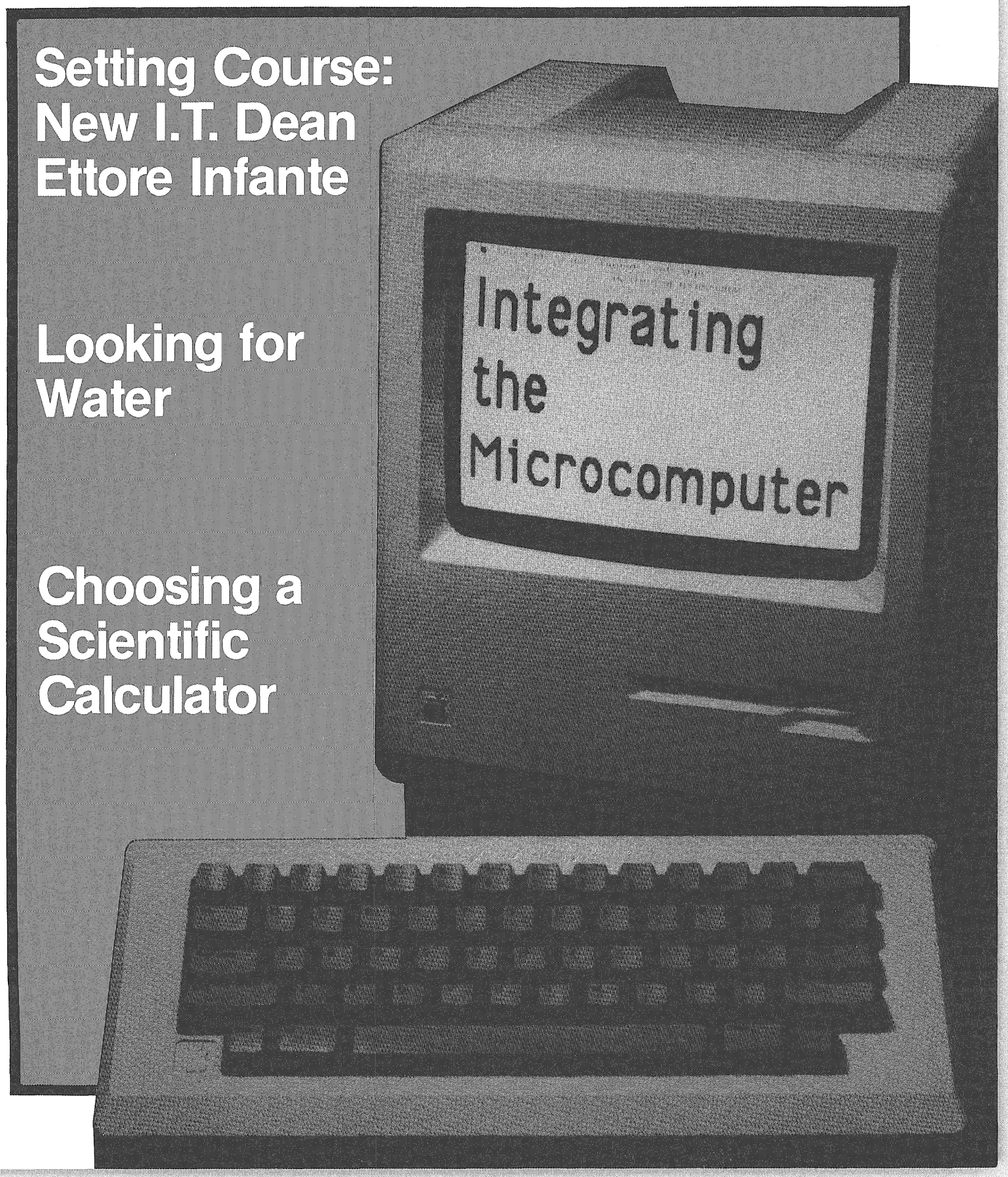
minnesota
Fall 1, 1984

TECHNOLOG

Setting Course: New I.T. Dean Ettore Infante

Looking for Water

Choosing a Scientific Calculator



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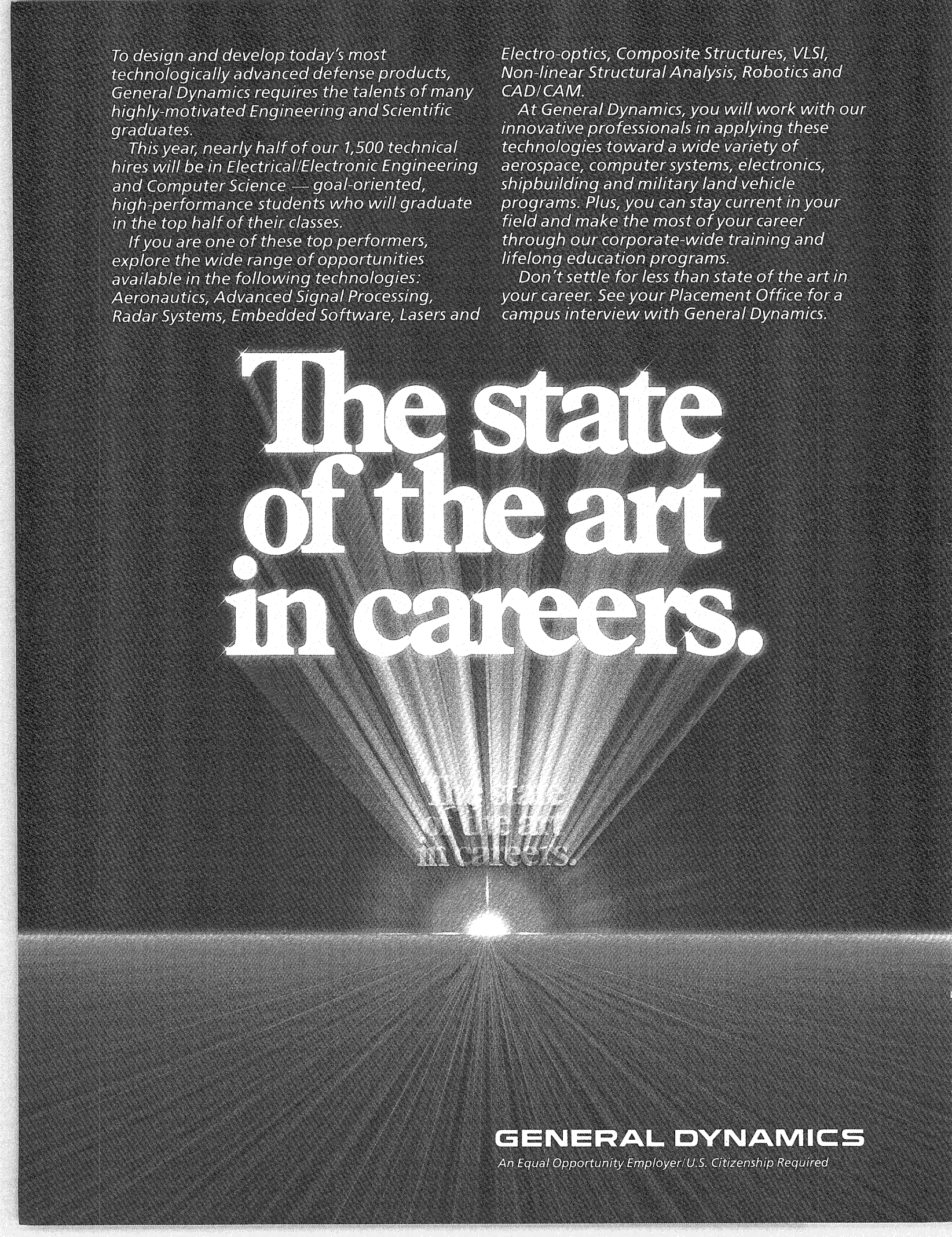

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Features:

Departments:

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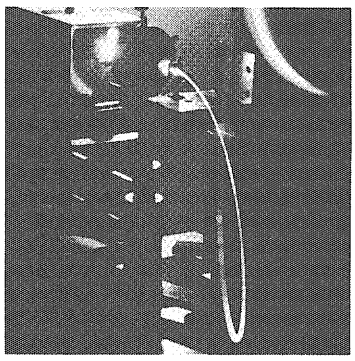

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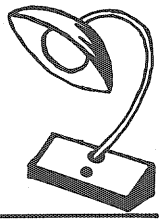


editor's log

Welcome Inside *Minnesota Technolog*

It's late September and you're back at school buying books, standing in long, hot lines, day dreaming through introductory lectures, and taking a good many more deep breaths than you were last week.

Whether you are a veteran at the University of Minnesota or a rookie walking the campus for the first time, *Minnesota Technolog* would like to welcome you to the Institute of Technology.

Minnesota Technolog is the official undergraduate publication of the Institute of Technology. You can pick it up twice each academic quarter in the halls of the engineering and science buildings. Between its covers you will find informative and objective articles about technology's accelerating leading edge and the University of Minnesota's relation to that edge. Sprinkled in, for your distraction, will be a bit of humor, a few brain teasers, and an occasional contest.

It is your magazine, and therefore your involvement is crucial. Reading *Minnesota Technolog* is the first step. However, please consider the opportunity to take another. If you enjoy writing, photography, illustrating, or just want to be active in a student organization, stop by our office in Room 2, Mechanical Engineering (373-5863).

Minnesota Technolog. Watch for it. Read it. Enjoy it.

The One Minute Student

There is a strong, driving force behind science and engineering. It makes you disassemble the odd piece of junk to reveal how it works. It motivates you to study the concepts presented in school. It prompts your questions and guides your answers. It is described by Horace Judson as "the rage to know." It is this rage that fuels the travel between problems and solutions.

When talk turns to technology, the topic is usually the flashy, final products. The Space Shuttle. The Cray-1. This year's model of the better mousetrap. While the final product can be fascinating, it often overshadows the steps taken during development. How does a student, full of a "rage to know," learn the road between problems and solutions?

Whether you are solving a calculus problem today or the world's problems tomorrow, "scientific method" is the mental process to satisfy your "rage to know." The idea is easy.

Identify the problem. It would seem impossible to reach a solution without a definition of the problem; yet, many students start working on solutions before they fully comprehend the question. Take time to carefully read and re-read the problem statement. Observers, who watched physics students solving problems at Carnegie-Mellon University, discovered those who completed a problem correctly spent three times longer reading the problem statement.

Model the system. Every introductory physics class presents the idea of the free body diagram. Some students draw the diagram as an attempt for partial credit, but the successful students draw and then use the diagrams to guide them to a solution. Translating a problem description into a model can be a difficult task. The University of Massachusetts Physics Department found seventy percent of their freshmen could not transform words into symbols (for instance, does four times as many men as there are women mean M=4W or W=4M).

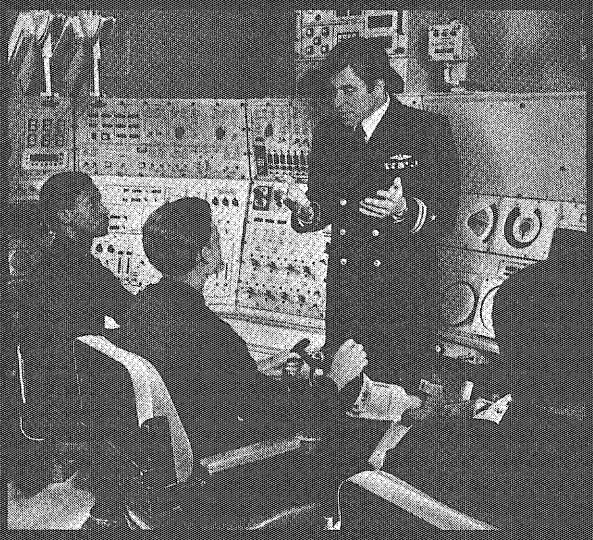
Develop a theory and test your ideas. This is the "results" portion of the process. If everything came together, you should have one answer. Is it correct? You will have to review and justify each step. Were your assumptions valid? Was your theory applicable? Look at your answer, its magnitude, its direction, its sign. This feedback may answer those questions for you.

Practice will develop and improve your problem solving skills. A study at McMaster University noted, "Students tended to solve problems by playing around with the given symbols and data until they found an equation that 'used up' all the given information." These are the students who respond, "I knew the material, but . . . ," when asked about a test. The distinction between knowledge and problem solving skills must be recognized. Solving problems is just as important as reading the chapter in preparation for a test. When the test comes back, review where you misunderstood the material and then review what you learned about problem solving.

"We live in a society in which there is a lot of talk about science, but I would say that there are not five percent of the people who are equipped by schooling, including college, to understand scientific reasoning," wrote Nobel biologist S.E. Luria. Through simple awareness, you can be one in the minority. One word of warning though, in trying to get to one answer you can easily generate five more questions.

David Herridge
Editor

Before We Put You In Charge Of The World's Most Sophisticated Nuclear Equipment, We Put You Through The World's Most Sophisticated Nuclear Training.



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I.T.'s Bulletin Board

Murthy Returns to Teaching, Research

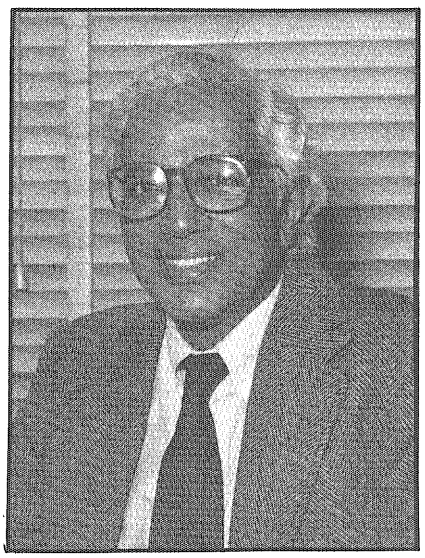
One year ago, the Institute of Technology went through an unsettling period. The opinions on I.T.'s future course were varied and well voiced. That was when Associate Dean Rama Murthy became Dean Rama Murthy. After one year, Rama Murthy reported with a thankful smile, "It is all now in a very steady mode."

Dean Murthy's title has changed again. This year, Professor Murthy will concentrate on his five year, National Science Foundation Grant to study the processes that occur in the Earth's mantle. "It is curious, I've been here nineteen years. If you call a normal professor someone who teaches and does research, I've only done that for four years." Prior to his promotion to the Dean's office, Murthy was the head of the Geology and Geophysics Department.

Reflecting on his year, Murthy noted the comprehensive plans to bring the Electrical Engineering and Computer Science Departments into national prominence. More money has been appropriated for professors and teaching assistants, and planning is underway for a new building. His biggest disappointment was the delay in finding new heads for those departments. Murthy explained, "If you want to find the right person you have to scout around . . . and that takes time."

When asked about the demands of being Dean, Murthy commented, "You should have a broad perspective, because I.T. is a very unique college in the country. We have both the basic sciences and the engineering sciences." He summed up, "this job is fairly intense."

Minnesota Technolog would like to wish Rama Murthy the best of luck.



Professor Rama Murthy

Students Invited to Education Meeting

The North-Midwest Section of the American Society for Engineering Education will hold its annual meeting at the University of Minnesota during October. The meeting will include industrial displays, creative computing exchange for software and computers, panel discussions on teaching methods, tours of the Institute of Technology (including the new CME building, UNITE facilities, and the CAD/CAM facilities), and other attractions in downtown Minneapolis.

The meeting will be held on October 15 and 16 on the Minneapolis campus. For more information, see Dr. Clausen in Rm. 23, Lind Hall. Students and faculty are invited.

Events off Campus

Engineering and Ethics

A colloquium covering engineering and ethics will be sponsored by the College of St. Thomas Physics Department in October. Case studies of four topics will be presented and discussed. For details, watch the *I.T. Connection* or call Dr. Tom Tommet at St. Thomas (647-5345).

National High Technology Week

If a Congressional Bill is approved, the first week in October will be the National High Technology Week. Watch the *I.T. Connection* for events sponsored by local companies and the Minnesota High Technology Council.

New EE/CSci Building Planned

The Electrical Engineering and Computer Science departments are moving ahead with their plans for a new building. The present EE building was built in 1923 to meet the needs of 200 students, the Computer Science department, which came into existence back in 1969, has never had a building to call home.

The idea of a new EE building is not new. In 1969, the State Legislature funded a project to determine the needs of the EE department and to develop a plan for a new building. Money for construction was to have been appropriated in 1977, but priorities within the University changed and the project was laid aside. In 1982, the University and former I.T. Dean Roger Staehle began the planning for a new building.

Hammel, Green and Abrahamson,

Continued on page **27**

Integrating the Microcomputer

By David Herridge

An engineer with a problem often turns to a computer for help. If an Institute of Technology proposal is implemented, I.T. students may soon turn to a microcomputer to solve their problems. The plan to integrate the microcomputer into the curriculum may send the pocket calculator to the same fate as the slide rule.

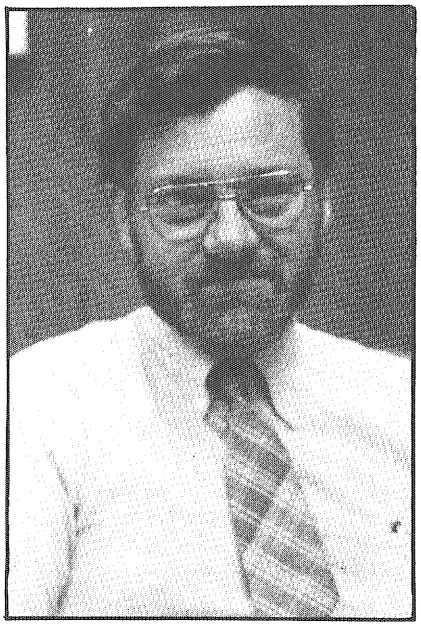
The abacus was one of the first computers. By sliding beads up and down the many rails, its user kept track of numbers. Then things began to change. Someone attached an electronic component here and a cathode ray tube there. Before long, the computer filled up a building. Along the way it evolved from a useful tool into a high-tech research project.

However, the evolution continued. The microcomputer, one recent branch in the computer's family tree, provides the computational power that once filled a room in a reliable and inexpensive package that fits on a desktop. Because schools have more desktops than just about anybody, they have welcomed the microcomputer. There are about a million general-purpose microcomputers in schools today.

Across the nation, universities and colleges are integrating the microcomputer into their curricula. Some schools offer discounts, others cluster facilities for student use, a few even require their students to purchase their own computers.

Why this trend? With one eye on industry, today's students recognize the importance of "computer literacy" and are demanding more computer time to develop their skills. To meet the increased need, educators must decide between upgrading their overcrowded timesharing systems or purchasing new supplementary systems. The microcomputer is an attractive choice for many reasons. First, bargains are available to many institutions from the major computer manufacturers, who hope students will develop brand loyalty for their products. Second, many students can buy their own systems, reducing the load on the school's facilities. Third, many micros have user interfaces which are less intimidating to students than timesharing terminals.

The Institute of Technology is riding the leading edge of this national trend. Last spring, the University Computing Center struck deals with Apple, Digital, Hewlett-Packard, IBM, and Zenith that make computers available to the University community at substantial discounts. The immediate effect of this program will be the increased sales of computers to students and faculty for



We are trying to put together a package which will essentially give all students and faculty enough access to computers so that access will not be a barrier any more.
Russell Hobbie
Associate Dean of
Undergraduate Studies

word processing and personal computing. The long range effect could be the integration of the computer into the I.T. curriculum.

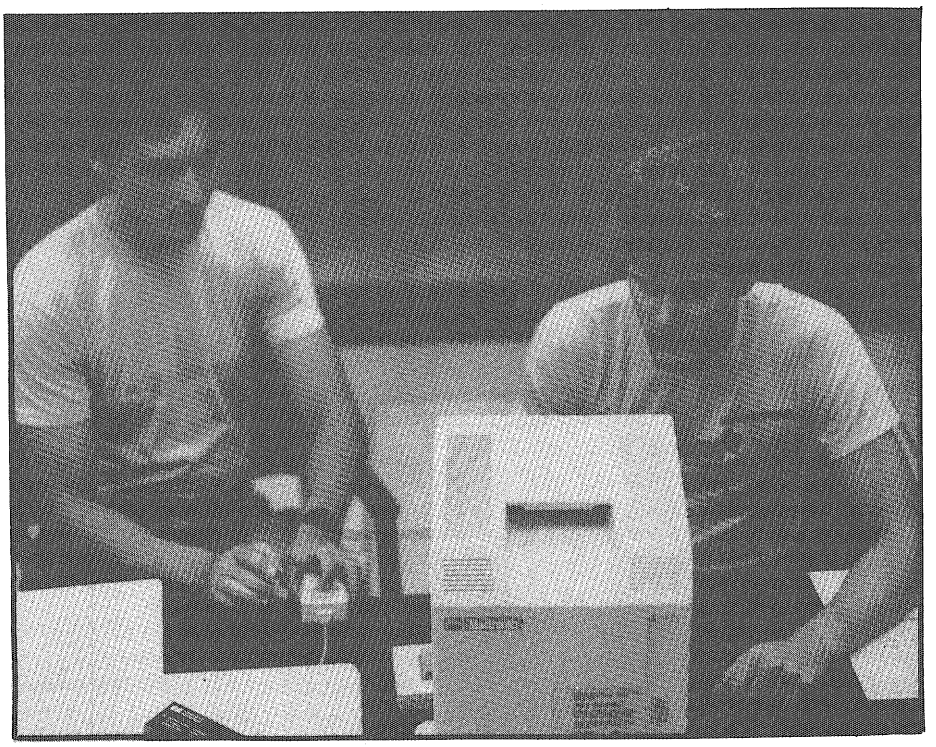
The I.T. Instructional Computing Committee (ICC) played a key role in initiating the discount program and recently proposed a plan to integrate the micro into I.T. courses. Associate Dean Russell Hobbie, who has chaired that committee since January 1, 1984, summarized their position. "We are trying to put together a package which will essentially give all students and faculty enough access to computers so that access will not be a barrier any more."

The proposal for a three year instructional computing plan was being reviewed by the Institute of Technology and the University of Minnesota when *Minnesota Technolog* went to press. The initial plan is outlined below.

The proposed hardware is divided into three categories. "Level one" machines constitute the majority of the total package. Through the discount program, many students have already purchased their own "level one" machines, like the Apple Macintosh. "Level two" machines list faster and more powerful microcomputers, like the Apple Lisa and the IBM-XT (when a high resolution graphics board is available). "Level three" boasts the best and most expensive hardware. Engineering workstations from Apollo, Sun, and HP are "level three" machines.

Delivery of 170 microcomputers is proposed for this year. Half of the shipment would go to faculty members with specific ideas for software development. The other 85 would be placed in a laboratory open to all I.T. students. Because time on these is expected to be saturated, use in courses would not be emphasized until more hardware is installed. In 1985-86, an additional 315 micros would be placed in student labs and the remaining 321 I.T. faculty would receive computers. If the initial proposal is implemented, 406 faculty machines, 250 "level one" lab machines, 140 "level two" lab machines, and 20 "level three" engineering workstations would be installed and running by the end of the 1986-87 academic year.

The largest obstacle in front of the program is funding. The proposal divides the three year, $7.8 million price tag among four groups: the Institute of Technology, the Minnesota State Legislature, local technical industries, and I.T. students.



While the rank of the instructional computing plan in I.T.'s budgetary priorities is not known, Dean Ettore Infante did recently write in a statement of priorities, "A program for the purchase and appropriate maintenance of computational equipment is required for the near future: this program will be undertaken in a cautious and conservative manner, but will require very significant investments." I.T.'s proposed investment of $800,000 for the first year is being discussed right now.

Local technical industries, who would benefit from graduates with improved computer skills, are being courted to raise the remainder of the first year's costs. It is hoped industry will contribute one million dollars over the first two years.

A special appropriation from the Minnesota State Legislature will be sought in the second year. Because the two million dollar target amount would be 44 percent of the second year's funding, the Legislature's support would be essential to purchase the volume of hardware scheduled for the second year.

The I.T. student body is the fourth source of funds outlined in the proposal. In the second year, the plan recommends that all students enrolled in I.T. courses which use computers be charged a fifty dollar per quarter access fee. Assuming the student would use the lab for 3.3 hours each week, the average charge would be $1.50 per hour. This would eventually drop to $1.28 per hour when all the proposed hardware is in place. The student fee would raise one million dollars for the program each year.

A $100 dollar fee is charged each semester to students at the University of Michigan for access to a similar program. Initially, the students objected to the surcharge. However, Dean Hobbie, who recently visited Ann Arbor with the Instructional Computing Committee, said, "They claimed within a month the opposition had vanished and the liberal arts students were asking if they could pay the $100."

The user charge would require a change in student fees policy. If you have any comments or suggestions regarding the program and the access fee, Dean Hobbie would be interested in your reaction. Student input is crucial now while the plans for the next three years are being formulated.

Across the country, different schools have taken different

approaches to blend the micro into the classroom. The Michigan visit left the impression that they had the hardware in place, but no real software. Minnesota is considering a different direction. "To buy all of the equipment right now and then wait for the software development, in my view, is a mistake because the hardware field is changing so rapidly," noted Dean Hobbie. Instead, the ICC propose to supply computers to faculty who will start developing software for courses. As the software became available, additional student workstations would be clustered in the engineering buildings.

This activity has most departments discussing their computer programs. There are many decisions left to the departments. Each must decide what role the micro will play in their computing plans. Then they have to pick the hardware to play that role. If they get this far, they still have to figure out where to put them. The proposal estimates 15,300 square feet would be needed by 1987. Because space is already a premium in I.T., many departments could expect some juggling in their space allocations. After mentioning the athletic training building being constructed near Bierman Field, physics professor Marvin Marshak joked, "Maybe the football team could lend us some room."

The Civil and Mineral Engineering Department has already made these decisions. In collaboration with IBM, they have placed computers in the hands of both professors and students to develop software. "We develop software applications in civil and mineral engineering to work on IBM machines and they provide machines," said Professor Alan Wassyng, who is the department's representative on the Instructional Computing Committee. The computer package included an IBM 4341 supermini, three IBM 9000 desktop computers, and 15 IBM PC's, each with two disk drives, a printer, and both graphics and text monitors. The 15 PC's are divided between a student lab, a demonstration lab, and a faculty lab. The department hopes to take delivery of 25 more PC's. "The idea is to put one on every faculty member's desk," added Wassyng.

To prompt development, Wassyng and his colleagues took time off from teaching students and taught programming to other professors and their accompanying graduate students. To the same end, the ICC proposal suggests a three day workshop on instructional program development be held when classes are not in session.

Yet, some faculty are still hesitant. "The most serious drawback at the moment is that any faculty member who wants to work in this area has to give up any thought of promotion," Wassyng emphasized. "You get no credit for developing programs, it does not count as a publication. The National Science Foundation does not recognize this area as a research area, yet."

"We do not want to do what others have done in computer-aided instruction (CAI)," continued Wassyng, "What we've been doing is producing packages that solve problems." Nine civil and mineral engineering software packages to run on IBM systems have been published, everything from tunnel design to an expert system for problems in soil mechanics. Most of the applications have been integrated into CE courses.

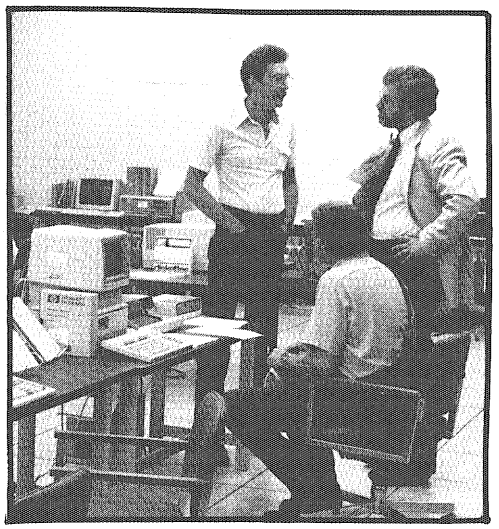
The Instructional Computer Committee supports a shift away from CAI. "One might spend 15 years developing electronic page turning and then discover a textbook is far cheaper and more aesthetic," said Dean Hobbie. The proposal lists two expected uses of the micros, homework or laboratory exercises in which students either write a program or use an existing program.
While most departments expect the integration of the micro to begin in the senior level courses, some feel the micro is best suited for the lower division. One example is Introductory Physics. "Most I.T. students do not take more than one year of physics," explained Professor Marshak, "so we must reach them in the first year."

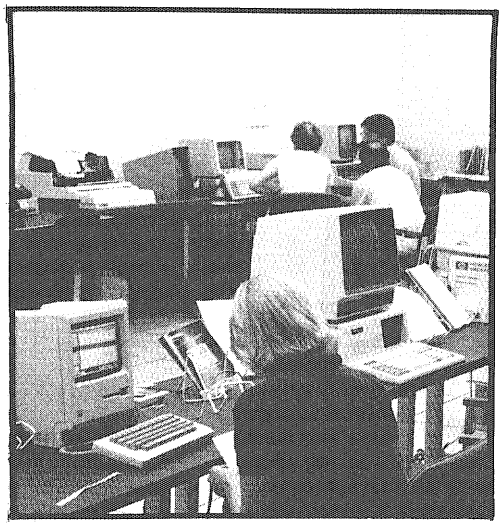
Continued on page **32**

Graduate student Wes Barris uses the Minn-Draft package on the Terak microcomputer. Minn-Draft, developed by the Mechanical Engineering Department, is for three-dimensional, computer aided drafting.

Photo David Herridge

Macro Discounts on Microcomputers





By Patrick McNamee

The Microcomputer Research Laboratory was recognized by Apple as one of the best programs in the country to assist students with computer decisions.

If you're ready to hop onto the personal computer bandwagon, the University has a deal for you. It's called the Microcomputer Discount Program, and it's a way for students, staff, faculty, and departments at the University to save 35-45% on the purchase of big-name microcomputers. The program, which was just getting started last spring, is in full swing now. Over 1,000 orders have been placed already, according to Shih-Pau Yen, Associate Director of the University Computer Center (UCC). Yen predicts that 5,000 orders will have been placed by next spring.

Initiated as a response to the growing presence of the microcomputer in our society, the discount program aims to make personal computers more accessible to the University community. The program's objective is to encourage the integration of the personal computer into our educational, research, and service activities.

To ensure that participation in the discount program is limited to the University community, eligibility requirements are strictly enforced. Only full-time students, faculty, and staff (with work-related use) may purchase through the program. The definition of full-time faculty and staff is that you work at least 75 percent of the time and are eligible for the benefits package. You are considered a full-time student if you are carrying at least 12 undergraduate credits or 8 graduate credits. Extension students are eligible if the meet the requirements of day school students and are enrolled in a degree or certificate program.

Participants must affirm that the equipment is for their sole personal use (including use by their immediate family) and that the equipment will not be sold or loaned to any non-eligible person or entity within a period of two years from the date of purchase.

The University has reached discount agreements with IBM, Apple, Zenith, Hewlett Packard, and Digital Equipment Corp. (DEC). The following machines are available through the program: IBM's PC and XT; Apple's Macintosh and Lisa 2; Zenith's Z-100, Z-150, and Z-160; DEC's Rainbow; and Hewlett Packard's HP 150 and HP 110. According to Mr. Yen, these systems were chosen for their reliability, price, and serviceability. Peripherals, software, and a variety of service contracts are also available.

If you're thinking "Great! Where do I place my order?", just hold on awhile. Buying a personal computer is not quite as simple as ordering a Big Mac. That fact is well-recognized by the people involved in the discount program, and steps have been taken to help potential buyers with the decision-making process. That process includes deciding whether or not you really need a personal computer, and, if you do, testing the various machines to decide which one will best serve your needs. The microcomputer is, after all, a tool, and any given system is better suited to some applications than others.

Questions can be asked, information can be picked up, and the computers can be tested at the Microcomputer Research Laboratory, 125 Shepherd Labs (9:30-12:00, 1:30-4:00, Monday through Friday, 376-4276). This pre-and post-sale support is an essential element of the program. The support staff is there to help you buy the right machine and get the most out of it.

The business end of the Microcomputer Discount Program is being handled through the Minnesota Bookcenter. Orders may be placed at Williamson Bookstore or at H.D. Smith Bookstore. Note that the Computer Store, formerly located in Experimental Engineering, has been moved to Williamson Bookstore.

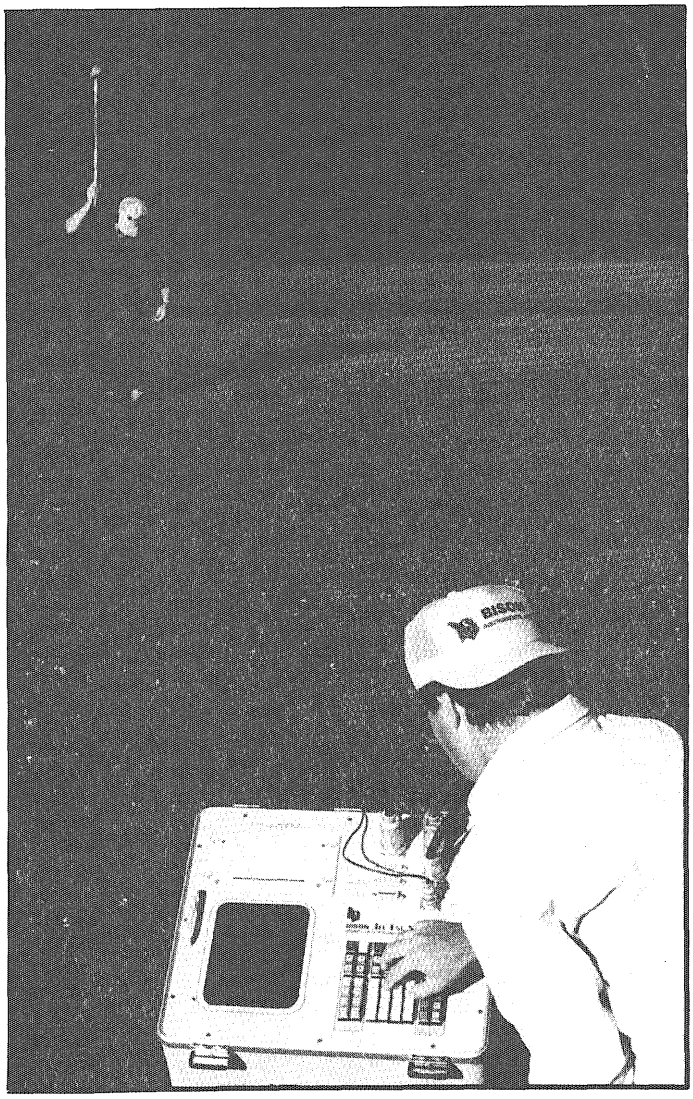
James Duffy, Director of the Minnesota Bookcenter, urges buyers to have patience after they place their orders. An inventory of computers will eventually be established, but buyers must now wait one to three months for shipments to arrive.

It should be emphasized that no student is required to purchase a microcomputer, and that integration of the microcomputer into the University curriculum will take time. Students should consider the possible improvements of the computer hardware during the one to three year span the University predicts it will take to develop educational software. But, to those of you who could make use of a personal computer and have some extra cash taking up space in a money market account, now may be the time to get a useful tool at a good price.

Looking for Water

By James Lundy

Minnesota agriculture is turning to irrigation to boost its yield. To monitor the effects on groundwater supplies, the Department of Natural Resources is investigating new seismic techniques.



From the earliest times, people have been confronted by the reality of limited supply of our most precious resources. Trapped in the desert without water, Moses was instructed by an important friend aloft to tap a stone. His belief was strong: lifegiving water gushed forth for the people to drink.

Those of us living in the twentieth century, largely lacking faith in such fortuitous connections, find ourselves relying on modern technology and effective planning to prevent disastrous overdrafts on our underground aqueous account. It may not be as flashy a solution as that of our Old Testament friends, but it is hoped to be at least as effective.

The hoping is being done at the St. Paul office of the Minnesota Department of Natural Resources (DNR) where in the past year much effort has been expended in the development of new capabilities to investigate, conserve, and monitor Minnesota's underground water resources.

According to Pat Bloomgren of the DNR, these resources are present in Minnesota in the form of groundwater aquifers, which are "formations or depositional bodies with enough water within them that they can provide a supply (of water) to a well." Three types of aquifers are present in Minnesota: 1) "surficial aquifers" are thin lenses of sand or gravel close to the surface; 2) "buried drift aquifers" are present at depths within the unconsolidated glacial deposits of an area; and 3) "bedrock aquifers" are usually sandstone, limestone or crystalline rocks with enough cracks or spaces within to allow the percolation and flow of groundwater. The study being conducted by the DNR focuses on the buried drift aquifers of Swift County in western Minnesota (see figure 1).

Though the problem of water supply is not yet a threat there, question marks dot the sky where thunderheads should be. The western part of Minnesota receives up to one-third less rain than the rest of this agriculturally-based state, making

irrigation of fields an attractive option for farmers. Once they adopt this practice, they commonly find that an acre will produce an average profit of more than $300, rather than $115 for a non-irrigated acre (1978 data). The cumulative effect has been explosive growth in irrigation, increasing at least 52 percent since 1973.

However, the groundwater supply is limited. Planning must be done to avoid depletion of the wells. Hence, the Legislative Commission on Minnesota Resources (LCMR) awarded $520,000 to the DNR for the two year study, which will attempt to learn, among other things, how fast aquifers are being depleted and recharged. Swift County was chosen because an extensive geologic data base already exists, courtesy of a recent United State Geological Survey (USGS) report. The only missing information, which the DNR hopes to produce, concerns the location, lateral extent, and geometry of the buried drift aquifers.

To this end, three types of data are being collected. Electrical resistivity, not dealt with in this article, attempts to delimit the extent of an aquifer by measuring the resistance to current flow in the surficial deposits between two electrodes. In addition, two shallow seismic techniques are being tested. These are outlined below.

Seismic studies have in the past relied heavily upon two methods for unraveling the histories of unexposed rocks and soils. Seismic refraction, a long-known and trusted technique, depends on the refraction of seismic waves incident upon a layer boundary below; seismic reflection, also long-known, but only recently applied to hydrogeologic problems, uses the reflection of these waves.

Variations of the seismic refraction technique have been employed in the mining and civil engineering fields. These applications can generally be grouped into depth determinations or velocity determinations.

Depth determinations attempt to discern the depth from the surface downwards to any denser layer beneath, usually the bedrock. For example, large parts of Minnesota are covered by tens to hundreds of meters of unconsolidated glacial deposits that rest directly upon the bedrock. A series of depth determinations could reveal the thickness of the glacial deposits in a particular area. For a successful depth determination, the layer being tested must be reasonably thick and of a higher seismic velocity than the overlying material (see figure 2).

Seismic velocity is the speed with which sound waves travel through a particular layer. Velocity varies from one material to another, the harder, denser materials (such as granite or gabbro) have higher velocities than the softer, less dense materials (such as unconsolidated sands or gravels). Consequently, seismic velocities can be used to characterize unseen layers of material. This is a particularly good way to distinguish between soil and rock, compacted soil from loose soil, soil from sand or gravel, weathered rock from unweathered rock, and soft rock from hard rock. Useful engineering characteristics, such as blastability and rippability, can also be determined without ever directly encountering the material. Some typical seismic velocities are shown in figure 3.

The theory of seismic refraction is based upon the idea that a seismic wave directed downward through a material with a velocity V(1) will propagate into a second underlying material of velocity V(2) (where V(2) is greater than V(1)) and return to the surface as a refracted wave (see figure 4). The travel time of the wave is recorded at various points along a traverse, and when the data is analyzed a picture of the subsurface or bedrock geology emerges.

At the location to be studied in the field, a seismic line is set up. The source, or point at which the seismic waves are generated, is located at one end. Geophones, pins that are placed in the ground for the purpose of detecting the arrival of seismic waves, are strung out in a line away from the seismic source. Geophones are spaced at equal distances from each other ("take-outs"), the first placed a known distance from the source ("offset"). The instrument responsible for recording the travel times of the

Figure 1: Minnesota and Swift County

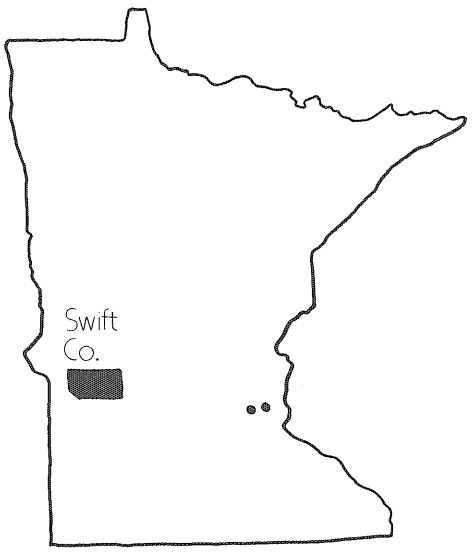
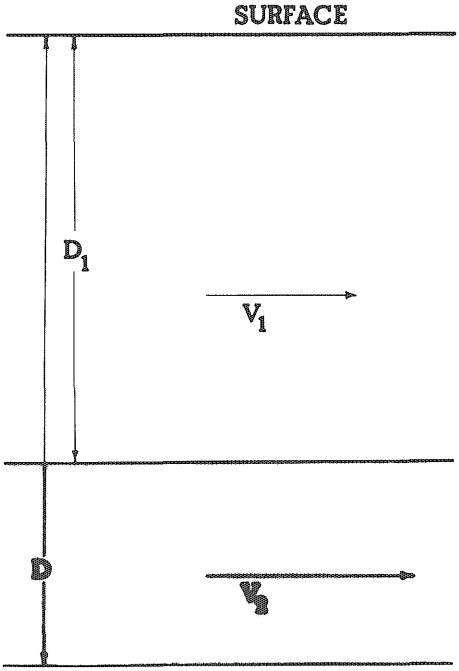


Figure 2: Geologic Layers with Different Seismic Velocities



To observe a buried layer using seismic refraction techniques, the underlying layer must be reasonably thick (one quarter of the thickness of the above layer) and have a higher density than the above layer.

Figure 3:
Examples of Seismic Velocities

1,000-3,500 fps	**soils, gravels, loose gravel, unconsolidated materials**
3,500-7,000 fps	**firmly consolidated gravels, soft rocks**
7,000-20,000 fps	**hard rocks**

waves, the seismograph, is connected by electric cable to the source and to each geophone. A seismic wave is generated at the source by striking a hammer, dropping a weight, or exploding a device. The seismograph then times and records the arrival of seismic wave at each geophone. The result is a graph much like that in figure 5, with time on the horizontal axis and geophone distance from the source on the vertical axis. For an experienced interpreter, the first arrival of a seismic wave at each geophone (the "first breaks") are easy to discern on a graph such as this.

From this "first break" raw data, another graph can be produced, this time placing distance on the horizontal axis and time on the vertical axis. The result, seen in figure 6, is a graph of two intersecting lines, each with a distinct slope. The slopes are calculated. Their inverses represent the velocities V(1) and V(2).

The point of intersection of the two lines in figure 6 is an important one, termed X(c), or crossover point. Some seismic waves propagate downward and resurface at another place far from the source, while other relatively slow waves travel close to the surface. These direct or surface waves cause the first breaks at geophones close to the source. However, at greater distances from the source, the first breaks are caused by the refracted waves, which have traveled farther, but in a higher velocity material than the surface waves. The point at which the refracted waves overtake the direct waves is known as the crossover point.

Once all of these values are known, the depth D to the layer of velocity V(2) can be determined from the following equation:

$$D=[0.5]\sqrt{[X(c)]\,[\,V(2)-V(1)/V(2)+V(2)\,]}$$

where: X(c)=crossover point
V(1)=velocity of layer one
V(2)=velocity of layer two
D =depth to layer of velocity

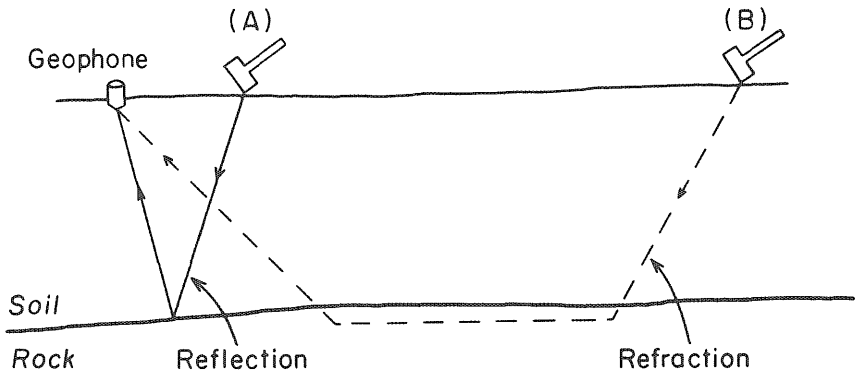
According to Brian Herrridge of Bison Instruments in Minneapolis, refraction is commonly used "because it works and it demands less of the operator. Only first arrivals need to be identified, and not some of the more complex waveforms that must be identified in the reflection method." However, long seismic lines must be laid out, resulting in higher field expenses for the refraction method.

The method of seismic reflection, which requires less field work and therefore less expense, provides data for greater depths and avoids many of the assumptions inherent with the refraction method, namely the assumption of increasing velocity with depth. Although deep reflection techniques have been used for many years by petroleum companies, shallow seismic reflection has not enjoyed widespread use before now.

Until recently, the accuracy required by the shallow seismic method was not offered by the available seismic instruments. Andrew Streitz, geophysicist at the DNR, explained, "It's as if the petroleum companies were using a method analagous to standing on the rim of the Grand Canyon, shouting, and timing the result. The reflector is so far away, so deep in the earth, that there was no problem with the accuracy of the instruments. They've been using the deep seismic reflection method for years. In attempting shallow seismic reflection, we, by comparison, are standing in a small room, half an inch from the wall, shouting, and trying to time the result. It just couldn't be done before."

