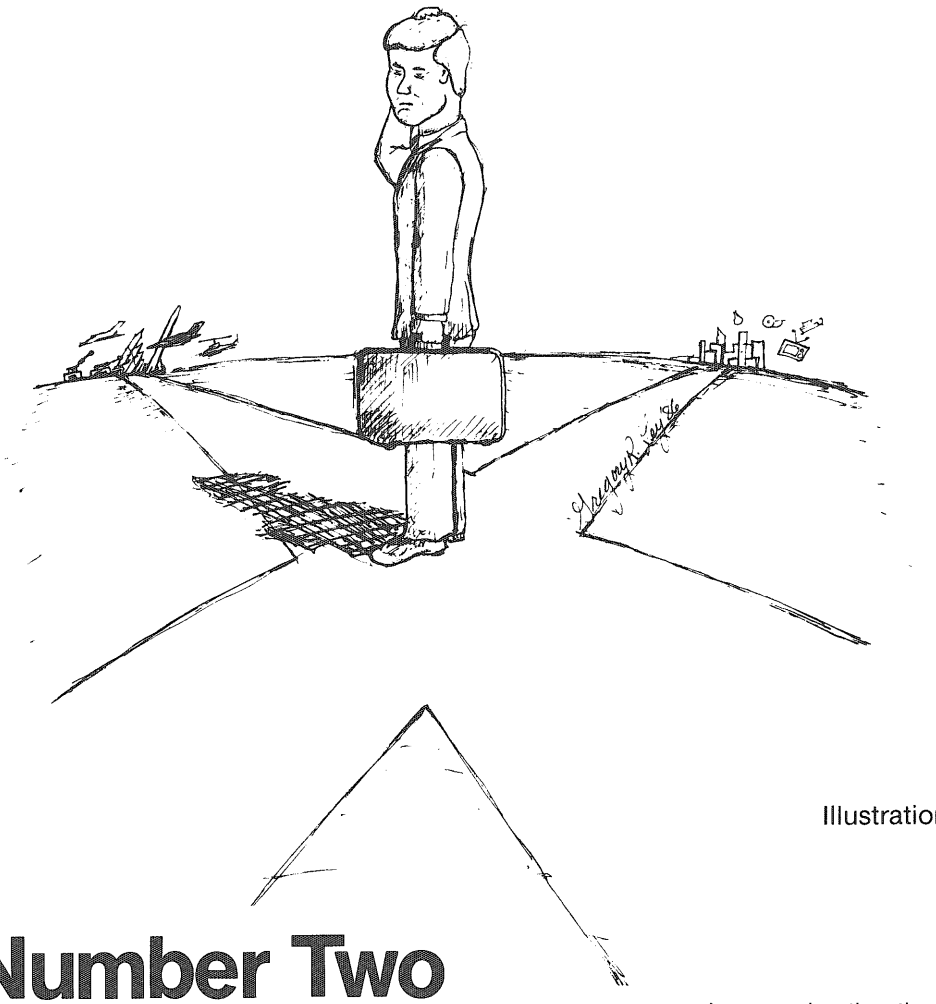


Illustration by Greg Ley

Case Number Two

Stan Smith, a young engineer with two years of experience, has been hired to assist a senior engineer in the evaluation of air and water pollution problems at a large plant—one that is considering a major expansion that would involve a new product. Local civic groups and labor unions favor this expansion, but conservation groups are opposed to it.

Smith's specific assignment is to evaluate control techniques for the effluents in accordance with state and federal standards. He concludes that the expanded plant will be able to meet these standards. However, he is not completely happy, because the aerial discharge will include an unusual byproduct whose effects are not well known, and whose control is not considered by state and federal officials in the setting of standards.

In doing further research, he comes across a study that tends to connect respiratory diseases with this type of emission in one of the few instances where such an emission took place over an extended time period. An area downwind of the responsible plant experienced a 15% increase in respiratory diseases. The study also tends to confirm that the pollutant is difficult to control by any known means.

When Smith reports these new findings to his engineering supervisor, he is told that by now the expansion project is well along, the equipment has been purchased, and it would be very expensive and embarrassing for the company to suddenly halt or change its plans.

Furthermore, the supervisor points out that the respiratory-disease study involved a different part of the country and, hence, different climatic conditions, and also that apparently only transitory diseases were increased, rather than really serious ones. This increase might have been caused by some unique combination of contaminants, rather than just the one in question, and might not have occurred at all if the other contaminants had been controlled as closely as they will be in the new facility.

If Smith still feels that there is a reasonable possibility (but not necessarily certainty) that the aerial discharge would lead to an increase in some types of ailments in the downwind area, should be:

A. Go above his superior, to an officer of the company (at the risk of his previously good relationship with his superior).

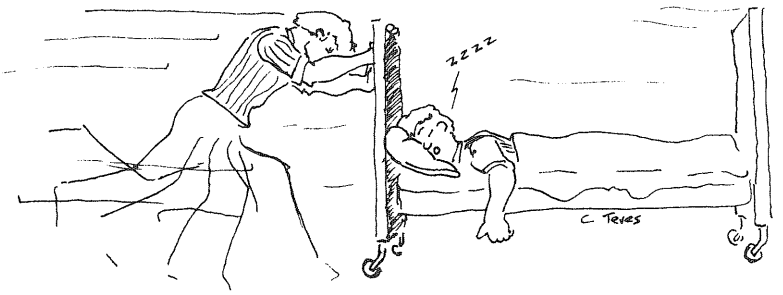
B. Take it upon himself to talk to the appropriate control officials and to pass their opinions along to his superior (which entails the same risk).

C. Talk to the conservation groups and (in confidence) give them the type of ammunition they are looking for to halt the expansion.

D. Accept his superior's reasoning (keeping a copy of pertinent correspondence so as to fix responsibility if trouble develops.).★

A History of I.T. Week

Have you ever wondered just how all the I.T. Week traditions got started?



By Members of Plumb Bob

Seventy-two years ago, when the spring celebration officially came to the University of Minnesota as E-Day, the engineering laboratories were open for all to see just what engineers did. Soon after, national and local industrial groups joined in on the displays and brought examples of fluorescent lighting, controversial transport aircraft, and demonstrations of mining equipment to the campus.

Early accounts cite both Minnesota and Missouri as the birthplace of this student engineers' celebration. Minnesota began with excavation for the foundation of an engineering annex in 1903. It was there that the legendary Blarney Stone was uncovered. This was not an ordinary stone, but one carrying a mysterious inscription in ancient script, "Erin Go Braugh," with a glowing green color.

On the evening of March 16, 1903, University of Minnesota engineering seniors, who had discovered the stone, revealed the meaning of its hieroglyphics: "St. Patrick was an engineer." Thus St. Patrick's Day, March 17, was made a holiday celebrating engineer's Irish ancestry. And a large group of students

Saint Patrick was an engineer.

dedicated themselves to the service of their patron saint and followed a band about the city, singing Irish songs and reveling.

While those of Irish or near-Irish ancestry were extolling St. Patrick's at Minnesota, students at the University of Missouri were looking for a similar excuse top enjoy the spring weather. Their elaborate celebrations soon spread to other schools, particularly to Iowa State University where they were enjoyed by a student named George C. Priester who came to Minnesota in 1910 as a postgraduate.

Priester passed on the tradition to engineering students here who initiated a major event in 1914 establishing E-Day at the University of Minnesota.

On March 17th of that year, an all-green Minnesota Daily proclaimed that 'St. Patrick was an Engineer.' Thereafter engineers would monopolize the Irish celebration and entertain the entire University. That day's jubilant events, sanctioned by University President George Vincent, included a noon parade with the University Band leading a procession of engineering students through the campus, a knighting ceremony at which Professor Priester, as "St. Patrick," conferred the title of knight of St. Patrick on the dean of the College of Engineering, its faculty, graduate students and seniors. They all then kissed the magical Blarney Stone and thereafter possessed the gift of golden tongues.

There was also a Green Tea held for all on campus in the electrical engineering laboratories and attended by William Howard Taft, who was lecturing at Minnesota. An evening engineers' ball, preceded by a vaudeville show held in the Armory, drew the largest crowd of any dance at that date. A spirit of promoting closer relations between engineers and the rest of the University's students prevailed.

This spirit has been nurtured by Plum Bob Society members who have been responsible for E-Week

A spirit of promoting closer relations between engineers and the rest of the university prevailed.

celebrations through the years as they enlarged to include more events and more than a day's time. The event soon reached into the community sector and the leaders invited high school and junior college students as well as the public on special tours of campus engineering facilities.

The fun increased, too. There were chariot races through campus, tugs of war with a fire hose awaiting the loser, greased pig contests, and other

The parade became a major extravaganza

sporting events. The parade became a major extravaganza—with numerous floats, bands and marchers. The honor of becoming "St. Patrick" passed from faculty members to prestigious students, and prizes were given to outstanding scholars and teachers as well.

The evening ball became the engineers Brawl and a Queen Coleen was crowned. The Green Tea died of its own popularity—not enough cups were available for those who attended. It was replaced by a special convocation, featuring internationally known speakers. Late afternoons were enlivened by satirical revues, starring engineering students. The Blarney Stone was very often the center of attraction. Numerous times during early celebrations the mining students, who for unknown or unpublished reasons, were not allowed in the E-Day festivities, managed to steal the stone, once to roll it into the river and later to drop it down a manhole, stopping traffic on Washington Avenue. The first time they made off with it in a wheelbarrow, a general alarm was sounded throughout the engineering buildings which rapidly emptied of students who raced to rescue their magical stone.

In 1918 the mining students once again stole the Blarney Stone and took it to a local rock crushing company where it was transformed into a stack of pebbles. Legend has it that the stone taken by the mining students was a fake, and had been purposely left unguarded while the real one was carefully hidden.

In 1981 Plumb Bob members decided to change E-Week to I.T. Week so as to include in this week of festivities all students who were in I.T. This year I.T. Week will be from May 5th to May 9th, 1986. The Technology Fair and the New Micro Fair will be held on the 8th-9th of May.

An Introduction To Switching Systems

Telephone switching has been needed ever since there were more than two phones. With the millions of phones spread around the world, it is imperative that switching systems be fast and have large line capacities.

By Chuck T. Lukaszewski

As many of you know, the University is in the process of installing a new phone system. You may also be aware that the new system will be based on touch-tone dialing, rather than rotary. However, most people know little of the fascinating evolution of telephone switching technology that has made features like touch-tone dialing possible. This evolution is occuring not only at the University of Minnesota, but also in a variety of cities around the world.

Telephone switching has been needed ever since there were more than two phones. If you have just two stations, there is no need to choose who you are going to call: you can only call the other station. However, if there are three telephones, it is desirable to have some way to select which of the other two you want to ring. This is the most primitive use of a switching system. Today, with millions upon millions of telephones spread around the world, it is imperative that switching systems be fast and have large line capacities.

A switching system has a variety of responsibilities. When you pick up your phone, the switcher must recognize this and issue a dial tone. It must then record the numbers you dial or press. Compared to the next step, finding a path to the phone you want to call, those first two steps are nothing. Let's say you're calling someone in New York from here on campus. The switcher will first try to connect you directly to New York. If the direct lines are busy, it will try an indirect route, perhaps to Washington and then up to New York. If none of these routes work, the switcher will try a three or four city route to New York. Should the switching system find a path, it then has to determine if the person you're calling is using his phone, and let you know how things are going with either a busy signal or a ring tone. The switcher is in every step of the call until you hang up, at which point the switcher must free the lines it has to New York, free your line, and monitor the next call. Switching systems must be able to do this for several hundreds or thousands of calls simultaneously.

The switching system is located in a Central Office. There are several hundred of these around the country. Each Central Office (CO) in a small area like a city is connected to the other ones in that city. In every city there is a main CO which is connected to other cities the same way suburban offices are connected to it.

The simplest kind of call is one between two phones controlled by the same Central Office. For example, all campus phones are run by the same CO, so any on-campus call falls in this category. If this is the case, the

The first switching systems were human: the operator

switching mechanism need only connect two lines that are 'inside' of it. However, if the call is to a phone in another Central Office, or to another city, the process described earlier is followed. These inter-office calls are carried over what are called 'trunk lines,' which are usually thick cables with many hundreds or thousands of wires inside. With recent advances in optical technology, wire trunks are being replaced by fiber optic trunks. These are called T-1 Carriers in Central Office jargon.

Switching hasn't always been automated. The first switching systems were human: the operators. Even today the operator is an integral part of the telephone console. Each of those 'places' had a lamp, a cord, and a socket. When the lamp came on, the operator knew someone wanted to make a call. She pushed her cord into the appropriate socket and asked for the number to call. She would then have to find the corresponding socket, and plug the caller's cord into it if it wasn't busy. When later the lamp went off, the call was finished and the cord could be put back.

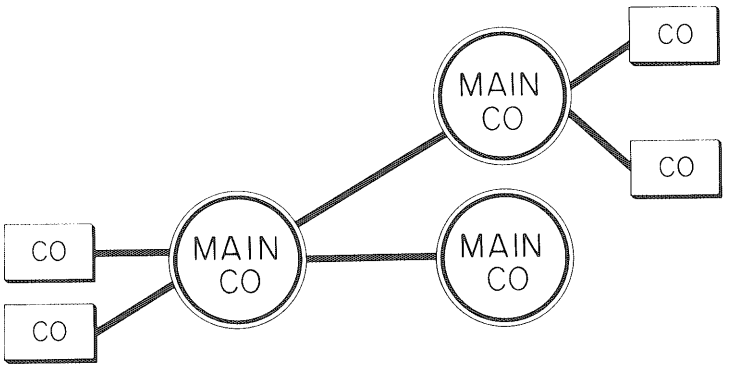


Figure 1: Each city has a variety of local Central Offices and one main Office. The main offices in each city are interconnected. When a customer dials another city, the direct route is tried first, and, if it is busy, the call is routed through different cities until an open route is found.

Illustration by Nan Gehrig

In the late 1880s, an undertaker named Almon Strowger invented a switch which could do the functions of an operator automatically. Beginning in 1918, his switch became the basis for automated switchers around the country. It was controlled by the pulses generated by a rotary dial on a customer's telephone. Each pulse moved a series of switches, called the switch train, that would ultimately connect you with your desired number. For instance, if you dialed 1234, the first digit would move a switch called the linefinder one unit vertically. The switcher moved horizontally to another open switch, this time moving two units vertically. This happened again for the third switch, the second and third switches being called selectors. The fourth switch was called the connector and when it moved four units vertically, you were connected.