The complexity of the waveforms and the problems in processing reflection data have also prevented its wide application. However, the advent of newer, more sophisticated and

Figure 4:
Reflected and Refracted Seismic Waves



Courtesy of Bison Instruments

more portable instruments, refined field techniques, and ever-cleverer data processing routines have recently made shallow seismic reflection an attractive option.

The method assumes that waves directed downward are partially reflected upward when they meet a velocity discontinuity at depth (see figure 4). The arrival times at each geophone are recorded by the seismograph and displayed on a plot, all much in the same way as for refraction work.

The difference between the reflection and refraction methods is mainly in interpretation. In seismic refraction, an interpreter looks for first breaks. In reflection work, an interpreter looks for "second arrivals." These are found by scanning the group response curves, or channels, for a particular seismic line and attempting to line up the significant waveforms on each channel that occurs after the "first break." Experience helps the interpreter distinguish between significant waveforms and unwanted noise.

The second arrivals usually fall along a curve in the raw data plot. This can be rectified by constructing a time-squared versus distance-squared plot . The slope of this line is equivalent to the inverse of the square of V(1). This value can be checked against a value calculated from the following equations (see figure 8):

$$R = \sqrt{[(X/2)^2 + h^2]}$$

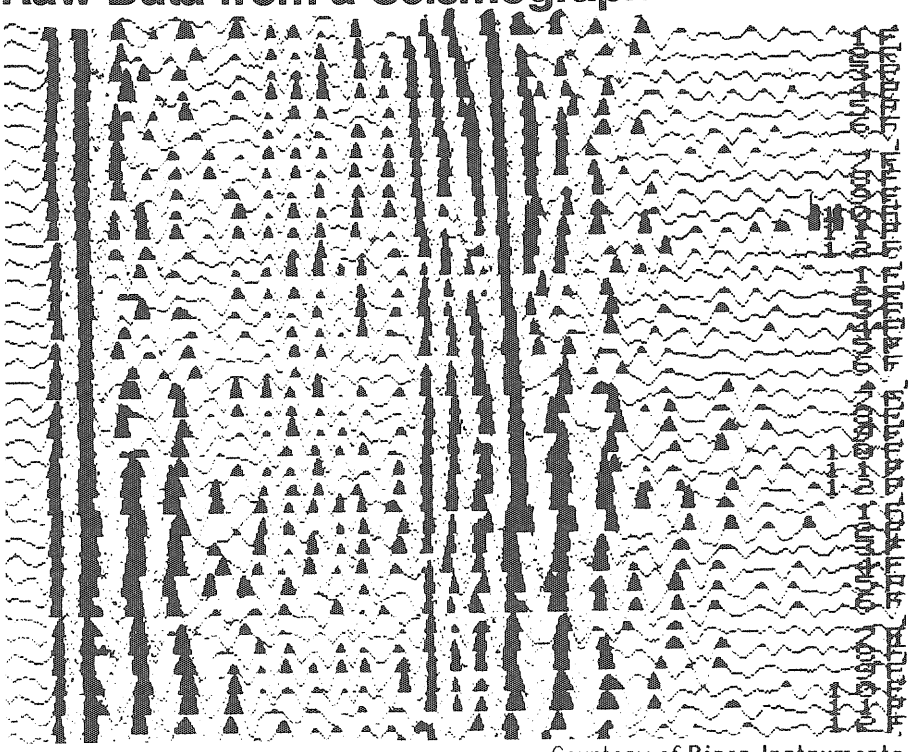
$$D = 2R = 2\sqrt{(X^2/4) + h^2} = \sqrt{X^2 + 4h^2}$$

$$t(x) = D/V(1) = (1/V(1))\sqrt{x^2 + 4h}$$

where: t(x) = reflection time at X
D = path length
X = offset
h = depth to reflector
V = velocity of material above reflector

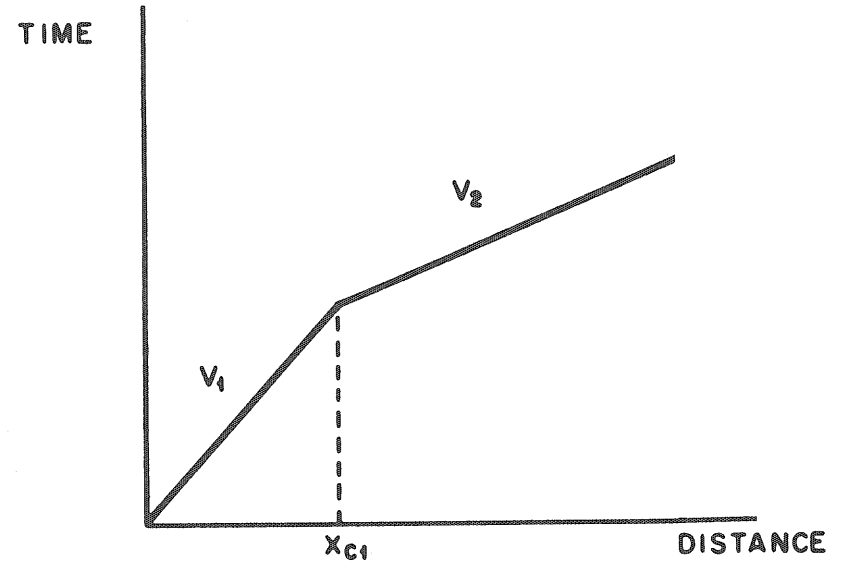
The fact that the "first breaks" occur before the second arrivals, the waves of interest, complicates the waveforms and the interpretation of the reflection data considerably. The amplitude of the second arrival is often smaller than the unwanted waves. However, because refracted waves are of no interest, shorter and therefore cheaper seismic lines can be surveyed. All geophones are located within the distance marked by the crossover point; at greater distances from the source, refracted waves will appear. Shorter seismic lines lead to more accurate measurements, since lateral velocity variations are less likely to occur than in a long seismic line. Since only a velocity change at depth is required, not the special case of V(2) greater than V(1), reflection may provide the only means of mapping some reflectors. This fact can be important

Figure 5:
Raw Data from a Seismograph



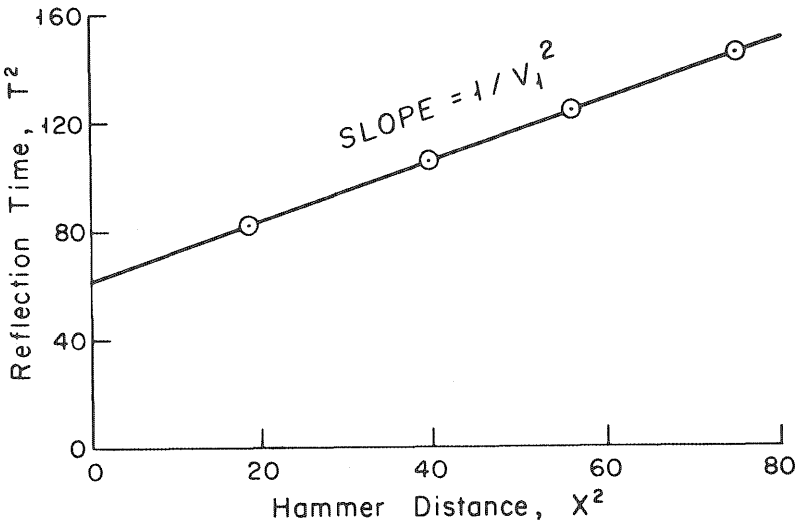
Courtesy of Bison Instruments

Figure 6:
Arrival Time vs. Geophone Distance



Courtesy of Bison Instruments

Figure 7:
Time Squared vs. Distance Squared



Courtesy of Bison Instruments

in seismic surveys of near surface, unconsolidated sediments, like found in Swift County.

The importance of testing these seismic techniques lies in their usefulness as a guide to a drilling program. According to Bloomgren, "It won't replace drilling, but it can make it more efficient... the data we've gotten already this field season (from geophysical methods) probably would have cost us many, many tens of thousands of dollars by more direct methods (drilling). We're testing resistivity versus seismic techniques over the same terrain to see which works better, which works faster, which works cheaper."

After gaining the proper operational experience, the next stage of the program, for which the DNR hopes to obtain funding, is to take the various geophysical methods into new, relatively unknown areas. Bloomgren noted that "This project has been done in Swift County only because the (base) data was already there. We're in the phase now where we're trying to apply the equipment in areas where we know what's going on in

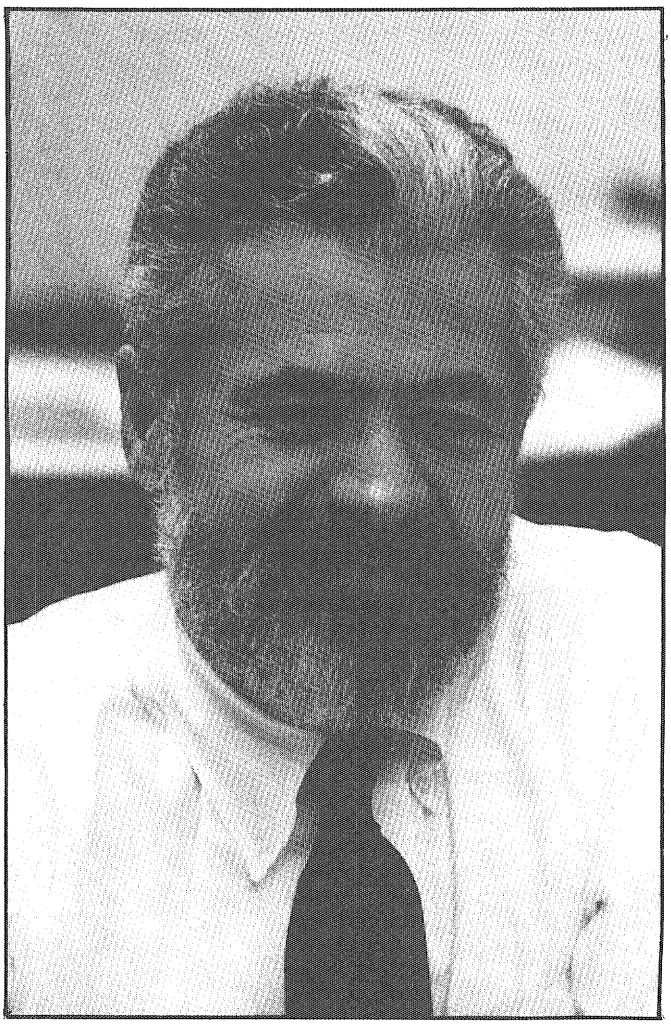
Continued on page **33**

Setting Course:

A Conversation with Dean Ettore Infante

By John Leier

Both the natural and engineering sciences exist in the Institute of Technology. To sit in the Dean's office requires the gumption to stimulate ideas across a broad spectrum of activities. I.T.'s new Dean, Ettore Infante, appears confident in meeting that requirement.



The new Dean of the Institute of Technology, Ettore Infante.

Last August, *Minnesota Technolog* had the opportunity to talk to the new dean of I.T., Ettore F. Infante. Dean Infante was born in Italy in 1938 and received degrees in both mathematics and aeronautical engineering from the University of Texas at Austin. He also received his Ph.D. from U.T.-Austin and taught engineering there until 1965. From 1965 to 1984, Dean Infante was with the mathematics department at Brown University. He was also a visiting professor at The Weizmann Institute in Israel, University of Paris, and the University of Notre Dame. While on a leave of absence from Brown, Dean Infante was the director of several divisions of the National Science Foundation.

Dean Infante has set several priorities for the Institute of Technology, among them are: retaining an excellent faculty through appropriate compensation, strengthening the computer science and electrical engineering departments, developing a supercomputer institute, alleviating shortages of people and equipment in several departments, and increasing the number of graduate students in I.T.

The following is a summary of the conversation between Dean Infante and *Minnesota Technolog.*

Technolog: Dean Infante, what special skills do you feel you have which will help you in this position?

Infante: At Brown University and before that at the University of Texas at Austin I was a faculty member. It seems to me that one of the things important for this job is to be a faculty member. Since Brown University is small and there are only two deans and a provost, the faculty does a great deal of administrative type work. Much of the decision making was done by committee, and I served on several important committees. I think that the most important skill anyone could bring to this job is a certain amount of intelligence and experience in dealing with the

problems associated with educational and research institutions. I think I bring a considerable amount of energy and willingness to work hard.

Technolog: What do you think the Dean's role should be at the Institute of Technology?

Infante: I feel very, very strongly that one of the most important things a dean has to be is the conscience of the institute. Each department chairman, each faculty member, each student can afford to be a spokesman for his own personal interest. My responsibility is to take a much broader viewpoint, identify the major problems facing I.T., and then stimulate the activity to resolve them.

I don't dictate what the policies of I.T. should be, for in doing so, I would risk finding myself marching at the head of a parade with no one behind me. I see my role as a kind of cheerleader—to work with the different groups to decide what the policies should be. A university is the antithesis of a military institution, where everything is dictated top to bottom. I don't feel that arrangement would work for a university because individuals make the institution what it is. For the University to function, people must be accountable to others, as I am accountable to Morrill Hall, and the department heads are accountable for their decisions, faculty for their teaching and research, and students for what they learn and don't learn.

One of the most important things a dean has to be is the conscience of the institute.

Technolog: With the number of industries in the area geared toward computers and electronics, should I.T. offer a degree in Electronic Engineering?

Infante: I believe strongly that one of the things that is absolutely essential at the undergraduate level is that students be given the type of education that covers the fundamentals. I do not believe in early specialization, let me explain to you why. I always think of undergraduate education as the priming of a pump. What is very important is that a student is able to leave here with the ability to continue to learn. We are always going to be confronted in life with problems which we cannot immediately deal with because we do not have the knowledge, yet, we have to have the capacity and self-confidence to do three things: to recognize when it is that we don't know something, to have the ability to know where to go to learn something, to have the ability to do that learning. To be able to do this, I think requires a strong base in the fundamentals. To me, anything which represents a narrowing of the student's education is not in their best interest. I like to compare education in a technical area to the building of a house. The taller the house that you want to build, the deeper the foundation must be. I would like our I.T. students to have a strong foundation, because without that strong foundation you cannot go very high.

I like to compare education in a technical area to the building of a house. The taller the house that you want to build, the deeper the foundation must be. I would like our I.T. students to have a strong foundation.

Technolog: Should the Institute of Technology strengthen its ties to the industrial community?

Infante: Well, actually we are in the same business, but our products are different. I.T.'s products are ideas and hopefully well trained people. We cannot sell either. Ever since slavery was outlawed, I can't put a price tag on a mechanical engineering senior and invite people to the auction. We are in the same business, in the sense that our output is their input, and so it is desirable to have a close relationship. However, this relationship should not violate what they do or what we do. In particular, I don't believe the University is very good at doing certain things and business is not good at other things: it is fortunate that the two compliment each other in their weaknesses and their strengths.

Since the University is such a fragile institution, the dean must be careful to assure that the University does not lose its identity while trying to establish a close relationship with industry. I look forward to establishing close relationships with the people in the business and industrial community, because of the invaluable advice they can provide.

Work hard, play hard, and learn a lot. This is one of the most important times in your life.

Technolog: What advice would you give to the students of I.T.?

Infante: I would say to them, "These are the four or five most important years of your life because what you do or what you don't do in these four or five years is going to be terribly determinate of what happens to you for the rest of your life. There is leverage at this point that does not exist in high school, elementary school, or later on in life. Work hard, play hard, and learn a lot. This is one of the most important times in your life.

profile

Seymour Cray: a leader in the past, present,

By Lee Atchison

Seymour Cray, the genius behind the Cray-1 supercomputer is a quiet, secluded man. While others sought success on the corporate ladder, Cray looked for and found success on a ladder of his own design. During his 52 years, he has combined the Cray style with his genius, making him a legend in his own time.

After graduating from the University of Minnesota in 1952, Cray went to work for the Sperry Rand Corporation's Univac Division, formerly Engineering Research Associated. Five years later, Cray left Sperry because the high-pressure, corporate life had become too bureaucratic and boring for him. Cray preferred working in small research teams away from large numbers of people. Sperry was not the place for him.

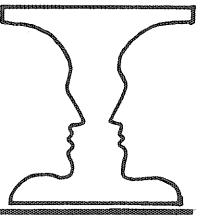
With a group from Sperry Rand, Cray formed the Control Data Corporation. After designing several computers, including some of the early transistor models, he began working on his first supercomputer. The CDC6600 was the first successful supercomputer to hit the commercial market.

Cray's work at Control Data was impressive. Yet, he was still in the corporate environment. Control Data, realizing how important Cray was to them, moved him away from the headquarters to where he felt at home. They built a research and design laboratory in Chippewa Falls, Wisconsin, Cray's home town. It was there that Cray designed the CDC7600, Control Data's second generation supercomputer which was announced in 1969.

Seymour Cray, a graduate from the University of Minnesota, designs the world's fastest supercomputers.

In a field where genius is almost taken for granted, he's a towering figure.

Cray had risen through Control Data's rank to a senior vice president and top designer. However, this arrangement did not last. In 1972, three years after the introduction of the CDC7600, he left Control Data. Cray explained he felt Control Data was too commercialized, bureaucratic and boring for him, the same reasons he had given for leaving Sperry. For the second time, when others would have felt successful, Cray chose to start over.



and future of supercomputing

The new company, Cray Research Inc., consisted of only a twenty-five man design team who set up shop in Chippewa Falls. The fresh start gave Cray an opportunity to set personal goals. From the beginning, they chose to build a machine which would be the fastest in the world.

Four years and $8.5 million later, they designed and built the first Cray-1 supercomputer. The Cray-1, standing six and a half feel tall and weighing several tons, comes in a cylindrical package with a section of the machine sliced away like a piece of cake. The two foot wide, upholstered bench that surrounds the computer is the source of its nickname as the "world's most expensive loveseat."

Doing what he does best, Cray concentrated on the design side of the Cray-1. During those four years, he tried to perform each step in the construction, at least once on his own, to test the design.

The initial operations investment was retrieved when the first Cray-1 was sold in 1976. Since then, Cray Research has become the leader in the supercomputer field. There are only 75 supercomputers operating in the world today and Cray Research has sold 54 of them. Quite an accomplishment for a company started by a man who described corporate life as dull.

Cray stepped down as chairman of Cray Research in 1981, leaving the day to day business of Cray Research to John Rollwagon, who returned to his native Minneapolis with degrees from MIT and the Harvard School of Business. An agreement was struck that allowed Cray to devote his time to supercomputer design. Until December 31, 1987, he is an independent contractor for Cray Research working on the evolution of Cray's line of supercomputers.

With the world's scientists demanding faster computers and with other firms developing computers to compete with Cray Research, Cray is back at work on the Cray-2 which will be five to ten times faster than the Cray-1. For Seymour Cray, going to work means designing and testing ideas in the seclusion and privacy offered by Chippewa Falls.

Of the seventy-five supercom-puters in the world today, Cray Research built fifty-four of them.

Seymour Cray was described by Gene Amdahl, the founder of IBM, as "the most outstanding, high performance, scientific computer designer in the world. *Fortune* magazine said of Cray, "In a field where genius is almost taken for granted, he's a towering figure." His machines brought life to the supercomputing industry, revolutionized the supercomputing industry, and point to the future of the supercomputing industry. To say he is a genius is an understatement.

Seymour Cray's creations have made him a legend in his own time.

assigned reading

Sci-Fi Ups and Downs

***Heretics of Dune,* Frank Herbert, G.P. Putnam's Sons, hardcover, 480 pages, $16.95**

By Renee Bergstrom

Here it is, the next book in the continuing saga of the planet Dune. It has been several millenia after Leto II, transformed into the Divided God that Dune priests worship. After Leto's death, many things occurred, the Scattering and the Famine Times. Now, the people of the Scattering have returned looking for power, the Bene Tleilax feel it's time for their ascendancy and the Bene Gesserit (religious sisterhood) have resurrected another Duncan Idaho ghola (clone of a dead man) to aid their design for mankind. The resulting power struggle threatens the very existence of Dune.

To aid the Bene Gesserit Reverend Mothers in their design is a young girl who can speak to and control the sandworms of Dune, an old military leader dug out of retirement, and a ghola that has been altered by the Bene Tleilax. The question that everyone is asking, "Is this still Leto's 'Golden Path?' "

This book is truly a marvel. Frank Herbert's fifth book in the series has managed to recapture and retain the beauty and excitement that was so apparent in the first books. The plot contains many subtle twists and turns, never letting the reader out guess the plot. The characters are well sketched out and there was plenty of action to keep the audience moving with the book. *Heretics of Dune* is a book that leaves the reader satisfied.

The beginning of the book contained political questioning and internal reflection, similar to *God Emperor of Dune,* that slowed the story down considerably. The pace is uneven because Herbert does manage to increase the tempo in the last half of the book.

This world too isn't on the gold standard. Herbert tries to bridge the gap between times, writing that a man is worth his weight in melange, the spice that is the standard for the economy. This statement appears trite and out of place. However, this is a minor complaint.

This book is a must for Dune fans and a real tribute to Herbert's writing abilities. For those who have not read the Dune series, start reading so you can finish with this book. Because another book would undue the complete circle that Frank Herbert has drawn with *Hertics of Dune,* let us hope this will be the end of the Dune series.

***Voyage to the City of the Dean,* Alan Dean Foster, Ballantine Books, paperback, 241 pages, $2.95.**

by Renee Bergstrom

In contrast to *Heretics of Dune* is a new book just released by Alan Dean Foster, titled *Voyage to the City of the Dean.* The setting is a new world, never before explored by outsiders. A husband and wife team of social anthropologist and geologist are sent to explore and chart this world, study the geological formations, and document the social adaptations of the people who live there. The people are divided into three races; The Mai, who are a greedy people thinking only of themselves and money, the Tsla, who pursue scholarly studies and pureness of mind, and the primitive, cannibalistic Na.

The characters in the book are all well developed, from the main characters of Etienne and Lyra Redowl to the natives who help them on their journey. The characters all think and feel with their own emotions and motivation. This is a refreshing point about this book. The husband and wife team constantly bicker, their marriage defined in terms of their occupation, rather than affection. They have a real life distinction from other story book characters whose marriages flow like silk.

However, the characters are not enough to redeem this book's plot which is far from substantial. It seems that Foster has spent more time developing characters than a plot. Foster created enough adventure along the way, but when he got the characters to the final destination, he fell asleep. I didn't feel much happened to the characters to warrant their one hundred and eighty degree turn from the direction they were heading. Everything was done for them in the end. The book was like a bad Indiana Jones cliff hanger.

Foster does some clever things with names, geology and anthropology in this book. That much is very well done. However, I would not recommend this book to anyone interested in reading good science fiction or fantasy. My money would have been better spent at the local Dairy Queen feeding my face.

Choosing a Scientific Calculator

By Michael Dean

So, you just came from the Bursar's line and you have a few dollars left in that dwindling bank account. If you need a new calculator, here are a few ideas and suggestions you might consider to spend your savings wisely.

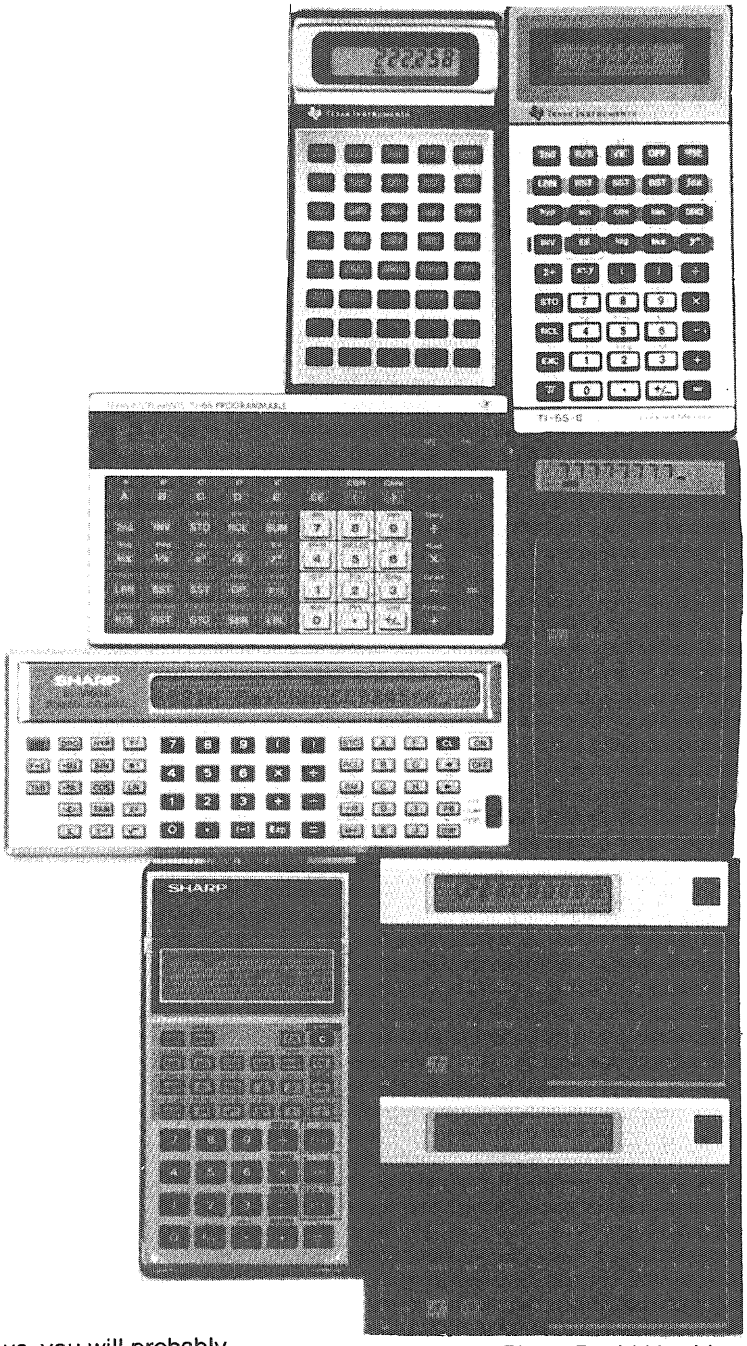


Photo David Herridge

How do you maximize your calculator/dollar ratio? Your first thought was probably to take the first derivative, equate to zero, and solve for x; but it's actually not that simple. There are dozens of scientific calculators on the market. Which one should you buy? It's a matter of trying to predict how much calculator you will need. Buying too much could deliver serious damages to the pocket book and social life, while not buying enough can cause lower test scores and possibly even Change of Major (CM). Consider what functions, how much memory, and how much, if any, programming capacity you could utilize. When considering cost, realize that several dollars difference between a good and a bad calculator is minimal, especially when you stack it against the $10,000 plus, you will probably pump into I.T.

Out of the many functions available on scientific calculators, which are you going to need? The scientific functions (trigonometric, exponential) and several constant memories will surely get you by. Statistics functions are very handy and probably worth paying for. Programming capabilities can save you a great deal of time, especially when processing data for those tedious lab write-ups. Functions such as matrix capabilities and numerical integration are helpful when you need them, but if you only use them once a year, it's probably worth the savings to just borrow someone else's calculator or turn to a microcomputer. Another very important criteria should be the calculator's ease of use, including the legibility of the keys and the display, and the layout and action of the keypad.

For this discussion, nine units from three manufacturers have been selected, although there are many other suitable models on the market. Not included are the pocket "computers" that are programmed in BASIC (Nobody seems to know what

those things are for, anyway. Asteroids programs will not work, we tried.). Programmable "calculators" are actually computers, but they are programmed numerically with keystrokes, rather than with actual BASIC commands.

For the most part, the calculators are fundamentally similar. The more you spend, the more functions you get, with one major exception, the logic system. Some of the calculators use common, left-to-right algebraic entry while others use Reverse Polish Notation (RPN).

RPN has an advantage over algebraic entry for lengthy calculations, fewer keystrokes are required. The system eliminates the need for parenthesis. Also, there is no "=" key because the current value of calculation is continuously displayed. The calculators from Hewlett-Packard use RPN, all the others use algebraic with hierarchy. The appended box contains an example of a calculation performed with both logic systems.

The calculators from Texas Instruments are easy to use, inexpensive, and probably the most common in the backpacks of I.T. students. For about $20 the TI35 will most likely handle 95 percent of your computing needs. It sports trig functions and constant memory, but is not programmable. The TI55-II adds programmability, nifty statistics functions, and even numerical integration for about $40. Twenty bucks more will get you into a TI66 which adds more memory, up to 500 steps of programmability, larger keys and display, and a port to hook up a printer. Note: there have been some durability problems on the keypads of the TI35 and TI55-II. Gone are the days of legendary TI30's that doubled as hockey pucks.

Sharp has a neat little scientific model, the EL515T, that never needs batteries because it's light powered (light not included). It can do huge calculations with its 15 levels of parenthesis and also does hex, octal, and binary conversions. Add programmability, a 24 character display, alpha characters, and Direct Formula Entry with the Sharp EL5100S. Direct Formula Entry is an impressive option that would allow Foresters to pre-program length-of-tree equations prior to exams.

From Hewlett-Packard, the HP11C is a slick RPN calculator that is programmable, does trig and stats, and has 67 registers for direct and indirect storage. It also has many time-saving functions, such as a backspace key that lets you undo mistakes without having to start the entire calculation over. All the HP's come with a durable, sure-shot keypad that has an excellent "touch." For around $95 there is the HP15C that looks and feels like the HP11C, but has the capabilities to store and manipulate five matrices, do complex calculations, and perform numerical integration. If you really want to go way out, take out another student loan and pick up the Cadillac of scientific calculators, the $289 HP41CX. This machine does it all. Built into the back of it are four input/output ports for memory expansion modules, a light pen for reading bar codes, a cassette recorder, a magnetic card system, and a printer/plotter. Several people have said that once they adjusted to RPN, they would never go back to the algebraic logic.

Again, you'll probably have your best chance of avoiding CM by carefully predicting what functions you will need. Make sure that you try the calculator out in the store before buying it. There are some calculators out on the market that are so compact they are in fact adult-proof. Also, make sure you get a little practice before that first exam. Some of the user's manuals are 400 pages thick and fumbling through one during a physics test because you can't locate the "ln" key could be very embarrassing. Remember too, that RPN takes a while to get used to. Finally, you will want to consider the calculator's beltloop capabilities if you're going to stylishly strut through the halls of I.T. with calculator ahip.

A Real Life Example: Battle of the Calculator Logic Systems

You take your six year old nephew to see Star Wars. The Mellenium Falcon is traveling away from the audience at a relativistic speed when it fires some sort of photon projectile, also at a relativistic speed away from the viewers. Your nephew grabs your arm and inquires, "What is the speed of the projectile relative to us?" He wants an answer fast! The equation for the velocity is

$$V = (W + U) / (1 + UW / c^2)$$

where U = Velocity of the ship
W = Velocity of photon relative to the ship
c = speed of light

Here is a comparison of the keystrokes necessary to reach the answer.

RPN	ALGEBRAIC
W	(
"Enter"	W
U	+
+	U
1.0	)
"Enter"	÷
U	(
"Enter"	1.0
W	+
*	(
c	U
"x^2"	*
÷	W
+	÷
÷	c
	"x^2"
	)
	)

Log Ledger from 7

the architectural firm chosen to do the initial design, will have to work within the $40 million construction budget expected to be appropriated by the State Legislature in the 1985 session. This $40 million ceiling represents a substantial reduction from the initial request of $56 million and will require some reorganization of the facilities that were in the original plan.

The building is expected to house both the Computer Science and Electrical Engineering departments in approximately 140,000 square feet of assignable space. Two locations for the building are being considered, one behind Lind Hall where Experimental Engineering stands and the other, east of Union St. across from Shepard Labs. Construction is tentatively scheduled to begin in October of 1985, placing its completion in late 1987 or early 1988.

Student Professional Awareness Conference

As you near the end of your academic career, you may feel some apprehension about entering your professional career. A good way to dispel this, and to gain a sense of professional awareness, is through discussion of issues relevant to the graduating engineer. Topics such as the first year as an engineer, professional ethics, and post graduate education options will be presented at a conference to be held at the University of Minnesota on October 17. This "Student Professional Awareness Conference" is sponsored by the IEEE, and features speakers who are working professionals, opportunities for discussion of questions, and a catered dinner. For further information, see the advertisement in this issue, or contact the IEEE office in the EE buildings.

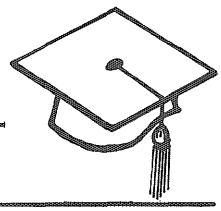
Magnetic Field Flip

We have always used the earth's natural magnetic field for guidance. Our planes, ships, missiles, etc. all use compasses to determine which direction they're traveling. Even birds, fish, and other animals use this feature of the earth to navigate.

There is now new evidence that the magnetic poles will reverse, causing climate changes, and other disastrous results. The intensity of the field has already decreased more than 50% over the past 4,000 years.

University of Minnesota geologist, Subir Banerjee, has found evidence of this change from a 60 foot long cylinder drilled from a Minnesota lake. The cylinder acts as an 11,000 year long timeline, preserving a record of the earth's previous magnetic field.

The earth's magnetic field reverses itself every 200,000 to 1,000,000 years. It has been 710,000 years since the last reversal. The overdue reversal could take place in anywhere from a few to a few thousand years.



the graduate

Communication: A Human Process

By Karen Auguston

Our world today is inundated with information. Man has developed increasingly complex and sophisticated devices to process, communicate and manage this information "explosion." Telecommunications equipment race signals around the globe instantaneously, delivering "live" broadcasts, assemble-it-yourself robots come complete with speech capabilities; and weather satellites furnish us with daily weather reports—from the moon, ". . . And the forecast today predicts a high of 212 F, nightly temperatures falling to a low of -240 F with a slight chance of late afternoon meteor showers developing . . ."

Man has made astonishing advances in the communications field, and young engineers today are at the leading edge of communications technology; their knowledge and skills will contribute to the design and development of new and advanced communication systems. Much of this technology has already made its way into the market place; from cars which greet us with, "Good Morning, left door open" to phone systems complete with automatic dialing, call waiting and conference calling. However, in this technology-oriented world we live in, we often overlook the singularly most powerful and effective communication device in existence—man. Communication, the exchange of ideas and information, is a human process.

An engineer's communication skills have become increasingly important. As new technology shifts from the engineering department into the office and home, an engineer must be able to share information with others in terms they will understand. According to Keith Gildersleeve, Manager of User Information Services at NCR Comten, "In industry, an engineer is judged primarily on his/her writing skills . . . it is what most people will ultimately see of their work."

College recruiters consistently rate communication skills among the top qualities they look for in potential job candidates. Last year, *Technolog* talked with representatives from local companies about the campus recruiting process; the recruiters frequently commented on the favorable impression a student with good communication skills made during the interview. This impression is often the basis for extending a plant tour to that individual.

Graduating Engineer published survey results which placed the amount of time an engineer devotes to writing, editing, and preparing reports between one fourth and one third of the time on the job.

This year, *Graduating Engineer* published survey results which placed the amount of time an engineer devoted to writing, editing and preparing reports between one fourth and one third of the time on the job. This works out to approximately 12 hours or one and one half days a week!

The technical coursework required in college provides the engineering student with an in-depth understanding of physical principles and concepts; however, students receive little instruction on how to communicate this knowledge and information to others. In fact, until recently, students enrolled in most degree programs at the University of Minnesota, Institute of Technology, were required to complete only one introductory composition course. For students graduating Fall, 1984, and thereafter, an additional course in advanced composition will be required. A variety of courses are offered which will fulfill this requirement; however, many degree programs specifically require Composition 3031, Technical Writing for Engineering.

Most college students will develop adequate communication skills. With some extra effort, however, an individual can further develop and "fine-tune" his/her personal communication system!

Put some coursework additives into your system

Nontechnical coursework is required throughout the degree program, and the University offers a wide selection of courses that will fulfill these requirements and take the future engineer far beyond the basics.

Students taking Composition 3031, Technical Writing for Engineering, learn how to approach the writing process and focus on the form and style of technical writing. Students complete a series of short assignments and one 20-50 page project which is presented to the class. The course also introduces students to the organization of technical libraries and how to find information (*without* the librarian!).

Two courses offered through the Rhetoric Department (Rhet 3562, Writing in Your Profession and Rhet 5257, Scientific and Technical Presentations) place similar emphasis on technical report writing and the art of presentation.

Writing and composition courses are not the only classes which require the preparation of writing assignments. Many courses in the History, English, Sociology and similar departments assign term papers and/or research projects; these writing exercises are a valuable experience. Suffering from writer's cramp? The University English Department houses a Writing Lab with personal computers available for students working on writing assignments.

Typically, engineering students make a few oral presentations to fellow classmates. However, for the brave (and soon to be articulate) who are wondering what they have been missing, the Speech/Communications Department offers a number of courses which concentrate on the verbal communication process. These courses provide opportunities for public speaking; individual speeches are filmed (didn't you always want to be on TV?) in front of live cameras when possible.

Read between the lines

Keith Gildersleeve, a lecturer in the University of Minnesota Composition Department, recommends reading as much as possible. "Through reading we can study and interpret the style and form of other writers and through this process develop and enhance our own writing skills." Reading is for the curious—through reading we become acquainted with the world. Read the cereal box at the breakfast table (amazing, isn't it, the amount of sugar in some of those brands?), the newsletter at the office, the evening paper . . . and learn to communicate with the world.

The Write Approach

Technical writing covers anything that has a technical subject. The major difference between technical writing and other types of writing is the style. According to Gildersleeve, technical writing has a "transparent style." The reader is not aware of how something is said, but what is being said. Technical writing is not easy—it is often comprised of statistical and quantitative data and difficult concepts which must be presented with clarity. However, as Gildersleeve points out, "Technical writing is hard work, but can be challenging and rewarding."

Consideration must be given to the audience for which the report is intended. Before beginning to write, Gildersleeve advises the writer to ask himself, "Who is this report directed toward? What can I expect them to understand easily and what do I need to go into some detail about?" Based upon some cases, an executive summary highlighting the major findings and results of the analysis is attached to the report for distribution throughout the organization. This provides a quick overview of the project for busy executives; individual managers can read the entire report if they are sufficiently interested.

Define clear objectives and goals for the writing of a report—develop a plan, and start writing as soon as some information has been gathered. "Don't tell yourself, 'I'm going to write this up,'" warns Gildersleeve, "and expect it to be easy."

Don't expect your writing to express exactly what you intended to say. It may sound perfectly clear to you, but you know what you were trying to say. Obtain feedback on your writing—it will help sharpen your writing skills.

Communication devices come in a variety of styles and packages. Consider the telephone: there is a Trimline model, a Princess model, a Mickey Mouse model—functionally identical machines in different packages. Similarly, man's personal communication system comes in a variety of styles and packaging. However, we each possess an inner communication system which is unique. Communication is self-expression, it is a reflection of one's personality. Develop good communication skills—without them, a Princess might be mistaken for a Mickey Mouse model!

1884 : 1984
A CENTURY OF ELECTRICAL PROGRESS
IEEE

The Institute of Electrical and Electronic Engineers Presents

A Student Professional Awareness Conference

SPEECHES:

"Plan and Control Your Own Career" Larry Dwon

This means more than just finding and holding a job. Factors include challenging assignments, continuing education, people, performance, values, and the economy.

"The Communications Connection" James Watson

A successful professional can clearly communicate his/her knowledge. Application of several fundamentals can improve your speaking abilities and build your confidence.

"Should You Try for an Advanced Degree?" Charles Alexander

M.S., Ph.D., and M.B.A. degrees. Which degree should you consider and when should you get started.

"Engineering Professionalism and the IEEE" Hans Cherney

Professional identity for the engineer, responsibility of the engineer to society, professional programs in the IEEE, and the IEEE organization.

"Professional Ethics" Robert Schlentz

The duty to society of the engineer to practice in a responsible manner.

Wednesday, October 17, 1984 3:30 to 9:30 PM
Coffman Union Great Hall, University of Minnesota

REGISTRATION:

	before Oct. 12	after Oct. 12
IEEE Members	$2	$5
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Fee includes dinner.
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IEEE Student Branch
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133 EE Building
123 Church Street
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Microcomputers from 10

Marshak noted that access to a computer would allow problems that are not reasonable questions for analytical methods to be solved by numerical methods. By spring quarter, the Physics department hopes to use micros in some Introductory Physics sections.

While the microcomputer's role will certainly increase in time, one should not ignore the role it has already played. Tucked away in nooks and crannies behind closed doors, the microcomputer is already being used. Terak, an early micro, has been used for many tasks in many departments.

Professor Art Erdman helped develop the Mechanical Engineering Department's LINCAGES package for the Cyber in the late seventies. To increase accessibility, a version was made for the eleven ME Terak microcomputers. "Originally the purpose was educational, it just turned out the package was also desired by industry," explained Erdman. Terak has since marketed the software and returns royalties to the University for each sale.

The Terak is also used in the Engineering Graphics course. In the seventies there was a movement to drop the course. However by updating it to include some exposure to computer drafting, the course was saved.

Continued on page **34**

Geophysics on the Iron Range

The usefulness of seismic methods in the solution of water resource problems in western Minnesota is being tested, but this is not the extent of the DNR's interest in geophysics. Recent work by the Hibbing office of the DNR suggests other applications may be useful there.

The Hibbing office supplied ground control for a regional aeromagnetic survey recently completed by the Minnesota Geological Survey. According to Lee Warren of the Hibbing office, this control consists of ground magnetic surveys, gravity surveys, and seismic surveys.

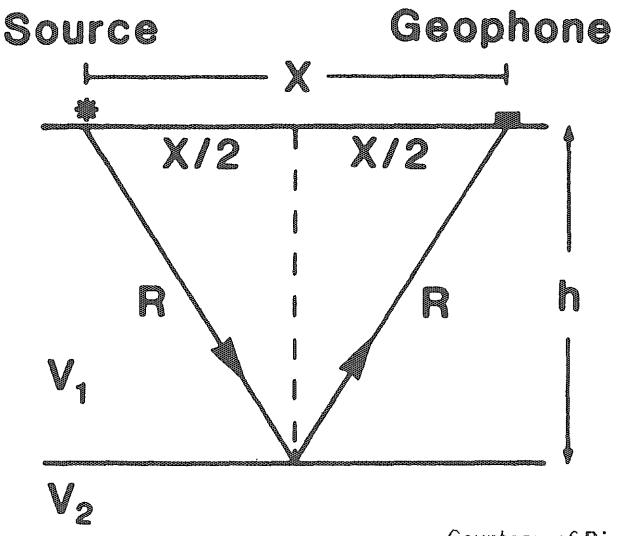
The seismic surveys will "give us a better understanding of the rocks, and may stimulate further exploration" for mineral potential, he said.

The surveys could do this by detecting mineable quantities of certain metals within the bedrock. The seismic surveys work by detecting layers of materials that are of varying seismic velocities. Velocity is controlled by the density and hardness of the material.

"If in determining mineral exploration potential, you're looking at rocks that have sufficiently different velocities, then yes, a seismic program can help," said Pat Bloomgren of the St. Paul DNR office.

The bedrock in the vicinity of the Iron Range is promising for this kind of work as it is quite similar in nature to bedrock north of the Canadian border. These rocks are thought to yield some metals, most notably gold. However, the DNR in Hibbing is involved in an on-going, many-faceted field program, and no special intensive effort is being made to find an antidote for the economic sickness of the Iron Range. Many workers seem to agree with Warren, who said, "In terms of economics (of the Range), nothing will replace iron mining."

Figure 8: Depth Determination



Courtesy of **Bison Instruments**

Minnesota Water from 16

which we hope to tackle next the subsurface. The logical extension, summer, is to begin using it as an exploration tool in areas where we don't know what's going on."

"The alternative is drilling, and that is too expensive," she continued. "We can't wait for industry to do this... if we're going to promote good, strong economic development, it requires water. It's one way to attract industry, to know what your (water) availability is. Since we can't afford to drill, we have to look at indirect, non-intrusive methods... geophysics was a natural."

We are searching for aquifers suitable for high density use—for industrial use or irrigation.
Pat Bloomgren
Minnesota DNR

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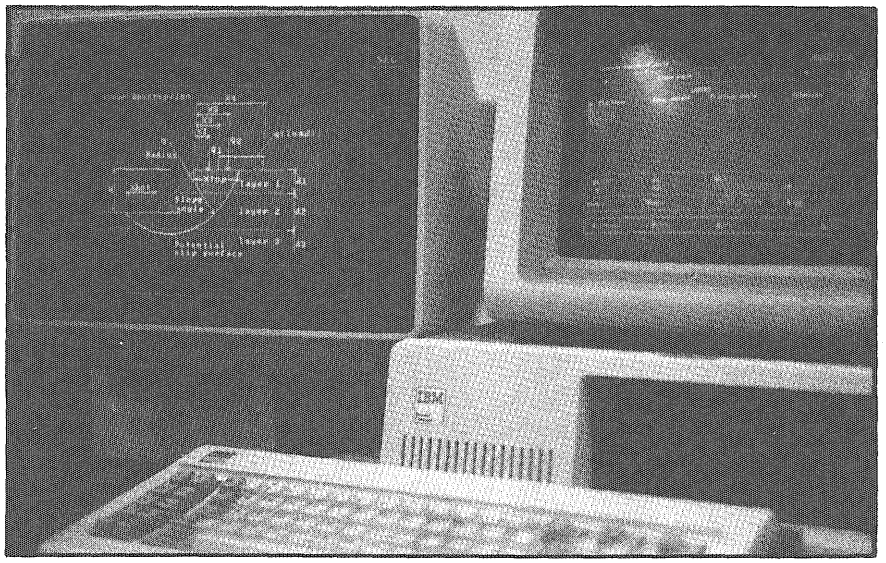
Microcomputers from 32

While the ME department considers the future role of the micro, they emphasize that the Terak will continue to play its part. After noting that the Terak hardware and software is already up and running, Erdman said, "We will continue to use those till they fall apart."