The successor to the Strowger switch (also called step-by-step, for rather obvious reasons) was the Crossbar system. As the technology for making the switches became more refined and as maintenance crews became upset with the large amount of maintenance and electricity required by Strowger systems, the Crossbar passed into widespread use. The basic idea behind Crossbar is that all the trunks in a CO are joined in a criss-cross matrix. When a number is dialed, it causes a vertical and horizontal magnet to be energized, completing a connection at a single point on the matrix, where the customer line and the called line intersect. As with the description of the Strowger switch, this has been greatly oversimplified. In the Crossbar Office, an analog program was responsible for determining the path of a call through the matrix. This was a step up from the 'brute force' method of line finding used by Strowger.

Stowger Switching System

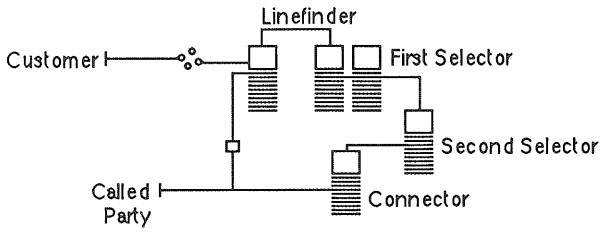


Figure 2: In the Strowger, or step-by-step CO, a call is processed by moving a switch called the Linefinder a certain number of units vertically. The second and third digits of the number move the first and second selectors vertically. The fourth and final digit moves the Final Selector vertically. This connects the parties.

Electronic Switching Systems were the next advance. Considering that the transistor was developed at Bell Labs, it seems logical that they would develop one of the major computerized telecommunications systems. The first ESS unit was tested in Morris, Illinois, in November 1960, and the first commercial ESS office went into service on May 30, 1965, in the city of Succasunna, New Jersey. By mid-1970, there were over 475 offices serving 5.6 million customers. As its name implies, the difference between Electronic Switching Systems and previous switchers is that ESS is fully electronic, using a technique called stored program logic. Incoming and outgoing calls under ESS are routed through a software program that not only handles the connection process, but also is capable of monitoring the state of the entire Central Office and diagnosing some forms of trouble. In addition, ESS is what provides features like call waiting, conference calling and call forwarding. Companies or universities can also purchase smaller ESS systems called Private Branch Exchanges (PBXs), that operate like privately-owned Central Offices.

Crossbar Switcher Crosspoints Matrix

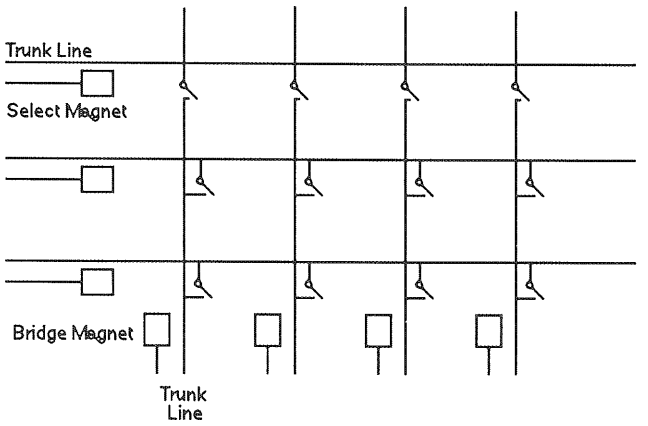


Figure 3: The Crossbar Central Office relies on a matrix of criss-crossed trunk lines to connect parties. The phone number dialed determines which column and row of the matrix to energize, thereby closing the connection. SM represents the Select Magnet; BM the Bridge Magnet.

Electronic switching systems provide features such as call waiting, conference calling and call forwarding

The Electronic Switching System is currently replacing both of its predecessors all over the world, and is itself being modified and taken to even greater heights. At the University of Minnesota, we are undergoing the inconvenience of this changeover.

The switching system currently used by the University called a Centrex Unit, which is really just a Number Five Crossbar unit. It is entirely contained at the main Northwestern Bell Central Office in downtown Minneapolis. The University uses one Centrex unit for both the 373 and 376 exchanges. Both are hardwired, meaning that the entire system is based on wire cabling and trunk lines that go downtown.

There are a number of motivations for moving to a more up-to-date switcher not the least of which is cost. As mentioned above, switches of the Strowger and Crossbar type require much more maintenance, replacement and electricity than an ESS system does. A second reason is that the Centrex Crossbar has a finite capacity, and though expansion is possible, it is again very costly. A third reason is that, with the increased amount of data transmission at the University, like with the MERITSS system, reliable data transfer is essential. The early switching systems were designed before there was data transmission, and were not designed, as ESS has been, specifically for it.

The new switching system is a private branch exchange manufactured by the InteCom Corporation of Allen, Texas. It represents a desire on the part of the University not only to catch up with switching technology, but also to move ahead of it. This is reflected in a number of features of the InteCom system. For instance, of the PBXs considered, it had the highest degree of voice and data integration. In other words, while other companies put voice and computer data on different lines, the InteCom unit can handle both on the same one. Another example of the advanced technology is that several parts of the system will be linked with fiber optic trunks, and the PBX linked to Northwestern Bell through the T-1 Carrier fiber optic trunk mentioned earlier.

The University network will be controlled by three InteCom S-80 computers using stored program logic. Each unit can handle up to 8,000 lines. Another interesting fact about these units is that they are 'nonblocking,' which means that 4,000 of those lines can talk to the other 4,000 simultaneously. This is different from the Crossbar system where there aren't enough switches to handle all of the unit's capacity at the same time. This entire network will now operate independently of the Bell System, using off-campus trunks only for off-campus calls. Installing the InteCom is more inconvenient than it might otherwise be because of its technical innovations. Wires have to be replaced with fiber optics, and new computer and switching centers have to be installed on-campus.

InteCom can handle voice and computer data on the same line.

What lies down the road in switching technology? New techniques are being developed all the time, and this process has been enhanced in the wake of the AT&T breakup. One such technique is called Common-Channel Interoffice Signalling, or CCIS, and is a method for sending voice data and switching data over two entirely different channels, thereby increasing the number of calls that could be transferred over a single trunk. The fiber optic technique will also continue to be refined. Perhaps advances in fifth-generation, or artificially intelligent computers, will yield an entirely new approach to telephone switching.

The university will not only catch up with switching technology but, aims to move ahead of it.

This introduction to telephone switching has barely scratched the surface of the technical accomplishments and physical attributes of existing systems. However, it has provided an insight into the complex and highly-evolved machinery that makes it possible to casually pick up a phone and literally call anywhere in the world, a service we take for granted.