The School of Architecture has used the Terak for computer aided drafting, but with the recent improvements in the micro and their proposed availability, they are looking beyond the Terak. The software for environmental, structural, energy, cost, lighting, and acoustical analysis already exists for IBM machines and the graphic capabilities of the Apple computers make both prime candidates for use in architecture courses.



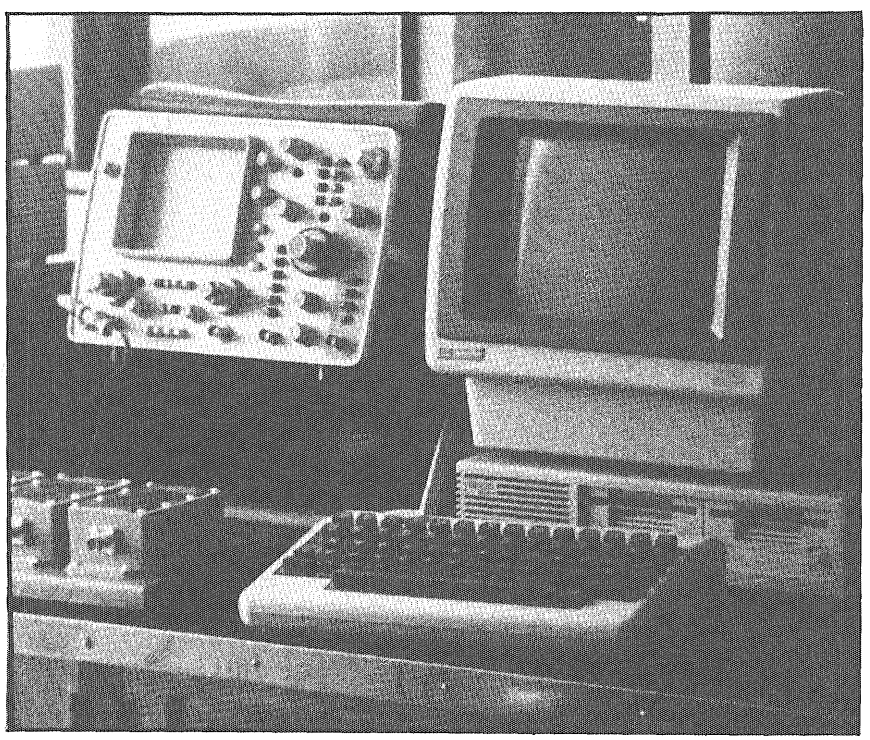
The civil and mineral engineering applications developed to run on the IBM PC utilize both a text and graphics monitor to display the modeled system.

Lee Anderson, Architecture's representative on the Instructional Computing Committee, explained how the micro would fit into their program. "Architecture uses a studio principle, this is unheard of anywhere else in the college. A student has a desk . . . that's where they work. If we are to have a tool that is effective, it has to fit into that environment. Down the street is not good enough." To accommodate the computers, a section of studio was walled off for security reasons and an air conditioner was installed to keep the hardware running. "Otherwise, it's very much like the studio space . . . we're not making it the pristine computer room," said Anderson.

What does all of this activity mean for I.T. students this fall? First of all, no student will be required to purchase a computer, so rest at ease if you feel pressure to buy. Lee Anderson emphasized an effort will be made to insure nothing inequitable happens in grading the performance of students who have their own micro.

For most undergraduate students, the integration into the curriculum will take time. One to three years are estimated to develop the software for students to apply to engineering problems. If you do place an order this fall, your primary use should be either word processing or individual program development.

It was not long ago that I.T. students performed their calculations by sliding plastic rules into alignment. The electronic calculator caused quite a stir in that environment. The microcomputer has the potential to cause a similar revolution. It has already found its way to the desks of engineers, scientists, architects and even some students. Whether it will find its way to the Institute of Technology's students is a question of time and money.



Hewlett-Packard microcomputers have been put to work in the Basic Measurements Labs doing data acquisition, automated control, and frequency response experiments.

for the record

1984 Cartwright Acceptance Speech

Last year, the IT Alumni Society sponsored an award to recognize and reward an I.T. student who had compiled a long and distinguished record of service to I.T. and/or the University. Scott Dacko, a graduate in Mechanical Engineering, won the first Paul A. Cartwright/IT Alumni Society Award for Outstanding Service. *Minnesota Technolog* would like to congratulate Scott.

Scott's acceptance speech at the last year's graduation ceremonies is published below.

It is indeed quite an honor to accept an award that is named after someone who has contributed greatly to the college—as well as an organization which continues to contribute.

One thing I've always enjoyed tremendously in I.T. is being around great people. Both in the classroom and through many other activities, I've met and worked with people who are dynamic, energetic, hard-working and creative. There are many people who have had a great influence on me:

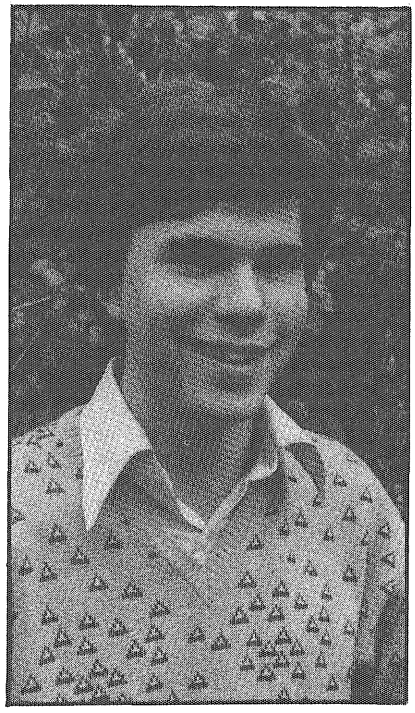
Outside of I.T., my parents and brothers have taught me the importance of pitching in; especially on Saturdays and Sundays.

Within I.T., one person of influence to me is former Dean Roger Staehle. He was the one who told me, "Scott, be very good at what you do. Get A's in all your classes. Become a great mechanical engineer."

Another person of influence was former Associate Dean Edwin Stueben. He emphasized to me the importance of continuity in organizations. When I first began I.T.'s newsletter, the *I.T. Connection,* he said to me, "The newsletter looks very good, Scott, but if you get hit by a bus, I want it to continue."

One person that has helped me a great deal is Professor John Clausen, the Director of Lower Division Programs. In addition to giving me career guidance, he's been a perfect model of someone who cares and is concerned about the well-being of others. His words of advice to me are countless.

Another special person I've had the opportunity of working with in the mechanical engineering department is Dr. Ken Whitby who passed away this last fall. By knowing him, I've gained knowledge, learned kindness, and recognized confidence in myself.



And from working with a lot of you in student organizations, I've learned the importance of collaboration—working together for the common good. It's really amazing what you can do when you work together.

Our classroom education has given us some excellent tools. Tools we can use to constructively increase the quality of our surroundings. But has our education in the classroom been complete? We've spent four years learning and practicing problem solving, but how much time have we spent on problem definition? And particularly, within an organization? It's interesting to note that the people in Cray Research have defined themselves as not being in the Computer Business—but rather the Information Processing Business. And they're growing fast. Maybe the reason Burlington Northern has declined is because they had defined themselves as being in the Railway Business—as opposed to the Transportation Business.

And in solving problems, have we acquired the COMPLETE knowledge to solve problems? We know all about the Ideal Gas Laws. We know that silicon is the best understood material on Earth. And we've learned about electro-magnetic forces and gravitational forces—but have we learned about political forces? And social forces? And how about the forces of change? Change may be perhaps the most powerful force of our lives. Twelve years ago, the last slide rule was manufactured. A year and two weeks ago, Smith-Corona made their last manual typewriter.

Finally, in solving problems, how about solving them CREATIVELY?! The world appears to be filled with conventional thinkers. There is great room for all of us to creatively solve problems outside the classroom. A personal example of mine is when the thermostat broke in my parents' home. When they asked me to come up with a solution, I said, "It's simple, sell the house!" That's just one example of a creative solution. All of us can be creative in meeting the needs of society. The Board of Regents were creative when in 1935 they passed an Act to create the Institute of Technology. Countless engineer-entrepreneurs are being creative today in forming companies to develop innovative ideas. And if we all work together—whether it be in education, industry, government or a combination of these—we can meet the needs of society in new and creative ways.

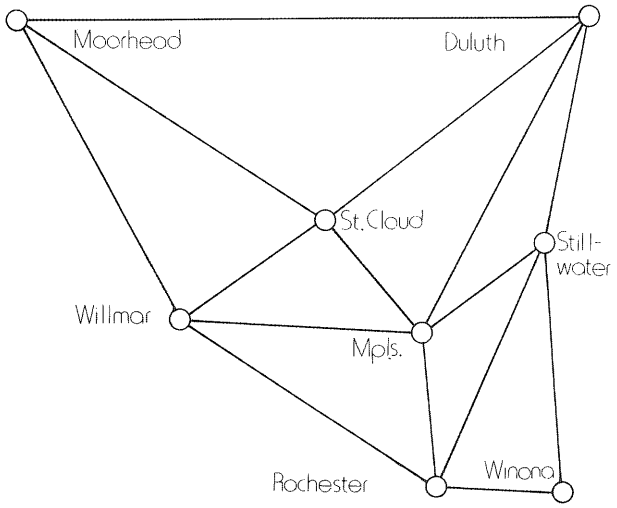
Thank you.

Mind Benders and Brain Teasers

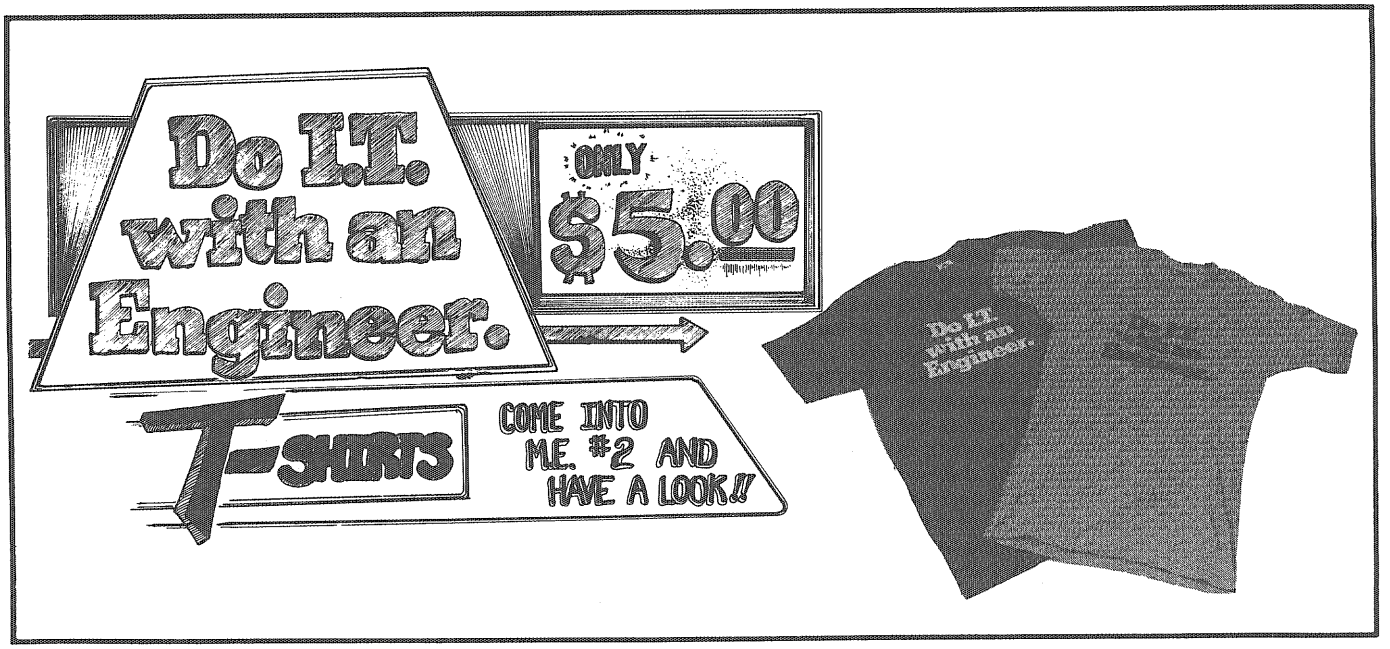
In each issue of *Minnesota Technolog* there will be some puzzle to challenge you. These are not entirely for your leisure; be the first person to bring the completed puzzle to the Technolog office in Room 2, Mechanical Engineering, and we'll give you a free "Do I.T. with an Engineer" T-shirt. Good luck!

1 A forester has a problem. He wants to plant a group of pine trees so that each tree is equidistant from every other tree. Because thoughts of geometry are too taxing, he turned to you to solve his problem. How many trees could he plant?

2 A civil engineering student works for the Minnesota Department of Transportation in Minneapolis as a highway inspector. As an incentive for efficiency, she could receive a bonus if she can cover the entire inspection route without driving any road twice. They'll toss in a week vacation if she can drive the route once and finish back in Minneapolis. Will she get a bonus? If so, what is the route that will bring the biggest bonus?



3 A geology student on a field trip hikes 120 meters north, 4 feet west, and 25 yards south. What is the maximum distance in meters that he could be from his camp?



Technotrivia

Questions

1) Which country has proportionally more scientists and engineers than any other in the world?

2) Pewter is an alloy of two other metals. What are they?

3) How many feet are in a mile? If that was too easy, how many feet are there in a league?

4) Here's one for the architecture students. The tip of the tower on top of the Empire State Building is 1,250 feet above ground. What was the intended purpose for the tower?

5) During his studies of perpetual motion, Blaise Pascal invented a device commonly found in Las Vegas today. What was his invention?

6) In November of 1980, Voyager 1's radio signal was weakened for 15 minutes as it passed behind Saturn's rings. Astronomers determined the thickness of the rings from this data. How thick are Saturn's rings?

7) Litmus paper can be found in most chemistry labs. What have you exposed blue litmus paper to if it turns red?

8) What mathematician said, "It is remarkable that science, which began with the consideration of games of chance, should have become the most important object of human knowledge?"

9) In 1969, Neil Armstrong stepped out of Eagle onto the Sea of Tranquility. Who was the second man on the moon? Give yourself a big pat on the back if you can also name the astronaut who remained in the command ship orbiting the moon.

10) If time is money, then the minute beginning at 7:59 p.m. on June 30, 1983 was a bargain. What was special about that minute?

Answers

1) Switzerland has 40 engineers and scientists per 1,000 people, more than any other country in the world. The Soviet Union placed second with 39.6. However, this figure includes many students who are not professionals. The United States lists only eleven scientists and engineers per 1,000 people.

2) Pewter is an alloy of tin and lead.

3) There are 5,280 feet in a mile. With three land miles making a league, there are 15,840 feet in a league.

4) Although it was never used for this purpose, the tower on the Empire State Building was intended as a mooring place for dirigibles.

5) The roulette wheel was developed as a by-product of Blaise Pascal's experiments on perpetual motion.

6) Howard Zebker and Leonard Tyler of Stanford University calculated the rings to be only thirty feet thick at some points. This is 100 times thinner than earth-bound observations had indicated. The discrepancy is attributed to a warping in the rings which makes them appear to be more than a half mile thick.

7) The litmus paper has been in contact with either acid or red food coloring.

8) The quote belongs to the famous French astronomer and mathematician, the Marquis De Laplace.

9) Edwin E. Aldrin, known as Buzz to many Americans, was the second human to leave footprints on the moon. Astronaut Michael Collins remained in the orbiting command ship.

10) That particular minute was 61 seconds long. The International Bureau of Time in Paris added one second to their atomic clock to compensate for the slowing of the Earth's rotation rate.

Score

0-1 Don't waste your time in the next issue. We tried to make this one easy.
2-3 Try to read more than just the cereal box at breakfast.
4-8 Congratulations! Ya done good.
9-10 Why don't you stop by our office and help us write the next set of questions.

---

science fiction writing contest

First Prize: $100
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deadline
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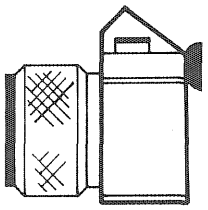
RULES:
The contest is open to all registered U of M students of amateur status (persons never having published a work of fiction for monetary payment), except *Technolog* staff and I.T. Board of Publication members past or present. Entries must be typed, double-spaced, with one-inch margins on 8½x11 paper and be no longer than 3500 words. Each entry must be accompanied by three photocopies of the manuscript and must bear an attached cover page with the story title, author name, home address and phone number. DON'T PUT AUTHOR'S NAME ANY WHERE ELSE ON MANUSCRIPT! *Minnesota Technolog* retains first publication rights to all winning manuscripts. If you have any questions, call 373-3298.



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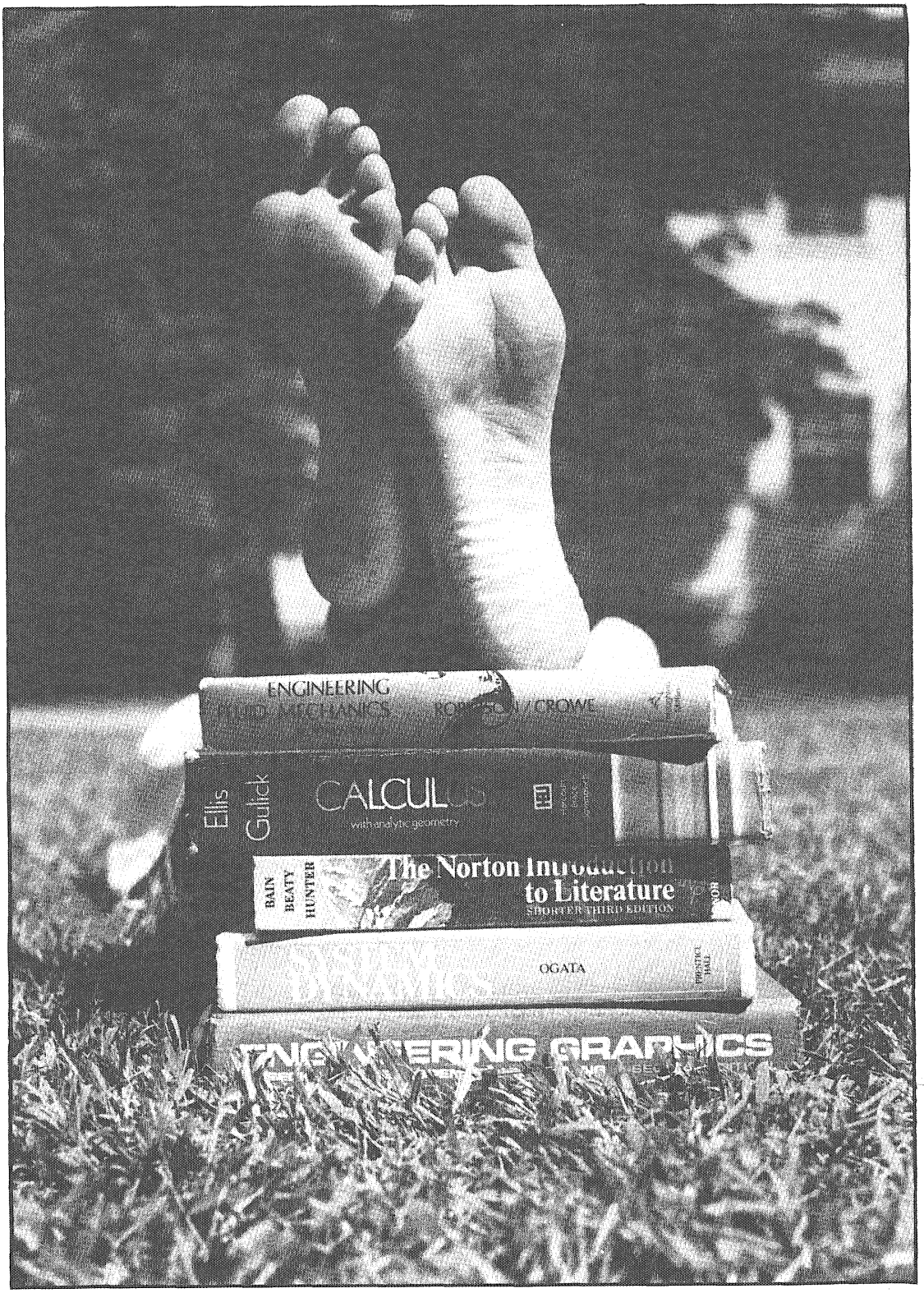

Photo David Herridge

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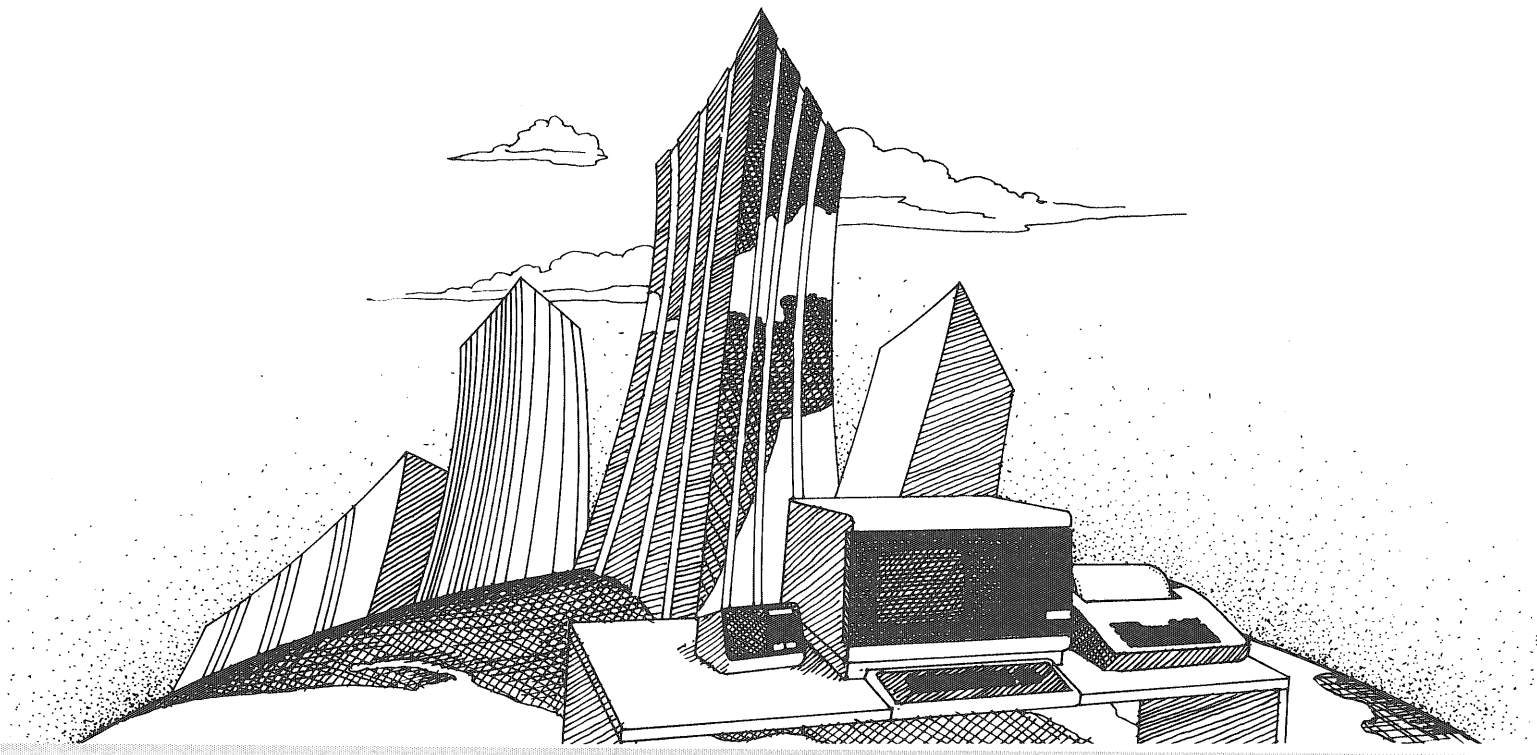

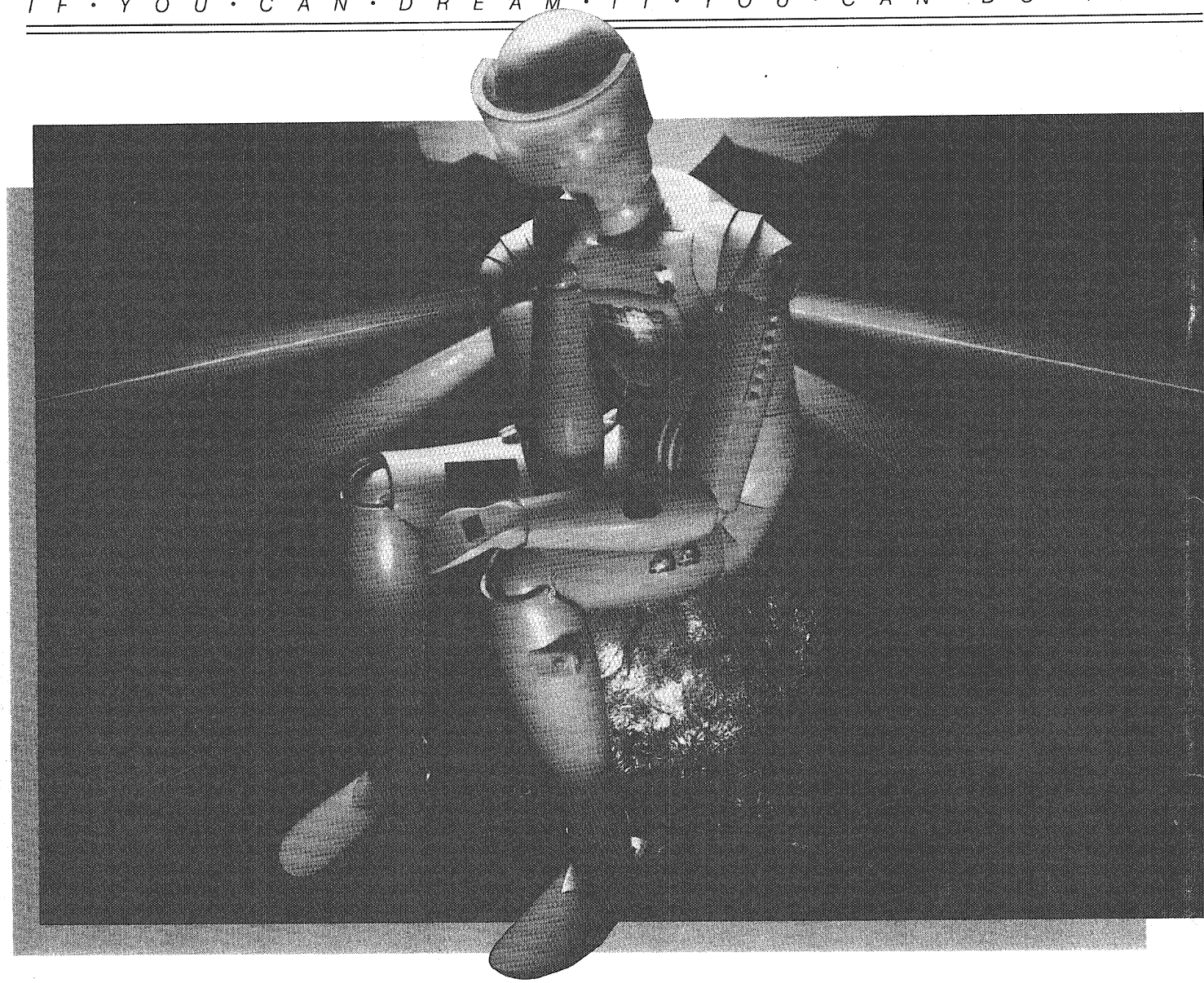

Create computers that capture the mysteries of common sense.

The brain does it naturally. It wonders. It thinks with spontaneity—advantages we haven't been able to give computers. We've made them "smart," able to make sophisticated calculations at very fast speeds. But we have yet to get them to act with insight, instinct, and intuition.

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We are also looking at parallel processing, a method that divides problems into parts and attacks them simultaneously, rather than sequentially, the way the human brain might.

While extending technology and application of computer systems is important, the real excitement and the challenge of knowledge engineering is its conception. At the heart of all expert systems are master engineers and technicians, preserving their knowledge and experience, questioning their logic and dissecting their dreams. As one young employee said, "At GE, we're not just shaping machines and technology. We're shaping opportunity."

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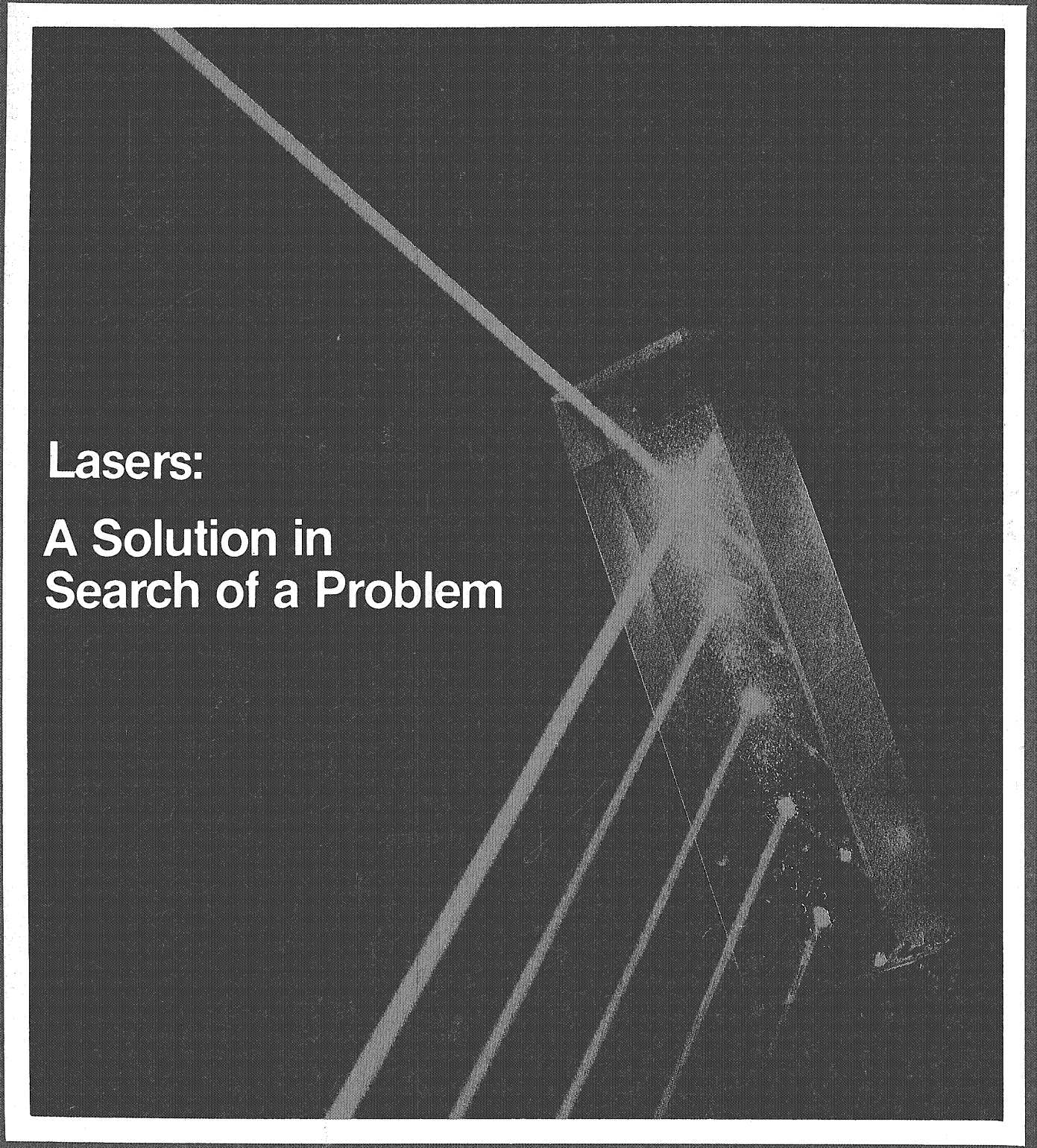

Lasers:
A Solution in Search of a Problem

Amateur Astronomy Computer Engineering

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minnesota TECHNOLOG

Fall, 2, 1984 Volume 65, No. 2

The official undergraduate publication of the Institute of Technology.

Features:

Departments:

Cover: *Minnesota Technolog* would like to thank Chris Faust for his photo of a laser.

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editor's log

Conquering the Experience Quest

You sit on your hands, biting your lip with anticipation. His eyes dart down the page, occasionally he hums a little melody. After the eternity of the opening minute, he looks at you over the top of the paper. You smile and try to find a good place for your hands. He does not seem impressed with your gray suit. Everyone he saw today wore a gray suit. He does not seem impressed with your resume. Everyone he saw today presented a similar resume.

During an interview, you must convince recruiters of your eagerness to work. The experience compiled on your resume provides the evidence for your case. A student questing work experience should consider entering a cooperative or internship program.

The benefits go beyond an eye catching entry in your resume. The hands-on exposure to industry eases the transition between the controlled, textbook setting of the University and the "real world." The intern experience can justify the long hours of study you have already invested by showing many textbook concepts at work, and it can rejuvenate your enthusiasm for future course material. One student interning through the ME department said he always felt eager to go to work at the end of a quarter, and eager to return to school at the end of work.

Your actual duties at work can vary between the excitement of a small project to the boredom of serving as a "go-fer," depending on the engineer you work under and the program you enter. The time commitment varies from two years of alternating quarters between school and work to a three month summer stint. Taking the initiative to give up your summer or a quarter at school shows a willingness to work.

Many firms will reward interns who exhibit that willingness by offering them full time positions upon graduation. "Our main goal is to bring the students in, have them intern with us a couple of years, then offer them full-time employment," said Dick Reid of Control Data in a recent *Graduating Engineer* article.

Many of the best intern opportunities are offered through programs organized by the individual I.T. departments. Because many award college credits, the department supervises how a firm uses its interns, thereby reducing the chance of a commitment to a token position. The only drawback is the longer duration many of the school programs request. You should contact your I.T. department for details on any opportunities. The deadlines for many programs are approaching.

Internships are available over shorter periods through individual companies. Directories published by the National Society for Internships and Experiential Education list programs available to undergraduates and graduates. These can be found in many libraries or purchased through the society at 1735 Eye Street N.W., Washington, D.C. 20006 ($9.50 each).

A unique internship program is sponsored by Honeywell each year. The Honeywell Futurist Awards Competition challenges students to imagine the world in 25 years. If your ideas are judged feasible and the most imaginative, you win a Honeywell internship and a bit of cash. The deadline for entries is December 31, 1984. Blue books can be obtained by writing to: Official Futurist Blue Book, Honeywell Futurist Awards Competition, P.O. Box 9017, St. Paul, MN 55190.

The whole matter of experience is really up to you. No one is going to twist your arm to accept some, you need to go after it. It isn't too early to begin arranging for a position for next summer, especially if you choose to enter a University program. If you decide to let it slide and your resume ends up looking sparse, there are other ways to find work after graduation. You could work on being adopted by someone who sits on a Board of Directors somewhere.

David Herridge

David Herridge
Editor

letters from readers

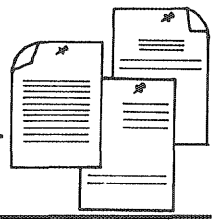
With regard to the comparison of RPN and algebraic calculators (Fall 1, 1984). The problem given can be done in 15 steps by the algebraic calculator, the same as RPN.

W + U = ÷ (1 + U x W ÷ C x^2 =
□ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □

Also, by not covering Basic programmable calculators, you are ignoring the calculators that give you the most memory for the money.

Michael Riley

Minnesota Technolog welcomes our readers' viewpoints. If you have a comment on the University, the Institute of Technology, or the content of *Minnesota Technolog,* feel free to drop us a note. Please double space. Letters must include the writer's signature, address, phone number, and major. If you have any question, call 373-5863 or stop by Room 2, Mechanical Engineering.



log ledger

University Supercomputer Plans

The University of Minnesota is one of 20 education and research institutions seeking authorization by the National Science Foundation (NSF) to establish a supercomputing center.

The proposal for the center is a result of a growing concern that the lack of available supercomputing time at most universities will hamper the nation's scientific research activities. If Congress approves funding, seven centers would provide supercomputer time to researchers via telephone and satellite links.

The final selections for the NSF endorsements will be announced in the spring.

* * *

The University of Minnesota is one of only four schools in the country operating a supercomputer. The University is planning to house its academic and research computers in a Supercomputer Institute. The University's Cray-1 at the UCC's Lauderdale headquarters will be joined early next year by a prototype Cray-2. Discussion for the acquisition of a Cyber 205 and a ETA GF-10 is also under way.

The development of a Supercomputer Institute was singled out by I.T. Dean Ettore Infante in a statement of priorities. He wrote that the Institute would be supported by significant resources from I.T. Dean Infante called the plan an "unusual opportunity for the entire Institute and the University," citing the strength it would bring to the electrical engineering and computer science departments.

The location for the Supercomputer Institute will fall inside the boundaries of the Minneapolis High Technology Corridor Project which hopes to attract businesses into a 70 acre area along Washington Avenue. The block edged by South 12th Street and Washington Avenue was approved by a review committee composed of University, city, and state representatives. The proposal submitted by Appletree Enterprises would convert the Holden Warehouse which occupies the block into a two level parking ramp and 120,000 square feet of office space. The University Board of Regents has not approved the site, wishing to further assess which of the four original proposals best suits its interests.

New Laser Fuses Research

The Lawrence Livermore National Laboratory in California announced its newest laser, which is over three times more powerful than any other in the world, is scheduled to begin operations this month.

Dubbed Nova, the ten beam laser will concentrate a 120 trillion watt pulse of light onto a target 100 feet away. The targets will be heated to temperatures exceeding 18 million degrees Fahrenheit and compressed under pressures above 10 million atmospheres. Under these conditions, the target will release energy as its nuclei are fused.

Nova's capabilities allow scientists to explore how extremely high temperatures and pressure affect matter. The laser is considered the first step toward the development of a fusion reactor.

Mac SIG

Through the University Microcomputer Discount Program, over 400 Apple Macintosh computers have been sold. In response, a Mac Special Interest Group has been formed. On the third Thursday of each month, a 7:30 p.m. meeting will present user information and discussion. For details, check the bulletin board outside 125 Shepherd Labs or call Ramsey Smith at 378-2775.

Smart, but Obnoxious

The more critical, mean, and obnoxious you are, the smarter you are perceived to be according to a recent three part study conducted by Dr. Teresa Amabile of Waltham, Massachusetts.

Forty-four students were hired to review essays on social problems. One group was hired with the condition that their continued employment would be determined by their reviewing performance. The second group was told the job status was guaranteed, no matter what their performance. Those who thought their work hinged on a good reviewing job were much more critical and nasty.

In the second phase of the study, 104 students were asked to assess the intelligence of an actor on a taped interview. The students who felt they were being watched as they viewed the tape were much more critical.

Part three was designed to determine whether people felt being "extra critical" makes you seem smarter. Fifty-five students examined a set of book reviews by the same author. Some were complimentary, others were pointed. Students felt the "mean" critiques were done by a more intelligent critic than the "nice" critiques.

The bottom line: if you want to be perceived as intelligent, be nasty.

Engineering Salaries Surveyed

A survey conducted by the National Society of Professional Engineers (NSPE) has shown the median income of NSPE members is $43,017 annually (1983 figures). This represents a 4.2 percent increase over the previous year.

The highest salaries were in Alaska, Guam, Hawaii, Montana, Idaho, Washington, Oregon, California,

Continued on page 30

Lasers: A Solution in Search of a Problem

When certain excited atoms relax you had better stand back. The energy emitted could be a thin, parallel beam of coherent light characteristic of a laser. That light has changed the world since it was discovered in 1960.

By Lee Atchison

Lasers have, over their relatively short history, grown immensely in their practical uses. They are now used in virtually every facet of science and engineering, including: surveying and measuring, communications, data storage, medicine, surgery, genetics, and military defense. They have grown so fast that whole branches of science have formed from laser technology. Laser's, because of their unique properties, have brought about improvements to our life style. They have brought a new tool to science and medicine. A tool who's uses are just now being explored.

Laser, which is short for *L* ight *A* mplification through *S* timulated *E* mission of *R* adiation, is a device which emits a thin, parallel beam of concentrated light. The light is monochromatic (i.e., of one particular frequency, or color) and *coherent.* Coherent light is in-phase with itself, i.e., the light emitted from one atom is in-phase (or a *fixed* constant out-of-phase) with the light from a second atom. These properties make lasers useful.

In 1917, the possible existence of lasers was first conceived by Albert Einstein. He realized, under certain circumstances, molecules could absorb radiation, store it, and later release this energy in the form of light. It wasn't until the 1950's that it was discovered how this held energy could be amplified and released in large quantities to make laser light.

The ten years following 1950 were filled with research and speculation. The first laser was finally built in 1960 by Theodore Maiman (see profile department—this issue). He used a flash lamp to expose a ruby rod to concentrated radiation. The light that flashed from the ruby rod was brighter than the sun. The first laser was born.

Laser research boomed during the next 20 years. Lasers now enjoy extensive and common use. Many different types of lasers have been developed in a variety of sizes and strengths. They vary in size from a large warehouse to a pinhead and in strength from being able to pulverize steel, to not being able to warm paper. In all their various forms, lasers have become prevalent in our lives.

How they work:

Energy storage is of prime importance to lasers. When an atom is supplied with radiation, it becomes excited. Excitation causes an increase in the energy level of the atom. This causes an electron to move "up" an energy level, i.e., move into a higher orbit around the nucleus of the atom. The energy from the radiation has been converted to potential energy.

Later, this electron will fall to a lower energy level, releasing the energy it was storing. The release of energy is in the form of radiation at a particular frequency. The frequency of this radiation is a function of the distance the electron dropped, and thus, a function of the initial energy put in. These can be expressed by this equation:

$$f = \frac{\Delta E}{h} = R_h \left(\frac{1}{{n_i}^2} - \frac{1}{{n_f}^2} \right)$$

Incoming radiation can excite an atom into a higher energy level. This potential energy will either be released naturally or through a stimulated release caused by more incoming radiation.

Figure 1a: Resonance Absorbtion

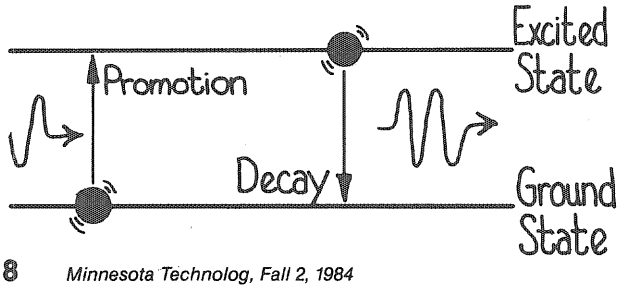
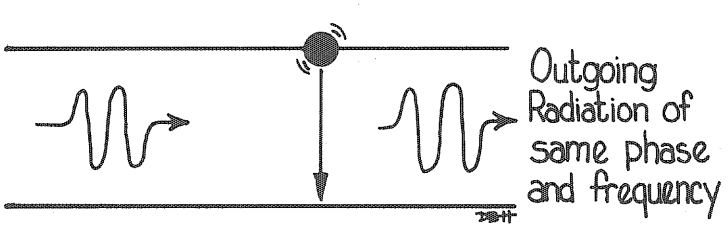


Figure 1b: Stimulated Emission



where f is the frequency of the radiation, E is the energy supplied (and removed) from the atom. RH and h are fundamental constants (called Ryberg's constant and Planck's constant respectively), and ni and nf are integers representing the initial and final level of the electron in the atom. This equation displays one other property of the energy storage: the quantization of energy. Seeing how ni and nf (the energy levels) are both integers, the energy, E, and thus the frequency, f, can only take on fixed, or quantized values. This is the basis of quantum physics.

Absorption, storage, and release of radiation can take on many forms. An atom which, after being excited by absorbing energy, releases it naturally undergoes what is called *resonance absorption* (see figure 1a). The release of radiation is not related to the acquisition of radiation, it occurs naturally. If an atom that is already in an excited state receives additional radiation, it will either become more excited, or, under certain circumstances, release its energy that it has stored along with the energy it has just received. This energy release is called *stimulated emission.* This occurs when the radiation being received is of a frequency that its energy is equal to the energy of excitement contained in the atom. They are in resonance (see figure 1b). The radiation that the atom emits is parallel, of the same frequency, and in phase with the incident radiation just received. This is what makes laser light monochromatic and coherent.

Light Amplification through Stimulated Emission of Radiation

In a laser, atoms are excited by *optical pumping.* Large amounts of radiation are pumped into atoms of some element causing them to become excited and gain energy. This is shown graphically in figure 2. The atoms are excited from the ground state, E1, to the excited state, E3, and then spontaneously drop back to energy states E1 and E2. If the pumped radiation is strong enough, more atoms are transferred to state E2 than E1 creating a *population inversion,* which means there are more high energy electrons than low energy electrons. When radiation with energy (E2-E1) hits these atoms, a stimulated emission results which releases radiation at that energy level. The result is an avalanche effect as large amounts of amplified radiation of a certain frequency (constant energy level) and completely coherent is released, creating laser light.