The InteCom PBX will become operative sometime in March of 1986. Remember there's more to it than meets the eye.★

Suggested Reading

[1] Poole, Joseph: The Telephone Handbook: Sir Isaac Pitman & Sons, Ltd., 1942, pages 280-290

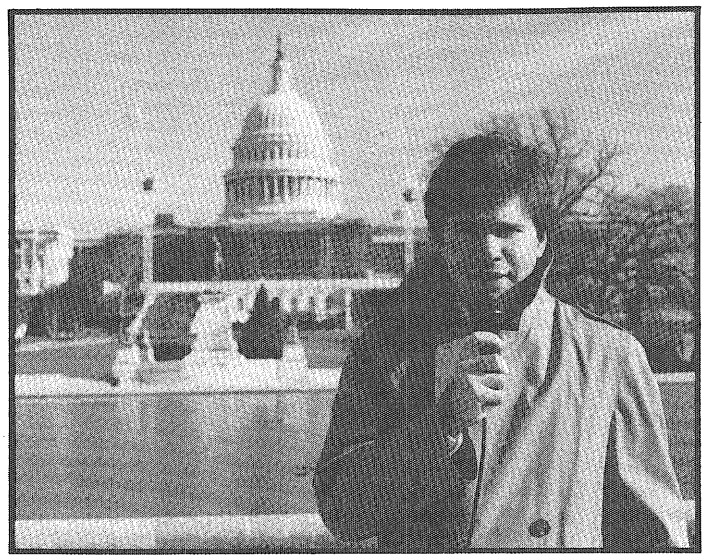
[2] Flowers, Thomas H.: Introduction to Exchange Systems: John Wiley & Sons, 1976, pages 130-132

[3] An Illustrated History of the Bells System: Bell Labs, 1978

[4] Flowers, Thomas H.: Introduction to Exchange Systems: John Wiley & Sons, 1976, pages 174-183

Alumni Profile

Scott Dacko graduated from the University of Minnesota with a Bachelor of Mechanical Engineering degree.



Scott Dacko "on vacation"

By Scott Dacko

About two years ago, I received a large manilla envelope in the mail. I was living in Oklahoma City at the time, working for a small electronics company. I was 800 miles from Minnesota, my home state, and was always excited to get mail from "way up thar." The return address of the envelope read, "University of Minnesota."

"Could this be it?" I said as I tore it open, ignoring the rest of the mail, which consisted of recently incurred bills. Yes! It was a diploma. And it read:

> "The Regents of the University of Minnesota, on recommendation of the faculty, have conferred upon Scott G. Dacko the degree of Bachelor of Mechanical Engineering, with all its privileges and obligations."

THIS was something to call home about.

As an IT graduate, I am really proud of our college. For me, it was an invaluable, irreplaceable learning experience which prepared me for a career and allowed me to grow as an individual. In this article, I will share some of my experiences—which I was recently asked to do through no actions of my own. Thus, note that any opinions expressed are those solely of the author and do not necessarily reflect those of *Technolog* or its editorial staff.

Confident of an interest in engineering but unable to decide upon a major, I initially entered it "Unclassified." That is, until Prof. John Clausen helped me decide upon mechanical engineering. If I were to name a few people who had a profound, positive impact on my career and education, he would be one of them. Roger Staehle, then dean of IT, would be another. It was he who told me as a freshman, "Be very good at what you do." So it was with this guidance and a desire to learn that I began a four-year course.

In addition to doing my best inside the classroom, I felt it was important to participate in activities outside the classroom. So, as a freshman I joined the IT Student Board, wrote for *Minnesota Technolog,* and started a newsletter, the IT Connection. I continued on these my sophomore year. As a junior, I was president of the IT Student Board. And as a senior, I started the Association for Creative Engineering—a student

Continued on page 32

Assigned Reading

Science and Crime

By Renee Bergstrom

Betrayers of the Truth, William Broad and Nicholas Wade, Simon & Schuster, Inc., pp. 256, paperback, $6.95.

Science is considered to be above cheating because of the self-policing, foundation in facts and data and the peer system. Unfortunately, this is not always the case and **Betrayers of the Truth** is a book with vivid explanations of what has been going on in science for centuries.

Broad and Wade write..

> According to the conventional wisdom, science is a strictly logical process, objectivity is the essence of the scientist's attitude to his work, and scientific claims are rigorously checked by peer scrutiny and the replication of experiments. From this self verifying system, error of all sorts is speedily and inexorably cast out.

Broad and Wade go on to point out examples where the system fails to live up to its conventional wisdom and they begin with examples of well-known scientists from history. They cite Claudius Ptolemy with borrowing the observations of a Greek astronomer and representing them as his own. Further, Ptolemy "claimed to have performed astronomical measurements which he did not." They also mention Galileo Galilei who "exaggerated the outcome of experimental results," Isaac Newton who "introduced fudge factors into his magnum opus so as to increase its apparent power of prediction," John Dalton who reported experiments that can't be repeated even now, Gregor Mendel who "published statistical results too good to be true" and Robert Millikan who didn't include unfavorable results in his published papers and yet claimed to have reported everything. The list continues.

Plagiary is a major crime in science but, very hard to detect.

With the history of fraud exposed, Broad and Wade continue on a point by point basis to criticize the conventional wisdom of the scientific community. Plagiarism is discussed and illustrated with modern examples. The authors write that plagiary is a major crime in science and yet it receives only a rap on the knuckles and is hard to detect. Also, the advancement of a career is supported and enhanced by publishing many papers. This push to publish increases the amount of plagiarism.

Previously, scientists were independently wealthy or had no monetary concerns. Science was not a vocation but an avocation. Things have changed in society because today's scientist is a careerist. This change has also changed the scientific structure. Scientists are no longer merely interested in the rewards and fame but in their career as well. About this change the authors believe that the "reward system and career structure of contemporary science are among the factors that create the inducement to fraud." Further, Broad and Wade state that crime in science is influenced by the rewards, the perceived chances of getting caught, and the personal ethics of the scientists.

Science was not a vocation but an avocation.

Broad and Wade cover other topics of fraud and the scientific communities structure. These other topics include self-deception, human factors influencing the discovery of fraud, power of the elite, immunity from scrutiny, etc.

This book takes a few steps back and looks at the scientific community from a distance. **Betrayers of the Truth** exposes the false beliefs about science and puts scientists on a realistic footing. The type is bold and easy to read, the examples are engrossing and the arguments presented are interesting. The arguments are perhaps slow to unfold, but are well worth the wait. This book is important reading for scientists and future scientists alike.★

organization promoting invention, innovation and entrepreneurship. In the organization's first year, we put on an Innovation Fair, where students competed to create marketable products with $500 in prize money acting as incentive. I'm quite happy to see the organization's current efforts expand to other colleges.

In addition to the above activities, I also tried to supplement my technical education with related work experience. As a freshman, I had the opportunity of working as an Engineer Trainee at Physical Plant on a year-long research project. After that, I worked in the Particle Technology Laboratory in the Mechanical Engineering Department as a Research Assistant and, among other projects, operated a mobile laboratory. For all of my activities in IT, something I always enjoyed was working with great people—students, administration, researchers and faculty. Dr. Ken Whitby, with whom I worked in the Particle Lab, was no exception.

Upon graduation, and completion of the work in the Lab, I accepted a position as Manager of Product Engineering with PHI Technologies, a relatively small company in Oklahoma. It was a unique opportunity—a management/ engineering position right out of college. The work environment was challenging and I learned "everything" it seemed about management. I received enormous satisfaction actively contributing to the growth of the company. But after living in Oklahoma for almost a year, I started to miss the many benefits of being in Minnesota: friends and family, an excellent educational system, a progressive state government, an abundance of cultural events, and lakes and wilderness. I wanted to be back in Minnesota. So, I interviewed with a number of companies in the Twin Cities and accepted a position with FMC Corporation in Fridley.

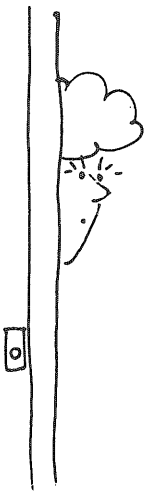
Scott Dacko is the founder of the Association for Creative Engineering.

The transition between companies was quite a change. I went from a company with 30 employees to a company with 30,000 employees. Both small and large companies have benefits that the other doesn't have, and at the present time I enjoy the many resources of the large company. After being with FMC for a year, I've had the opportunity to work on many projects in both mechanical engineering design and concept development.

And with the University nearby, I've found it very easy to continue being involved in the U community. I have a life membership in the IT alumni Society and I'm pursuing an MBA degree in the Business School's Evening MBA Program. All of these activities are fun, and I am quite happy to have returned to Minnesota. When it comes time for you to graduate from IT, I certainly hope that you consider the many benefits this area has to offer, and that you won't be too far away when it's your turn to get a large manilla envelope in the mail.

Dating Tips for Engineers

By John Krumm



1. Introduction

It's ugly but true, friends. As engineers, we are a bunch of social misfits, not to mention cultural pinheads and athletic degenerates. Despite these deficiencies, however, as spring comes on ever stronger, even the most dedicated of our ranks can become annoyed by thoughts of love, or at least intense like. It can be frustrating. Love to a technical person is like a wet deck of cards to a poker player: it's hard to deal with. You can either ignore your feelings, which is like leaving a square root in the denominator, or you can do something about them, which is what we're here to discuss today. To "do something about them" means going out on a date, and a date means actually having to have an adequate time with someone else without the aid of a textbook or calculator. This is not as bad as it sounds. Having been on one or two dates myself (well O.K., one), I know what it's like, and I know you can do it too.

What follows is a step by step guide to a tolerable first date. It is written for a male courting a female, but it applies equally to a female courting a male, or what have you. The recommendations also apply to a second date, assuming your companion is different from your first date. Should you fall into the trap of a second date with the same person, you're on your own, as very few engineers ever get this far.

1. Meeting Someone

For those of us with the social skills of an inert gas, the initial meeting is often the hardest part. For many engineers, the only time they are worthy of attention is when they use the salad fork on the entree. Experts say the best way to meet someone who likes to do what you like to do is to go out and do what you like to do. It's really not that simple, because I've tried it. One of my favorite activities is to lie in bed all day and memorize trigonometry identities. I haven't met one single (ha, ha, yes, it's a pun) person this way, and if I did, she would probably be really boring.

For those of us with the social skills of inert gas, the initial meeting is often the hardest part.

But let's give the experts the benefit of the doubt and say you end up in the proximity of someone of the appropriate gender. In fact, let's say you're a computer science major at a *Star Trek* outtakes festival, and you're seated next to a female who could win the Miss Crab Nebula contest on looks alone. You say something like, "How come when they burst from sublight speed to warp 7, no one in the crew bats an eyelash, yet they careen around the bridge like microwave popcorn when the Enterprise gets hit by the tiniest enemy projectile?" You can usually expect a response like, "Well, I don't know. You could ask my boyfriend the lifeguard and professional bass fisherman. I only came here because I thought the sign said 'Star Search,' not 'Star Trek.'" So much for the experts.

Your chances of meeting someone will be better if you go to places where people go to meet someone. This, of course, means the proverbial singles' bar. All you need are some snappy clothes and pickup lines to match. As of this writing, the *Miami Vice* look was still in, so try a pastel sport coat with a yellow tee shirt. Use

mascara to draw on some chest hairs if you don't have any. (Remember ladies, I'm writing this from a male's point of view.) In your opening line, you should show a sincere interest in the other person. Try these:

1) "Does your whole family have big noses, or just you?"
2) "I'm with you lady. Forget fashion and wear what's comfortable."
3) "Are you tense, or do you sit that way because of a wound?"

The next level of desperation is a want ad. These are the little blurbs you see near the end of *City Pages* and *The Twin Cities Reader.* You write an ad, pay about $20, and the flood of repsonses is forwarded to you through the newspaper. (Don't get the idea that I've ever stooped this low. I just happen to know how it works. Incidentally, you can usually get a better response from *The Reader,* but *City Pages* is cheaper.) You can save money on your ad by using abbreviations. Here are some of the more common abbrev.:

SWM: single white male
NS: nonsmoker
BLIP: big life insurance policy
PFOSW: personal friend of Slim Whitman
IHNDTBBAFSISTI: I have never done this before, but a friend said I should try it.

If you do place an ad, be honest. Lying about your attributes and interests will only attract the wrong kind of people. Be sure to spice up your ad with descriptive adjectives. For a typical engineer, the following might be appropriate:

> Male engineer, 21, dull, seeks female companionship. I like anti-static mats, plane potato chips and T.V. shows about sport fishing. I own my own Ronco Disco-Vac Record Care Kit that I use frequently on my extensive collection of Italian funeral dirges. My equally vivacious companion should be into cotton/poly blends, Velvetta cheese and Post-it notes. Respond to Bob (Mr. Excitement) at box 1003. Let's have a perfectly O.K. time.

2. Asking for a Date

Now that you've got a prospect chosen, it's time to bare your soul and ask her out. This is normally done over the phone. You should thoroughly practice your side of the conversation before you make the actual call. In fact, I recommend that you set up a detailed tree structure covering all possible paths of the conversation. If it turns out that she has just accidentally burned off all her hair, you might suggest a lively evening of bowling rather than the movie *the Towering Inferno.*

You should always be prepared for the worst—rejection. Be aware of the subtle signs of unwillingness lest you make a fool of yourself by being persistent. Rejection often comes in the form of nebulous replies and unlikely excuses. Should you be the victim of a rejection, be prepared with a stinging reply so you can retain a shred of dignity. I like to say something like, "Oh yea? Well I wouldn't go out with a lard-eating scum princess like you even if you were the last female on earth!" You may want to leave out the "lard-eating" part if you plan to try again later.

3. Preparing for the Date

Adequate preparation is the key to any successful event. You'll want to insure that you arrive at your date's home looking sharp and smelling nice. Be especially alert to unsightly nose hair and traces of spaghetti sauce on your mouth. If you are still unsatisfied with your looks after a thorough shower, you may want to consider major reconstructive facial surgery and a diet of muscle-building steroids. Use aftershave in moderation, as too much could ruin your companion's senses of taste and smell as well as stain someone's furniture if you begin to sweat a lot. Also, make sure you have enough cash. I usually bring along about $2,000 just in case I have to post bail or entice my date to stay out with me past 9 p.m.

Be especially alert to unsightly nose hair and traces of spaghetti sauce on your mouth.

4. The Date Itself

Your arrival at your date's door is a critical time, because this is when you will set the tone for the rest of the evening. If your date herself answers the door, above all, don't appear too aggressive or overconfident. I normally shield my face and say, "Hello, I'm your date. Should I leave forever?" I know they like this, because I receive an affirmative reply only about forty percent of the time.

If one or both of her parents answers the door, you are in for a macabre circus of unthinkable anguish. Try to be pleasant in spite of them. Say something that indicates your admiration for their daughter and your interest in their lives. You could try, "Gosh, that Sally sure has nice legs. Which one of you two taught her how to shave so good?"