In a ruby laser, a ruby rod is polished and capped with mirrors (see figure 3). One side is completely reflective, the other only partially reflective. The ruby rod is pumped with green light which excites the ruby atoms. If enough green light is pumped in, stimulated emission starts

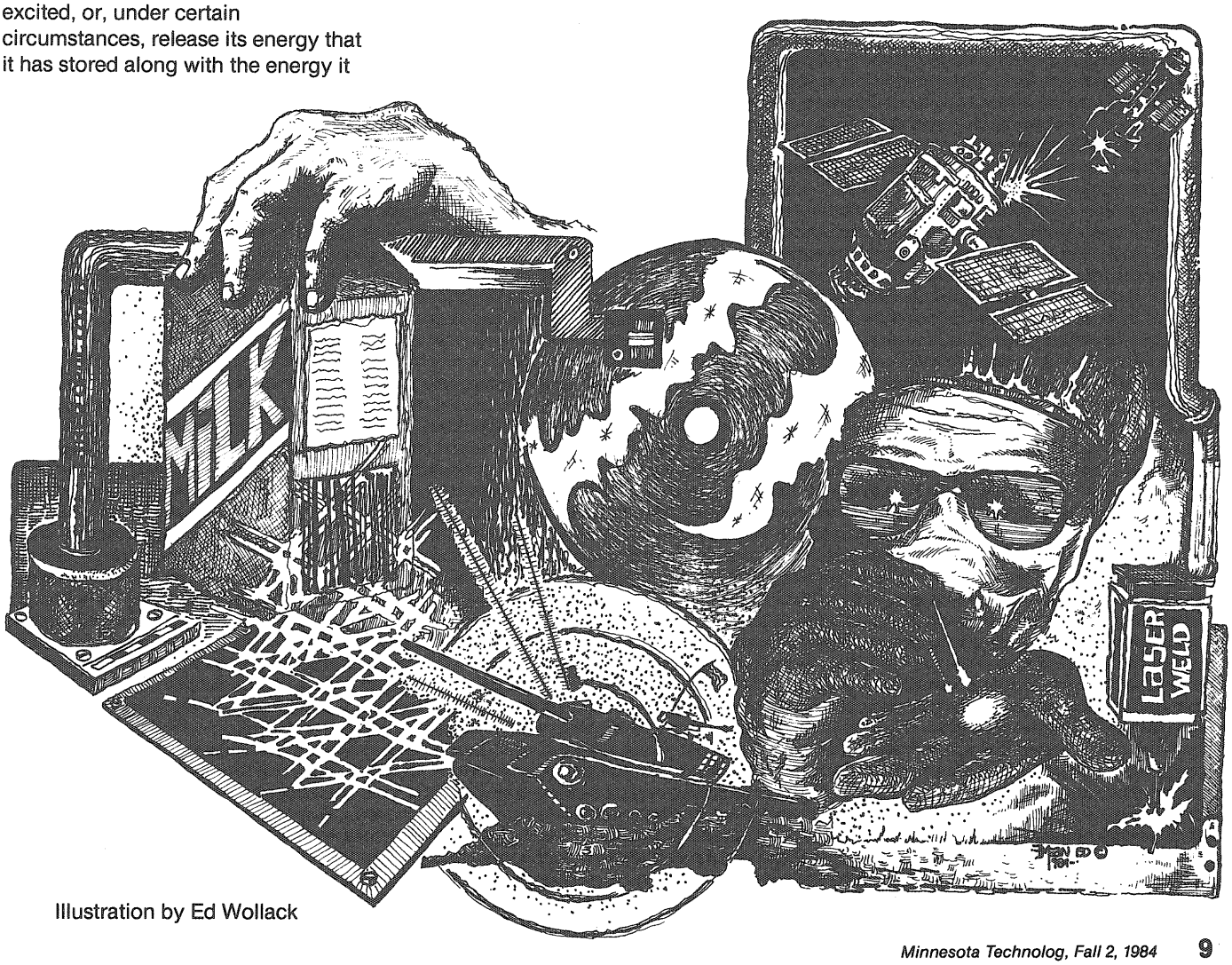


Illustration by Ed Wollack

up an avalanche of light which bounces back and forth from end to end along the rod. This bouncing back and forth causes more stimulated emissions. When the intensity of the light is high enough, it leaves the laser through the partially reflective mirror in a thin strand of monochromatic, coherent light.

Types of lasers:

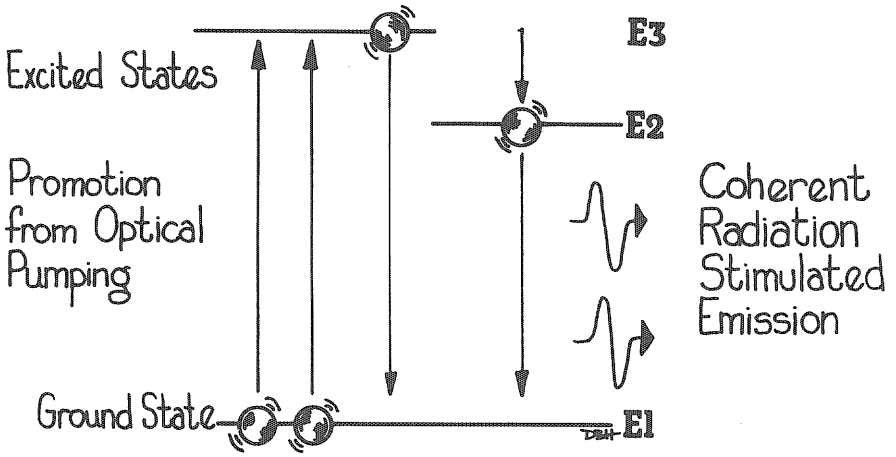
Lasers come in various forms. They vary in strength from the typical supermarket checkout laser which couldn't harm a fly, to lasers that can vaporize iron, raising its temperature at a rate of one trillion degrees per second.

The most common laser, the helium-neon laser, consists of a glass tube filled with helium-neon gas. The ends of the glass tubes are covered by mirrors: one totally reflective, the other partially reflective. The gas is excited by an electric current coming from a cathode similar to a neon sign. The excited gas emits light which escapes the rod through the partially reflective mirror. This particular laser is used extensively in supermarket checkout counters to read the UPC (Universal Product Code) that identifies products being purchased.

There are two main areas where lasers differ. The first is the material used to create the light. The other is the energy "pumps" used to excite the base material. The most common materials used in lasers are carbon dioxide, ruby, argon, YAG (yttium, aluminum, and garnet), and helium-neon. The different types of energy used are electrical, radio waves, light, chemical, and radiation (from nuclear explosions).

Every laser gives light at its own particular wavelength (color). Not all lasers emit visible light, they emit radiation anywhere from the microwave range to the X-ray range.

Figure 2: Electron Promotion and Decay



Electrons undergoing stimulated emission are promoted to high energy levels and decay to their ground state.

The laser, because of the special properties of the light it emits, has a wide variety of uses. Many of the uses are just now being explored, some are just dreams, others haven't been conceived yet. The possibilities are so endless that the laser sometimes has been called "a solution in search of a problem."

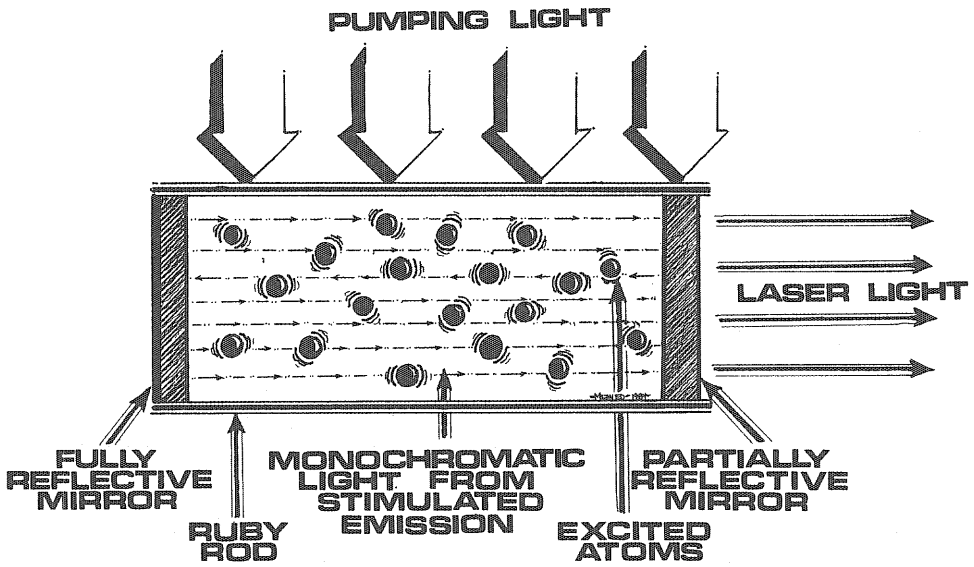
Lasers are used by surveyors to drill tunnels and measure long straight lines. They are much more accurate than conventional measurement techniques. They are used to detect minor movements between sections of land; thus, detect earthquakes early.

Lasers can transmit information through optical fibers over extremely long distances with much less noise and loss than electrical lines or radio transmission. Semiconductor lasers, formed from a crystal like silicon, are smaller than the head of a pin. Hundreds of these lasers can be formed from a single sheet of crystal and used to transmit hundreds of pieces of information simultaneously over a single fiber optic bundle, inexpensively and reliably. The laser can be used to store large amounts of information on video-disks. These disks, consisting of platters with billions of tiny pits each holding a bit of information, can store the equivalent of many thousands of books.

Early after the discovery of the laser, its importance in medicine was

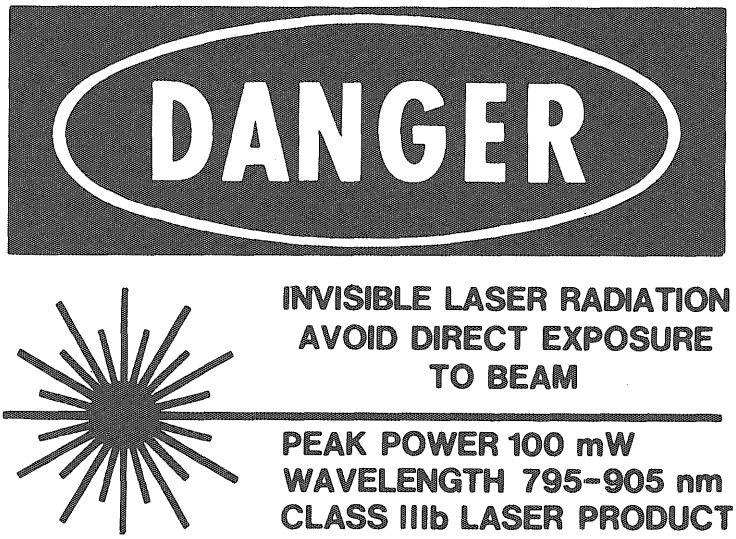
Continued on page 28

Figure 3: Operation of a Ruby Laser



The pumping light causes the atoms in the ruby rod to become excited. The energy they release when they decay is monochromatic light which bounces back and forth between the mirrors that cap the rod, eventually escaping through the partially reflective mirror.

University Lasers



Acoustic Microscope Looks Beyond the Surface

By David Herridge

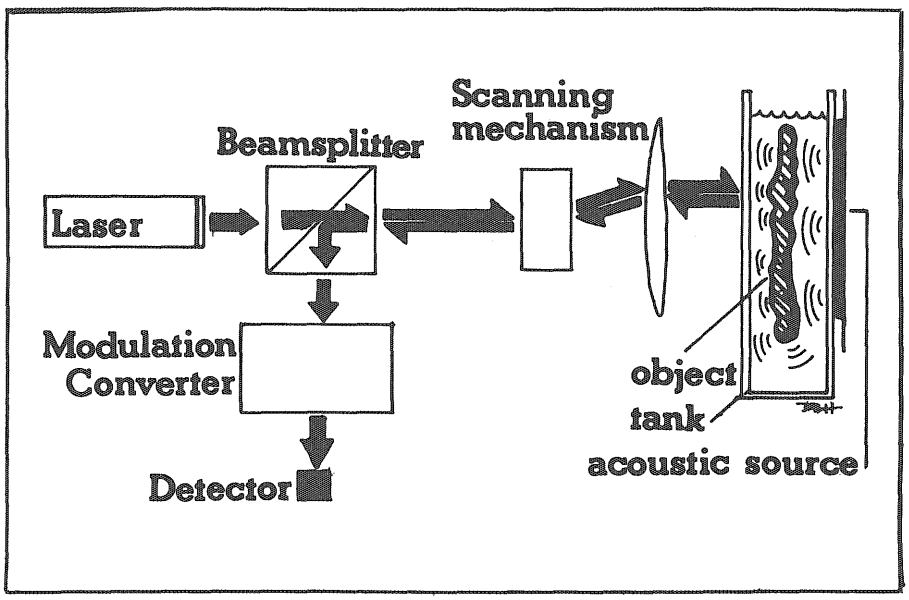
The acoustic microscope is a new tool that allows researchers to determine subsurface density and elasticity through nondestructive techniques. Rolf Mueller and Richard Rylander were both active in the development of an acoustic microscope here at the University of Minnesota.

Many different configurations of acoustic microscopes have been developed. The scope here at the University utilizes a laser to detect the vibrations which are reconstructed into an image of the object.

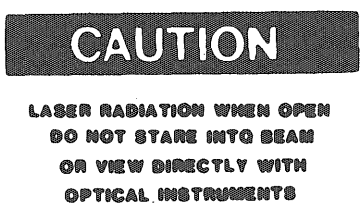
The object under inspection is submerged in a liquid cell, one side of which is an optical mirror while the other side is coupled to a large area acoustic source. The mirror vibrates when the sound wave from the object passes through it, causing a scanning laser beam's phase to undergo modulation. The laser light that is reflected off the vibrating mirror carries the information of the mirror's phase and amplitude. This light is then recollimated and directed into a phase modulation converter that provides an output of intensity modulation. The light is finally focused on a photoelectric detector to produce an electric current. The modulating current is linked to a cathode ray tube to display the object's sound transmission properties.

The resolution of the laser scanned microscope has been limited by the wavelength of the laser light. It is hoped that through electronic image processing, the resolution can be improved. Currently, the laser scope is best suited for displaying the transmission characteristics of relatively thick objects (exceeding several wavelengths).

The ability of the acoustic microscope to probe below an object's surface and return information of physical properties (like density, viscoelastic moduli, and thermoelastic coefficients) makes it a valuable tool in materials research, biomedical research and diagnostics, microelectronics inspection, and quality assurance.



The laser scans the optical mirror which vibrates from the waves off of the object. The modulation in the laser light is eventually converted into current which is fed to a CRT to construct the microscope's image.



Nd-YAG Laser Operates Where Others Cannot

By Vernon Thorp

Early this year, the Pulmonary Division of the University of Minnesota's Department of Medicine received its first Neodynium-YAG (Neodynium-Yttrium-Aluminum-Garnet) laser system. It is used to treat problems due to cancer in the tracheobronchial tract.

The Nd-YAG laser delivers a beam of near infrared radiation with a wavelength of 1064nm. A quartz monofilament fiber conducts the beam through a flexible bronchoschope. Also tied into the system is a helium-neon pilot laser to illuminate the target area of the invisible Nd-YAG laser. The bronchoscope's coaxial design allows the quartz fiber to be cooled by a continuous air flow.

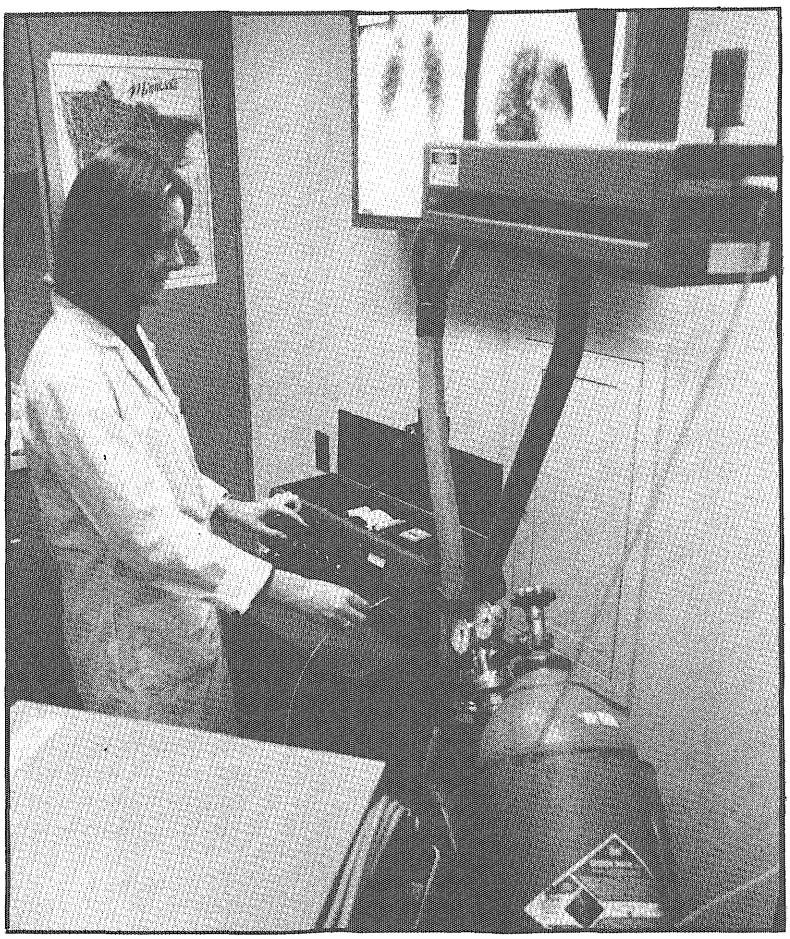
According to Dr. Linda Hedemark of the Pulmonary Division, the $100,000 system enables the doctors to treat previously inoperable conditions. An inoperable condition may exist when a tumor is located in an area that cannot be reached by conventional surgery, or when a tumor involves a large area of the tracheobronchial tract. In both of these cases the laser can destroy the tumor, transforming it into scar tissue.

The most common application of the new Nd-YAG laser has been to clear airway obstructions caused by large tumors. These tumors fail to respond to chemotherapy or radiation treatments and cannot be resected (removed) due to their large size. In the past, this meant a very uncomfortable situation for the patient, possibly ending with suffocation. The Nd-YAG laser allows doctors to reduce the tumor to benign scar tissue and return the airway to its normal size. Cancers that spread to the tracheobronchial tract from other areas can also be treated. Besides the accessibility the bronchoscope-laser combination provides a doctor, there are several other characteristics that make the laser especially valuable for use in the airway. First of all, scar tissue is minimized. Second, blood vessels in the affected areas are cauterized. Finally, there is much less edema (tissue swelling) compared to conventional surgery.

The Ng-YAG laser allows doctors to treat previously inoperable conditions.

Special precautions must be observed when operating the Nd-YAG laser. Attending personnel must wear goggles to prevent retinal damage from any stray radiation. Also, caution must be exercised in administering anesthetic gases to a patient undergoing Nd-YAG laser therapy. An oxygen rich environment around the operating field creates a slight risk of fire in the airway. Continuous air-cooling of the optical fiber and avoidance of flammable gases and flammable materials in the construction of the bronchoscope minimize this risk. No airway fires have been reported with the Nd-YAG laser, but several have occurred with more powerful CO_2 lasers.

Nd-YAG lasers are relative newcomers on the medical scene, having been used in tracheobronchial applications less than five yeares. No new research is being planned for the Pulmonary Division's Nd-YAG laser at this time. Doctors will continue to use the laser in cases where traditional therapy does not work and surgery cannot be safely performed.



A Ng-YAG laser is used by the U of M Pulmonary Division of the Department of Medicine.

Searching for Relics of the "Big Bang"

By David Herridge

A long time ago, right here in this universe, there was a very big bang.

Today, right here at this university, Professor George Greenlees is searching with lasers and highly sensitive light detectors for an atom which theory predicts was created during the first few microseconds of the big bang. When energy was turned into matter, a special sub-atomic quark could have marked many atoms with a nucleus weighing hundreds of times more than normal.

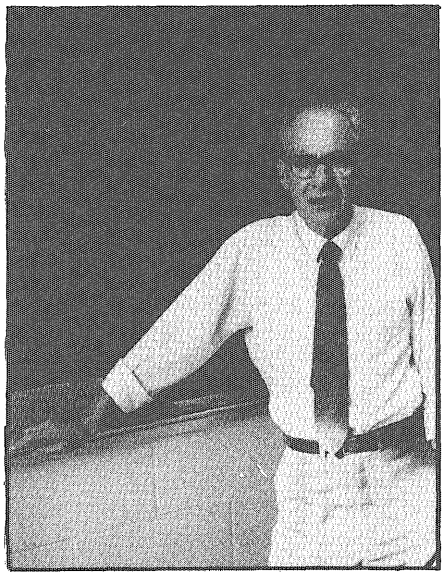
One out of every trillion atoms in the universe might have the heavy nucleus.

Greenlees, a physics professor, is searching against the odds. He estimates one of every trillion atoms in the universe might have the heavy nucleus. Finding that one atom to support the theory is no easy task. "It's like looking for a needle in a haystack, with the needle made of dense straw," said Greenlees in a Minneapolis Tribune article.

The first stage of the experiment used a dye laser directed across the dark laboratory into a sample of burning sodium. A dye laser is capable of providing light across a range of frequencies. By precisely tuning the yellow laser light to the correct frequency, information about the sodium atoms which pass through the beam can be retrieved.

When an atom is struck by the laser, its electrons are stimulated to a higher orbital. When the electron drops to its original orbital, the scattered photon is detected and recorded. The energy required to reach an excited state is dependent on the atom's mass and the energy the laser provides is dependent on its frequency. This correlation allows Greenlees to search for a heavy atom of unknown mass by varying the laser's frequency and watching for the emitted pulse of light.

After collecting about one hundred hours of usable data on the sodium samples, no heavy atoms had been discovered. Originally, it was planned to sample sodium from all over the world in case the Earth's formation concentrated the atoms in a specific locality. The new plan will narrow the odds another way.

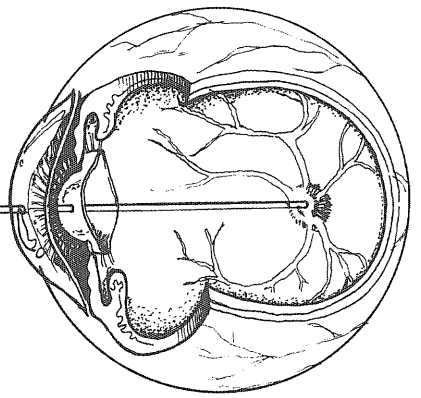


Physics Professor George Greenlees uses a laser to search for atoms marked by the energy of the "Big Bang."

The laboratory is waiting for a new dye laser whose frequency range will allow Lithium samples to be observed. Lithium, unlike Sodium, was one of the original elements present when the big bang occurred. It is hoped the odds that heavy Lithium still exists will be more favorable. Greenlees expects it will take a couple of years to reach any final results.

Lasers Restore Vision

By Vernon Thorp



Ophthalmologists have developed many techniques for treatment and diagnosis of eye problems using lasers.

For the past 20 years, lasers have been available for use in the field of ophthalmology. Since their introduction, the equipment and techniques have dramatically improved. Laser applications in ophthalmology fall into two broad categories: treatment and diagnosis.

Treatment makes up the largest of these two categories. It involves using a laser to burn or to cut. Burning consists of destroying tissue and promoting scar formation, while the cutting ability allows a surgeon to operate on the interior of the eye without actually opening the eye to get inside.

Laser burns depend on the thermal properties of the tissue being treated. One of the first applications of lasers in ophthalmology was for photocoagulation. Photocoagulation requires a temperature rise of 10 to 20 degrees Celsius in the tissue. The temperature increase is caused by pigments in the tissue absorbing incident laser light in the visible range. Ruby, xenon, and argon lasers produce light in this range. The actual type of laser used depends on which wavelength is needed, which in turn depends on the type of tissue being treated. Photocoagulation allows reattachment of detached retinas by "welding" them back into place on the underlying layer. It can also seal off leaking blood vessels or destroy unwanted tissue.

A laser produces a cutting action through photovaporization. This occurs when a short burst of energy heats cells in the target area past the boiling point of water. The cutting action results from the almost instantaneous vaporization and expansion of intra- and extracellular water. Wavelengths are usually chosen so the energy is concentrated on the surface of the target tissue, destroying cells and creating an incision. A major advantage of this technique is that it immediately cauterizes surrounding blood vessels,

Continued on page 30

Getting the Whole Message

Holography, a lensless photographic process, uses a laser to record all of the characteristics of an object's shape, color, and position. When the information is reconstructed, the three dimensional image is nearly identical to the original object.

By Debby Latimer

With the invention of the telescope and the microscope man has been able to extend his vision out into two fascinating realms: reaching into infinity with one eye while glimpsing into the heart of an atom with the other. It has been said that the discovery of the lens is the one most important piece of scientific equipment of use to man in the whole of natural science. Without it, our knowledge of many disciplines would certainly have remained at a very primitive stage of development. The importance of the lens and its effect on mankind is startling. Yet, in contrast to these dramatic consequences, a new and exciting procedure has come to the attention of scientists and artists alike: holography, which is a *lensless* photographic process.

Originally, the hologram was conceived by Dennis Gabor in 1947 to improve the resolution of electron microscope photographs. The word itself originates from the Greek 'holos' meaning 'whole' and 'gram' meaning 'message'. Unfortunately, his idea was ahead of the technology. For the light needed to demonstrate the full capabilities of holography, a single-frequency form called coherent light, was not available until 1960 when the laser was developed.

The actual technique of holography is similar to photography in many respects, yet it is fundamentally different. In photography, one records the optically formed image of an object. The image focused upon through the lens is recorded directly onto the film. Holography records the wave field of light the object scatters, which is called the interference pattern. Since no image-forming device is used to create a hologram, no recognizable image forms on the plate. Instead, the plate records the pattern of the light waves that impinge upon it.

An interference pattern looks like a meaningless mixture of lines and blotches, yet it contains all the information about the object's shape, color, and position. The information content latent in the interference pattern is much more extensive than the information which can ever appear on an ordinary photograph. An ordinary photograph records only

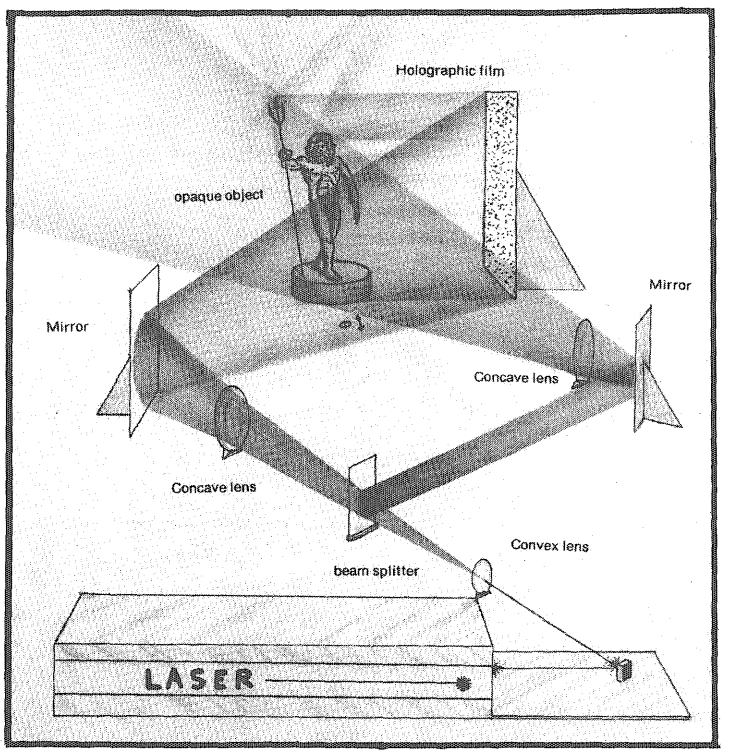


Figure 1: How to make a Hologram

The interference pattern from the direct and diffracted light is recorded on a photographic plate to make a hologram.

the intensities of the beams diffracted by an object, while a hologram contains information about the phase of the lightwave too.

The holographic process is generally carried out with coherent light. Coherent light is monochromatic—having a single wavelength, and its waves maintain the form of their wave fronts. Maintaining continuity in the shape of the wave is a very important aspect of holography. To produce a hologram, light from a laser is split into two intersecting beams, the object beam and the reference beam. As interference occurs between the coherent direct light (reference beam) and the coherent diffracted light (object beam) an interference fringe pattern is recorded on a photographic plate. After the plate has been developed, illumination of the hologram will reproduce the original image.

To better understand the holographic process, it will be useful to look more closely at two fundamental quantities of the light wave: amplitude and phase. Amplitude, or intensity of the wave, manifests itself as brightness.

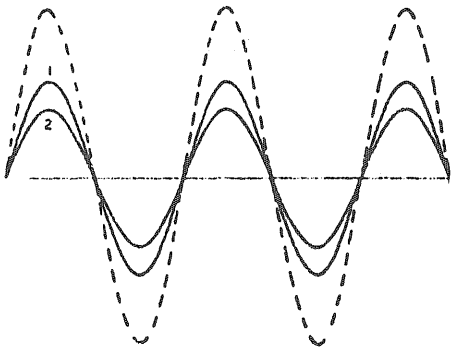
The phase refers to the shape of the wave fronts. Light-sensitive devices are insensitive to the phase. But to record the light wave completely, as holography requires, the phase as well as the amplitude must be recorded.

Before the phase can be recorded photographically, it must be converted into intensity. This is done by the technique of interferometry, wherein the reference wave interferes with the subject wave. The principle of interference is shown in Figure 2.

In Figure (2a), two waves arrive at the recording surface in phase. That is, the crests arrive simultaneously. The wave amplitudes add to form a resultant that is greater than either wave acting alone. This is called constructive interference. Figure (2b) shows two waves arriving out of phase. This results in the difference of the two amplitudes and is called destructive interference. For sound waves, such additive and subtractive effects cause increases and decreases in loudness in the sound pattern. For light waves, they cause variations in brightness or light intensity.

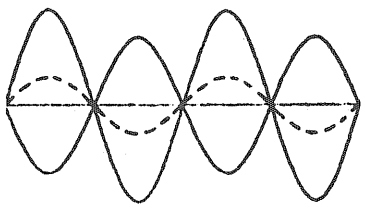
Interference converts phase differences into intensity differences and thereby permits phase effects to be recorded photographically. The completed hologram becomes a blueprint of the lightwave interference

Figure 2a: Constructive Interference



Interference between waves convert phase differences into intensity differences.

Figure 2b: Destructive Interference



The fringe pattern caused by the interference of two light waves is the blueprint of the holographic image.

activity.

To view a hologram, wave front reconstruction is used. When the hologram is placed in a beam of coherent light, it generates a new wave that produces a 3-dimensional image of the original object recorded on the hologram. The regenerated wave and the original are identical to the eye. The observer sees what appears to be the original subject suspended in space. In the March, 1984 issue of National Geographic, tourists at the CBS Laboratories in Stamford, Connecticut were described as being convinced that they saw the real Dennis Gabor working at his desk as they passed by his office door. However, what they really saw was his holographic image.

Holography is a fascinating visual medium and has many practical applications. The scope of holographic applications is growing exponentially.

MICROSCOPY

In conventional microscopy only a limited portion of an object can be in focus at one time. In other words, high resolution is achieved at the price of a very limited depth of focus. This has made analysis very difficult. A solution to the problem is to record a hologram of the object by using a pulsed laser. The object is then frozen in time. Since the hologram contains all the necessary information to explore the full object volume, analysis can continue with the use of an auxiliary optical system. Thus, sequential observation becomes possible.

VIBRATION ANALYSIS

Holography is very useful in non-destructive testing of various

MEMORY

There has been considerable interest in utilizing holography to file and store information. Binary data can be stored in a hologram without the problems associated with conventional microfiche. Since any fragment of a hologram can regenerate the entire image, the fear of losing information is greatly reduced.

DESIGN

There has been an increased use of holograms in the automobile industry to show 3-dimensional images of their products.

ART

One major aspect of the hologram not yet mentioned is as a new art form. Its artistic value adds yet another dimension to the science of holography.

The hologram is simultaneously welcomed as a tool to further the advancement of scientific principles and warmly embraced as a medium of creative expression. The result of such an interlocking of disciplines is that science and art begin to merge together in order to develop the potential of a field of study that may one day change fundamental notions about the nature of our visual stimuli. Holography becomes a space wherein the imagined becomes reality.

profile

Theodore Maiman: the father of

By Patrick McNamee

This article is largely the result of a telephone interview with Dr. T.H. Maiman, held by Technolog *in September, 1984.*

On February 19, 1880, Alexander Graham Bell and his assistant Sumner Tainter succeeded in communicating over a modulated beam of sunlight using Bell's newly invented device, the photophone. Bell was delighted, exclaiming "... can imagination picture what the future of this invention is to be!" He considered the photophone to be his most important invention. Technology, however, was not yet ready for such an advance—practical problems (clouds, nightfall, etc.) forced Bell to scrap the idea, and the photophone was left to gether dust at the Smithsonian. Serious research into lightwave communications would have to wait until a source of coherent (single wavelength), controllable light became available.

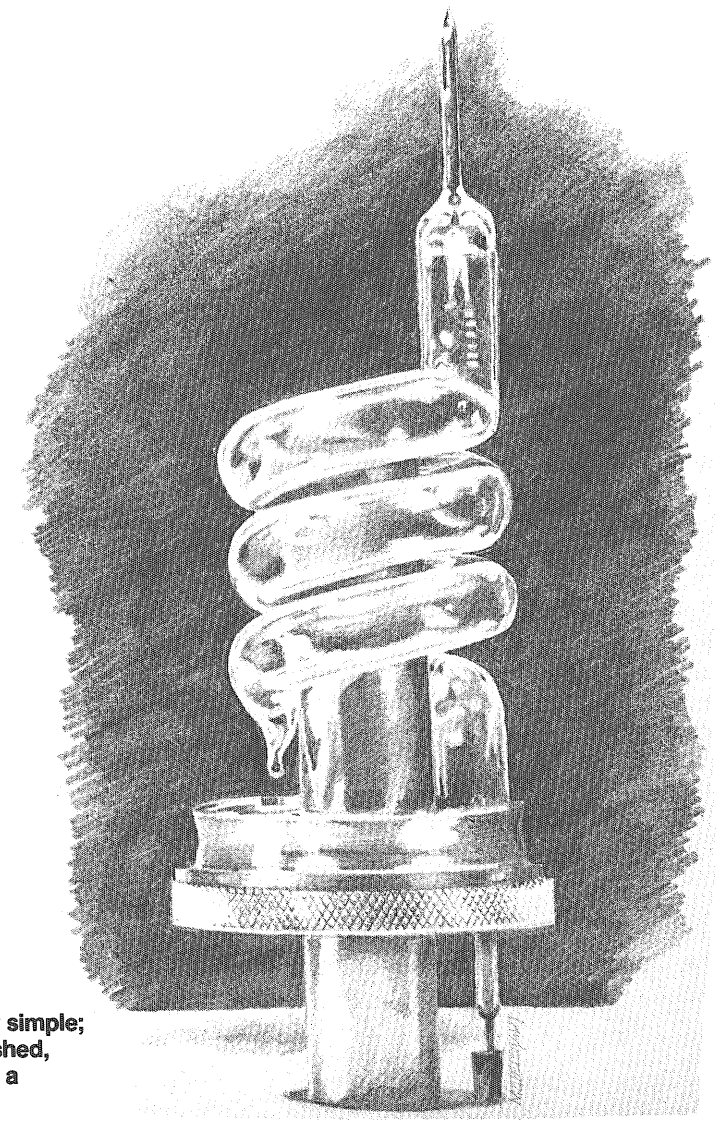
On July 7, 1960, Hughes Aircraft held a news conference announcing the invention of a device by Dr. T.H. Maiman that could produce a thin, powerful beam of red light. The Minneapolis Tribune on July 8, 1960 reported an "Atom Lamp Brighter Than Sun's Center" that had potential uses in medicine and industry. Other newspapers around the country reported—irresponsibly, according to Maiman—the development of a "death ray." Medical wonder tool, communications boon, death ray: an invention that would change the world, the laser, was born.

An early start

Theodore Harold Maiman, born in Los Angeles on July 11, 1927, had an early start in science and engineering. Guided by his father, an electrical engineer with Bell Telephone, Maiman developed expertise in electronics while still in his teens. He earned his First Class Radio-Telephone license at the age of 16.

After high school, he was given the opportunity ("I had a good boss," said Maiman) to design test equipment for vacuum tubes. After high school, he joined the Navy, where he continued his study of electronics. He completed his service hitch and decided to attend the University of Colorado at Boulder, graduating in 1949 with a BS degree in engineering physics. Choosing to pursue advanced degrees, Maiman went on to Standord for a Master's in EE and a Ph.D. in physics, completing his doctorate in 1955. His Ph.D. thesis, foreshadowing his later work, utilized microwaves and optics in a series of measurements of the basic atomic properties of helium.

His university education complete, Maiman went to work for Hughes Aircraft, where he became involved in maser research. (Masers produce coherent microwaves.) At that time, the maser was a cumbersome, impractical device. Maiman, in advancing the maser's design, was able to replace a 5,000-pound magnet with one weighing only one pound. This breakthrough, he says, "made a practical device out of a monstrosity."



The first laser was deceptively simple; a synthetic ruby rod with polished, mirrored ends, surrounded by a coiled flash lamp.

coherent light

One goal of the Hughes Atomic Physics Department was to produce coherent energies at slightly higher than microwave frequencies. An increasing number of scientists were speculating on the possibility of producing coherent waves in the optical region of the spectrum. By 1958, numerous schemes for achieving such production were being tried, but the question of whether or not it was even possible was still being asked.

Background made the difference

Dr. Maiman said his background in electronics, lab work, optics, and physics provided the right combination of experience and knowledge to develop a feasible design. His approach emphasized simplicity. Since he wasn't certain that coherent light could be produced, Maiman wanted to keep his design simple enough so the entire process could be understood. He wanted a device that was small, rugged, and operable at room temperature. As it turned out, the final construction was deceptively simple. It consisted of a cylindrical rod of synthetic ruby with the ends polished and parallel, then silvered. This was surrounded by a foiled flash lamp. The lamp excited the ruby's electrons, and, in subsequent energy level changes, energy was released in a cascade of red light.

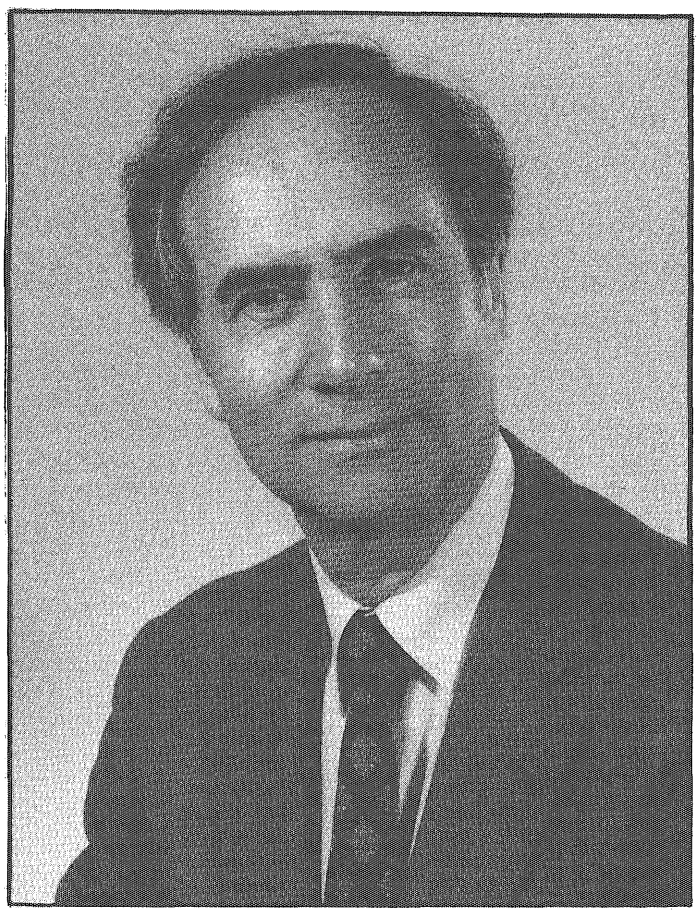
Cascades bred cascades

In the wake of Maiman's success, a cascade of uses for the laser has emerged. Applications have been found in industry, data processing, communications, and many areas of scientific research. Of all the uses, though Maiman is most gratified by the laser's success as a medical tool, remarking, "I feel pretty good about it... very good."

His approach emphasized simplicity.

A year after demonstrating his invention, Maiman left Hughes to begin a series of entrepreneurial ventures. He was involved in a laser manufacturing company, a laser television firm, and a company formed to develop an automatic digital telephone. In 1976, Maiman joined TRW Electronics as a vice-president for advanced technology. His job was to uncover new technological areas for TRW to venture. the most profitable of those new ventures has been TRW's entry into the commercial chip business.

Always interested in new and exciting challenges, Maiman left TRW when a management change altered the entrepreneurial environment. Since then, he has been involved in a variety of consulting and research projects, including the development of a new aircraft.



Dr. Theodore H. Maiman: scientist, inventor

Creativity and courage

Dr. Maiman emphasizes creativity in scientific research. He has, during his career, encountered a tremendous amount of negative reaction to new and different ideas. "People seem to resist change," he said. His message for students is, "if you have an idea that you believe in, go for it. Become an expert. Don't wait until everyone tells you it's a good idea. That won't happen." There's no guarantee that you'll always have success, he added, but when you do, it's amazing how fast the scoffers change their tunes. Concluded Maiman: "It's really important to do what you enjoy doing."

Dr. Theodore H. Maiman has made a career of doing what he enjoys doing, and he's being rewarded with a satisfying life, many honors, and a place in history. In fact, last February, he was inducted into the National Inventors Hall of Fame, an honor he shares with such innovators as the Wright Brothers and Alexander Graham Bell. Given the laser's hundreds of uses today, one would expect Bell to rhapsodize again, picturing "what the future of this invention is to be!"

UMD: Engineering a Computer

Computers are turning up everywhere. They are on your desk, in your car, at your bank, and even in your toys. A new program at the University of Minnesota-Duluth is preparing students to design and interface computers for all of these tasks.

By David Herridge

For a long time, the Twin Cities was the only game in the state if you wanted to dabble in engineering. The Institute of Technology alone offered students a four year engineering program. Now, it has some company. The University of Minnesota-Duluth opened its doors this year to students pursuing a four year, bachelor degree in computer engineering.

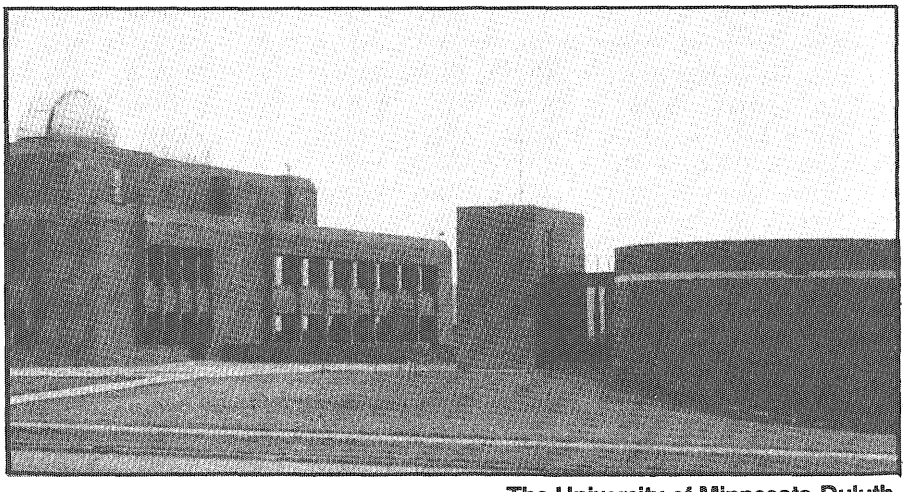
Computer engineering is *not* computer science, it is instead, much closer to electrical engineering; in fact in many schools, computer engineering is offered as a specialty area of electrical engineering. Because of the incredible growth in the use of microprocessors and the complexities of the recent computer advancements, the program in Duluth was separated into an individual discipline. The UMD program focuses on electronic hardware, circuit design, and interfacing computers with other systems; not on the programming languages offered in computer science.

Computer engineering is *not* computer science.

Dr. James H.W. Tseng, who came from sunny California to head the program in Duluth, explained why the computer engineering discipline came into existence, "Long ago, a few manufacturers made mainframes, today there are more than 200 vendors making microcomputers." Dr. Tseng continued the story, noting the increased use of microprocessors in dedicated machines, in control devices, and in communications. Because many simple computer components are so inexpensive, their use in scientific and commercial products has increased dramatically. The evidence is everywhere; cameras that tell you your pictures are going to be dark, cars that monitor and adjust their fuel consumption, children's games that will test the quickness of your eyes and your thumb, and laboratory control systems that allow today's scientists to collect more data with less trouble. All of this created an increased need for computer engineers.

It was projected that in 1984, only 15,000 electrical and computer engineers would graduate while the demand hovered around 50,000. Most of the computer engineering programs exist in California colleges, and as you might expect, most Californians are not eager to come to work in Minnesota. It is hoped UMD will supply the needs of the many computer based companies headquartered in the Midwest.

Engineering is not new to the University of Minnesota-Duluth. For many years, the college has supplied the Twin Cities campus with transfer students who completed Duluth's pre-engineering program (first two years). Prompted by community and political support, the Duluth College of Letters and Sciences was reorganized and divided into the College of Letters and Social Sciences and the College of Science and Engineering. The baccalaureate degree program in computer engineering is the first of three, four-year engineering disciplines planned for Duluth to accompany their natural science programs. In the fall of 1986,



The University of Minnesota-Duluth.

upper division industrial engineering and materials processing engineering programs will be initiated.

Students, who enter the University at the three campuses offering pre-engineering (Twin Cities, Duluth, Morris), are eligible to attend the upper division programs offered at either the Institute of Technology or UMD, upon satisfactory completion of the two year pre-engineering courses. All students who qualify will be treated equally when they apply for admission to an upper division program. No preference is shown to students based on the lower division residency or their choice of major.