Once the date starts in earnest, you can put your master plan into effect. This is, of course, to win her heart with your charm, wit, intelligence and any other desirable qualities you can pretend to have. I like to get charm out of the way first so I'm not bothered by it for the rest of the evening. I usually accomplish this by opening the passenger door for her and then adroitly whisking away the athletic socks and McDonald's bags that have accumulated on the spot where she is about to sit.

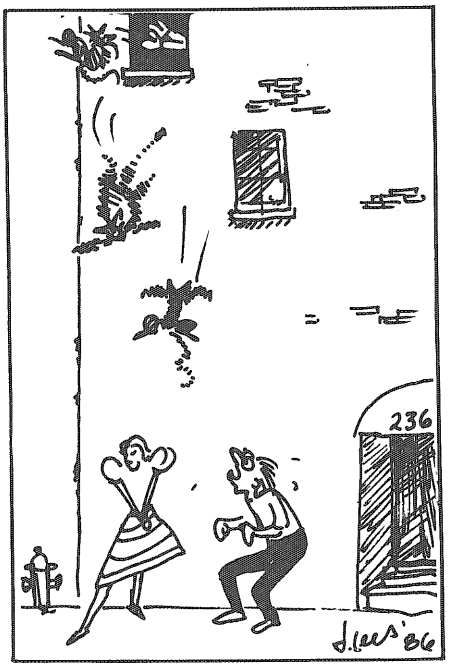
Conversation is the key to revealing your desirable inner self, so you should maintain a lively verbal exchange. Concentrate on a topic of obvious importance to both of you, that being "you." It's always good to show that you're "into" something intellectual. Pick a subject that she will know nothing about so you can say anything and still be believed. I've had success with topics like ancient Chinese banjo music and the fascinating world of hyperbolic partial differential equations.

You should, above all, remain agreeable in your conversation. There's no use starting an argument over something you were lying about in the first place. If she disagrees with a statement you've made, you should graciously acknowledge that her position is not completely indefensible. For instance:

> You: "I love kids."
> Her: "I could never get along with them."
> You: "Yes, children are a pock on the face of this nation."

No matter how much effort you put into conversation, however, you'll find

that actions speak louder than words. How many times have you wished you could impress your date by fighting off a marauding gang of punk youth or by saving a single mother and her child from a quick but painful death under the wheels of a steamroller? Take it from me, these golden opportunities just don't seem to present themselves when you need them most. There is a solution, however. You can create your own crisis situation and then skillfully deal with it because you've had time to make plans. For instance, wouldn't it be nice if you were confronted by the horror of stray cats being dropped from a ninth story apartment? Of course it would, and you can make it happen with the help of a friend and a visit to the local animal shelter. After you get a whole big bag of the furry felines, given them to a friend who lives in a ninth story apartment. When you and your date walk by on the sidewalk below, the fun begins. After a couple hit the ground, yell, "Holy cats! Someone has a whole big bag of furry felines that they're dropping from that ninth story apartment! We've got to do something!" Then you run around in stunned disbelief,



catching cats in your arms and humanely releasing them as your date begins making your wedding plans.

5. The End of the Evening

The end of the evening is another critical time. It is here where each of you will communicate your interest, or lack thereof, in seeing each other again. Once again, be prepared to take a subtle hint. If she asks you to fly with her for two weeks on a secluded island in the South Pacific, you can generally take this as a good sign. You should reciprocate with a display of mutual interest. If you think you can get away with it, try a friendly punch to her left shoulder. (Contrary to popular belief, this will not cause either of you to go blind.)

If, on the other hand, she slaps you silly and lights you on fire, it may imply that she would prefer not to see you again (unless you're into that sort of thing). If you manage to detect this attitude, you should probably invoke the "scum princess" retort to maintain some degree of dignity.

6. Conclusion

These, then, are the rules for a successful encounter with a female. It's not always easy, especially if you're not a seasoned professional like, say, me or Tom Selleck. Above all, never spend the entire evening with old radio parts dangling from inside your nose, as tempting as this may be. I've tried it, and they just don't realize that it's suppose to be funny.★

TIME MACHINE

E day 1957

TechnoTrivia

By John Krumm

Questions

1) Remember those annoying killer bees from South America? Are they still on their way or what?

2) What's the most popular kind of cookie?

3) What's the more common name for polytetrafluoroethylene? (Hint: It's the slipperiest solid known to humanity.)

4) True or false: Common AC house voltage fluctuates between approximately +/- 120 volts.

5) What is the world's most oft-consumed drug? (Hint: It doesn't rhyme with weasel.)

6) Why is it easier to ride a bike a mile than to run a mile?

7) O.K., goll darn it, you weren't paying attention, and here you are in your car at the bottom of Lake Calhoun. What do you do now? (Hint: You don't continue to "cruise chicks.")

8) In general, are women whose weight is considered medically normal satisfied with their size?

9) What's the most dangerous children's toy in terms of number of emergency room visits? (Hint: It's not the "Rambo Learns to Spell" Fun Kit.)

10) True or false: Hairballs extracted from the stomachs of cows are becoming a popular hors d'oeuvre item at many parties in the Uptown area.

Scoring

0-1 Don't insult humanity by becoming a brain donor.
2-4 Expect those pesky calls from the Nobel Prize committee to taper off.
5-7 You'll have 1.3 children and will drive a 4-door Cutlass.
8-10 You will sell wrecked 4-door Cutlasses to unsuspecting normal people.

Answers

1) Yes. Expect them as far north as South Carolina by late 1988 or early 1989. This is small potatoes compared to the ornery dung beetles rumbling in from Wisconsin next month.

2) Chocolate chip cookies are most popular, followed by oatmeal and peanut butter cookies.

3) Yes, it's Teflon. It was accidentally invented by Du Pont chemist Roy J. Plunkett in 1938 when he was trying to create a new kind of refrigerant.

4) False. 120 volts is the approximate rms voltage. The actual amplitude is about $\sqrt{2}$ 120 = 169.7 volts.

5) Caffeine. (Pertinent health note: Five to ten grams of caffeine is a fatal dose for humans. This amounts to about 200 cans of cola, so just remember this the next time you get crazy. One thing's for sure, you wouldn't die in your sleep.)