In its first year, the computer engineering program attracted 36 students, two dozen juniors and one dozen freshmen (many other Duluth students are undesignated). They are still accepting applications to meet the target goal of 200 students.

Upper Division students combine courses in digital systems, electronics, networks and signals, and high and low level computer science languages into a graduation plan. Presently, there are two elective options for students. One in computer design and another in telecommunications.

It is hoped UMD will supply the needs of the many computer based companies headquartered in the midwest.

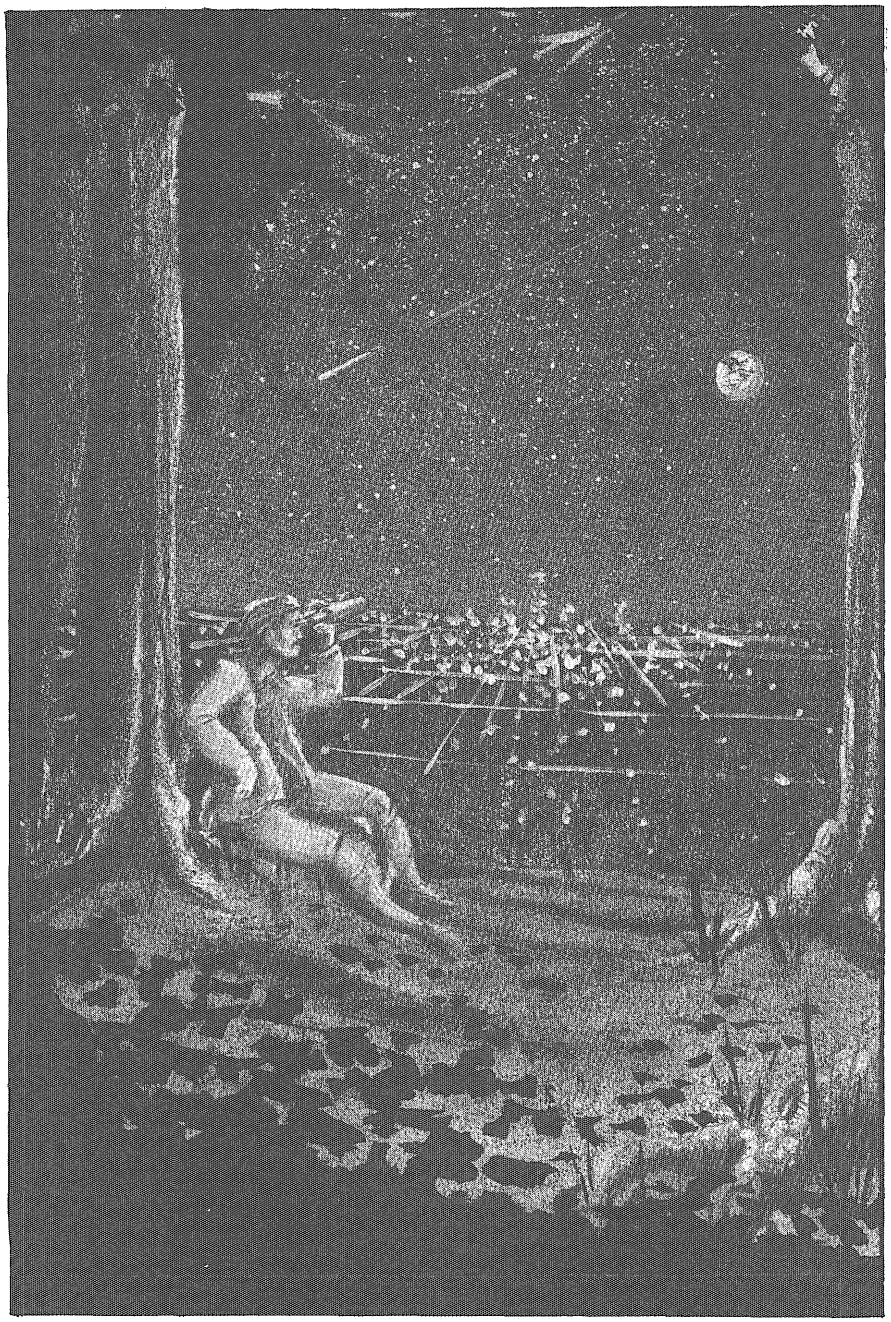
For students who choose computer engineering, UMD has a few fresh and good ideas. The laboratory equipment budget was supplemented by corporate gifts to fill the labs with the state of the art in electrical and computer equipment. Watching over the labs are professors, not T.A.'s.

After the junior year, the computer engineering students are required to enter a summer employment program. Although the intern program is not yet fully organized, its objective will be to give the juniors some exposure to an industry setting.

When the students return for their senior year, they will have to prepare a proposal to their advisor for a senior design project. Students would then complete the project over the next two quarters.

The final twist in the UMD program is a mandatory professional ethics course. Because computer crimes can amount to astronomical monetary amounts, some estimates venture as high as 45 billion dollars yearly, the course hopes to teach the students to think critically and to distinguish between right and wrong.

"We hope for closer ties in the future relationship between the Twin Cities and UMD. Both should work toward the common goal of better education in engineering," said Lewis Oakland, the Director of Pre-Engineering. The establishment of the engineering programs at the University of Minnesota-Duluth is not the introduction of a competitor to the Twin Cities. Rather, the programs and plans proposed for UMD compliment the offerings in the Institute of Technology, expanding rather than repeating the Minnesota student's opportunities in engineering.



Touring the Night Sky

If it is a clear, dark night, grab a pair of binoculars and head for a comfortable spot. Much of the cosmos can be enjoyed from your back yard without investing your tuition in a telescope.

By Jon Soland

As late as 1923, astronomers could not conclusively show that anything existed beyond our own galaxy. In that year, Edwin Hubble used the properties of a particular type of star to show the Andromeda nebula was too far away to be in the Milky Way. He established that it was a separate galaxy. It was not until the early 1950's that its currently accepted distance was determined.

Astronomy is a fascinating field that can bewilder even the experts. Its vastness is astounding! If the Sun were shrunk to a diameter of only one foot the earth would be slightly larger than a BB 107.5 feet away. Pluto would be more than 4,200 feet away. The nearest star would be over 5,500 miles away.

Who hasn't been out at night and looked at the sky, wondering about this or that star? There are many things to observe in the night sky that can be seen with the naked eye or a pair of binoculars. Binoculars, because of their wide field of view, are the preferred equipment for someone just learning their way around the night sky. This article will tour a few of the brighter objects.

It should be noted that the city lights produce a haze in the sky that diminishes the visibility of fainter objects. Also, it takes at least 15 minutes for your eyes to adjust to darkness properly.

Ahhh... where to start? There is the Moon, the planets, the asteroids, the meteors, the comets, the galaxies, the nebulae, and the stars. There are other objects too of course, quasars, pulsars, radio sources... but they would require equipment far beyond our reach. All objects in the night sky can be assigned a magnitude that describes their brightness. One magnitude of difference is defined as the 5th root of 100, or about 2.512, with the smaller of two magnitudes being the brighter. For example, a star with a magnitude of -1.0 would be 2.512 times as bright as one at 0, which would be 2.512 times as bright as one at 1.0 and so on.

The Moon

The Moon, with a diameter about one quarter of the Earth, is hardly a satellite governed by the Earth, but rather the lesser partner in a double planet system. The Earth and Moon revolve around each other, and it is their common center of gravity that revolves around the Sun.

The Moon is an excellent binocular object, revealing craters with diameters of 10 to 15 miles. The most spectacular viewing will be found along the terminator. The terminator is the line between the light and dark portions of the Moon. It is the line that separates the lunar night and day. As the phases pass from new (completely dark), to first quarter (right half showing), to full, to third quarter (left half showing), the terminator moves from right to left and back again. The features along the terminator are greatly enhanced by shadowing due to the low angle of the sunlight at that point. A few days after the first and third quarter, for a few hours, one can glimpse with the naked eye the rugged peaks of the Apennine Mountains (see figure). Another striking object in the same area is the crater Copernicus. It is 56 miles across, with walls rising 17,000 feet from its floor, a central peak over four miles in height, and rays second only to Tyco's. Tyco, a mid-southern, 50 mile wide crater is at the center of the most extensive ray system on the Moon. Some of these rays extend for a thousand miles and are believed to be made up of debris thrown out during meteor impact. Other objects worth looking for are the craters Aristarchus and Kepler. Although their diameters are only 30 and 60 miles, they are two of the most luminous objects on the Moon owing to their complex ray systems.

For a couple of months each year, Mars appears to stop normal easterly progress and move backwards in its orbit.

The Planets

Next on the magnitude scale come the planets, with Venus (always the brightest) reaching -4.4 at maximum. Aside from their movement with respect to the stars, brightness is probably the best clue that what you're looking at is a planet.

The planets fall naturally into two classes, inferior and superior. This is not a statement of their aesthetic worth, but refers to the position of their orbits with respect to the Earth's; inferior being inside, and superior being outside. Two properties common to all planets are they rarely twinkle and their orbits lie more or less in the same plane. As a result, when visible, they can always be found in a fairly narrow band traversing the sky. This band follows the ecliptic, an imaginary line marking the Sun's path in the sky. Because the inferior planets have orbits smaller than the Earth's, they never stray far from the Sun (see figure). They are visible only in the early morning or early evening. The superior planets suffer no such restriction, and can be found anywhere along the ecliptic.

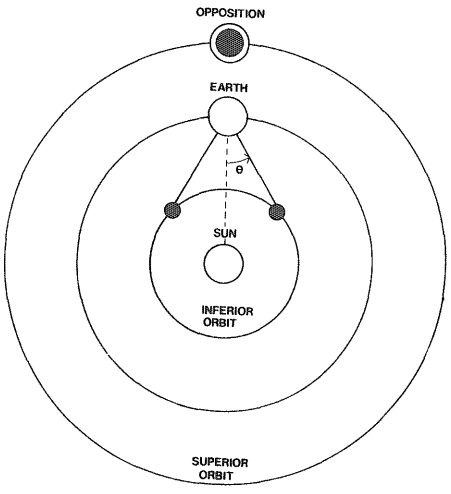
Mercury: Mercury is the smallest of the planets, and the closest to the Sun. Because of its small orbit its maximum angular separation from the Sun is about 18 degrees. Mercury just may be visible right at dusk.

Venus: Venus too is inferior, but has a larger orbit than Mercury, and thus a larger maximum separation from the Sun, up to 47 degrees. Venus should be 3.4 degrees (about 7 Moon diameters) above the ecliptic and will set at around 7 p.m.

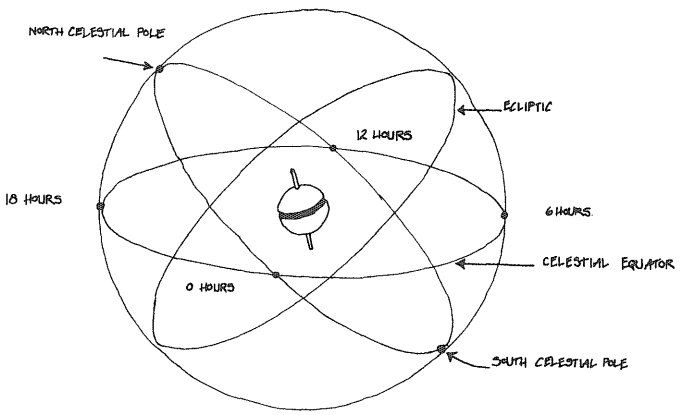
Mars: Mars is the closest of the superior planets and has a brightness that varies between about -1.0 and -2.5. Mars best exhibits a quirk all of the planets share, retrograde motion. For a couple of months each year Mars appears to stop its normal easterly progress (easterly with respect to the constellations) and move backwards in its orbit. This was one of the most confounding problems of the Ptolemaic, or Earth centered, solar system. Mars will be 2.2 degrees above the ecliptic and should set around 9:00.

Jupiter: The largest planet is a very interesting object. Its diameter is about one tenth of the Sun's. Its interior experiences such enormous pressure that it actually radiates more heat than it absorbs. Had Jupiter been just a little bigger it would have become a small star. Jupiter is often the brightest object in the night sky, its magnitude hovers near -1.5. Binoculars will generally reveal one or two of its 14 Moons. It is fun to watch

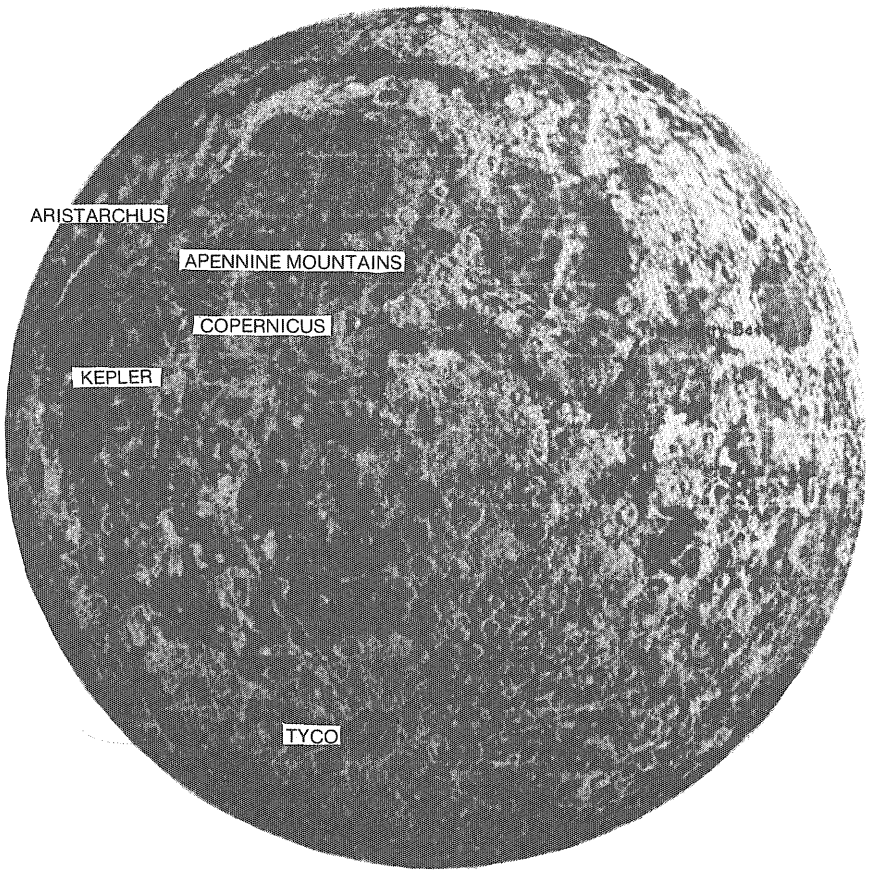
Superior and Inferior Orbits



The Ecliptic and the Cellestial Poles



The Moon



Binoculars, because of their wide field of view, are the preferred equipment for someone just learning their way around the night sky.

them move from night to night. Jupiter should be setting around 7:30.

Saturn: Saturn, the second largest planet, is a fascinating sight through a large telescope or via satellite, but appears only as a small disk through binoculars. It has a magnitude of something less than +1.0 at opposition and should be setting around 7:00.

Binoculars will generally reveal one of Jupiter's fourteen moons.

Uranus, Neptune, Pluto: Viewing these planets is difficult. Uranus and Neptune are within reach if you know where to look for them and are willing to spend the time required to identify their movements. Because of their enormous distances (1.8 and 2.8 billion miles), these two make slow progress in their orbits. Only four degrees per year (with respect to the constellations) for Uranus, and two degrees per year for Neptune. Pluto is nearly 4,000 times dimmer than the naked eye's limit, and is therefore only visible through a fairly large telescope.

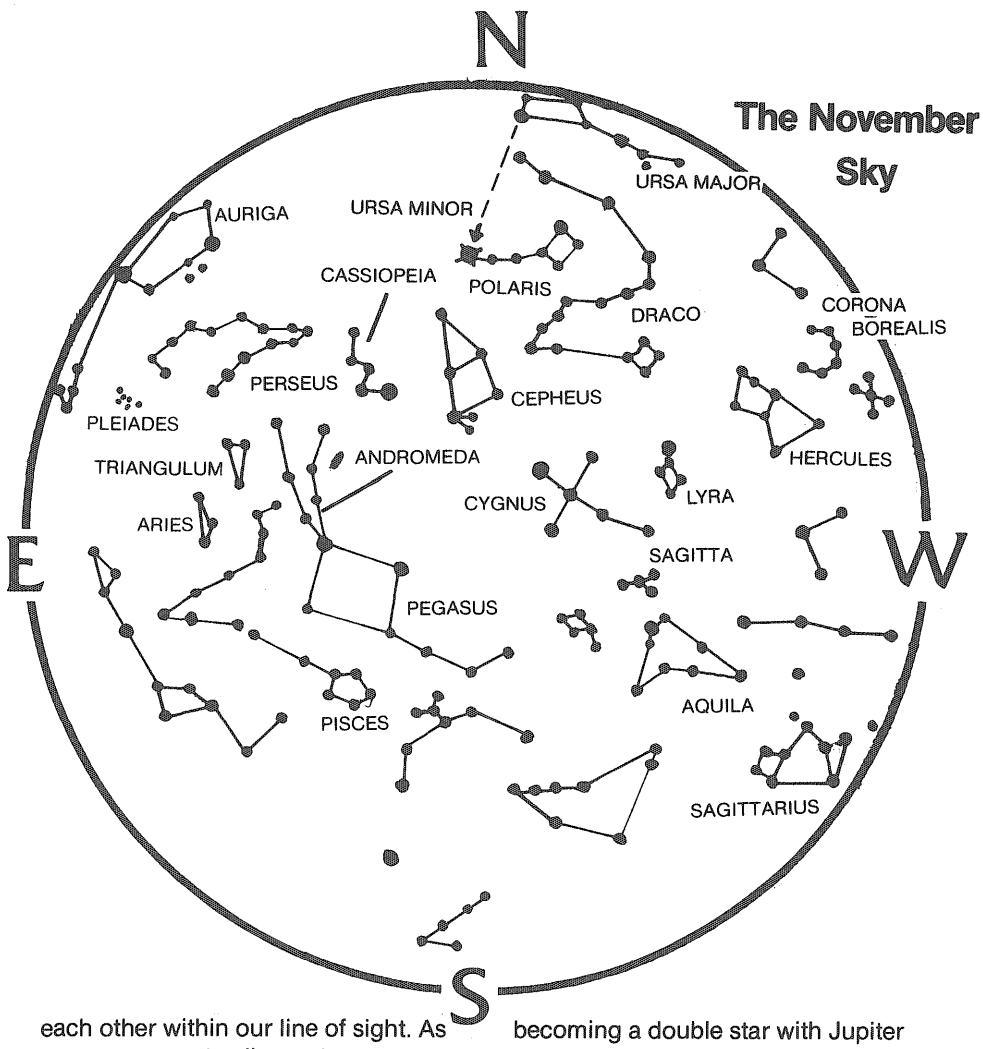
Because the planets are always moving, the information regarding their positions is accurate only on November 23. Before that date they will set a little later, and after that date a little earlier.

The Stars

There are many more things to see in the night sky than the Moon and planets. On a clear, dark night there are about 6,000 stars visible to the naked eye. It is fun to lay back and wonder about all the different things you can see. It is more fun still if you know something about them, the type of star, its distance, and its age. Many astronomy handbooks contain this information. The system astronomers use to identity stars in the sky is somewhat akin to latitude and longitude. It projects coordinates onto the celestial sphere, a natural abstraction used for mapping the sky. To understand how it works, first assume all the stars are the same distance from the earth and that they form a globe around it. Extend the earth's equator and poles onto this globe, tack on "celestial" in front of them and we are set. Latitude on the celestial sphere works just like latitude on the earth. It is measured in degrees north and south of the celestial equator. To keep things separate, the word declination is used in place of latitude. Similarly, plus and minus replace north and south. Celestial longitude is a little different. If you watch the sky for a few hours you will notice that a constellation that was due south at 9:00 is 15 degrees to the west at 10:00. Everything seems to move across the sky with time, thus the hour circle is born. Divide the celestial equator into 24 increments of one hour (15 degrees) each, using minutes for finer divisions. Set the zero hour (prime meridian) along the eastern edge of the Square of Pegasus, and you can identify any point in the sky. Right ascension (R.A.) is the angular distance east of the prime meridian. Most books will give an object's position using this system. For instance, Betelgeuse (a bright red star in Orion's armpit) has coordinates: RA. 5h 52.5m dec. +7 degrees 24 minutes. That seems easy enough

and it works well if you have a telescope with an equatorial mount, but there is a better way if you are out there just looking around. That is to use the constellations.

Once you learn a few of the constellations, and with the help of a star chart, the rest of the sky will quickly begin to unfold. The constellations are more than characters in mythology, they define a system for dividing up the sky. Each constellation has a definite boundary, and the stars within it belong to that constellation. The New General Catalog 1888 (NGC) uses this system. The Greek alphabet is used to label the individual stars, with the brightest being alpha, the next brightest beta, and so on (there are exceptions, e.g. the Big Dipper is labeled by position). Using this system Betelgeuse becomes Alpha Orionis, the brightest star in the constellation of Orion. Using the NGC system and an astronomy handbook it is fairly easy to find and identify the different objects in the sky.



The constellations are more than characters in mythology, they define a system for dividing up the sky.

The stars come in all shapes and sizes, young and hot, old and cold, singly and in groups. You can tell something about a star just by looking at it. Stars have subtle differences in color, ranging from blue to red. From the color you can estimate the surface temperature. A very blue star is usually quite young and has a surface temperature near 50,000 K (Kelvin), while a red star (like Betelgeuse) is older and much cooler with a surface temperature between 3,000 and 3,600 K.

Many stars vary in their brightness or magnitude. Some vary in a regular way, some in a very irregular way. Some vary a lot, some just a little. Some have a period of a few hours, some of several years. Of these variable stars there are two general types, eclipsing variables and intrinsic variables.

The eclipsing variables are double stars which happen to rotate around each other within our line of sight. As one component eclipses the other, the light we see dims until the other component reemerges. A good example of an eclipsing variable is Algol (Beta Persius).

The intrinsic variables fluctuate due to physical changes within the star. There are many types of intrinsic variables, one of these is the Cepheid variable. Cepheids vary in a regular way such that their period of variation is proportional to their absolute magnitude. Because of this property, Cepheids have been used by astronomers to determine the distance to a group of stars. In fact, it was Cepheid variables that were used to first determine the distance to the Andromeda galaxy. An example of a Cepheid variable is delta Cepheus, the star that gave them their name. To watch a variable star vary, you need to consult a handbook for its period and range of fluctuation. Then find two neighboring stars with bracketing magnitudes, and keep an eye on all of them over the appropriate interval.

Twenty-five percent of all stars are double stars, physical systems of two stars rotating around a common center of gravity. The Sun just missed becoming a double star with Jupiter as its secondary. If you are looking for double stars it is a good idea to know the secondary's position, magitude, and separation. This information should be available in a good handbook. Under excellent conditions, the naked eye can distinguish between objects down to about 4 minutes of arc. With a pair of 8 x 30 binoculars, properly supported, you may be able to extend this to about 30 seconds (1 second is the apparent width of a half dollar at 4 miles). If either component is much brighter than the other these limits should be doubled or tripled. Mizar the second star from the end of the handle in the Big Dipper is a double, with a separation of 11.5 minutes, about one third the width of a full Moon.

There are larger groups of stars, termed clusters which also form physical systems orbiting around a common center of gravity. There are two types of clusters, globular and open. Globular clusters are made up of thousands of tightly packed stars, but none of these groups are close enough to appear as anything more than a small, hazy patch of light.

However, there are many open clusters within reach of the naked eye. An open cluster is a scattered group of stars. A fine example is the Pleiades. The Pleiades is a group of more than 100 hot, young stars about 600 light-years distant (one light-year is approximately 5.88 trillion miles). The brighter stars form a tiny dipper just below Perseus' foot. Sometimes called the seven sisters, the group forms a good test of visual acuity. Although there are 11 stars brighter than the sixth magnitude (generally considered the naked eye limit), six stars should be readily visible with the seventh being somewhat more difficult.

The most elusive stellar objects for binoculars are the galaxies and nebulae. These two very different objects were grouped together until 67 years ago, when Edwin Hubble resolved the outskirts of the Andromeda nebula into individual stars. They are perhaps the most beautiful objects in the universe. It is unfortunate that without a large telescope a milky patch of light is all that attests to their existence. Although the image through binoculars is unspectacular, knowledge of their staggering dimensions adds to the view.

Far away from the city lights, you can see the Andromeda galaxy with the naked eye. To view it from town, you will need a pair of binoculars and a little patience. Start at the Square of Pegasus; it should be nearly overhead in the southeastern sky at 10:00. Next, find the star in the northeastern corner, this is Alpha Andromedae. About 15 degrees to the east-northeast (nearly in line with the northern edge of the square) is another bright star, this is Beta Andromedae. There should be a dim star about midway between these two. Starting at Beta, form a line perpendicular to the one made by Alpha and Beta. There should be two very dim stars along this perpendicular north of the square. Everything up to this point should have been visible to the naked eye. Using your binoculars, look above and to the right of the second dim star. You should see a fairly large, but very dim wisp of light. This is the Andromda galaxy. The light you are seeing left that galaxy some 2.3 million years ago, long before the first man walked the earth. It is the farthest thing visible to the unaided eye.

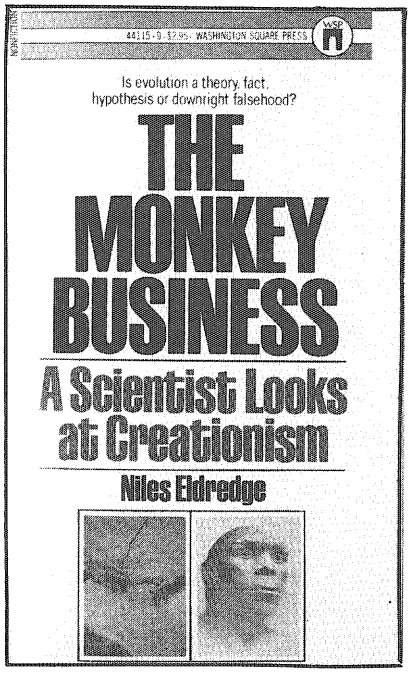
On a clear, dark night there are about 6,000 stars visible to the naked eye.

If you would like to pursue the subject further, an excellent book is *Astronomy with Binoculars* by James Muirden. A good handbook is *A Field Guide to the Stars and Planets* by Donald Menzel, it's part of the Peterson field guide series. The Astronomy department prepares a taped message each month called Minnesota Starwatch. To listen to this message, call 376-5587. The Astronomy department also opens their telescope for public viewing each Friday night that the sky is more than half clear. To participate, show up on Friday after 8:00 p.m., it is located in Physics room 450.

assigned reading

The Fact and Sci Fiction of Evolution

By Renee Bergstrom



***The Monkey Business, A Scientist Looks at Creationism,* Niles Eldredge, Washington Square Press, 1982, paperback, 157 pages, $2.95.**

This book examines the changes in the theory of evolution, from Darwin's original ideas to evolution as it stands today, and the controversy between creationism and evolution.

For an introduction, Eldredge describes the range of present opinions. First, the scientific creationists who believe the literal truth of Genesis. They seek to promote themselves by disproving evolution and attacking geology. Second, the theistic evolutionists who read Genesis metaphorically. God created Heaven and Earth, but used his own natural laws. And finally, the scientists who consider only naturalistic terms for the origin of all things. For himself, the author believes that modern science neither threatens nor enhances Genesis.

For the controversy, the author states, "Though the debate for the most part has left purely theological circles, it is the perception of the fundamentalists that science and religion are in conflict that underlies the creationist endeavors." Eldredge continues by arguing that creationists are using two arguments. Both creationism and evolution are scientific (author states that creationism is falsified science). Lastly, both are religious beliefs. Eldredge denounces this argument quite strongly.

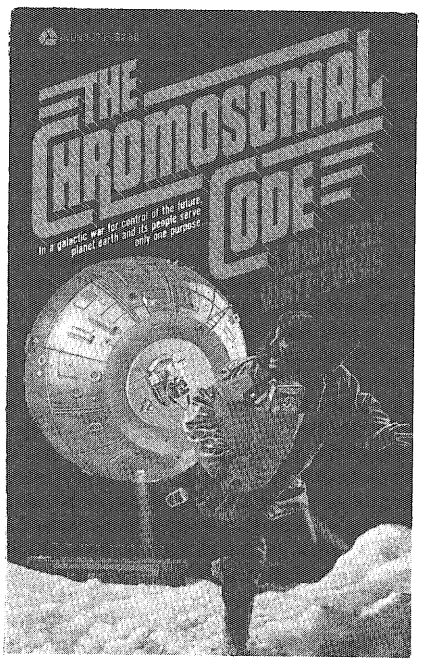
After the introduction, Eldredge reviews where the conflict started, where it has gone, and where it stands now, from Clarence Darrow to the Archbishop Ussher of Ireland.

There is also a close look at evolution. Such as a definition of evolution—"Evolution is 'descent with modification'—to use the phrase of Charles Darwin himself." The major point with evolution is not that it has been proven true, but that it has not been proven false.

The book explains the existing fossil records and suggests they support the statement that "life has evolved." Because how life evolved is still under scrutiny, the book examines some of the ideas and concepts, past and present.

Eldredge, after laying the groundwork of evolution, pursues to dispute the creationism arguments. He ends his book with a look at science, religion, and politics. "In the end, the evolution/creationism controversy is a battle over public opinion. It hasn't been an intellectual problem for at least a century."

The writing is excellent, although the book presents a biased rebuttal of creationists' arguments. Indeed, the author never promised it to be anything else. If you're interested in the controversy, this is a good book. It's not something you can pick up and read in one sitting (a bit dry for that), but as an occasional distraction, it offers many interesting and challenging concepts for thought.



The Chromosomal Code, Lawrence Watt-Evans, Avon Books, 1984, 204 pages, paperback.

Here is a book that solves the evolution problem, if you can believe that man was genetically engineered by an alien whose spaceship crash-landed on earth.

Imagine a blizzard has covered the earth and the majority of the planet's population is living in Brazil. All governments have collapsed and now an alien group, claiming it's from the Galactic Empire is on earth to help. The aliens have set up a world government to search for something, but no one knows what.

The main character, John Starkmen, who suffered, from a genetic eyecolor mutation, was collected on the glacial field that was once Pennsylvania. Starkman had felt shunned by society who deemed him a freak. It has been years since he made contact with any other humans. On board the aliens' spacecraft, he makes contact with other humans causing his old feelings to surface.

"He mentally cursed his carelessness; he was outcast all over again, it appeared. Always he remembered, people had stared at him, and he had had to struggle to be accepted as a human being."

All people from all over the world are told by the aliens they are being tested for diseases. Starkman escapes with the help of a rebel doctor who believes Starkman is what the aliens are searching for.

The aliens' plot uncovered, Starkman must decide his fate: run or die. His will to live and disbelief in everything he was told prevent him from following the request the rebel made of him. He alone may be responsible for earth's fate.

This book is a combination of all the favorite topics of science fiction writer of the last few years. A little Armageddon and the number of the beast, a little evolution and some genetic engineering, all rolled into a tidy package.

Though this is not a work art or a deep, philosophical masterpiece of classic literature, it is not the usual formula fiction. The author created an intrigue which allowed me to concentrate on the story. There were many plot twists and an enjoyable, almost laughable, satirical ending. My expectations for this book were pleasantly uprooted.

The author, Watt-Evans, did disappoint me in a few instances, leading me to believe he was new at the game. The story resorted to some old cliches that detracted from the style of the book. "He pulled the flashbomb out of his pocket, looked over it carefully, then returned it. 'Maybe they're sworn not to kill,' he muttered to himself, 'but I'm not.'"

Another failure by the author was his attempt to make the character of John Starkman believable. In some instances, Watt-Evans was trying too hard. True, John Starkman had a violent streak because of social rejection. However, he looked worse than Dirty Harry. Starkman was constantly punching clones that didn't react to him violently or threaten him. Dirty Harry at least picked on people his own size.

All in all, if deep reading is desired, this book could leave a black smudge of disappointment behind. However, for an afternoon of light reading, *The Chromosomal Code* fits the order.

Lasers from 10

realized. To date, over 5,000 laser assisted operations have been performed. They are used to sever and cauterize blood vessels without injuring any other body tissue. They are used, in an optic fiber catheter, to transverse through a blocked artery to remove calcium buildup. They can be used to destroy cancer cells inside a patient without using chemotherapy and X-rays. This could, in the future, give hope to some terminally ill patients. They can also be used to detect cancer: cells are stained with a dye and analyzed with a laser scanner, cancerous cells show up because they absorb more dye.

Lasers are often used in eye surgery to seal leaking blood vessels. When hit by a laser, the blood vessels raise in temperature from 37 degrees to 65 degrees celcius. They can burn away tumors by raising their temperature to over 400 degrees celcius, vaporizing them in fractions of a second. They can remove tissue that causes the eye to become blurred by supplying a pulse of light at a temperature of 20,000 degrees celcius for a few billionths of a second. This causes the tissue to fall away, removing the bluriness.

Eventually, lasers will be used to trace individual molecules and position them in various locations allowing the tailor-making of drugs. They will be used to view viruses and DNA molecules, allowing the tracing and research of diseases, genetic defects, and other problems.

Lasers have another interesting use, just now being developed. This is in the design of a laser gyroscope. In a laser gyroscope, two beams of monochromatic (laser) light transverse a ring in opposite directions. If the ring is rotating, the two beams will appear to have a slight frequency shift. The amount of rotation determines the amount of frequency shift. By monitoring the two frequencies, the rotational speed can be computed. This has uses in missile and rocket guidance systems.

By far, the most extravagant and controversial use for lasers is in the military. Lasers are now being used to target enemies. Laser light is bounced off a target and intelligent missiles head for the bounced light.

Lasers may be developed to destroy missiles. Satellites, equipped with high power lasers, could home in and destroy nuclear missiles launched towards the U.S. land based lasers could beam high energy laser radiation at large mirrors in space which beam the rays toward targets, destroying them. Reagan's "Star Wars" plan proposes a "shield" of laser defense weapons around the U.S. preventing incoming nuclear missiles from reaching their targets. This plan has met political controversy. Some opponents say it isn't possible to protect the U.S. from incoming missiles, others say it's too dangerous to try.

Practical laser weapons depend on the construction of X-ray lasers. These are very high frequency, high energy lasers that are capable of destroying missiles and satellites. These X-ray lasers are still in the experimental stage.

One of the problems with X-ray lasers is the need for high intensity energy pumped into the laser to produce the very short wavelengths of X-ray light. Possible sources of this energy are radiation from a nuclear explosion or the output from another high intensity laser. It's thought that an excimer laser (made from diatomic gas molecules) could pump one trillion watts of power in one trillionth of a second into the X-ray laser which would further amplify the energy. The result would be incredible destruction.

X-ray lasers have more potential than just destruction. X-ray laser beams could detect the existence of particles down to the size of an atom. These lasers would be able to photograph DNA molecules, and, using holography, create three dimensional photographs of DNA molecules. This would supply vital information to genetic biologists who could track genetic disorders and diseases.

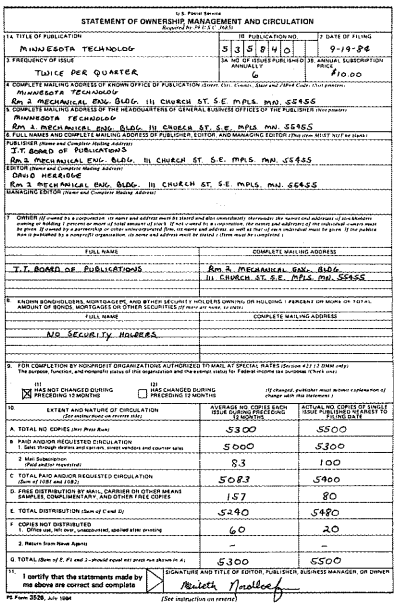
Lasers are a major part of our lives. We see them in grocery stores. We use them to communicate. We use them to save our lives. Soon we may use them to protect our lives. We have only touched the surface of the uses of lasers. The next 20 years will show dramatic changes in our lives as a result of lasers. Changes that we can't even begin to comprehend—yet. Lasers will become, if they aren't already, one of the most significant discoveries of this century.

Ophthalmology from 14

thereby avoiding bleeding that can obstruct a surgeon's view. Another way lasers perform as scalpels is through a process called photodisruption. This occurs when a laser is so intense it strips the electrons off the molecules in the target area and turns the tissue into a plasma which rapidly expands and destroys the surrounding cells. Even though the event is of short duration (30 picoseconds to several nanoseconds) and limited to a small target area (less than 1mm cross section), the results are violent enough to create shock waves within the eye. These can cause damage to other parts of the eye if the procedure is not planned carefully.

Diagnostic use of lasers allow ophthalmologists to examine the retina and distinguish between problems in the optical pathway and problems in the retinal nerves. Even if the optical path is damaged, an interference pattern of laser light can be focused on the retina so it is visible to the patient. From the patient's description of the pattern, a doctor can assess the condition of the retina. Ocular holography is another diagnostic technique being developed. It produces a three dimensional internal image of the eye that provides vital information to the ophthalmologist.

New laser methods frequently arise in ophthalmology, and a great deal remains to be learned about what combinations of factors (e.g. wavelength, pulse duration) work best. As the complexities of laser-tissue interaction become better understood, lasers wil be applied more effectively in all areas of medicine.



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PS Form 3526, July 1984

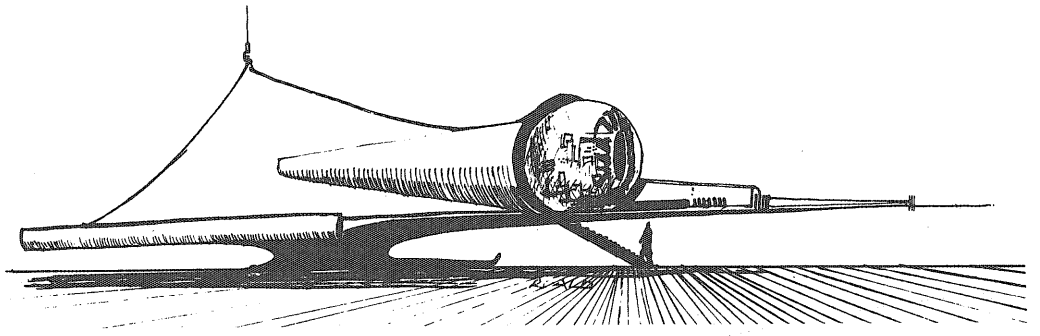
Log Ledger from 7

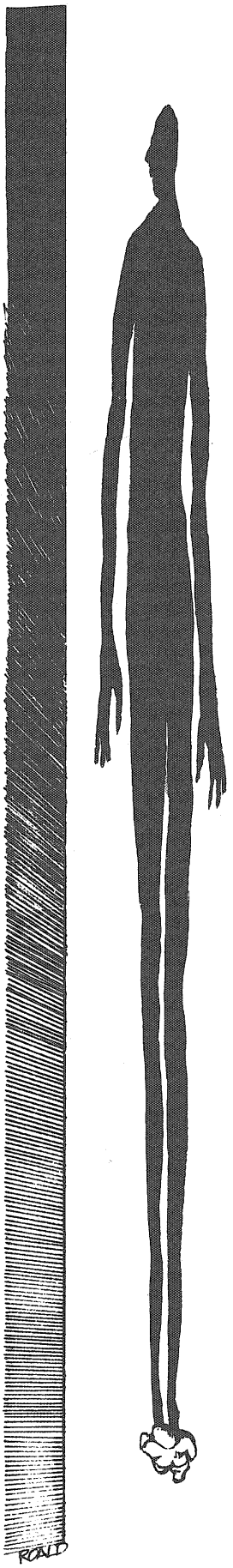
Nevada, Utah, and Arizona. The states with the lowest average salaries were North and South Dakota, Minnesota, Iowa, Missouri, Nebraska, and Kansas.

The highest paid disciplines were petroleum and mining engineering with mean salaries of $51,059. The lowest paying employer was the government, offering salaries between $37,681 to $40,869.

On the average, a first year engineer earned $26,000, while the thirty year veterans pulled in $52,000.

The results are based on 16,000 questionnaires returned from 62,371 NSPE members across the country.





Science Fiction Writing Contest

First Prize: $100
Second Prize: $50
Third Prize: $25

Deadline:
February 8, 1985

Rules:

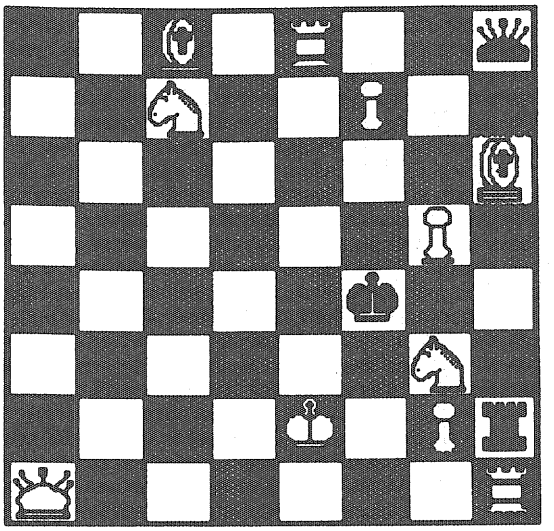
The contest is open to all registered U of M students of amateur status (persons never having published a work of fiction for monetary payment), except *Technolog* staff and I.T. Board of Publication members, past or present. Entries must be typed, double spaced, with one inch margins on 8½ x 11 paper 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.

Mind Benders and Brain Teasers

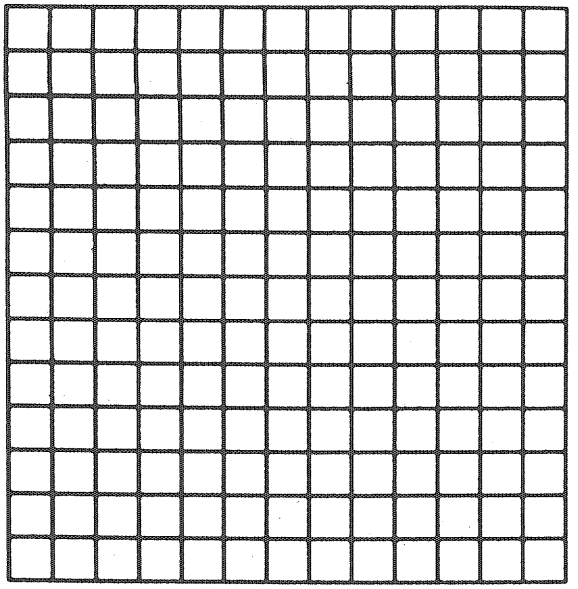
In each issue of *Minnesota Technolog* there will be some puzzle to challenge you. These are not entirely for your leisure; be the first person to bring the completed puzzle to the Technolog office in Room 2, Mechanical Engineering, and we'll give you a free "Do I.T. with an Engineer" T-shirt. Good luck!

1 If the opposite corners of a checkerboard are removed, leaving 62 squares, can the board be covered using 31 dominoes? Each domino covers two adjacent squares.

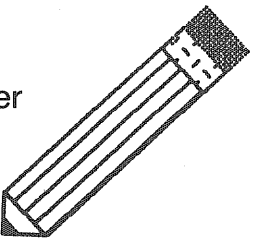
2 What one white move will checkmate black?



3



You may want to grab some graph paper for this one. The problem is to pack a group of smaller squares into one larger one. Determine the smallest number of squares into which a thirteen unit square can be divided without overlap or left over squares (one is not an acceptable answer).



There is a tougher problem to ponder in your leisure. If each square in the set used to build the large square must be a different size, how many different squares will you need and how many units will the side of the final square be?

technotrivia

By John Krumm

Questions

1) Within three years, how old was Einstein when he published his theory of special relativity?

2) What is an ectomy?

3) True or false: Henry Ford dreamed of making cars entirely from soybeans.

4) Rolaids consumes up to N times its weight in excess stomach acid. What's N?

5) Townsend Speakman of Philadelphia invented the first example of a popular type of liquid refreshment, and he called it Nephite Julep. What was this invention?

6) True or false: The watt was named after James Watt.

7) In 1982 the Department of Defense introduced a new Pentagon computer language called Ada. Where did this name come from?

8) What is the approximate average diameter of the Earth in miles?

9) In 1889 New York State condemned William Kemmler to death by electrocution, the first act of its kind in the world. Did they use AC or DC? (Fabulously lavish bonus prize if you can tell why.)

10) True or false: Carl Sagan's favorite musical group is The Cramps.

Answers

1) 26. (In other words, it's about time you got to business.)

2) It is the removal of excess fat by a scalpal.

3) True. (What would he have called the process—"Model T Helper"?)

4) N=47.

5) Soda pop.

6) True. (Scottish, 1736-1819)

7) The name came from Lady Augusta Ada Byron Lovelace, an expert mathematician and close friend of Charles Babbage.

8) Exactly 7917.78 miles. Take credit for 7800-8000 miles. If you knew the exact answer, quit staying home Friday nights.

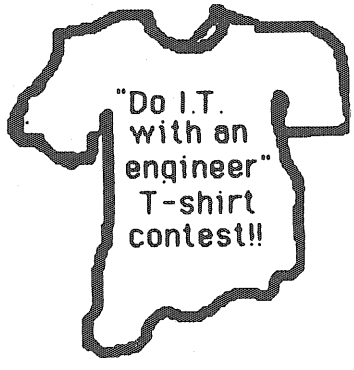
9) AC, largely because Thomas Edison had declared the competing AC system of George Westinghouse too deadly to have around the house compared to Edison's own DC system. (Extra point if you knew why.)

10) Of course not. (He does like the Inflatable Boy Clams, however.)

Score

0-1 Newborn slugs have done better than you.
2-4 O.K. If you are on an athletic scholarship.
5-7 Welcome to the ranks of the mediocre.
8-10 The goal was to answer the questions, not connect matching numbers.
11 Oh sure, and you probably have a bridge you'd like to sell.

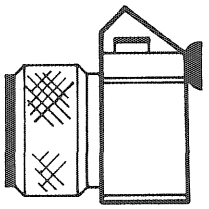
I.T. T-SHIRT DESIGN CONTEST



Deadline: November 26, Noon

Submit designs in Room 2, Mechanical Engineering

Reward: Ten dollars and a free shirt



...a thousand words

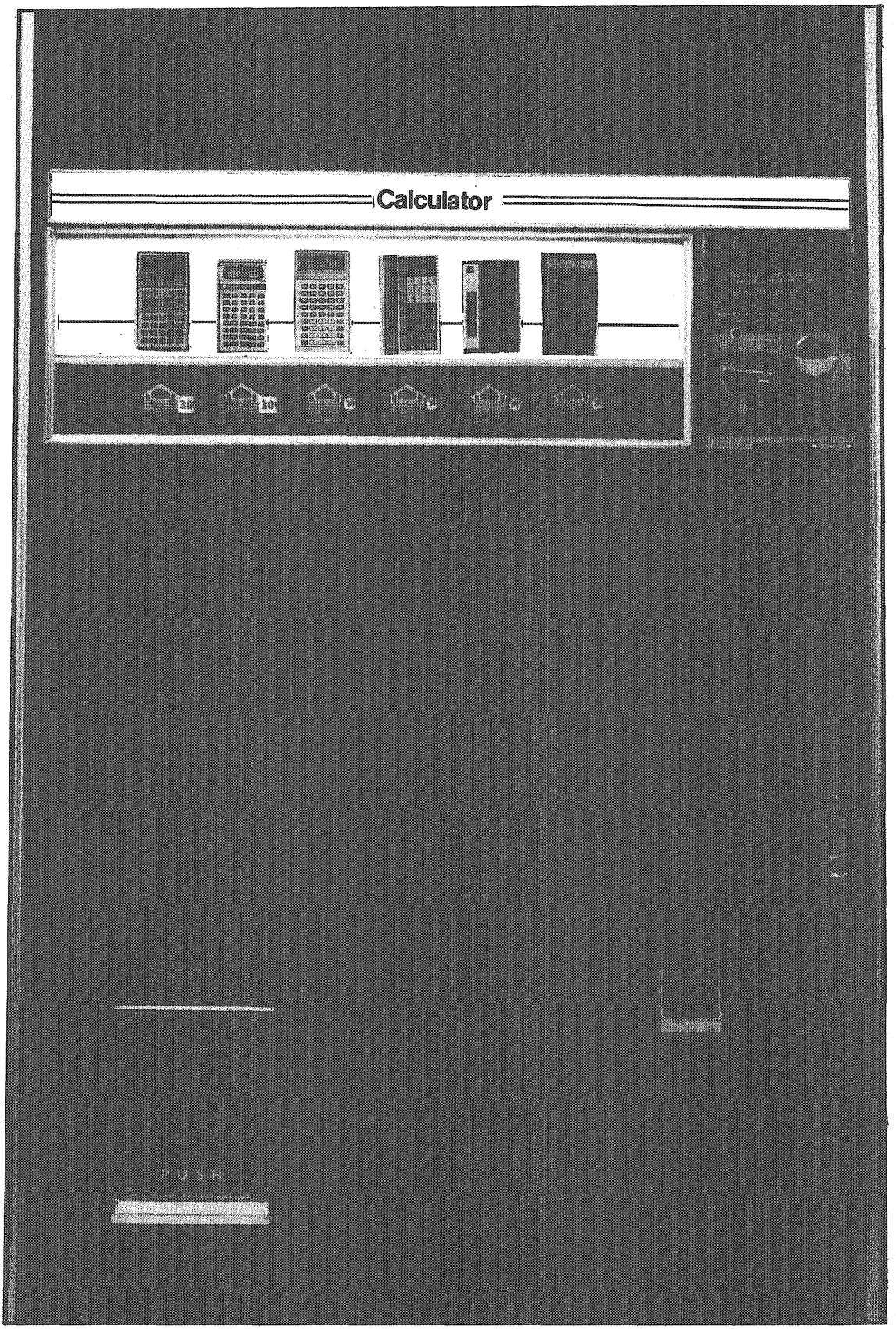


Photo by David Herridge

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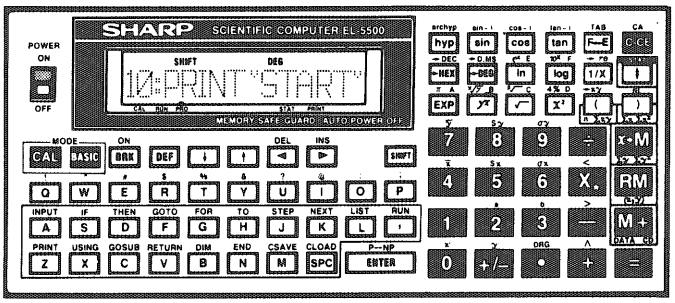

MODEL EL-5500-II

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- 19 statistical functions, including linear regression
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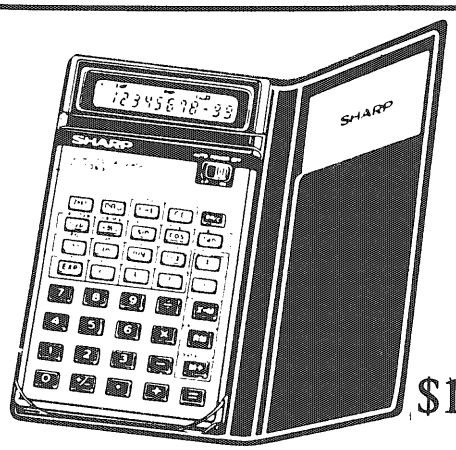

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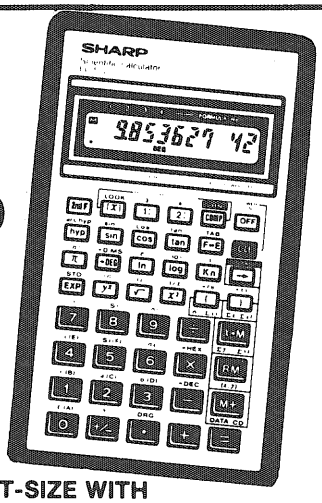

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Health Sciences Bookstore (Unit A) * Minnesota Book Center (Williamson)
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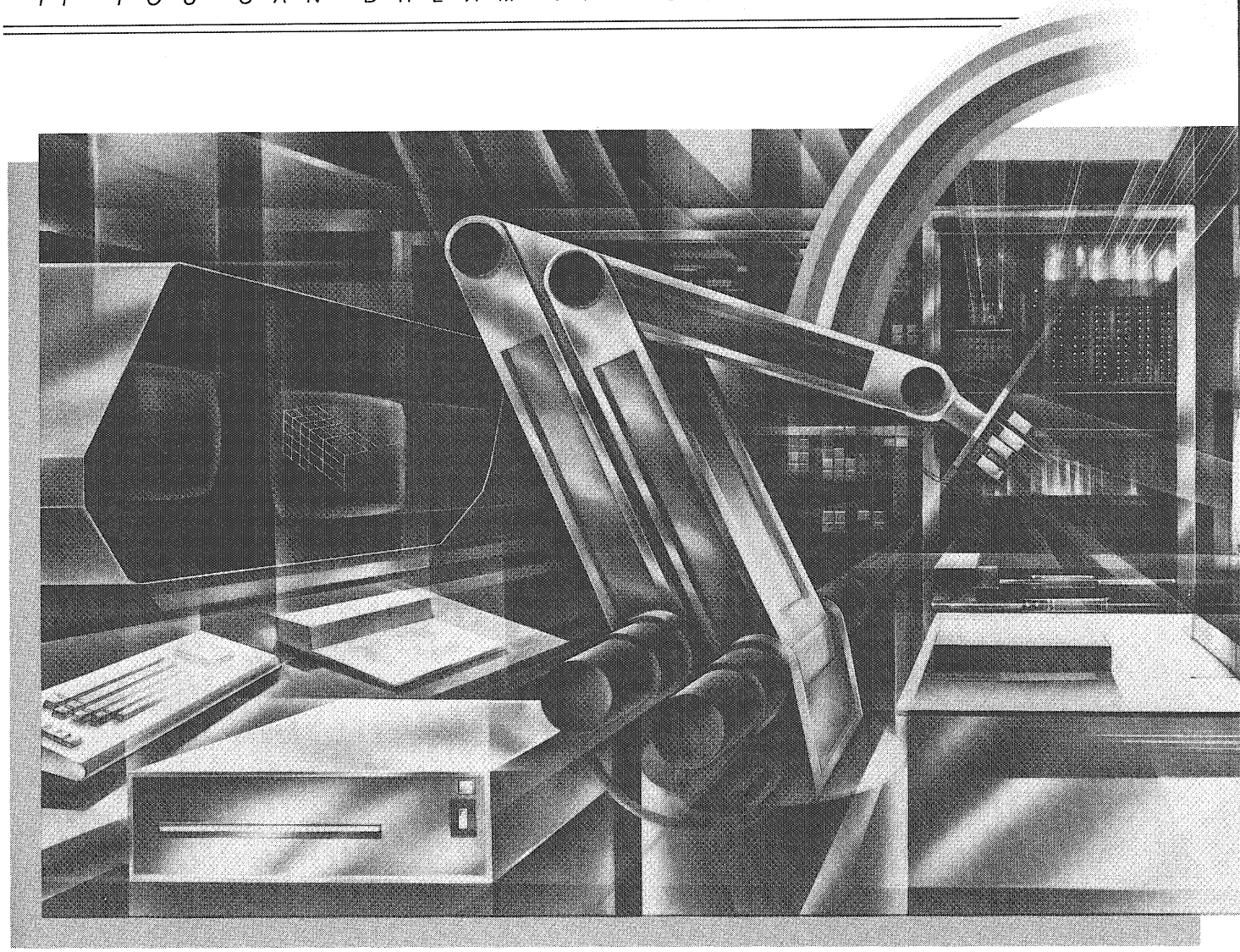


Convert the production line into a frontier of creativity.

The cast-iron technology of the factory will soon be silicon technology.

Chips and computers transfer design information directly to the factory floor. Other chips make possible flexible robotics, programmable controllers for machine tools, automated test systems and digital inspection cameras. Local area networks tie together all these systems.

These are revolutionary changes that can result in better-made products, manufactured of new materials at lower cost.

GE is deeply involved in bringing manufacturing into the silicon age. In one plant, electronics and computer systems enable us to reduce production time of a locomotive's diesel engine frame from 16 days to 16 hours. At our dishwasher production plant, a master computer monitors a distributed system of programmable controls, robots, automated conveyors, assembly equipment and quality control stations.

We're working on robots that can see, assembly systems that hear, and machinery that can adapt to changes and perhaps even repair itself.

This transformation of manufacturing from the past to the future creates a need for new kinds of engineers to design and operate factories of the silicon age. They have to be as familiar with the realities of the assembly line as with the protocols of software communications.

They will synchronize dozens of real-time systems whose slightest move affects the performance of every other system. The frontiers of manufacturing technology have been thrust outward. Old ideas have been questioned, new ones probed. Some ideas are now on production lines. Others are still flickers of light in an imagination.

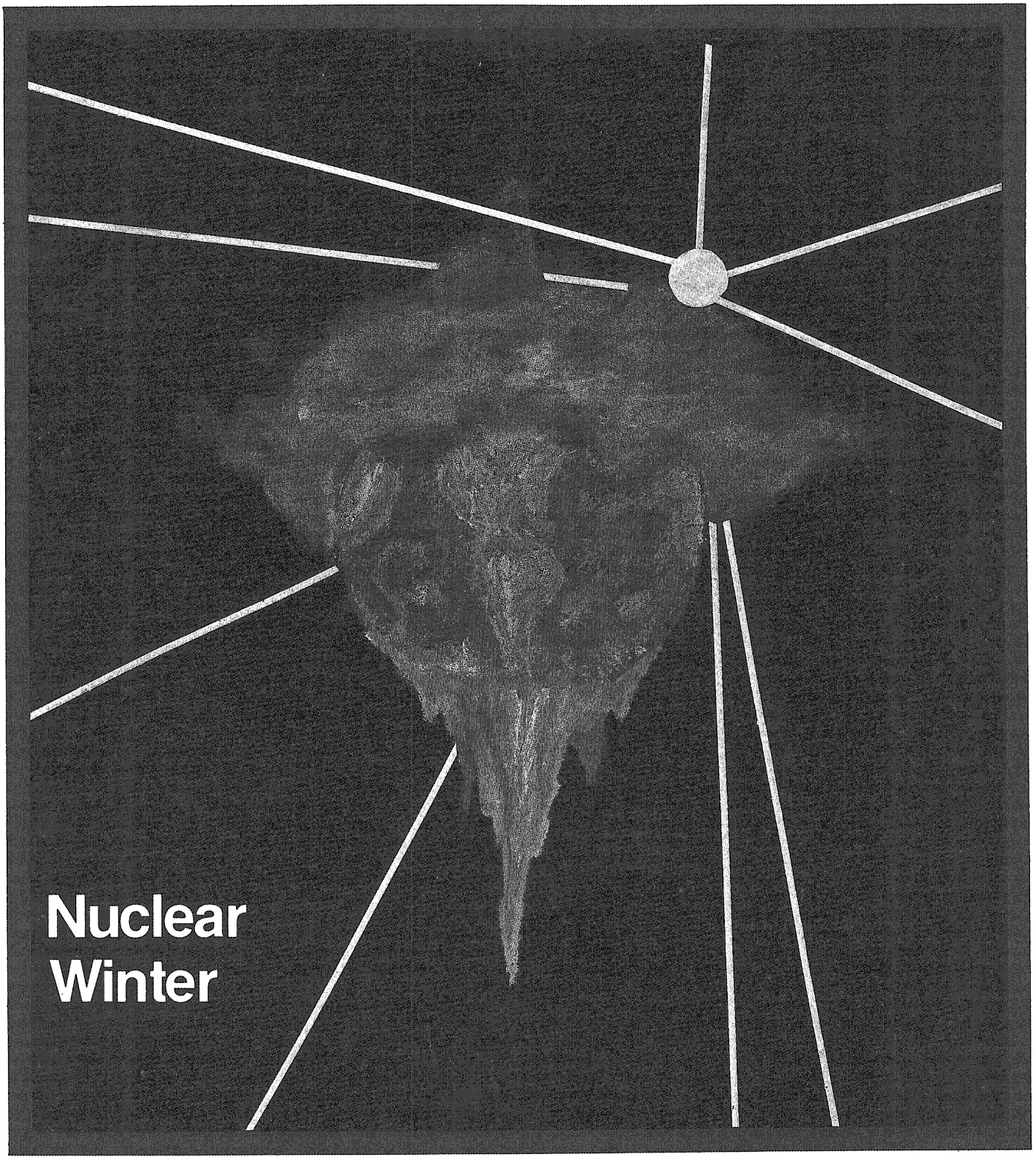
All offer opportunities for you to seek, to grow, and to accomplish.

If you can dream it, you can do it.

minnesota

WINTER ONE, 1985

TECHNOLOG



Nuclear Winter

Digital Audio

Science Museum of Minnesota

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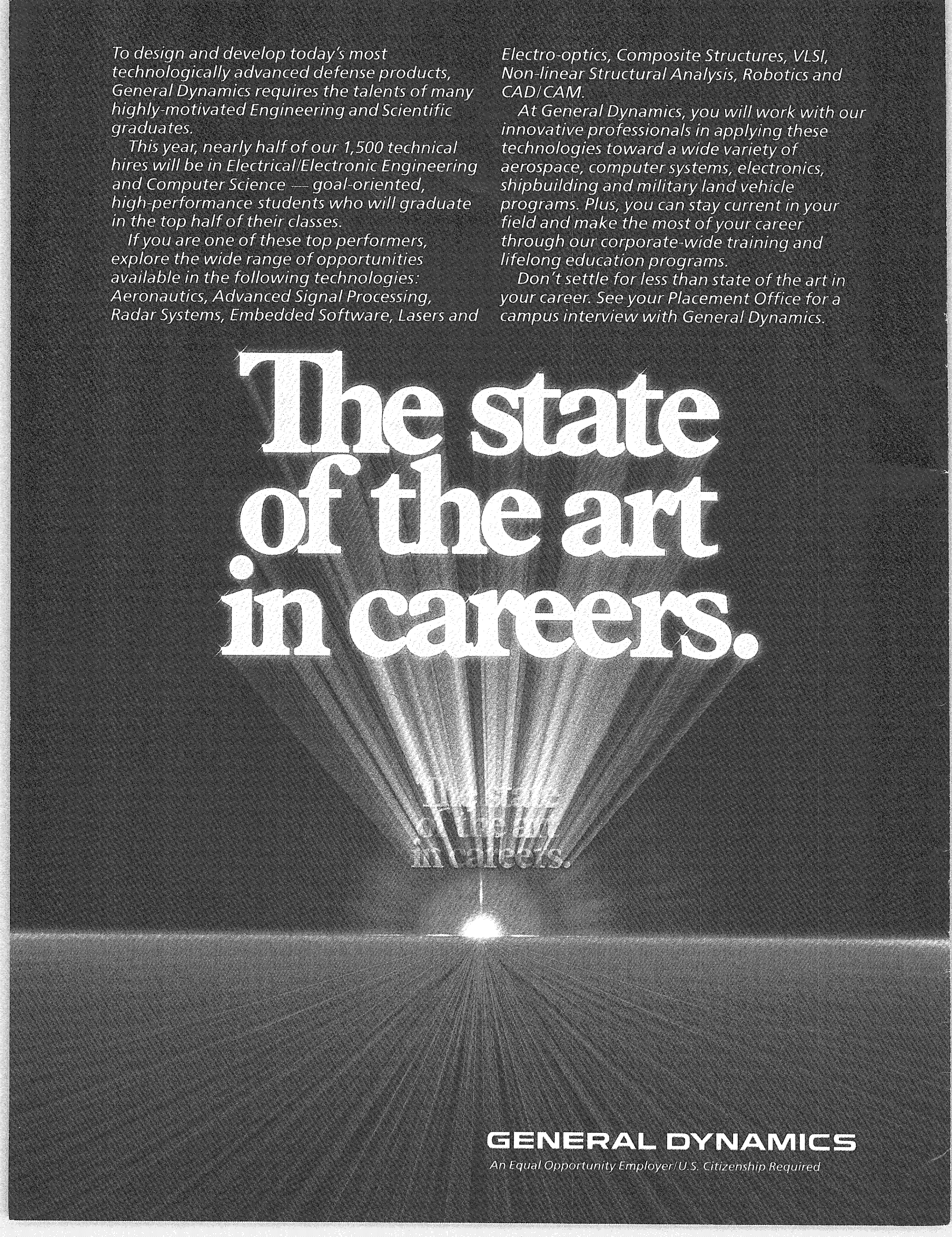

GENERAL DYNAMICS

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Cover art submitted by James Bailey

minnesota TECHNOLOG

Winter One, 1985 Volume 65, No. 3

The official undergraduate publication of the Institute of Technology.

Features:

Departments:

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letters from readers

Calculated Objections

It was of some interest to read Michael Dean's article on choosing a calculator in your first fall issue, because I have a different view of this problem. In particular, I suggest to new students in science or engineering that they buy a $20 calculator; this will easily handle what they will have to cope with until they learn enough calculus and numerical analysis to need something fancier. One very nice calculator is the Sharp 5100 (about $60) which can be programmed in ordinary algebra and which has some very nice features, like a built-in least squares procedure. And that's it as far as calculators are concerned!

The TI-59, the HP-67 and 41, the Casio's etc., were all very nice in their day, but machine-language programming with hundreds of steps is a thing of the past. I very bluntly tell students that is an outright swindle to be selling them these obsolete machines when, for typically less money, they can buy a real computer about the size of a paperback book which uses BASIC and operates for at least a year on one set of batteries.

The original pocket computer, the Sharp 1211/Radio Shack PC-1, doesn't seem to be available any more, but there are better ones now, such as the Sharp 1500A, which has about 6K of user-available memory built-in and can be expanded to over 16K. I raced the Sharp 1211 against a 41 CV and found the latter to be about twice as fast, but the 1500/1500A are significantly better. In addition, you can get a printer-plotter which looks like a toy but actually produces graphs and print-outs of professional quality in four colors and, with its case and accessories, is about the size of a three-ring notebook, making it very portable. Considering the fact that a fancy ray-tracing program I once wrote would just barely fit in the available memory (249 steps) of a programmable calculator, but that it all boiled down to 20 short lines of BASIC, you can see why I tell students not to waste their time or money on calculator programming.

If you want to get even fancier, the HP-71 (about $400), a Radio Shack 100 ($600) or HP-75 (about $800) are lovely portable computers, although they are rather slow when you use them for long programs which take full advantage of the memory. It would be much better, if you can afford it, to invest the approximately $2,000 needed to take advantage of the discount which the bookstore offers on Apples, IBM's, etc. and acquire a real personal computer which will be usable for some time to come.

May I also add that these computers will not be of much use unless the owners know BASIC and how to program well-known numerical procedures, such as the Newton-Raphson method, Simpson's rule, and Runge-Kutta algorithms, in this language. With this kind of background, we can handle classroom problems that were out of the question in the slide-rule days.

Alan Nussbaum
EE Professor

Corrections

In the profile column on Seymour Cray in the Fall 1 issue, Gene Amdahl was incorrectly identified as the founder of IBM because of an error in a source. While Gene Amdahl did work at IBM, he is too young to be its founder. He is currently the Chairman of the Board for Trilogy Systems.

In the feature article on the University of Minnesota-Duluth computer engineering program, the qualifications necessary to enter an engineering program were not clearly stated. The entrance requirements for I.T. and the upper division engineering programs can be explained in the I.T. Admissions Office.

Credit Where Credit Is Due

Due to an editorial oversight, a few individual's names were not typeset for the second fall issue. *Minnesota Technolog* would like to thank our new photo editor Mike McGee, illustrators Helen Mittelstadt and David Hyde, and photographer Mike Moffa for their contributions in the last issue of *Minnesota Technolog.*

editor's log

Our Nuclear Response

When the bulb of an ordinary thermometer is held in a flame, the mercury inside changes volume, moving through the capillary in the glass until a new equilibrium is reached. The system inside cannot change instantaneously with the surroundings outside. As each multiple of the time constant ticks away, the system becomes closer and closer to its final state.

On July 16, 1945, the first atomic bomb was detonated at the Trinity test site in New Mexico. One month later, the atomic bomb brought the war with Japan in the Pacific to an end. Since then, the world count of nuclear warheads has approached fifty thousand and society's response to their presence has lagged behind their growth, trying to catch up, much like a thermometer thrust into a flame.

Our nuclear arsenal has become the focal point of a growing national debate. Hundreds of politically vocal groups, who either favor a strong "defense" of nuclear power or propose a "freeze" of nuclear development, have prepared persuasive presentations with convincing charts to display their statistics for their case. I'll leave that argument to them.

Instead, I would like to say a few things about the history of our response to nuclear weapons.

Japan's surrender, which followed in the wake of the destruction at Hiroshima and Nagasaki, set society's initial mood toward nuclear weapons. We were at war and the atomic force we harnessed and released was seen only as another weapon of war. In the United States, the bomb was justified by the thousands of U.S. soldiers who returned to their homes without having to stage a grim invasion of the Japanese mainland.

I saw a Hollywood movie once where a gunfighter rode into a western town and shot up a few bad guys who were causing a disturbance. Seeing the relative peace after his explosive arrival, the townsfolk enlisted him as their sheriff. The response to nuclear weapons In the late forties was probably much the same. After their success at bringing peace, the purpose of nuclear weapons was extrapolated to keep the peace.

In spite of the immeasurable importance of nuclear weapons, the world has declined, on the whole, to think about them very much.

Jonathan Schell

Sometime between then and now, a new response to the nuclear presence emerged. In *The Fate of the Earth,* Jonathan Schell wrote, "In spite of the immeasurable importance of nuclear weapons, the world has declined, on the whole, to think about them very much." While this is difficult to explain, it is understandable. In a time when the statistics of the world's destructive capabilities have grown beyond a person's capability to judge their magnitude (how do you fathom billions of tons of TNT), the decision to just not think about them is convenient, and therefore popular.

Not everyone, however, ignores the nuclear presence. Some groups propose to dismantle their way back to a time when energy was energy and matter was matter. But they cannot remove the nuclear knowledge that $E = mc^2$ from man's mind. There are other groups who dream of new equations for new weapons to make the old equation's weapons obsolete. Each side controls a rhetorical flood of evidence to support their stand.

A solution cannot be found by looking back to 1944 or ahead to 2000. What is needed is a third group. One that recognizes we live in a nuclear world which needs input and feedback on nuclear ideas to develop good nuclear policies. The decisions surrounding the future of nuclear weapons are too important to be forfeited to the vocal minorities at the extremes of the debate.

Our national leaders have resurrected the belief in the need for open minds on the nuclear issue by resuming talks with the Soviet Union about the future of each country and the nuclear presence. Hopefully the "numbed" majority of this country will follow suit by opening their minds to the same issue.

On that note, I invite you to read the article in this issue of *Minnesota Technolog* which examines the recent study that theorizes the possibility of a nuclear war triggering a "nuclear winter."

David Herridge
Editor

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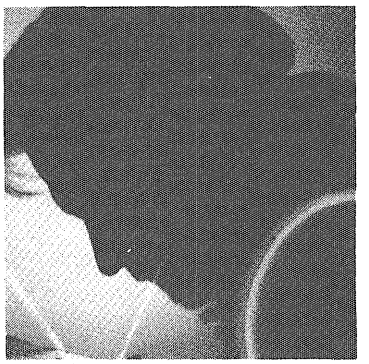

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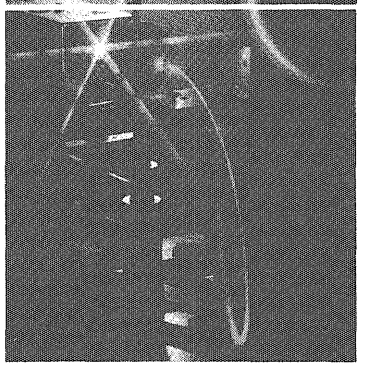

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Don't miss this opportunity to meet with us, have some refreshments, and talk informally about your career goals and how we can meet them.

If your BS or MS degree is in EE, CS or ME—or you have specialized in industrial engineering, MIS or technical writing—come to this informative session on February 5th. Learn about challenging career opportunities all over the country. Then, on-the-spot, you can schedule a convenient interview for either February 6th or 7th.

Casual attire. But don't forget to bring 3 copies of your resume. U.S. citizenship or permanent residence is required for interviews.

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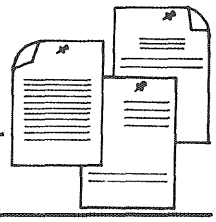


log ledger

Important Work on the Important Problems

The longer you stay in school the more specialized your studies are likely to become. If you desire to pursue a field of research, but are uncertain which field will keep you on that "cutting edge" of science, here are a few hints for you.

In *The Search for Solutions,* Horace Judson outlined eight areas where he felt scientists could do "important work" on "important problems."

The Cosmological Question: The answers to how the universe began have eluded man for centuries. Theories have come and gone, and before one is postulated that will stick around, whole new ideas of physics will likely be developed.

The Unified Theory: The strong force, the weak force, the electromagnetic force, and the gravitational force are all mentioned in freshman physics. In the seventies, physicists discovered a relationship between the strong and weak forces, but there is still a great deal of work to be done on the total unification of all four forces.

The Formation of the Solar System: The theories behind the origin of our solar system have been the focal point of many arguments. Today, astronomers are watching the heavens in hopes of finding other solar systems still in the early stages of development (see below article).

The Origin of Life: A quarter of a century ago, an experiment on the origin of life was conducted by Stanley Miller at the University of Chicago when he electrically stimulated a mixture of substances he felt were present on the young Earth. Today, experiments continue to solve and create the questions on the origin of life.

The Quantitative Basis of Natural Selection and Evolution: The theory of evolution does not address the rate of change of the evolutionary process. Studies and experiments by today's researchers hope to unravel some of that mystery.

Development and Differentiation: The complicated control system that turns the fertilized egg into an organism has escaped biologists and remains one of today's "important questions," according to Judson.

Aging and Death: The mechanism that causes the failure of an organism has been theorized to be the "inevitable accumulation" of errors and mutations. Only more research will tell.

Neurobiology: Judson wrote some of the most complex problems facing researchers are in the neurobiology field. How animals perceive, recognize patterns, and remember has not yet been determined.

Physics Lab Goes Underground

Several physics professors from the University of Minnesota are cooperating on a project which will bring a new proton decay detector to Lower Soudan State Park in Northeastern Minnesota. The detector will be housed in a new $1.5 million physics lab which is now under construction. Professors Hans Courant, Kenneth Heller, Marvin Marshak, Earl Peterson, Keith Ruddick, and Michael Shupe from the University along with others from Oxford University, Tufts University and the Rutherford Appleton Laboratory of the United Kingdom Science and Engineering Research Council will use the lab. The new lab will be 375 feet long by 45 feet wide and 38 feet high. It will be 2,400 feet below ground and should be completed in the spring. Half of the detector will be assembled in Chicago while the other half will be sent from England. The total cost of the project is $10 million and is being funded by money from the U.S. Department of Energy, the government of the United Kingdom, the State of Minnesota and the University of Minnesota. (Portions adapted from *ITEMS*).

By Mark Werner

Opportunity Knocking

Each winter an exceptional opportunity is offered to the students of the Institute of Technology. A new editor and a new business manager are hired to oversee next year's six issues of *Minnesota Technolog.* No experience is required. If you have an interest in writing, editing, and management or financial management, please stop by Room 2, Mechanical Engineering to have a look around. If you agree what you see looks like as much fun as it really is, then get together a resume, a transcript, and any samples of your work and apply. We hope to see you soon.

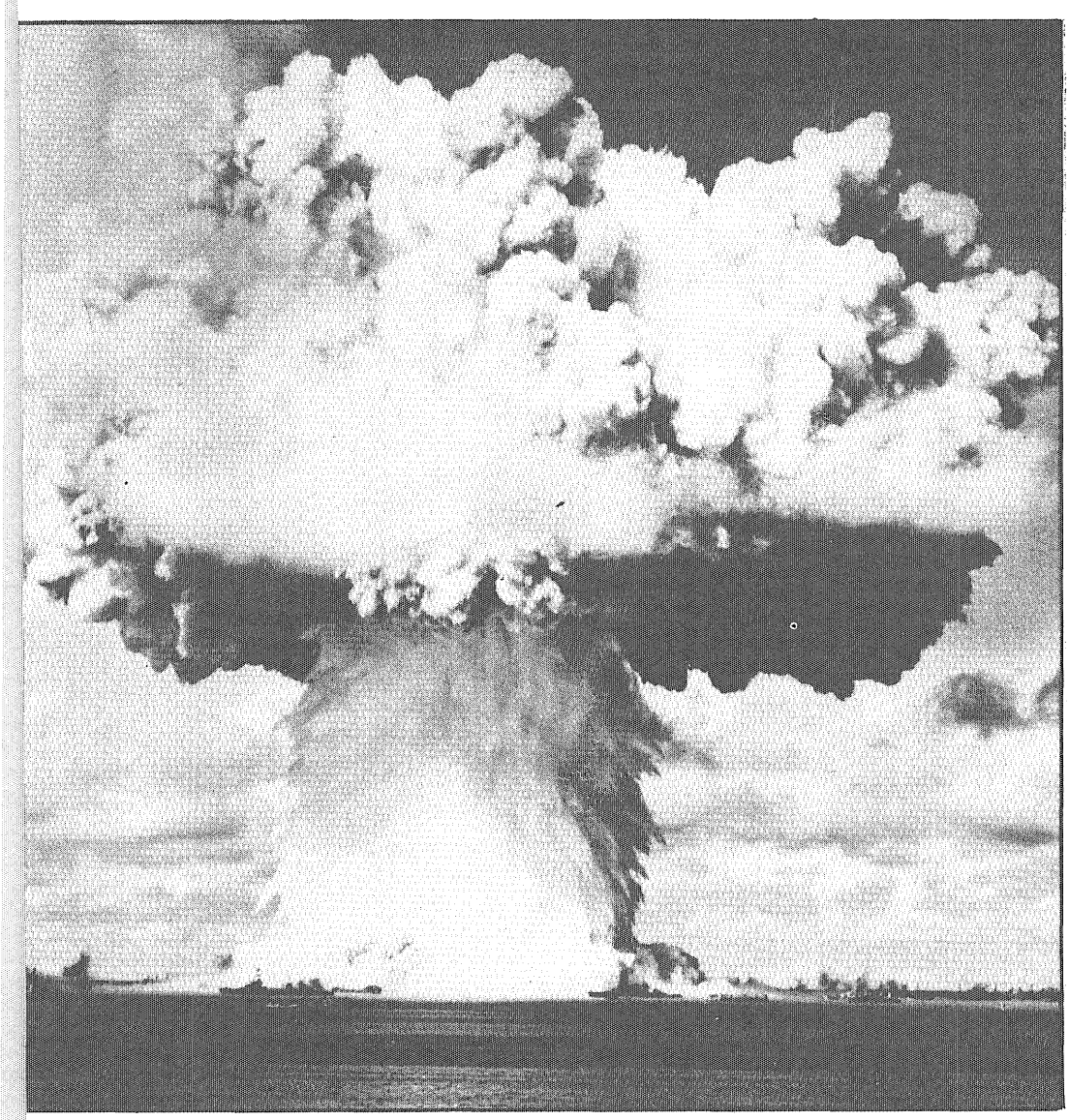
Colloquium on Technology in a Human(e) Society

A coloquium titled "Technology in a Human(e) Society" is scheduled for February 21-22 in Coffman Union. I.T. Dean Infante will introduce the colloquium which will examine the effects of technology on society and government. Contact Nancy Cobrin at the Center for Humanistic Studies (376-8322) if you would like more information.

Ingredients of a Solar System Sighted

Astronomers have a lot to be excited about these days, especially Bradford Smith of the University of Arizona and Richard Terrile of NASA's Jet Propulsion Laboratory. Using a 100 inch telescope at Chile's Las Campanas Observatory, they

Continued on page 14



Nuclear Winter: After the Blast

By Alan Hauser and
Randy Smith-Kent

The particles a nuclear explosion would introduce into the atmosphere could cause serious climatic consequences on a global scale. The assumptions and arguments behind the "nuclear winter" theory are at the focal point of today's nuclear debate.

It was a cold world.

Jim hoisted himself over the rim of the tunnel mouth, stepped into the new world, and fought back a surge of panic as he saw the magnitude of it all. Even at night, even by moonlight, it was possible to see how the flat ice sheet spread out to the horizon...

One by one, the men were coming up out of the tunnel. Carl emerged, and cringed in disbelief at the immensity of the ice field...

"It's cold," he whispered. "So cold!"

... They fell silent. After a while, Jim said, "The sky is much clearer than I expected it to be. Where's the famous dust cloud that caused all the trouble?"

"It's there," Dave Ellis said. "Thinner than it was 200 years ago, probably, but it's there."

"Where?"

"Diffused in the atmosphere. One particle every few square feet, probably."

"And a little dust made the whole world freeze?" Carl asked.

Dave laughed. "It didn't take much to do the job," he said. "Just enough to screen off some of the sun's warmth..."

Time of the Great Freeze, *Robert Silverberg*[1]

In his 1964 science fiction work about Earth after a major climatic change, Robert Silverberg describes how dust in the atmosphere caused a decrease in the amount of solar radiation reaching the surface, resulting in cooling and, eventually, an ice age. Now, 20 years later, Richard P. Turco, Owen B. Toon, Thomas P. Ackerman, James B. Pollack and Carl Sagan have published a set of papers which indicate that dust and smoke dispersed into the atmosphere by a

nuclear war could have a similar (although not as long lasting) effect.[23] Their theory paints a picture of a frozen, dark and dismal wasteland where the remaining inhabitants would face starvation and disease in the absence of medical services and the infrastructure necessary to combat these afflictions. But the cold and darkness are only two aspects of the problem. According to the theory, "In the aftermath of such a [nuclear] war vast areas of the earth could be subjected to prolonged darkness, abnormally low temperatures, violent windstorms, toxic smog and persistent radioactive fallout—in short, the combination of conditions that has come to be known as 'nuclear winter.'"[4]

How would a nuclear winter come about? According to the Turco, Toon, Ackerman, Pollack and Sagan (TTAPS) papers, a large-scale nuclear strike by the superpowers would raise large amounts of dust into the atmosphere. This dust, along with the smoke and soot from the many fires ignited, would block out much of the sunlight which usually strikes the Northern Hemisphere. One would observe darkness throughout the day. The dust and smoke, however, would be of such a diameter that the longer wavelength infrared radiation (heat) emitted by the earth could pass through the dark veil into space. Thus heating would stop, but cooling would continue, and the continents would cool quickly. Oxides of nitrogen produced in large fireballs would enter the stratosphere and cause depletion of the ozone layer, which is responsible for screening out harmful ultraviolet (UV) radiation. Thus once the dust settled or was washed out, the environment would be exposed to high doses of UV radiation. The settling dust would also be radioactive, exposing the general population to external doses and, as the dust entered the food chain, internal doses of radiation. After a nuclear attack burning cites would become surrounded by a smog of toxic gases formed during the combustion of the many synthetic organic chemicals found in modern buildings and stored near metropolitan areas. These effects make up what is now called nuclear winter.

The idea that atmospheric dust can cause surface temperature variations is not new. For many years it was believed that volcanic dust may have caused the advent of the ice ages. "There are still some people who believe that the volcanic theory has some importance," says Professor Herbert Wright of the University of Minnesota's Geology Department. "Some people believe that it is *the* cause. Others say that it is a minor cause."

Even individual volcanoes can affect the climate. In 1815 the Tambora volcano in Indonesia exploded, spewing fine aerosols into the stratosphere. The following year was known as "the year without summer."

Professor Richard Skaggs of the Geography Department at the University of Minnesota stated the following:

"Most climatologists feel that some of the very large class [of volcanoes] have put enough particulate matter into the stratosphere so that there have been measurable changes in climate at the surface of the earth, usually in the form of a small decrease in temperature .... But that isn't a universally accepted notion .... The changes from volcanism are so relatively small that they are just on the lower limb of the expected values of global temperatures. So it turns out that there is room for debate—whether there is a physical cause and effect relationship here or whether there isn't."

However, evidence recently collected by Valmore LaMarche Jr. of the Laboratory of Tree-Ring Research and Katherine K. Hirschboeck of the Department of Geosciences at the University of Arizona suggest that the temperature depressions following major volcanic eruptions are not coincidental.[5] They analyzed frost rings in old trees to obtain dates of unusual coolness, which they then compared to the dates of known volcanic eruptions. They found that there is a definite correlation between the two.

While some of the authors of the TTAPS papers had been researching the climatic effects of volcanoes, Carl Sagan became involved in the study in a very dissimilar way, as he explained in October 1983 at the Conference on the Long-Term Worldwide Biological Consequences of Nuclear War.[6]

"For me, it began in 1971 with the Mariner 9 exploration of the planet Mars .... The spacecraft arrived at Mars to find the planet completely covered with a global dust storm .... During those first three months, there was very little to look at except the dust in the atmosphere. There was an instrument on board the spacecraft called an infrared interferometric spectrometer, which had the ability to examine the atmosphere at various wavelengths and therefore, to probe to different depths in the atmosphere—from very high altitudes down to the surface .... The results showed that the atmosphere was considerably warmer than is usually the case on Mars, and the surface considerably colder."

This group of scientists, with their diverse backgrounds, came together and, following much work, produced a study with results which even they found surprising.

To simulate the climatic effects of a nuclear war, the group of scientists adopted three models, each containing a certain number of simplifications and assumptions. "The nuclear winter theory is a totally new one," said co-author Toon during a *Technolog* interview. "When it first occurred to us, we realized that the first step is to do the simplest thing that you can in order to understand what might happen." Thus a one-dimensional microphysical model was used to predict the formation of dust and smoke clouds. Also a one-

According to the theory, "In the aftermath of such a (nuclear) war vast areas of the Earth could be subjected to prolonged darkness, abnormally low temperatures, violent windstorms, toxic smog and persistent radioactive fallout.

dimensional radiative-convective model was used to calculate light fluxes and air temperatures. Both models depend upon the amount of dust and smoke put into the atmosphere, which is itself dependent upon the type of nuclear attack postulated. Therefore, a nuclear war scenario model was developed.

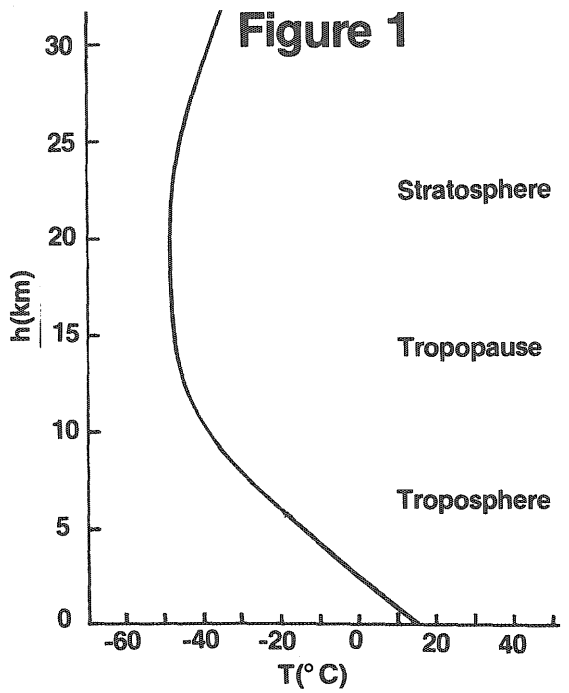
The total number of strategic, theater, and tactical nuclear weapons in the American and Soviet arsenals today is approximately 50,000.[7] These weapons have a total yield near 15,000 megatons. (A megaton is the explosive equivalent of a million tons of TNT.) To gain a perspective on the destructive power of this arsenal, one may note that in the earlier part of World War II a single large blockbuster bomb had a yield of ten tons, while the Hiroshima bomb had a yield of 0.012 megatons. With such large destructive capabilities at their fingertips, the superpowers could choose strikes and counterstrikes of various magnitudes.

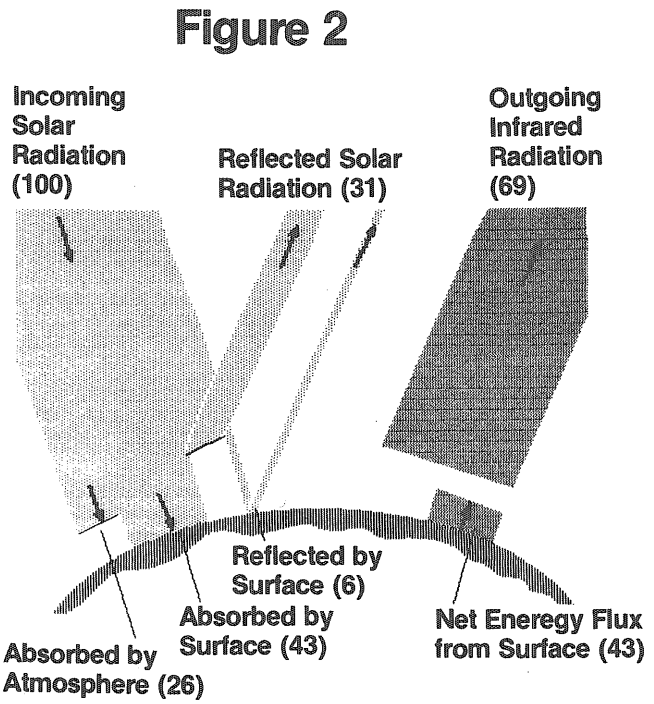
Figure 1: Temperature variation with altitude in the atmosphere. In the troposphere temperature decreases with increasing altitude. Thus warm air near the Earth's surface rises because it is less dense than the cold air above it. This results in mixing. In the stratosphere temperature increases with increasing altitude, forming an inversion and resulting in little vertical mixing.

The attacks may also be launched against a variety of targets. "Counterforce attacks," are targeted against missile silos, airfields, naval bases, command centers and other "hard" targets which require fairly high yield ground bursts because of current limitations in nuclear weapon accuracy. Such high yield ground bursts will vaporize and pulverize the surface and lift large quantities of fine dust into the stratosphere and the upper troposphere (see figure 1). Being of supreme importance in a long-term way, industrial centers may also be targeted in what is called a "countervalue attack." Since industrial centers are not "hard" targets, it is likely that they and the cities surrounding them would be destroyed with air bursts, nuclear explosions less than a kilometer above the surface, such as those used to destroy Hiroshima and Nagasaki during World War II. Massive fires would then follow due to the high density of combustible material in cities. These fires could place large quantities of smoke in the upper troposphere and possibly even the stratosphere. Obviously the amount and size of the aerosol in the different atmospheric levels are dependent upon the type of attack launched. In light of this, several dozen cases were examined, each corresponding to a different nuclear war scenario. The "baseline" case assumes a 5,000 megaton exchange, 20 percent of which is detonated over urban, suburban, and industrial areas.