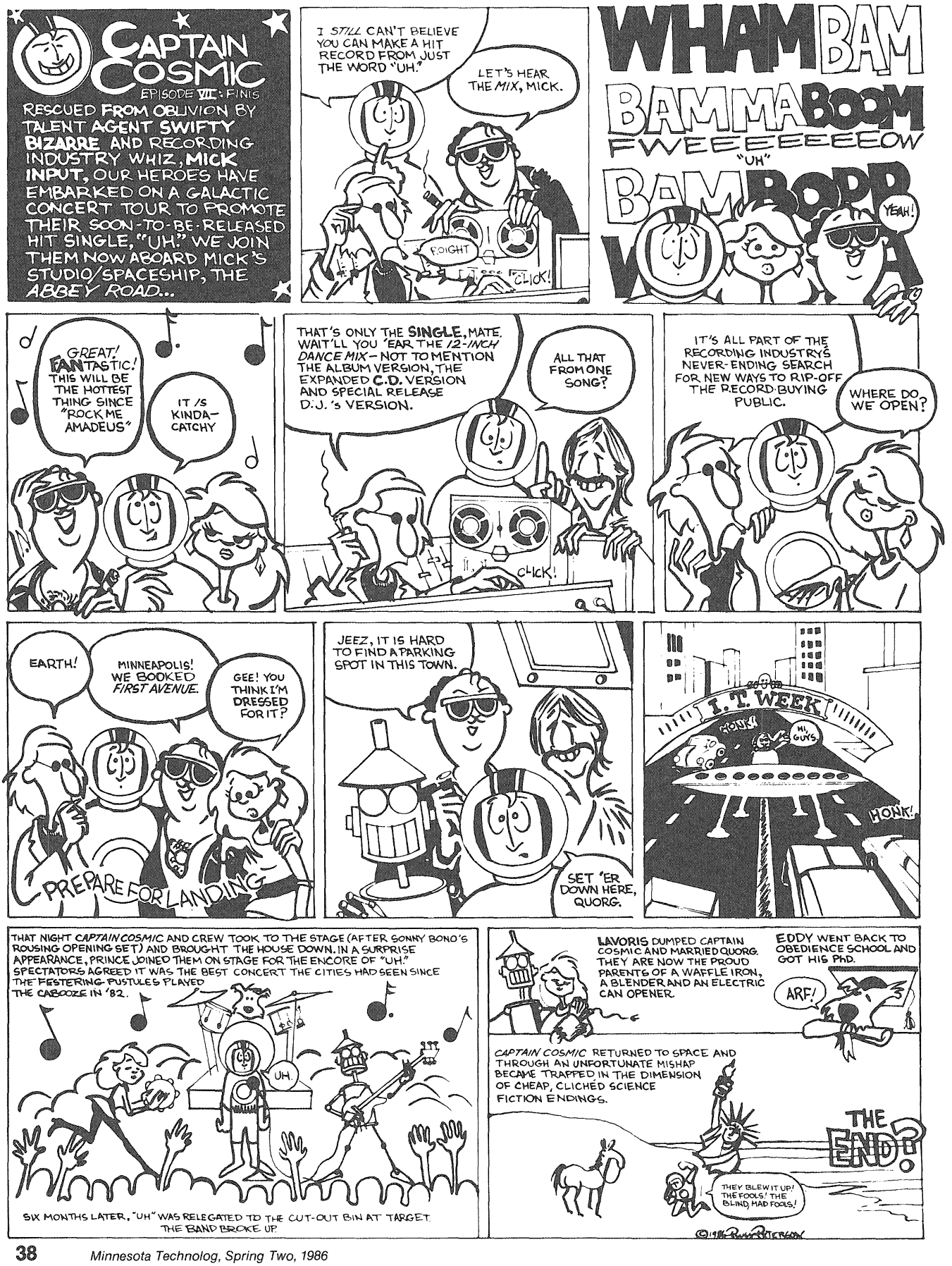
6) In riding a bike, the most significant forces to overcome are those of friction. When running, however, the body bobs up and down every step, resulting in "mgh" work of about eight times that required for riding a bike.

7) Try to escape through a window, because the water pressure will make it nearly impossible to open the doors. Be sure to set our flares to warn other unwary motorists of your plight.

8) No. When polled, 82% of normal-weight women considered themselves too fat. Most men, however, were satisfied or at least neutral about the issue (that is, their own weight).

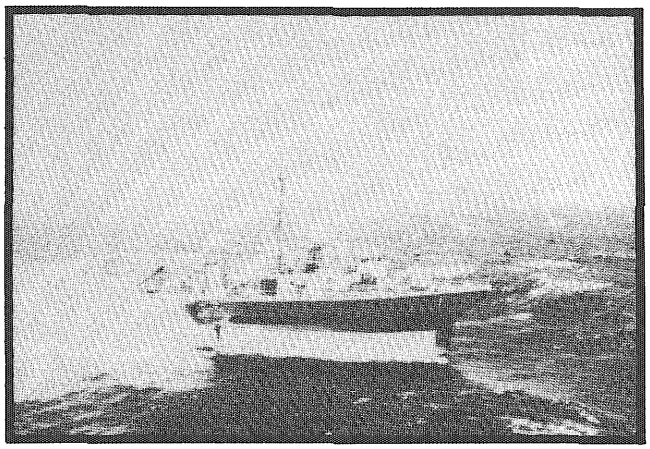
9) The bicycle. Of 588,700 toy-caused emergency room visits in 1984, 385,000 were due to bicycle accidents.

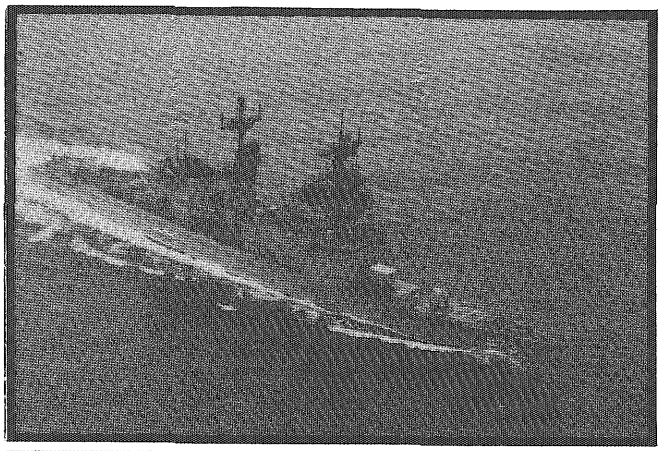
10) False. Besides being rather cumbersome to chew, hairballs are difficult to heat uniformly. There's nothing worse than biting into a delicious-looking hairball only to find that the center is still frozen.

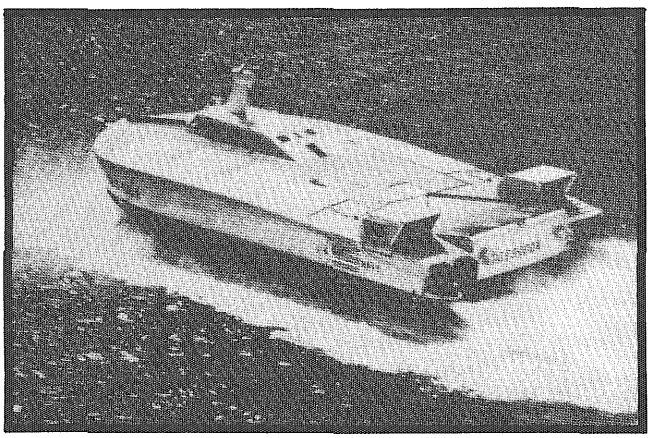

CAPTAIN COSMIC
EPISODE VII: FINIS
RESCUED FROM OBLIVION BY TALENT AGENT SWIFTY BIZARRE AND RECORDING INDUSTRY WHIZ, MICK INPUT, OUR HEROES HAVE EMBARKED ON A GALACTIC CONCERT TOUR TO PROMOTE THEIR SOON-TO-BE-RELEASED HIT SINGLE, "UH." WE JOIN THEM NOW ABOARD MICK'S STUDIO/SPACESHIP, THE ABBEY ROAD...
I STILL CAN'T BELIEVE YOU CAN MAKE A HIT RECORD FROM JUST THE WORD "UH."
LET'S HEAR THE MIX, MICK.
FOIGHT
CLICK!
WHAM BAM
BAMMA BOOM
FWEEEEEEEOW
"UH"
BAM BOPP
YEAH!
GREAT! FANTASTIC! THIS WILL BE THE HOTTEST THING SINCE "ROCK ME AMADEUS"
IT'S KINDA-CATCHY
THAT'S ONLY THE SINGLE, MATE. WAIT'LL YOU 'EAR THE 12-INCH DANCE MIX - NOT TO MENTION THE ALBUM VERSION, THE EXPANDED C.D. VERSION AND SPECIAL RELEASE D.J.'S VERSION.
ALL THAT FROM ONE SONG?
CLICK!
IT'S ALL PART OF THE RECORDING INDUSTRY'S NEVER-ENDING SEARCH FOR NEW WAYS TO RIP-OFF THE RECORD-BUYING PUBLIC.
WHERE DO WE OPEN?
EARTH!
MINNEAPOLIS! WE BOOKED FIRST AVENUE.
GEE! YOU THINK I'M DRESSED FOR IT?
PREPARE FOR LANDING
JEEZ, IT IS HARD TO FIND A PARKING SPOT IN THIS TOWN.
SET 'ER DOWN HERE, QUORG.
I.T. WEEK
HONK!
HI, GUYS.
HONK!
THAT NIGHT CAPTAIN COSMIC AND CREW TOOK TO THE STAGE (AFTER SONNY BONO'S ROUSING OPENING SET) AND BROUGHT THE HOUSE DOWN. IN A SURPRISE APPEARANCE, PRINCE JOINED THEM ON STAGE FOR THE ENCORE OF "UH." SPECTATORS AGREED IT WAS THE BEST CONCERT THE CITIES HAD SEEN SINCE THE FESTERING PUSTULES PLAYED THE CABOOZE IN '82.
UH.
SIX MONTHS LATER, "UH" WAS RELEGATED TO THE CUT-OUT BIN AT TARGET. THE BAND BROKE UP.
LAVORIS DUMPED CAPTAIN COSMIC AND MARRIED QUORG. THEY ARE NOW THE PROUD PARENTS OF A WAFFLE IRON, A BLENDER AND AN ELECTRIC CAN OPENER.
EDDY WENT BACK TO OBEDIENCE SCHOOL AND GOT HIS PhD.
ARF!
CAPTAIN COSMIC RETURNED TO SPACE AND THROUGH AN UNFORTUNATE MISHAP BECAME TRAPPED IN THE DIMENSION OF CHEAP, CLICHED SCIENCE FICTION ENDINGS.
THE END?
THEY BLEW IT UP! THE FOOLS! THE BLIND, MAD FOOLS!
©1986 Russ Peterson

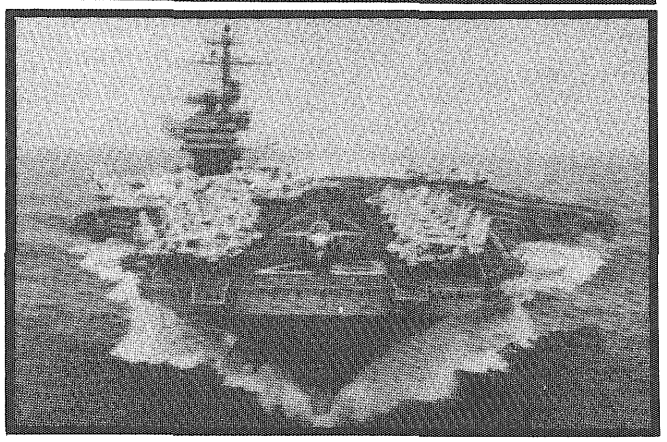
NEW NAVY ENGINEERING INTERN PROGRAM

WE CALL IT NAVY ROTC









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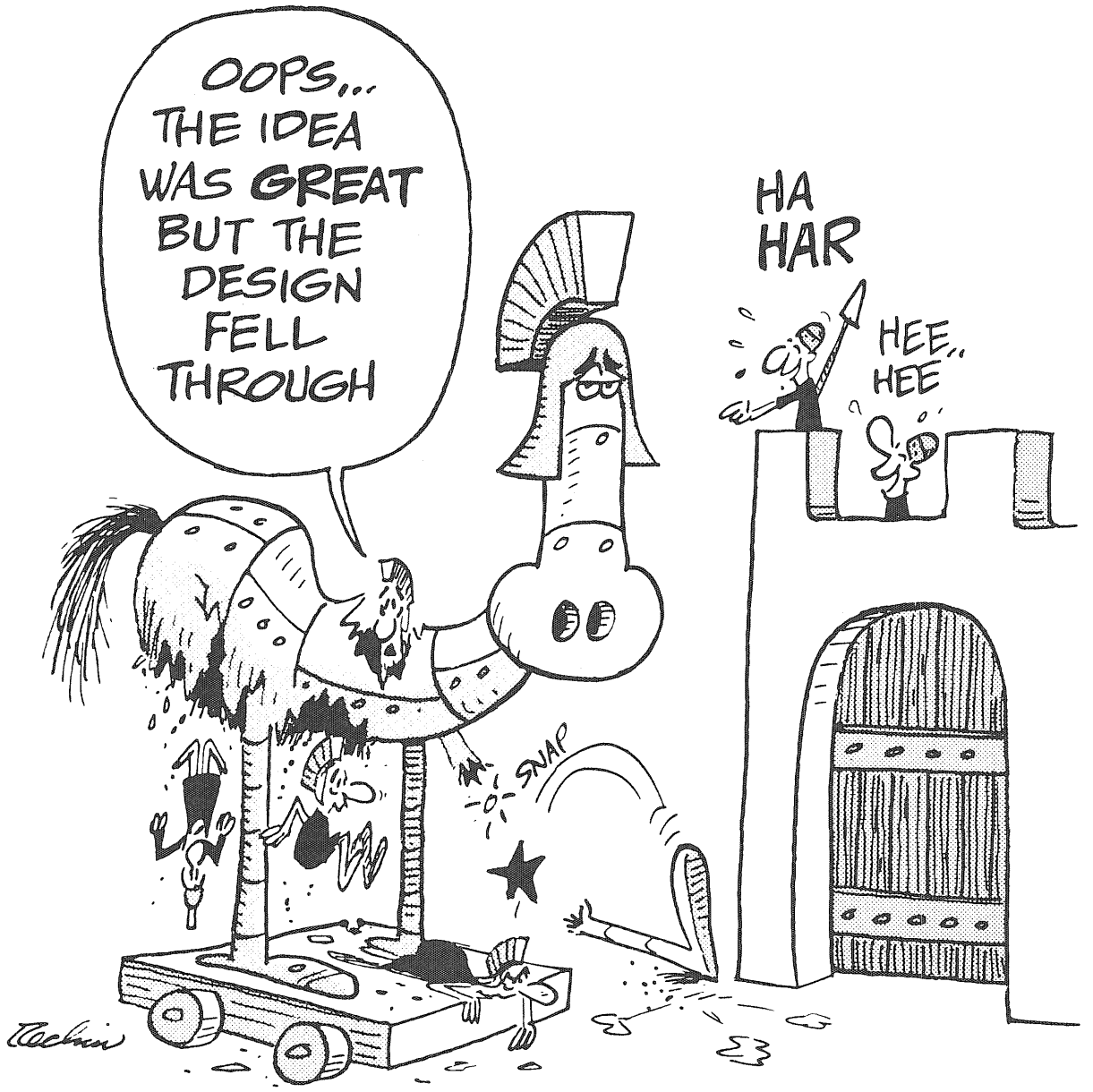

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