To understand how particles in the atmosphere can affect the Earth's radiation balance, or budget, one must first understand how such a balance is maintained in the absence of war-generated particles. The characteristic wavelength of radiation is inversely proportional to the temperature of its source. Since the sun is much hotter than the Earth, solar radiation has a much shorter wavelength than infrared radiation emitted by the Earth. Figure 2 shows the normal radiation fluxes to and from the Earth. Note that 43 units of incoming short wavelength solar radiation reach the surface. This energy is re-emitted as long-wavelength radiation which is readily absorbed by the lower atmosphere. The ability of the atmosphere to absorb long-wavelength radiation while allowing short wavelength radiation to pass through is called the greenhouse effect. It allows the Earth's surface and lower atmosphere to be much warmer than the surface of a corresponding planet without an atmosphere. In summary, the incoming solar radiation acts as a heat source within the Earth's surface.

Figure 2: The Earth's normal radiation balance.
Adapted from Turco *et al.*, "The Climatic Effects of Nuclear War," *Scientific American,* Vol. 251, p. 36.





The greenhouse effect then acts as a blanket and keeps this heat near the surface.

Things change drastically when nuclear dust and smoke are spread throughout the atmosphere. At the University of Minnesota's Physics Department, Professor George Frier, who has studied meteorology and climatology for years, described the situation as follows:

"When the nuclear cloud is present, most of the sunlight will be scattered or will be absorbed in the atmosphere. Very little of it will get through to the Earth. A good rule to remember ... is if the size of the particles is anywhere near the wavelength of the light, then they can scatter the light. Our solar spectrum is centered at about 0.5 microns, so any particles from a tenth of a micron on up will scatter light like crazy .... The problem with the nuclear holocaust is that it will put lots of particles into the air that are capable of scattering light."

Figure 3 shows that when dust and smoke are added to the atmosphere only five units of radiation make it to the surface. Much of the rest is absorbed by the particles in the upper atmosphere. Thus only a small net amount of infrared or long-wavelength radiation is emitted by the surface and absorbed by the lower atmosphere. Laden with light-absorbing particles, the upper atmosphere becomes warmer while the lower atmosphere and the surface cools, much as Mariner 9 observed on Mars during the dust storm. Figure 4 illustrates this profile.

To simulate the climatic effects of a nuclear war, the group of scientists adopted three models, each containing a certain number of simplifications and assumptions.

Figure 5 shows the surface temperature as a function of time. After several weeks or months the particles in the lower troposphere begin to settle out or are washed out by rain. Aerosols in the stratosphere, however, may remain for several years since the stratosphere is very stable and subject to only horizontal, not vertical, air movements. Tropospheric smoke is largely responsible for the relatively short-term drastic temperature depressions while stratospheric dust causes the long-term temperature reductions. This can be seen clearly by comparing case 10 to case 11. Both are 3,000 megaton exchanges but case 11 is an attack composed of only ground bursts over hard targets (not cities). Therefore the effects of fires and smoke were ignored. Case 14 indicates that temperature drops of 40 degrees Celsius can be observed in a relatively mild 100 megaton exchange if only cities are targeted. Note that 100 megatons is smaller than one percent of the total nuclear arsenal available to the superpowers.

It is also interesting to note that it was assumed that little smoke reached the stratosphere in the baseline, 5,000 megaton case. If large firestorms—towering urban fires accompanied by hurricane-force winds due to rapid upward air convection—were common in a nuclear exchange, much more smoke would reach the stratosphere, and the nuclear winter would be much more severe. Such firestorms did occur in the World War II bombings of Dresden and Hamburg.

But cold is not the only effect of solar insolation reduction. A nuclear winter, unlike a conventional winter,

Figure 3: The Earth's radiation balance during a nuclear winter.

Adapted from Turco *et al.*, "The Climatic Effects of Nuclear War," *Scientific American,* Vol. 251, p. 36.

Figure 4: Variations in atmospheric temperature profile due to fine particles raised by a nuclear war.

Adapted from Ehrlich *et al., The Cold and the Dark,* p. 12.

Figure 3

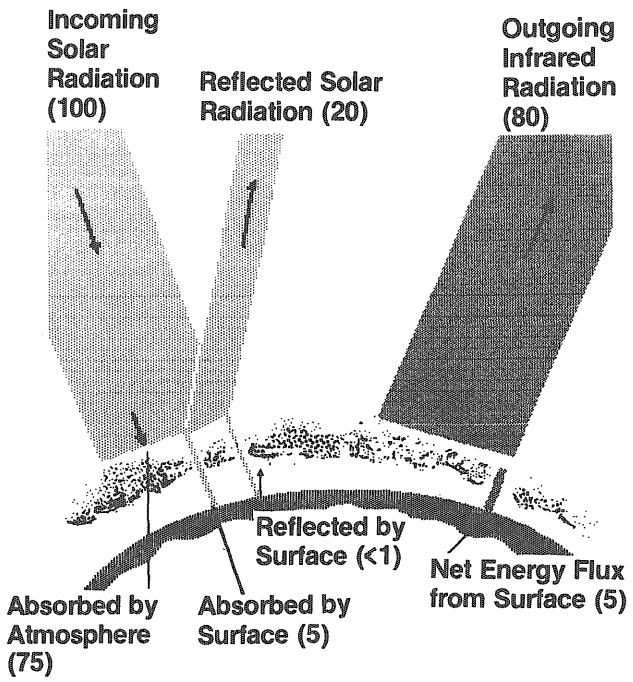
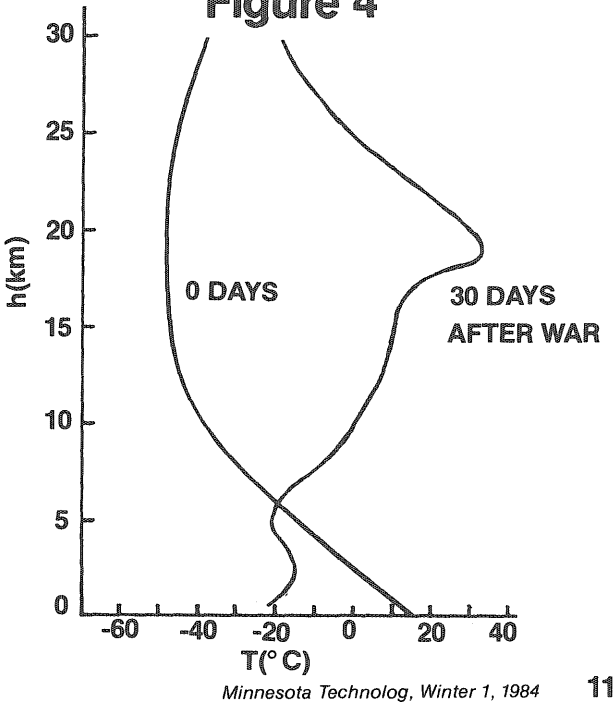


Figure 4



would be quite dark. Freier explains how one can imagine the degree of darkness:

"They said that it [the nuclear explosions] would raise about 9.6×10^8 tons of dust. Taking the density of the dust, you can calculate how many cubic meters that is. Then I put a sheath around the Earth and asked what thickness would it be in order to have this 9.6×10^8 tons. The thickness turned out to be 1.8 microns.... I think a good thing to think about is a photographic emulsion or negative.... those particles in there are on the order of a micron.... If I have a micron particle everywhere on the film, I can hardly see the sun through it. So the dust, if it were uniformly distributed, is enough to cover the whole Earth with [the equivalent of] a photographic emulsion."

Indeed, the TTAPS authors coldly state, "... within the target zones it would be too dark to see, even at noon."[7] Such darkness would have a profound effect on all plants which are dependent on photosynthesis.

After a certain period of time the dust would settle or be washed out. The survivors of the cold and darkness may find this a mixed blessing since a nuclear exchange could very well destroy the ozone layer, and if this were the case, the dust would be the only thing protecting the Earth's inhabitants from harmful ultraviolet radiation.

Nuclear explosions with yields equal to or greater than 100 kilotons are concurrent with the creation of a fireball which rises partially or completely into the stratosphere. Oxides of nitrogen are formed when nitrogen is chemically ignited by the high temperatures of the fireball. These oxides of nitrogen destroy the ozone in the stratosphere. The mechanism is described by Professor Konrad Mauersberger of the Physics Department at the University of Minnesota as follows:

"NO takes an ozone and forms NO_2 and O_2.

$NO + O_3$ yields $NO_2 + O_2$

The $NO_2 + O$ yields $NO + O_2$

In chemistry, we call this a catalytic cycle. The initial molecule, NO, goes through a cycle and comes back as NO. And now it can start to destroy ozone again."

Sagan states that a nuclear war involving thousands of high-yield weapons could increase the amount of dangerous UV light by several hundred percent.[8]

Every thermonuclear bomb uses fissionable material as a trigger—a device used to start the fusion reaction. Usually made of plutonium, the trigger produces an abundance of radioactive products which are harmful to human beings. Particles injected into the lower troposphere by low yield explosions coagulate, settle, or are rained out, taking their radioactivity to the Earth's surface. Sagan states that in the baseline 5000 megaton case 30 percent of the Northern Hemisphere would be exposed to a radiation exposure dose of 250 rads.[9] (A rad is a unit of radiation exposure equal to 100 ergs of ionizing energy per one gram of

Figure 5

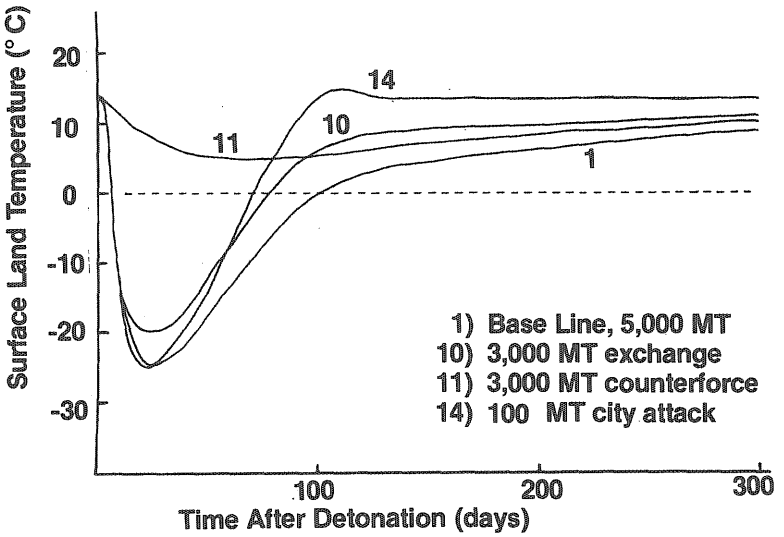


Figure 5: Surface temperature versus time after nuclear detonations for several nuclear war scenarios.

Adapted form Turco *et al, Science,* Vol. 222, p. 1286.

tissue.) In addition, a dose of 100 rads is delivered throughout the Northern Hemisphere because of external emitters and ingested radioactive material from the contaminated food supply. The accepted lethal dose is between 400 and 500 rads, assuming comprehensive medical care is available. Joseph Knox of the Lawrence Livermore National Laboratory has estimated that if nuclear power plants were targeted the average dose could be increased by several hundred rads.[10]

Besides generating large volumes of smoke, urban fires may also produce a toxic smog. The authors of the TTAPS papers state the following: "In addition to carbon monoxide, which is produced copiously in many fires, hydrogen cyanide and hydrogen chloride are generated when the synthetic compounds in modern building materials and furnishings burn. If large stores of organic chemicals are released and burned in a nuclear conflict, additional airborne toxins would be generated." The possibility exists for the transportation of toxic clouds over vast distances.

Besides predictions of coldness, darkness, UV radiation, radioactive fallout, and toxic smog, the TTAPS papers also proposed one more consequence of a nuclear war. In the past it had been assumed that although a large-scale nuclear war would cripple and possibly even destroy the Northern Hemisphere, the nonparticipating nations of the Southern Hemisphere would be left intact. Turco *et al.* challenge this assumption and indicate that changes in global circulation patterns caused by the aerosols in the atmosphere could cause rapid dust transport to the Southern Hemisphere.

"A rough analogy can be drawn with the evolution of global scale dust storms on Mars. The lower martian atmosphere is similar in density to the Earth's stratosphere, and the period of rotation is almost identical to the Earth's (although solar insolation is only half the terestrial value). Dust storms that develop in one hemisphere on Mars often rapidly intensify and spread over the entire planet, crossing the equator in a mean time of approximately 10 days. The explanation apparently lies in the heating of the dust aloft, which then dominates other heat sources and drives the circulation."

"...Within the target zones it would be too dark to see, even at noon."

TTAPS Report

Transport may also occur in the stratosphere, which experiences very little vertical mixing but does contain horizontal mixing. Observations of the cloud emitted by Mexico's El Chichon volcano (located at 14° N) show that between 10 and 20 percent of the particles in the stratosphere were transported to the Southern Hemisphere after only seven weeks.

Of course, the TTAPS study is by no means the final verdict concerning the nuclear winter question. Like all new theories, it contains many assumptions and simplifications. When asked which major questions remained to be explored, Toon replied, "The first major question is how much material which is burned makes it into the atmosphere and how much dust is injected into the atmosphere—what fraction of the city is burned, for example . . . The second uncertainty is where does this smoke end up. Basically what we assumed is that most of the smoke ends up in the upper troposphere . . .

Changes in global circulation patterns caused by the aerosols in the atmosphere could cause rapid dust transport to the Southern Hemisphere.

There are some people who think the smoke will end up in the lower troposphere, and it will rapidly get rained out. Nobody really knows where it will end up . . . The third uncertainty is the climate. It is a complicated system which is hard to model."

The importance of ascertaining the size of particles and the height to which they are propelled is illustrated by the relative climatic effects of volcanoes. "As I understand things, one of the crucial differences between Mount St. Helens and El Chichon is in terms of the kind of material that was put into the stratosphere," said Skaggs. "Mount St. Helens was not a very gaseous—particularly sulfur oxide gaseous—explosion. As a result it put into the troposphere and the stratosphere relatively large pieces of material which obviously tend to fall out more rapidly. In the case of El Chichon, much of the material ejected into the stratosphere was . . . in the form of sulfur oxide gases that then precipitated into very small particles in the stratosphere. And so the amount of material that was put in the stratosphere by El Chichon was much larger than in the case of Mount St. Helens and [this material] has the tendency to stay there longer because of its very small size." Thus it is currently believed that El Chichon, not Mount St. Helens, may have had a noticeable effect on the climate.

Other uncertainties include the amount of smoke generated and the effects of patchiness of the original nuclear cloud, as pointed out by Edward Teller of Lawrence Livermore National Laboratory.[11] Teller added that the ozone depletion scenario depends on the use of large yield weapons, and the trend in both the United States and the Soviet Union is toward smaller weapons. He also claims that metropolitan areas would not be subjected to air bursts, but this argument is disputed by the authors of the TTAPS papers, who claim that large urban fires are unavoidable if industrial centers are targeted since most such centers are in or near large cities.

Originally many scientists complained about the simplicity of the one-dimensional model, which takes into account changes in

Continued on page 26

Log Ledger from 7

took photographs of the sky around the star Beta Pictoris. These photographs reveal a disk of matter, including ice, carbon, and silicon, that is approximately 80 billion miles in diameter. It is believed that this disk of matter will eventually form a new solar system. A great deal of understanding on the origin of our solar system could be gained from watching what may be a new solar system in an early stage of formation.

Searching for planets is difficult because the stars they circle are so much brighter than they are. However, the ratio of star to planet brightness is much smaller in the infrared range. Smith and Terrile were led to investigate Beta Pictoris more closely when satellite data showed heat emissions coming from it.

In an earlier search for planets outside our solar system, astronomers were drawn to Bernard's star when they detected a wobble in the apparent motion of the star. The findings of the Bernard's star study have long been in dispute, but the method used, astromety, is a good one, and is currently being used in various forms in other studies. As astronomers use these "old" methods of observation and develop new ones to study Beta Pictoris, we may gain valuable insight into the "hows" of the universe.

By Lorrie Sheets

One of the Hundred Brightest

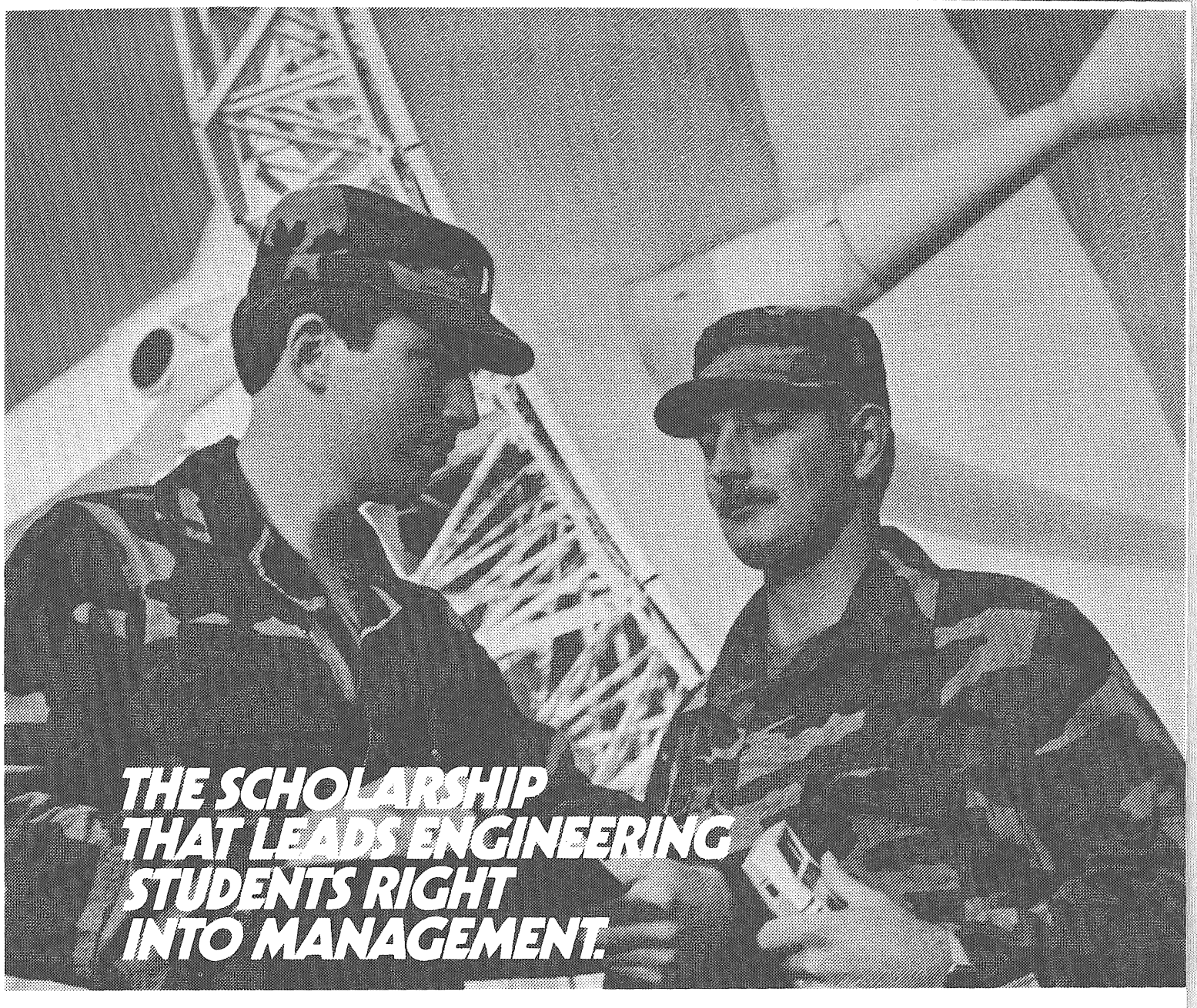
Who are the 100 brightest American scientists under 40 years old? A survey in the December *Science Digest* asked 55 senior scientists around the nation's foremost research laboratories and institutions to nominate the young, innovative scientists who will be tomorrow's leaders. The list includes twenty-nine year old George Barany, a chemistry professor at the University of Minnesota.

According to *Science Digest,* Barany jumped from high school into a graduate program where he completed his Ph.D. at 22. Barany's teaching at the University is limited to 40 lectures a year because of the time demanded by his research grants investigating peptide synthesis.

Magnetic Research Attracts Attention

The Institute of Technology announced the establishment of a magnetic research center in the Department of Electrical Engineering. The Magnetic Information Technology Center (MINT), under the directorship of Professor Jack Judy, will join interdisciplinary faculty with the existing EE Magnetics Research Lab "to operate and maintain a world class center of excellence in research and education in the area of advanced magnetic information technologies," wrote former I.T. Dean Rama Murthy.

Six research programs have been established to explore the design of magnetic media, heads, and sensors: 1) correlation of the micromagnetics of new materials, 2) modeling of recording and sensing devices, 3) determination of magnetic interaction between devices, 4) optimization of recording systems, 5) characterization of the effects of wear and corrosion, 6) and design of signal detection electronics.



There's a lot more to an Army ROTC scholarship than tuition, books, lab fees, supplies and up to $1,000 per school year for living expenses.

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profile

Lester Krogh: Innovation was the key to

By David Herridge

The textbook problems presented during many classes in the University can often be solved by flipping back the pages until you stumble upon the right equation. While some would argue the luck of the stumble plays a big part in research too, a researcher in industry needs other attributes to become a success. Knowledge from school and work must be gained and maintained. And that knowledge must be applied to the problems in innovative ways to seed growth. Lester Krogh, the Vice President for Research and Development at 3M, faces problems that do not have answers in the back of a text. His ability to discover solutions to those problems fueled his rise through the company ranks and earned him the recognition of the University Board of Regents, who granted Krogh the University of Minnesota Outstanding Achievement Award last November.

Krogh's first love was chemistry. While growing up in Ruskin, Nebraska, Krogh found a parent's college chemistry book and it captured his attention. It was not long before Krogh had his own chemistry set to satisfy his scientific curiosities first hand.

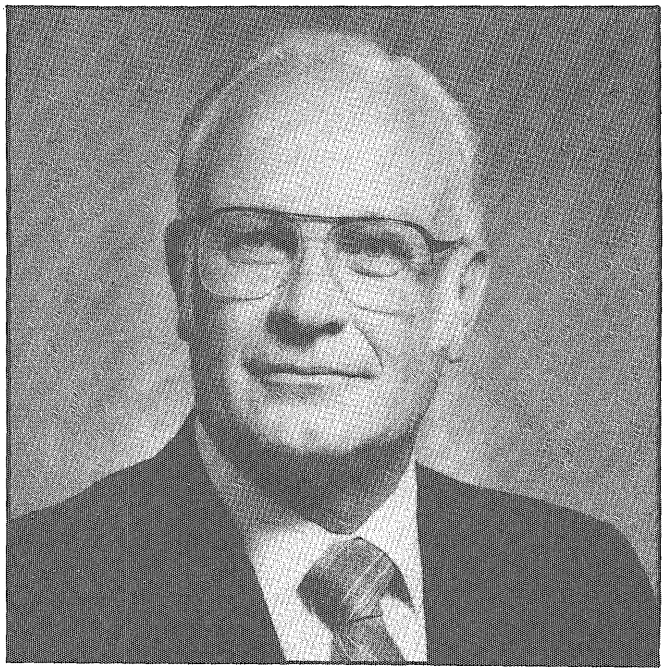
When Krogh enrolled at the University of Nebraska he chose to pursue chemical engineering over chemistry because a comparison of the programs revealed that more chemistry was offered through the engineering program. Krogh jokingly added, "I had read chemists made $2,000 a year and chemical engineers made $2,200."

A draft notice left Krogh a few hours short of completion for his bachelor degree. However, a wartime rule allowed students to receive degrees short of the full requirement, so the head of the department granted Krogh his B.A. in chemical engineering on Krogh's promise that he would return to graduate school after his military discharge.

After serving in the U.S. Navy in the Pacific after World War II, Krogh applied to many Big Ten graduate schools, but returned to Nebraska because most schools were not accepting out of state students. Krogh completed the courses he had missed during his bachelor studies and in 1948, received his Master's degree in organic chemistry.

"At that time, students were encouraged to get at least one degree in a different institution," said Krogh. So, in his words, he was chased out of Nebraska. The University of Minnesota accepted him and he completed his doctorate four years later in organic chemistry.

When asked what the University was like when he attended, Krogh jested, "Back then, it had a good football team." He continued, commenting on how much the University had grown, especially on the new buildings. His final note was a comparison to the Nebraska campus. The University of Minnesota, because of its commuter campus, thought Krogh, fostered a different social atmosphere than Nebraska had. He remembered the Minnesota Union being the social center only during the day. At night, everyone had dispersed.



The inter-relationship of all the scientific disciplines will affect us more strongly in the future than it does today.

Dr. Lester Krogh

While finishing his Ph.D., Krogh began working at 3M during the summer. This opened the door after graduation to a full time opportunity as a senior chemist with 3M's central research laboratories.

When he became a research group supervisor in the coated abrasives lab, there was a drive to develop a new generation of products. A problem that had always plagued the production of abrasives was the humidity response of the paper and cloth backings. The backings were subjected to a wet environment during glueing and

his success

to a hot environment during drying. The result was uncontrollable "curling" which Krogh described as "a nuisance" to production and use. Strong polyester film had been released a few years earlier and because of its lack of response to dramatic humidity changes, 3M hoped the next generation of abrasive products would use polyester backings. Krogh's job was to find out how to adhere abrasive materials to the smooth, clear films. The chemical process Krogh developed changed the film's surface characteristics, in a sense "priming the film." The abrasives developed are used today to polish plastic lenses for eyewear and smooth the disks used in personal computers. The "priming" process was eventually adapted to produce the first videotape. When asked to estimate the number of 3M products his patented process has effected, Krogh would only say it would be quite a number.

At that time, students were encouraged to get at least one degree in a different institution.

Krogh attributes some of his success to the combination of chemical engineering and organic chemistry he completed in school. "It has been a good combination. Organic chemists make new materials and they have to talk to the chemical engineers in order to translate what they do into production," said Krogh.

The path Krogh took through the company ranks changed between the business and the research sides of 3M. In 1982, he was appointed vice president for research and development. While the promotion placed him on 3M's management committee, Krogh emphasized he is deeply involved in 3M's research. He heads the 6,000 research and development personnel employed by 3M around the world. The many research laboratories, where 3M plans and perfects its huge product line, also fall under Krogh's jurisdiction.

Many results of 3M research have made front page news in the last few months. The last space shuttle mission carried a set of 3M experiments into orbit. Away from the Earth's gravitational effects, the containers produced very large, single crystals, according to preliminary reports.

Another development was the FDA approval for a cochlear implant for people with no sense of hearing. The device allows the recipient to hear noise similar in quality to a slightly untuned radio. The audio input, despite its current poor quality, makes lip reading much easier.

The future of 3M research was described by Krogh to be "very rosey."

Krogh's supervisory position brings him into contact with many young researchers. In an article in *Items,* Krogh said, "I have always enjoyed talking to younger people who were doing research at the bench. I want to make them feel that what happened to me could happen to them."

Krogh's advice for reaching a position like his is the same advice his earlier supervisors had for him. They insisted he stay current in the literature in his field and to read broadly in others. "The inter-relationship of all the scientific disciplines will affect us more strongly in the future than it does today," emphasized Krogh. Because a varied knowledge of many fields can generate innovative ideas, Krogh suggested students get into the habit of studying and continue to study after graduation.

Solutions to real engineering problems are not found in the backs of textbooks. An innovative mind must generate and recognize the solution without the safety of an answer key. Lester Krogh has clearly demonstrated his engineering and leadership skills during his career at 3M.

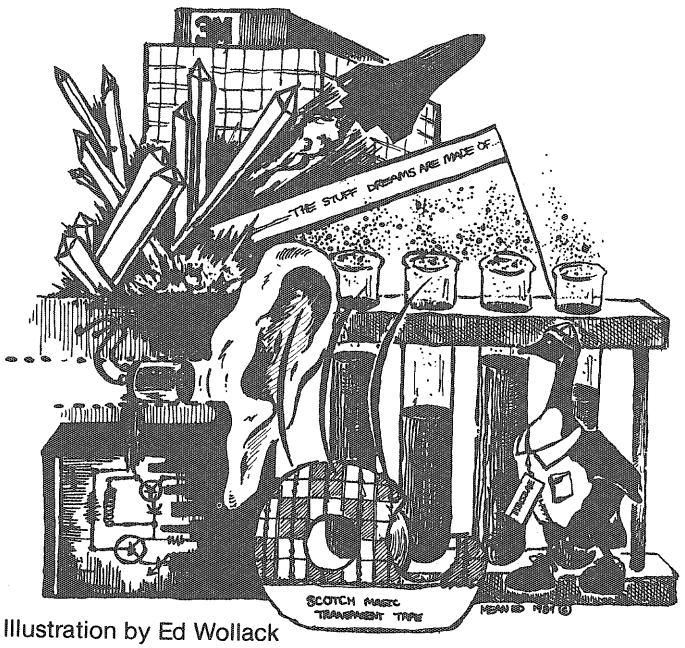


Illustration by Ed Wollack

The Equilibrium Solution

Rapid, reliable methods for solving chemical equilibrium equations have long been sought by scientists asking fundamental questions about systems as varied as the atmosphere, the human body, and the internal combustion engine. An interdisciplinary collaboration at the General Motors Research Laboratories has produced a breakthrough with potentially universal applications.

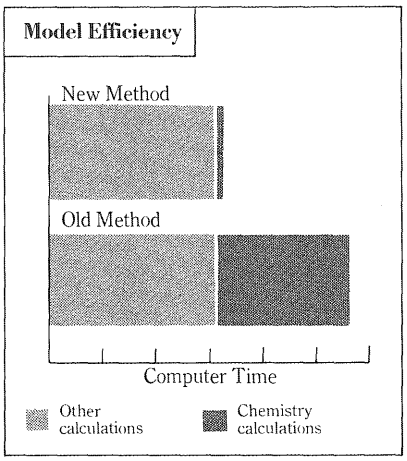
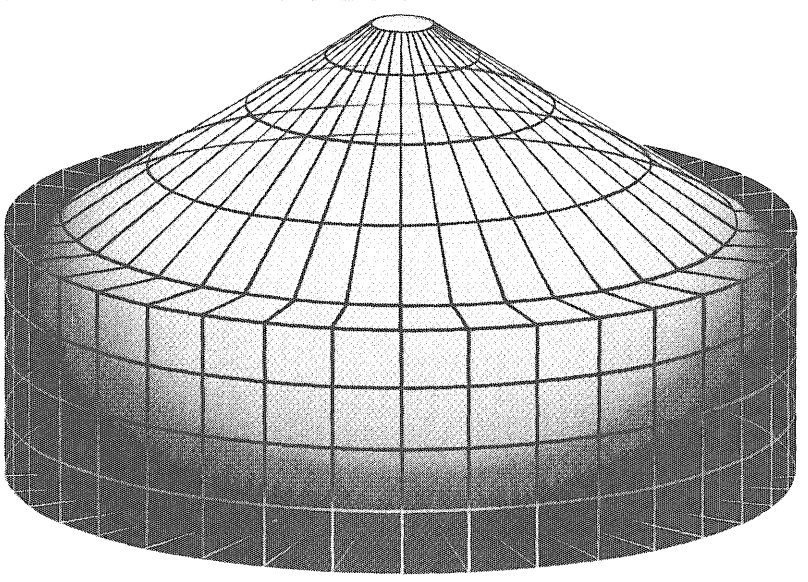


Figure 1: Computer time required by an engine combustion model. Time required for chemical calculations decreased greatly with the new methodology.

Figure 2: Artist's illustration of a chemically reacting flow. The physical space is divided by a latticed network into units of volume, and the solution must be recalculated for each grid point at each instant of time.



WHEREVER CHEMISTRY is involved, the need to solve chemical equilibrium equations arises. Although methods for solving such equations have existed for some time, they do not offer the speed demanded by the most challenging problems. For example, predicting the composition of gases inside an engine cylinder may require as many as a million equilibrium calculations per cycle. Two researchers at the General Motors Research Laboratories have developed a systematic way to reduce the mathematical complexity in these problems, thus making it possible to solve them rapidly.

Chemical equilibrium occurs when the rates of a forward and reverse reaction are equal. Mathematically, this statement usually translates into a system of nonlinear polynominal equations. Until now, there has been no fast reliable method for solving such systems. Solutions to particular problems have demanded thorough familiarity with the physical conditions. In most cases, this means partial knowledge of the answer.

Dr. Keith Meintjes of the Fluid Mechanics Department and Dr. Alexander Morgan of the Mathematics Department began their research by considering recent advances in the theory of continuation methods. They concluded that a suitable continuation algorithm could be relied on to solve the nonlinear polynomial equations that make up chemical equilibrium systems. In this insight lies the realization that the solution can be obtained without any knowledge of the physical nature of the problem.

In seeking the most efficient implementation of the continuation method, the researchers discovered that chemical equilibrium equations can always be systematically reduced to a substantially simpler mathematical form. The reduced systems have fewer unknowns and a smaller total degree. The total degree of any system is the product of the degrees of each of its equations. Reducing the total degree makes a system easier to solve. A typical combustion problem with ten equations and total degree of 192 was reduced by the researchers to two cubic equations with a total degree of nine.

The reduced systems can then be systematically scaled to fit within the limits imposed by computer

arithmetic. The range of coefficients in chemical equilibrium systems tends to be too large or too small for the arithmetic of the computer. Consequently, the solution process can fail. By construction of an effective scaling algorithm, this arithmetic constraint can be eliminated. Suitably reduced and scaled, the equilibrium systems can then be solved reliably by the continuation method.

THUS, Drs. Meintjes and Morgan accomplished their original goal of developing an innovative reliable approach to solving chemical equilibrium equations. They also made a final, unexpected discovery. Certain standard solution techniques, which fail on the original systems, can be made absolutely reliable when applied to the reduced and scaled systems. These methods, which are variants of Newton's method, are also many times faster than continuation.

This research has produced an extremely effective solution strategy—reduction of the equations, followed by scaling of the reduced systems, followed by the application of a suitable variant of Newton's method. The simplification of the systems, which was originally formulated to facilitate the implementation of the continuation method, proved to be the critical factor enabling the use of fast techniques.

In one application, the chemical equilibrium calculations are part of a model which predicts details of the flow, turbulence, and combustion processes inside an engine. By using their methodology to develop an equilibrium solver for this application, the researchers greatly increased the model's solution efficiency (see Figure 1).

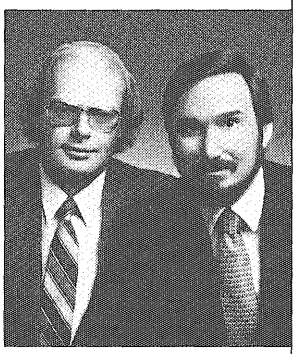
"It was the characteristic structure of equilibrium equations," says Dr. Meintjes, "that allowed us to perform the reduction. The unexpected mathematical simplicity of the reduced systems suggests that even more efficient solution methods may be discovered."

"Critical to this research," says Dr. Morgan, "was the dialogue between disciplines. I hope that this dialogue will continue as scientists and engineers in diverse fields explore the capabilities of this new methodology."

General Motors

GM
MARK OF EXCELLENCE

THE MEN BEHIND THE WORK



Dr. Keith Meintjes, a Staff Research Engineer in the Fluid Mechanics Department, joined the General Motors Research Laboratories in 1980. Dr. Alexander Morgan, a Staff Research Scientist in the Mathematics Department, joined the Corporation in 1978.

Dr. Meintjes (left) was born in South Africa. He attended the University of Witwatersand, where he received a B.Sc. and M.Sc. From 1973 to 1975, he taught fluid mechanics and engineering design at the university. He then went on to study at Princeton University, where he received an M.A. and Ph.D. in engineering. His doctoral thesis concerned numerical methods for calculating compressible gas flow.

Dr. Morgan (right) received his graduate degrees from Yale University in differential topology. His Ph.D. thesis concerned the geometry of differential manifolds. Prior to joining General Motors, he taught mathematics at the University of Miami. His book, "Applications of the Continuation Method to Scientific and Engineering Problems," will soon be published by Prentice-Hall.

assigned reading

Heinlein Bounces in same Dimensions

By Renee Bergstrom

Job
Robert A. Heinlein,
Ballantine Books, hardcover,
1984, p. 376, $16.95.

The prolific and revered Heinlein is out with a new novel and this book, unlike all the others, has a Christian protagonist. However, even with a new class of character, the writing has not changed much and this book resembles other Heinlein works.

The story revolves around a fundamentalist preacher who is caught up in what he feels is a practical joke by Satan. The trouble all started when Alexander Hergensheimer walked through a fire pit and wound up on another earth mistaken for Alec Graham. Graham had been having an affair with a stewardess, Margrethe, and she didn't believe that Alex was not Alec. From then on, Alex and Margrethe bounce from one earth to another. Alex believes during this time that the Rapture will occur; unfortunately, his Margrethe is not in a state of grace. (She believes, rather, in the old Norse pantheon.)

The story, after a time, becomes fairly predictable. The pace was slow up until the last 70 pages and it often resembled a previous Heinlein novel *The Number of the Beast.*

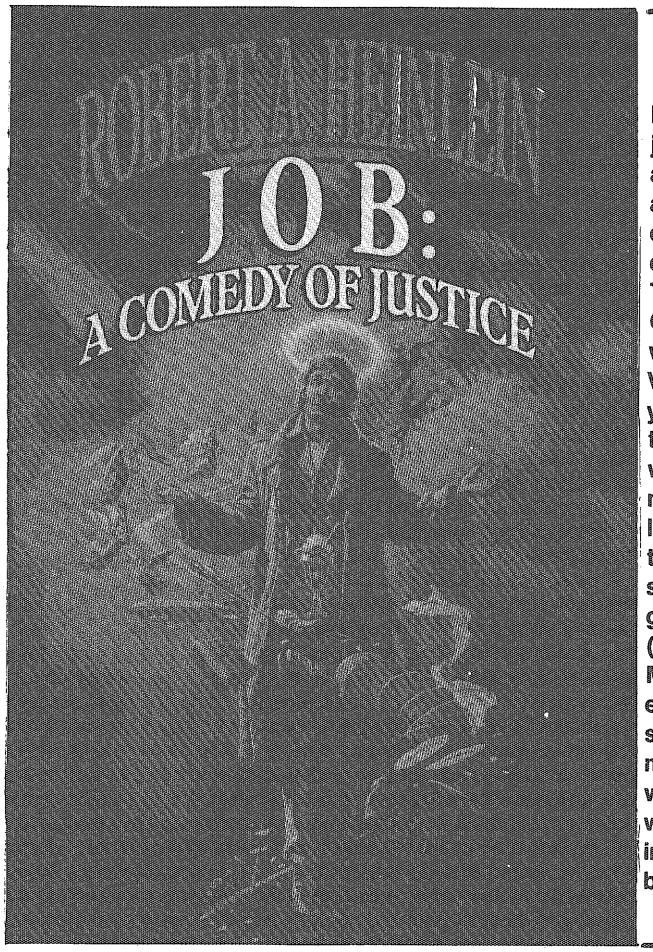
Comparing new and old there are similar problems in both. First, the bouncing between dimensions in *The Number of the Beast* got monotonous after a time and *Job* mirrors the same. Secondly, in the past, the female characters have lacked personality. In *The Number of the Beast* the characters blur together (male and female) and the women's lines were written like a man writing a woman's part. *Job's* women also fail in this respect. In other words, Heinlein lacks the insight to fully develop his female characters.

Differences in the novels are also apparent. First, like *Beast,* the characters jump through what they feel is time, but the Earths have stronger similarities and different histories. Secondly, both stories were written from the first person point of view, but *Job* doesn't shift between the narrator's and the main character's thoughts, like in *Beast.* Finally, *Job* is a success over *Beast* because it doesn't rely on established characters to pull it together.

The book is a biblical allusion, paralleling the story of Job in the Old Testament. The protagonist's values decay far more rapidly than is believable for the fundamentalist he is supposed to portray and his struggle is minimized more than I felt it should have been.

One disappointment is that Heinlein is full of off-the-cuff remarks filled with sexual overtones which add nothing to the story. "Do you want his basic statistic? If so, do you want it relaxed or at attention?"

Altogether, for those who like Heinlein, they will like Heinlein regardless. But for the fundamentalist, he or she may find the conclusions Heinlein presents offensive. This book is certainly not Heinlein's worst, but it's not his best either.



"In one day I had had two dishwashing jobs in the same town at the same address...and had collected nothing. It is difficult to collect from The Lonesome Cowboy Steak House when it turns into Vivian's Grill in front of your eyes. The same was true three hours later when Vivian's Grill melted into a used-car lot. The only good thing about these shocks was that by great good fortune (or conspiracy?) Margrethe was with me each time—in one case she had come to get me and was waiting with me while my boss was figuring my time, in the other she had been working with me."

The One-Two Punch of Digital Audio (or, how to fit a concert hall in a breadbox)

Digital recording provides the data necessary to reproduce sound with striking clarity. Today's compact disc players now allow you to bring that sound into your home, without having to mortgage the house.

By Wayne Whitwam

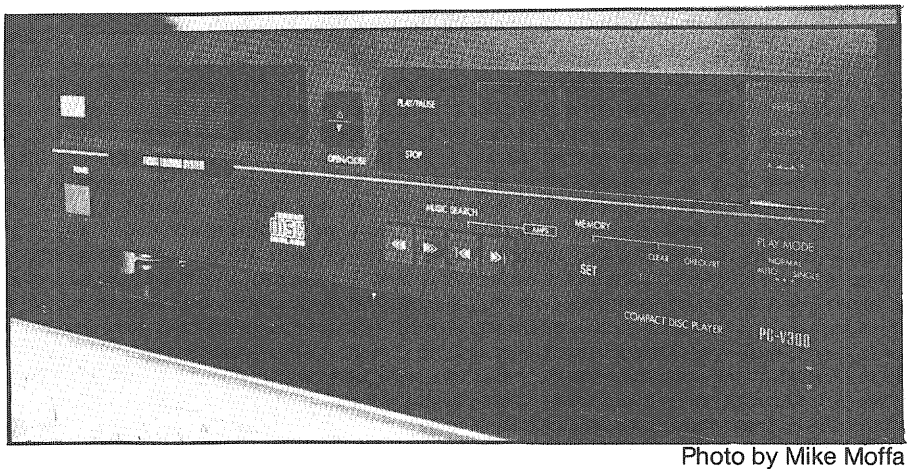


Photo by Mike Moffa

If you have listened to recorded music in the last couple of years, you are most likely aware of the advent of digital recording. This recording process uses a computer to produce music with crisp highs and booming lows. However, to do any justice to this process, a storage and retrieval method was needed that also used a computer. Hence, the result was the compact disc (CD) player: a computer replaced the turntable, a small shiny disc replaced the LP record, and a laser replaced the phonograph needle.

About two years ago, the CD player was first shown in this country at the Consumer Electronics Show. You'd have thought this was the rebirth of the stereo LP; the audio press jumped on the bandwagon with consistent praise. However, despite the revolutionary performance of these first-generation players, their price of $1,000 outclassed all but the fussiest audiophile.

Lately, these units have been stripped to the bone and slashed in price to meet the consumer pocketbook. A year ago, the last place you'd expect to see a CD player was in a store that also sells trash compactors. Yet, there they are today, going fast at $349.95.

Although these new CD's are the bare bones of the older generation, amazingly, they still sound as good as the more expensive models. That's because the basic features of the disc player have not changed dramatically.

When Philips of the Netherlands first introduced the compact disc in 1979, they wanted to avoid the "VHS-Betamax" type of format battle with Japanese manufacturers. So, they built it in conjunction with Sony. Basically, Philips developed the laser-tracking, video-disc system. Meanwhile, Sony's engineers perfected the sophisticated data-coding and error-correction circuitry.

The result of this combined effort is some pretty impressive specs. The signal to noise ratio, or the clarity and crispness of the music above the background, rates a superb 95dB. Compare this to 60dB S/N ratio on a reel-to-reel tape deck. On a CD, channel separation is more than 90dB: nearly perfect sounding stereo. A reel-to-reel deck has only 50 dB separation. Also, the compact disc system claims a dynamic range better than 95dB, a frequency response from 5Hz to 20kHz, with harmonic distortion less than 0.005% and unmeasurable wow and flutter.

What all this means is that the sound of a master tape will be brought into the home just as if it were the original recording, without the shortcomings of a conventional

phonograph record: no pops, crackle, rumble, wow and flutter, distortion from bad pressings, and best of all, no disc wear even after years of play.

Sounds fantastic? Just wait until you listen to it. The striking clarity of the music, even in the soft passages, sells these systems far better than an impressive list of specifications. (Remember, the disc will only sound as good as the stereo it's played through.) But before you rush off to the hi-fi store to listen for yourself, you may want to know what makes these players so special. Sure, you can ask a salesman all about the CD system. But he's probably got better things to do, like sell you a trash compactor, than to try to answer your endless questions.

THE DISC PLAYER

In case you've never seen a compact disc, it's merely a plastic-coated, metalized disc about four and three-quarter inches across—small enough to fit in a coat pocket. And yet, each CD can hold over one hour of music. The disc is similar to a stereo LP in that the information is pressed into the material. However, data stored on a conventional phonograph record is analog. Whereas, data stored on a CD is digital.

The term analog means that information is represented in terms of continuously variable quantities. More simply, analog is continuous. For example, a slide rule is an analog calculating device. A watch with hour and minute hands is an analog clock.

Phonograph records attempt to reproduce analogous copies of the original sound wave. You can see these changes by simply examining the tiny grooves on a record. So what you hear when you play a stereo LP is the stylus vibrating in correspondence with the groove that it is tracking. The stylus vibrates between tiny coils of wire, which produce an electro-magnetic field that induces a current. This current, in turn, is amplified and sent to the speakers.

The digital system works on a completely different principle: it is discontinuous. In other words, each unit can be broken down into discrete, smaller units. A motion picture provides a good analogy to a CD system. Individual frames shown quickly in sequence will result in continuous motion. Similarly, what you hear from a compact disc are regular, closely-spaced samples of the sound wave. This is known as linear pulse code modulation or PCM. When these individual samples are presented in rapid succession, you hear what seems to be continuous sound.

What all this means is that the sound of a master tape will be brought into the home just as if it were the original recording, without the shortcomings of a conventional phonograph record.

A physicist named Nyquist mathematically determined that to accurately reproduce this continuous sound, you would need to take twice as many individual samples as the highest frequency contained in the signal. In other words, to ensure frequency response to the upper limit of human hearing, or 20,000 cycles per second, the system must take at least 40,000 samples of the sound wave during that time frame. The sampling rate used in each of the two channels of the system is 44,100 times per second.

Each snapshot of the sound wave is then assigned a number (see Figure 1), whereby each number is expressed in 16-bit binary groups, i.e. 16 digit numbers using only ones and zeros. As a result of using a large number of digits, the system is able to accurately represent even very small changes in the sound wave. Similarly, it can handle a dynamic range from silence to 90dB's with comparably little distortion.

All this digital information is pressed on the disc in the form of a dense series of reflective pits, 0.1 micrometers in depth and 0.5 micrometers in width. A single disc contains roughly five billion of them with the digital signals expressed in terms of the length and distance of the pits and the spaces between them. Like stereo LP's, compact discs have the sound information arranged spirally, but with CD's, the album starts near the center and moves to the outside edge of the disc. The CD rotates at a slower speed as the pickup moves toward the edge of the disc, thus keeping the linear tracking velocity constant. Therefore, unlike conventional records, the same high quality of reproduction is possible at any point across the disc.

The entire playing surface is protected by a clear plastic coating, thereby keeping dust and scratches away from the actual information. So when you listen to a CD you will never hear those annoying sounds, commonplace to a stereo LP, of a stylus tracking across a strand of hair,

A home compact digital audio player (above left) reads bits of musical information through the protective plastic cover of a compact disk (right) using a laser "stylus." The sound reproduced as astounding.

Photo by Mike Moffa

dust, or a small scratch in the record.

How this works is simple. Instead of a diamond stylus, the disc player uses a laser beam and a light detector to read the information encoded in the disc. The laser focuses only on the reflective surface inside the disc, so that the light scattered by the edge of the pits is read as the presence of a bit (see Figure 2). Similarly, since dust and dirt on the outside of the protective surface are out of focus, they do not interfere with the sound reproduction. Furthermore, since the laser never makes physical contact with the CD, disc wear is virtually eliminated.

The sampling rate used in each of the two channels of the system is 44,100 times per second.

THE ERROR-CORRECTION SYSTEM

With the possibility of as many as 30 tracks packed into an area no larger than the width of a human hair, some bit errors are inevitable. These errors would cause the players to skip and skitter, repeat the same groove over and over, or produce clicks during play, if it were not for sophisticated error-correction and tracking circuits incorporated into the systems.

When a recording is transferred to the disc, additional data is included to

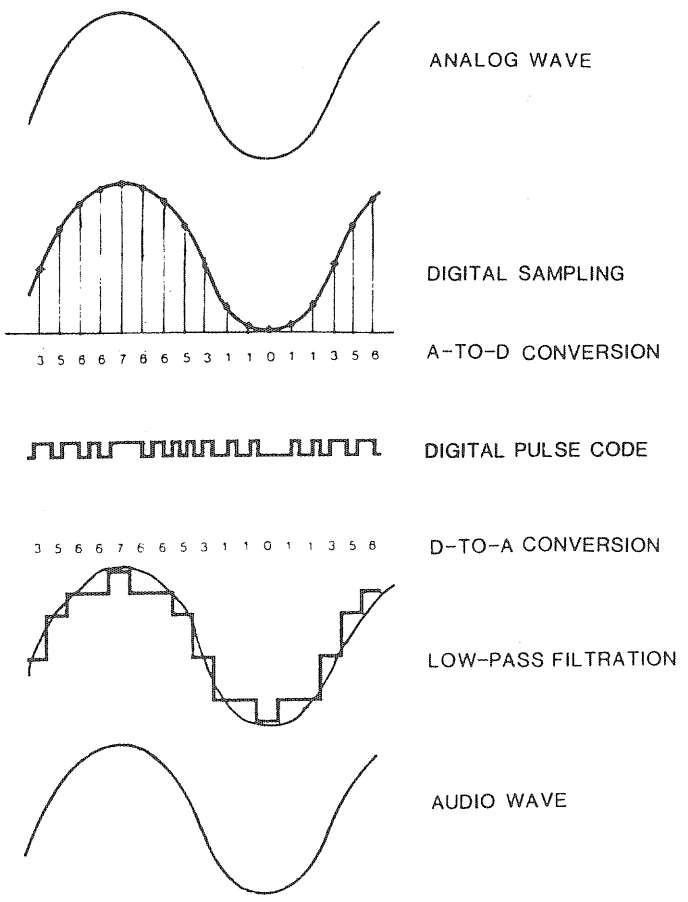


FIGURE 1
Musical information in the form of an analog wave is sampled 16 times and converted to a binary code, where ones and zeroes correspond to the voltage level of each sample. This data is then placed on a CD. During playback, it is re-processed to recreate the original waveform.
Illustration by Wayne Whitwam

ensure that the sound information is accurate. These additional bits are known as parity-bits, where each bit checks a corresponding group of audio bits. If the particular group of audio bits has an even number of ones, then the added parity-bit is a zero; if odd, then it's a one. The digital code, including the parity-bits, are fed into the system to be checked. If the total number of ones in each group checked equals an even number, as it should, then it's correct; if it's an odd number, then the group has an error. The parity system cross-checks itself so that it is able to determine exactly the incorrect bit or bits.

Once the error is located, it's rather a simple and clear-cut process to correct it. If it is supposed to be a one, make it a one. If it is supposed to be a zero, take the one away. But let's say there's a scratch in the disc large enough to scatter the laser light; that it wipes out more consecutive bits than the parity-check system can successfully correct. Fortunately, the error-correction system has already taken this into account. By using a process known as interleaving, in addition to parity-checking, the system can identify and even correct an entire chain of lost data-bits.

During interleaving, the order of the 16-bit digital code is scrambled, or rather, re-sequenced before it is recorded on the disc. During playback, data is briefly stored in a memory and then unscrambled, putting the information into its correct order.

As a result, consecutive bits that may be destroyed by a scratch can be fully corrected by unscrambling the information so that individual samples of bad data are interspersed between good data samples. Consequently, this makes it easy for the parity-checking system to pick apart and recover the lost data.

When errors occur that are too large to be corrected by interleaving and parity-checking, the system simply ignores the chunk of bad data and attempts to make a smooth transition between the borders of the good data samples. This is known as interpolation. And for the most part, this method works so well that you won't hear it while it occurs. Sometimes, however, the interpolating process can be heard as distortion or a low-level click.

A single disc contains roughly five billion reflective pits.

For even larger errors, some CD players will simply mute the audio signal. However, if the error is so large that the laser tracking system can no longer see the pits on the disc, mistracking will result, leading to the CD equivalent of a skipped or stuck record.

Once the errors have been corrected, the digital pulses are converted into voltages by clocking them into a digital-to-analog converter. These pulses are clocked with controlled regularity, so as to avoid any wow and flutter. From this, the voltages are then filtered to smooth out the staircase effect of the digital signal. The result: the regenerated audio waves, free from noise.

IN-STORE EVALUATION

Why discuss errors and error-correction systems? Because, except for the control features, CD players differ mainly on how well they track the disc and handle errors. In fact, they all sound so good, with practically no audible differences among them, that you really can't go wrong choosing any model.

Knowing what to listen for, you can now make your own in-store evaluations. Tell the salesman what you want to do and ask him to help you out. Most good stores will provide what is known as an "error-test disc." This product, made by Philips, is a lab-standard defective record for testing the players' error-handling capabilities. If the dealer doesn't have one, you can always make a reasonable facsimile using a three-inch wedge of Scotch Magic Tape. Affix this wedge to the non-label side of a new disc so that the tape is pointing toward the center. After you've purchased your new player, simply remove the tape and carefully clean the disc with isopropyl alcohol or disc cleaner and a cotton swab. The CD will be as good as new and ready for listening.

During your evaluation, listen for the player that best handles the errors without clicking or muting. It's best to know the music passage, that way you can measure the distance the

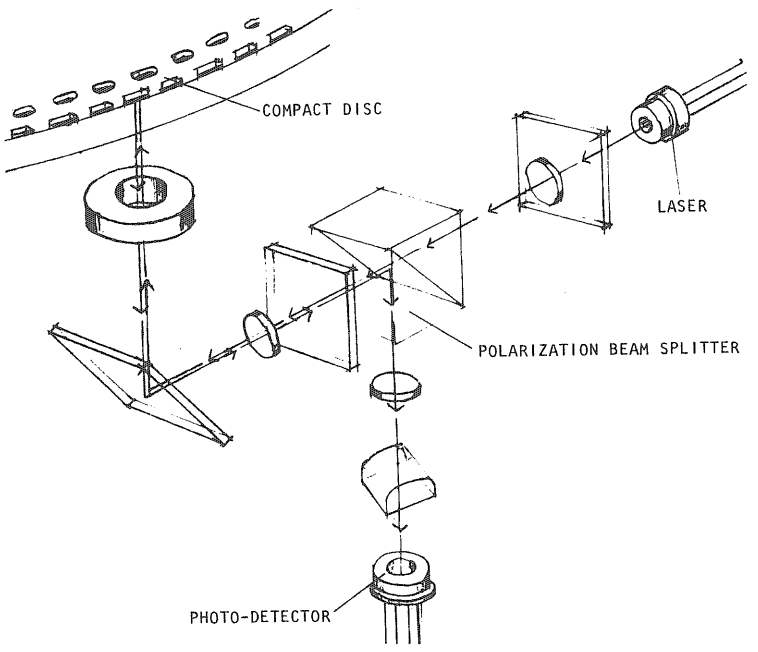


Illustration by Wayne Whitwam

FIGURE 2
Using a laser beam, the CD player reads the signal pits engraved on the disc, and converts these signals into the music that you hear. Light is first emitted by the laser, and reflected by the disc surface. The information is then read by the photo-decoder.

player tracks before you hear any glitches.

To check the tracking ability, give the unit a few taps during play. Some players are very sensitive to even minute vibration while others can handle a sharp rap without a hitch.

Finally, consider the list of features that compact disc players have to offer. For example, some players have complete time displays that keep you on top of every note of music. Others don't include this feature. Some players mute the sound when scanning for a certain passage, while others will provide some audible output. Also available are such features such as advanced cueing, headphone outputs, variable output levels, and remote control. Of course, which features suit you best is a purely personal decision.

While you are in the store, you may also want to take a look at the new portable disc players and the new units for the car. What makes these especially nice is that music will not have to be transferred to cassettes, just pull the disc out of the home unit, pop it into the car stereo, and you're ready to go.

They all sound so good, with practically no audible differences among them, that you really can't go wrong choosing any model.

In future generations, home players may also offer video stills, where your TV screen could show lyrics or liner notes. Also, soon to come are unerasable CD recording systems for the home, and eventually even erasable recorders.

Nuclear Winter from 13

temperature, particle density, etc. in the vertical direction but not in the horizontal direction. The one-dimensional assumptions could certainly affect the results of the calculations. C.F. Clement of the Theoretical Physics Division, AERE, England, declared, "If you take a one-dimensional radiative transfer model, you get that land temperature falls approximately 20 degrees Celsius in three weeks even in the summer. Now, the temperature of the sea cannot drop 20 degrees Celsius in three weeks because it is a large heat resevoir. This model is totally unrealistic because it doesn't have any heat transfer between the sea and the land, as is pointed out in the paper." Indeed, horizontal heat transfer between the oceans and the continents could not be taken into account with the one-dimensional model.

"Suppose you take an earth that is totally covered with continents and no ocean," said Toon. "You will find that the temperature drops considerably [when a nuclear dust and smoke cloud is formed.] Then suppose you try another earth totally covered by ocean. Then you get no temperature drop. What that said to us qualitatively is that the land near the ocean will have a small temperature drop whereas inland we will have a large temperature drop. We couldn't quantify it with our one-dimensional model, but that is what was expected from the three-dimensional model."

Fortunately the results of a simplified three-dimensional analysis were soon published by Curt Covey, Stephen Schneider and Starley Thompson of the National Center for

Continued on page 30

The new model found that when the moderating effects of the oceans were taken into account, the inland temperature depressions were halved.

The grass is always greener on the other side of the diploma

By Jon Soland

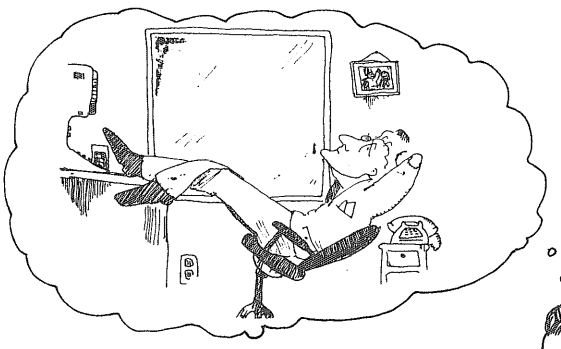


Illustration by James Bailey

Is there life after graduation? Who would know? Graduation seems to be one of those things that doesn't really exist, it's just something people talk about and look forward to, kind of like heaven. Actually, people do graduate and unlike heaven you only almost have to die to get there. They say when you embark on your journey to heaven there is a bright light at the end of a long tunnel. If you're a senior that light is probably just now coming into view. "To be employed. Won't it be wonderful to be a regular, working, person?" Enduring wierd hours, eating Cheerios for breakfast lunch and dinner, and having to say "no" to any sort of social event is about to pay off. The world for you is about to change. As Monty Python would say, "And now for something completely different."

Rather than being a student around the clock you'll be able to call some of your time—your time. You'll only have to work a measly eight hours a day. Do you know what that means? You'll have 16 hours a day plus weekends free! If something needs doing around the house, or on the car, you'll be able to just do it. If you want to watch TV you'll be able to guiltlessly turn it on, maybe even watch two shows. You'll be able to make plans a whole two or three days in advance, go out on Friday night, and not set you alarm for some ungodly hour Saturday morning. Sixteen hours a day plus weekends. Whew! That could be dangerous.

You will have cash! You'll be rolling in dough! You'll have mountains of money! Well, that may be going too far, but it is likely that you will be able to buy groceries in between pay checks. You will be able to buy gas just because your tank is empty. You will go out for a beer even if it isn't happy hour. Not only that, once you've had money, it gets easier to spend money you don't have. You'll be able to get Visa, Master Card, American Express, Dayton's and Amoco cards. Get a non-guaranteed, non-student loan. There are a lot of surveys around that report starting and average salaries for engineers and scientists, but they don't make any difference. No matter what you make it is bound to be a lot more than is coming in right now.

Your life style in general is going to change. Instead of being one of the groveling masses, you'll be a big shot. Have your own desk, your own phone, maybe even your own office and secretary. You'll have to place a lot of long distance phone calls, talk to J.S., and go to meetings and stuff. On occasion, the firm you work for will fly you around to talk to other big shots. You'll need to stay on top of developments in business and industry and creatively adapt and incorporate new ideas and techniques. Your opinions and perceptions will be valued. You will be making a contribution.

School isn't all bad to be sure, but the prospect of emerging from the life of a student to participate in the world at large is pretty exciting. This transition won't be without sacrifice. For instance, there will be no more getting up at 2:00 in the morning to do circuits problems. No more scrambling to put tuition and book money together. Just getting up, having breakfast, going to work, breaking for lunch around noon, heading for home around 5:00, and having dinner. Then, after a couple of months when you get settled into your new schedule and you're sure it's for real, you'll be able to look back and say, "Gee, those years I spent in college sure were the greatest."

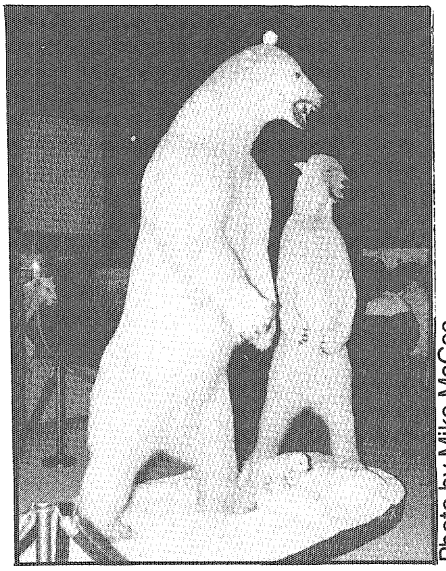
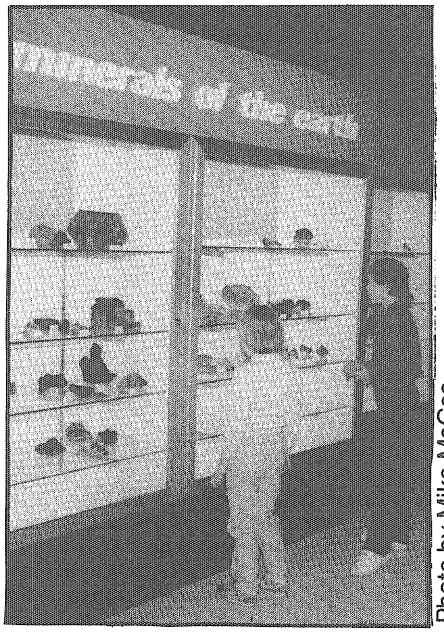


Photo by Mike McGee



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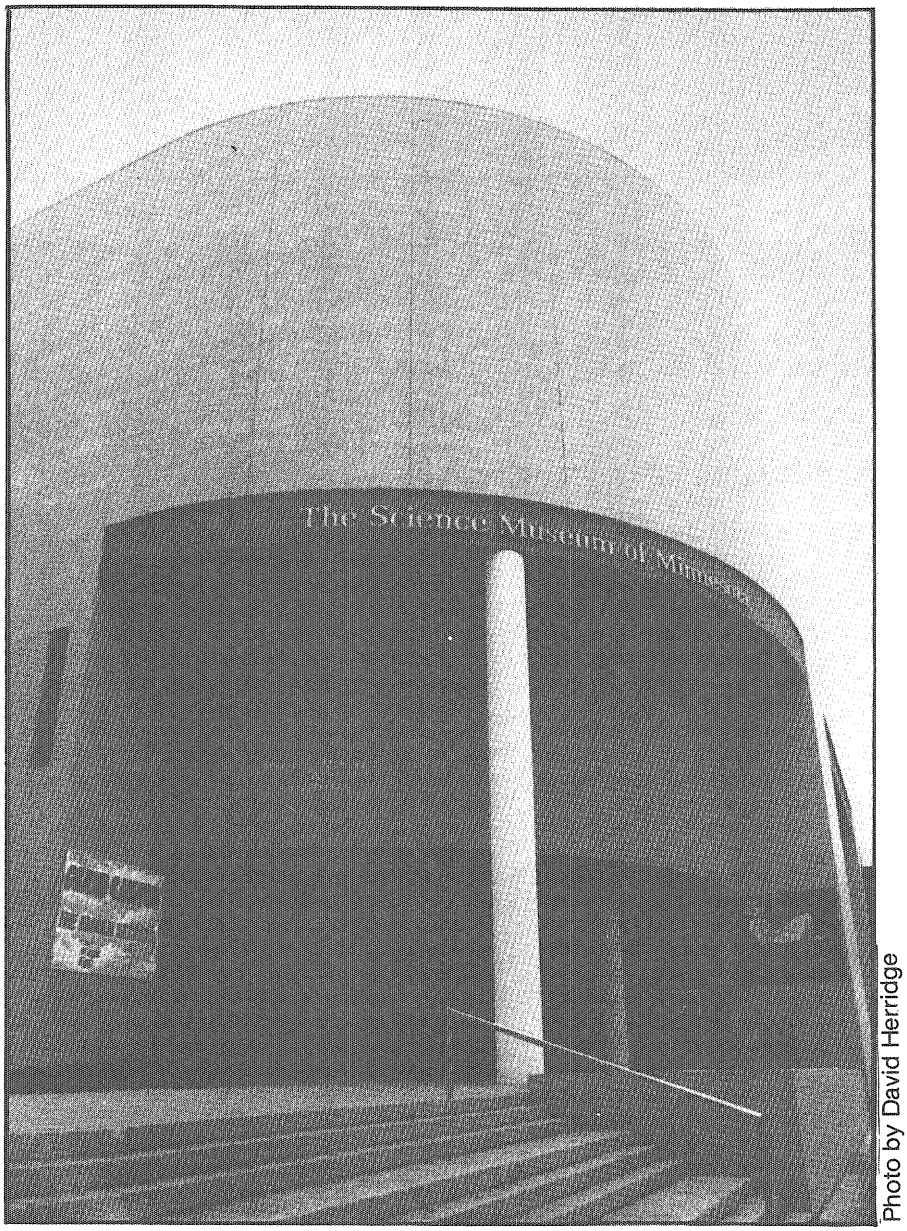


Photo by David Herridge

A Fun Place on a Cold Day

The Science Museum of Minnesota in downtown Saint Paul offers dozens of interesting exhibits, an entertaining "kids" area for some hands-on fun, and quite simply the best movie house in the cities.

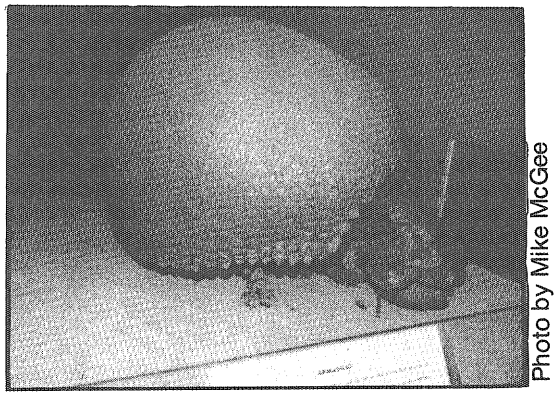
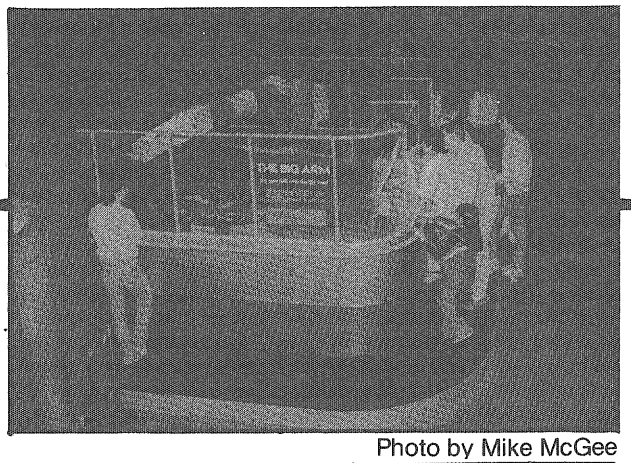


Photo by Mike McGee



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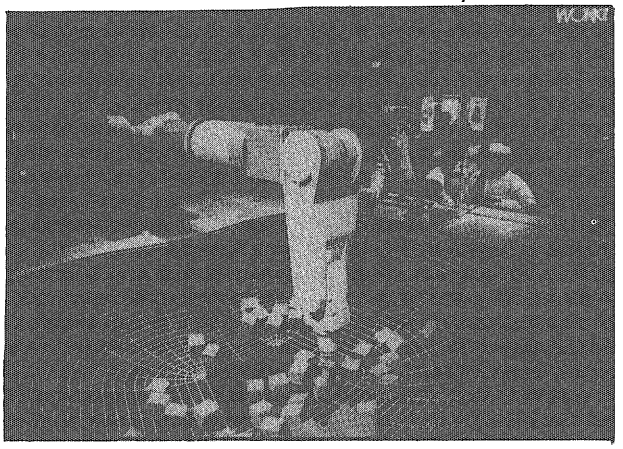
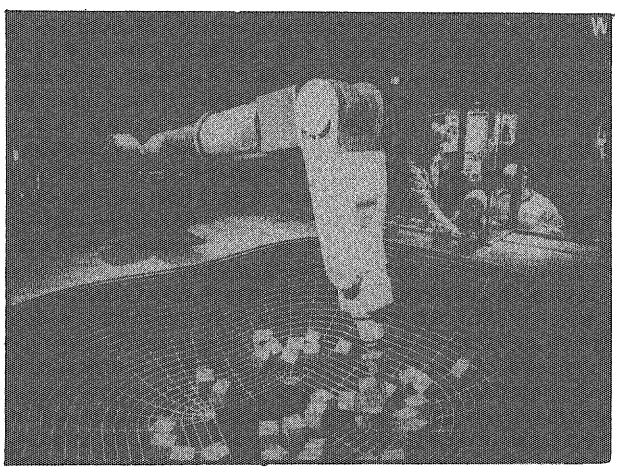




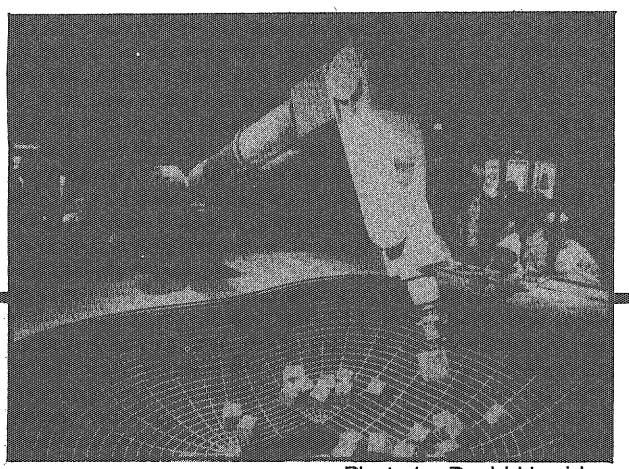
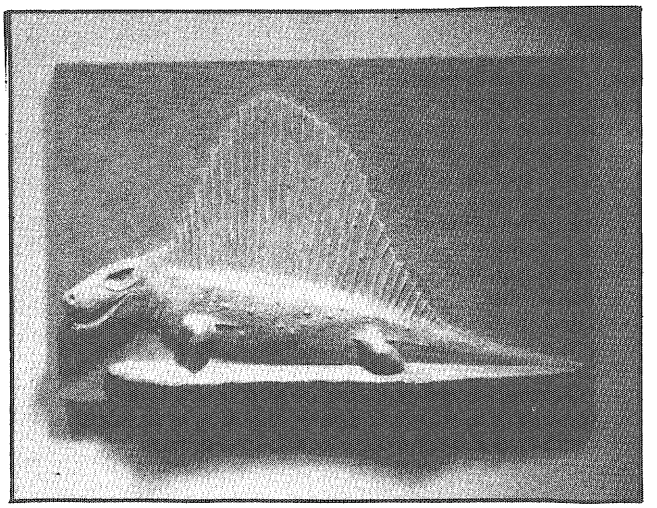


Photo by David Herridge



The Science Museum of Minnesota

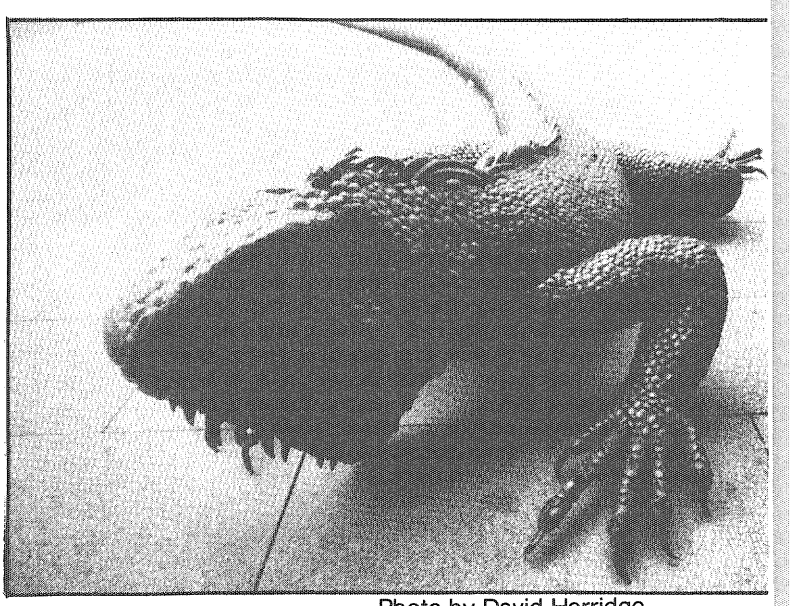


Photo by David Herridge

Admission Prices

Omnitheater only	$4.50
Exhibit Halls	$3.00
Omnitheater and Exhibit Halls	$5.50

For information and show times, call 221-9400

Nuclear Winter from 26

Atmospheric Research.[12] The new model found that when the moderating effects of the oceans were taken into account, the inland temperature depressions were halved, and little temperature depression was felt near the coasts. However it was also found that global air circulation patterns were altered in such a way that aerosols were indeed pumped rapidly into the Southern Hemisphere (see figure 6).

The Covey model is not free of flaws, though. It assumes the same starting configuration as the TTAPS model—a uniform cloud spread evenly across the Northern Hemisphere land masses. Also the model does not have the resolution to take into account small-scale air movements.

Despite the many uncertainties, the authors of TTAPS papers felt that the following conclusions could be drawn from their work and that of Covey *et al.*:

1) Unlike the predictions of earlier studies, the TTAPS study does predict drastic temperature depression and darkness in the event of a nuclear war. This effect would be relatively short-lived, and no ice age would ensue.

2) Even a very small nuclear exchange (100 megatons) could have incredible climatic consequences, such as a temperature drop of 20 degrees Celsius, if cities were targeted.

3) Particle transport to the Southern Hemisphere and, therefore, climatic alterations in that hemisphere could be expected.

4) Radioactive fallout may have been underestimated by earlier studies since only immediate fallout had been taken into account. In fact, large doses of radiation would be common due to intermediate fallout.

And if one accepts these conclusions as at least qualitatively valid, and if one assumes that a nuclear war is unavoidable, what lies ahead for mankind and his environment? A group of 40 biologists, headed by Paul Ehrlich of Stanford University, attempted to answer this question at the Long-Term Worldwide Biological Consequences of Nuclear War conference held in Cambridge, Massachusetts in April 1984.[13] Ehrlich states that it is estimated that between one and two billion people would be immediately killed or wounded by the blasts in a nuclear exchange. That is between 25 and 50 percent of the total population of the world. Those who remained would likely face starvation. A 20 degree Celsius temperature decrease is more easily appreciated when one realizes that a

Continued on page 34

Figure 6

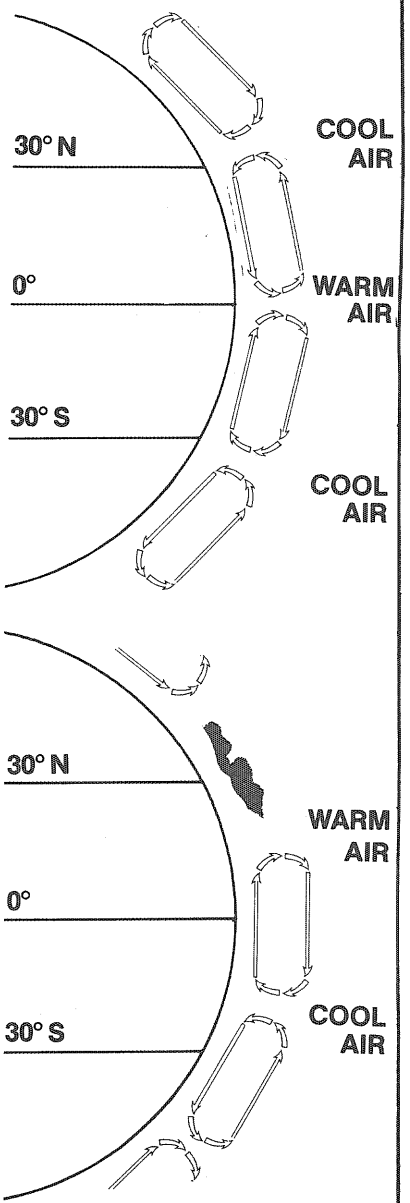
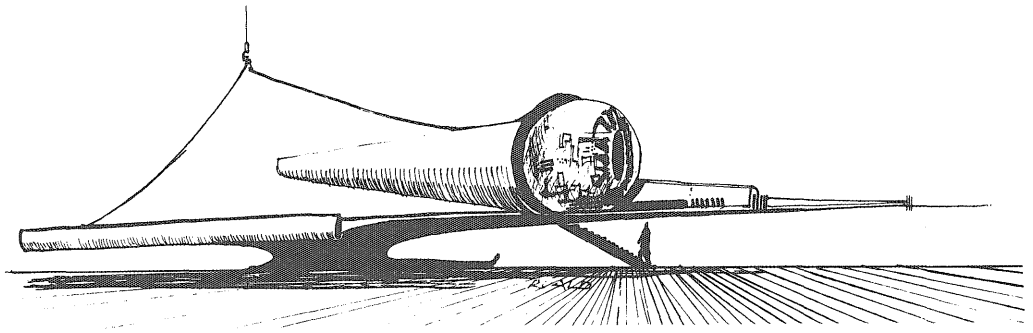
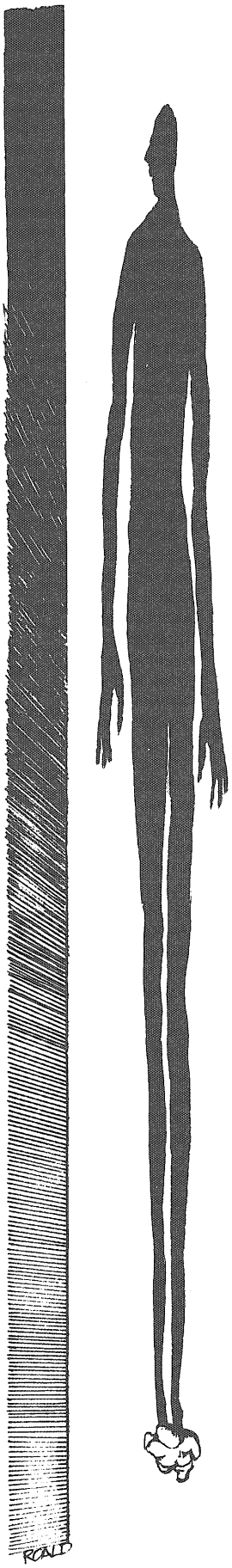


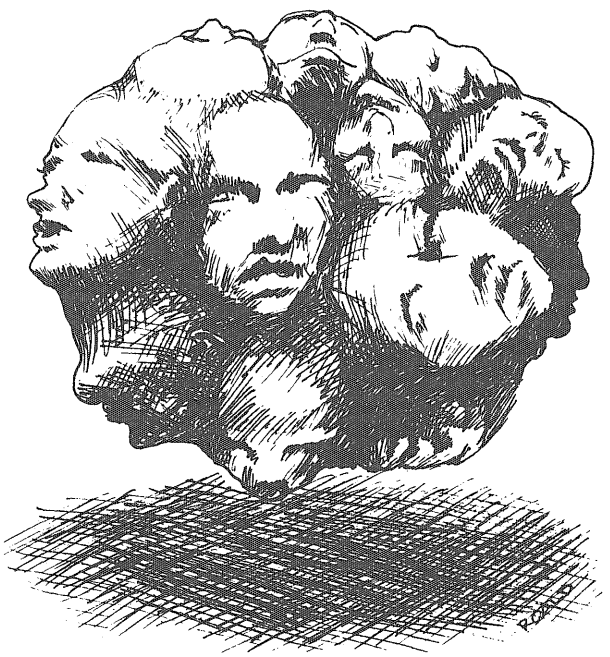
Figure 6: Global circulation patterns before and after the introduction of large dense clouds of dust and smoke into the atmosphere.
Adapted from Turco *et al., Scientific American,* Vol. 251, p. 43.





Science Fiction Writing Contest

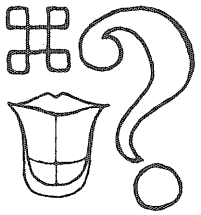
First Prize: $100
Second Prize: $50
Third Prize: $25



Deadline:
February 8, 1985

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.



Mind Benders and Brain Teasers

In the past, the correct solutions to the problems presented here could earn you a free T-Shirt. Unfortunately, our supply of shirts has become depleted, so the satisfaction of completion is the only reward we can offer.

1 Determining your program requirements can be somewhat confusing. If you are an ME major you can take CSci 5101, but if you are a CSci major you can take CSci 5101 and not get credit, or you can take CSci 3107. If you have already had CSci 3107, then either you are a CSci major, or you enjoy personal suffering. You can't take both CSci 3107 and CSci 5101.

If you have a friend that has had CSci 3107, then if he or she is an ME major, you can be certain that he or she has masochistic tendencies and therefore needs help. How can you be certain?

2 If there is a line at the U, you will be standing in it not accomplishing anything. This is an immutable property of nature. Can you show that it is a consequence of the following two premises, which are also immutable truths?

P1: For all of the lines at the U there will be somebody there, and it will be you, and you will be standing in the line.

P2: It is not possible for there to be: a line, for you to be standing in it, and for anything to be accomplished.

technotrivia

By John Krumm

1) What do well-versed wine tasters do after they sip, swish and gargle their sample?

2) What letter in the English alphabet is used the least?

3) Why do golf balls have dimples?

4) When mild-mannered Clark Kent uses his x-ray vision, why don't his glasses melt?

5) Let's say you're walking down the middle of Church Street and as often happens, you are confronted by an ornery crocodile. What is the best strategy for protecting yourself.

6) We've all heard that sight is the first sense to go when a person is dying, and that hearing is last. What goes second?

7) True or false: One can make a tired dog become wide-awake with a blood transfusion from a wide-awake dog and vice versa.

8) True or false: A plumber from Beresford, South Dakota once developed the ability to pop his left eye out of the socket and peer into his mouth.

9) Which has a higher percentage of sugar, a Milky Way® candy bar or Froot Loops®?

0-1 Quit college and go into street repair
2-4 You're lucky this won't show up on your transcript
5-7 You're tolerably normal (surprised?)
8-9 Cheaters never prosper

1) The next step is to spit out the wine. This procedure is not recommended for culinary delights like pizza, however.

2) Q is used the least; E is used the most.

3) Dimples make the balls fly farther. the normal spin on a golf ball causes the dimples to scoop up air from above and deposit it below, thus creating a favorable upward pressure gradient.

4) He cleverly fashioned his lenses from the windshield of the space capsule that he used to get to Earth.

5) Run in zigzags because a crocodile cannot make sudden changes in direction. If, on the other hand, you come across a crabby computer science major, just say: "Look it's Lieutenant Uhura from *Star Trek*," and calmly proceed toward your destination.

6) They are, in order, sight, taste, smell, touch, and hearing. (If you are expecting some kind of death joke now, you are sick, sick, sick).

7) Amazingly true. A tired body produces fatigue toxins in the blood which affect how tired we feel. The theory was verified with transfusions on dogs.

8) False.

9) Froot Loops® 47.4%, Milky Way® 26.8%. You will be happy to know that the popular Hostess Ding Dong® comes in third with a mere 29.9% sugar.

Techno Scope

By John Krumm

After what must have been minutes of thinking, our crack team of paranormal researchers has developed this collection of predictions and recommendations for you, the I.T. student, based on your major.

AEROSPACE ENGINEERING—Your cosmic energy will reach its maximum soon. Don't blow it by wearing unmatched socks. Write a letter to a close friend, but don't ask for money this time. Be wary of tall women wielding cattle prods. As an effective social ice-breaker for that special someone in one of your classes, mention that you know a guy named OHO Pilot who has flown almost every plane in use today.

ARCHITECTURE—All the rest of I.T. wonders what you people are doing in college, so be prepared for mild violence. You have unique abilities in vegetable-based solvents, so let them work for you. Tomorrow will be a day like any other, so don't waste time thinking about it. The day after however, will by slightly different from 3:00 to 4:00 p.m., after which it will be like any other day, unless you have two living aunts, in which case normalcy will resume approximately ten minutes earlier.

CHEMISTRY AND CHEMICAL ENGINEERING—Litter today and you will regret it for perhaps half an hour. Because they think you're so smart, friends and relatives seem to secretly hate you, but we all know that this is untrue. (How much your friends and relatives like you, however, is another matter.) Today you may feel free to step on sidewalk cracks without the normally ensuing adverse medical conditions afflicting your immediate family. For loads of laughs, visit the Dean with a pipette in your ear.

CIVIL ENGINEERING—Don't believe all the vicious rumors going around about you people. A good thirty percent of them are slightly exaggerated. Be wary of others, especially while you are eating. For instance, if you are served live eels for breakfast, be suspicious. This is not the season for eels, and they are customarily eaten for lunch anyway. This would be a good day to cement relations with potential friends. (Cement—get it?)

MECHANICAL ENGINEERING—A steamy affair with a CLA major will be abruptly snubbed when you exclaim blunderingly, "Who was this Shakespeare guy anyway? Was he, like, a knight or something? Didn't he write *Planet of Doom*?" You can take comfort in the fact that your ex probably didn't even know what a Nusselt number is. Tomorrow you may find a little something extra in your oatmeal, but some Roach Motels should take care of it.

PHYSICS—You will be the life of the party when you show up with the latest improvement of the joy buzzer: the hilarious joy accelerator. Amaze your friends and confuse your enemies as you eject a thin beam of quarks which bounce harmlessly off your victim's head onto his shoulders where it looks like embarrassing dandruff. Check the mail regularly because your Carl Sagan mood ring and bathroom accessories kit should arrive soon.

COMPUTER SCIENCE—Indications are that the dullness you have been experiencing the last few days will continue. To liven things up, write a program to simulate an exciting weekend. Be sure to include some of your favorites, such as four consecutive hours of *Star Trek,* calculator races, ruler bending, and (if you dare) a solo game of Twister. Put in comments like; "Here's where the phone rings, but I can't answer because I'm flossing."

ELECTRICAL ENGINEERING—You should begin emulating your heroes, but don't carry it too far, especially if they are dead. Now would be a good time to do that dreadful task you've been putting off. For instance, you could clean out the refrigerator, particularly since the cheese has begun going through its own Late Precambrian period. For a good time, do all your thinking in the frequency domain, and watch the wacky hijinks begin.

MATHEMATICS—Romance will come knocking at your door again in the near future, but don't answer because you will have a problem set to finish. If you end up with a date anyway, don't mention L'Hopital's rule, not even once. You will soon turn the mathematics world on its ear with the invention of a new variable which will bear your name. You will begin an 18 month tour of the world during which you will introduce your variable to all walks of life with the help of your new book *Mr. Derivative Visits Hilbert Space.*

Nuclear Winter from 30

one degree Celsius cooling could eliminate wheat growing in Canada.[14] A three degree Celsius decrease in average July temperature would force the northern limit of corn production to southern Iowa and central Illinois. Some evidence suggests that particle loading and temperature inversions would hinder rainfall, further devastating the agricultural base of society.

Increased levels of UV radiation, Ehrlich states, would also be detrimental. "One response of plants to increased UV-B is reduction of photosynthesis. Furthermore, leaves that develop in dim light are two to three times more sensitive to UV-B than those that have developed in full sunlight. Thus UV-B will compound the damage caused by earlier low levels of light. The immune systems in *Homo sapiens* and other mammals are known to be suppressed by even low doses of UV-B. Thus mammals that were subjected to increased ionizing radiation (which also suppresses the immune system), diseases, and a host of other stresses in a postwar world might have one of their most important defenses impaired. It has also been suggested that protracted exposure to increased UV-B could lead to widespread loss of sight. Survivors among people and other mammals might again find themselves in darkness soon after the sky cleared."[15]

If dust and smoke were transported to the Southern Hemisphere, the tropics would be affected. Says Ehrlich, "Many plants in tropical and subtropical regions do not possess dormancy mechanisms enabling them to tolerate cold seasons. In these regions, large-scale injury to plants would be caused by chilling, even if temperatures did not fall all the way to freezing. In addition, vast areas of tropical vegetation are considered to be very near the photosynthetic 'compensation point'—their uptake of carbon dioxide is only slightly more than that given off. If light levels dropped, those plants would begin to waste away—even in the absence of cooling. If light remained low for a long time, or if low light levels were combined with low temperatures, tropical forests could largely disappear . . ."[16]

After hearing such words as "mass starvation," "disappearance of the tropics," and "genetic mutations," it is hard to view the TTAPS study as anything but depressing. Another viewpoint, however, is justified. Since the 1950's, leaders in both the United States and the Soviet Union have unknowingly had the power to destroy the entire globe. Now the extremely severe consequences of any nuclear exchange are known, and policy decisions can be made from an enlightened viewpoint. One possible consequence of the failure to reassess nuclear policy is summarized by Ehrlich *et al.* as follows: "In any large-scale nuclear exchange between the superpowers, global environmental changes sufficient to cause the extinction of a major fraction of the plant and animal species on the earth are likely. In that event, the possibility of the extinction of *Homo sapiens* cannot be excluded."[17]

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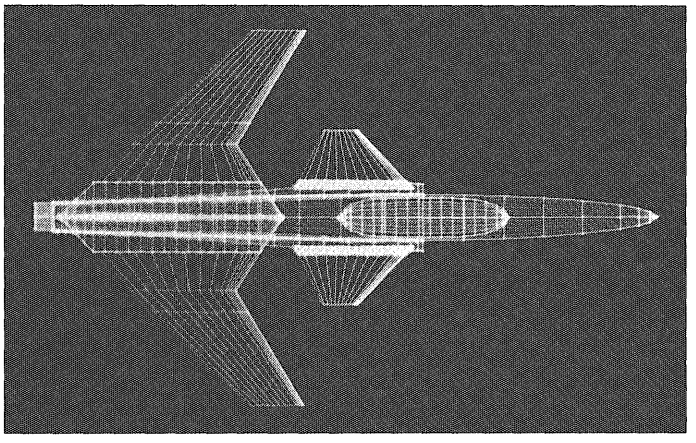
Engineering takes on exciting new dimensions in the Air Force



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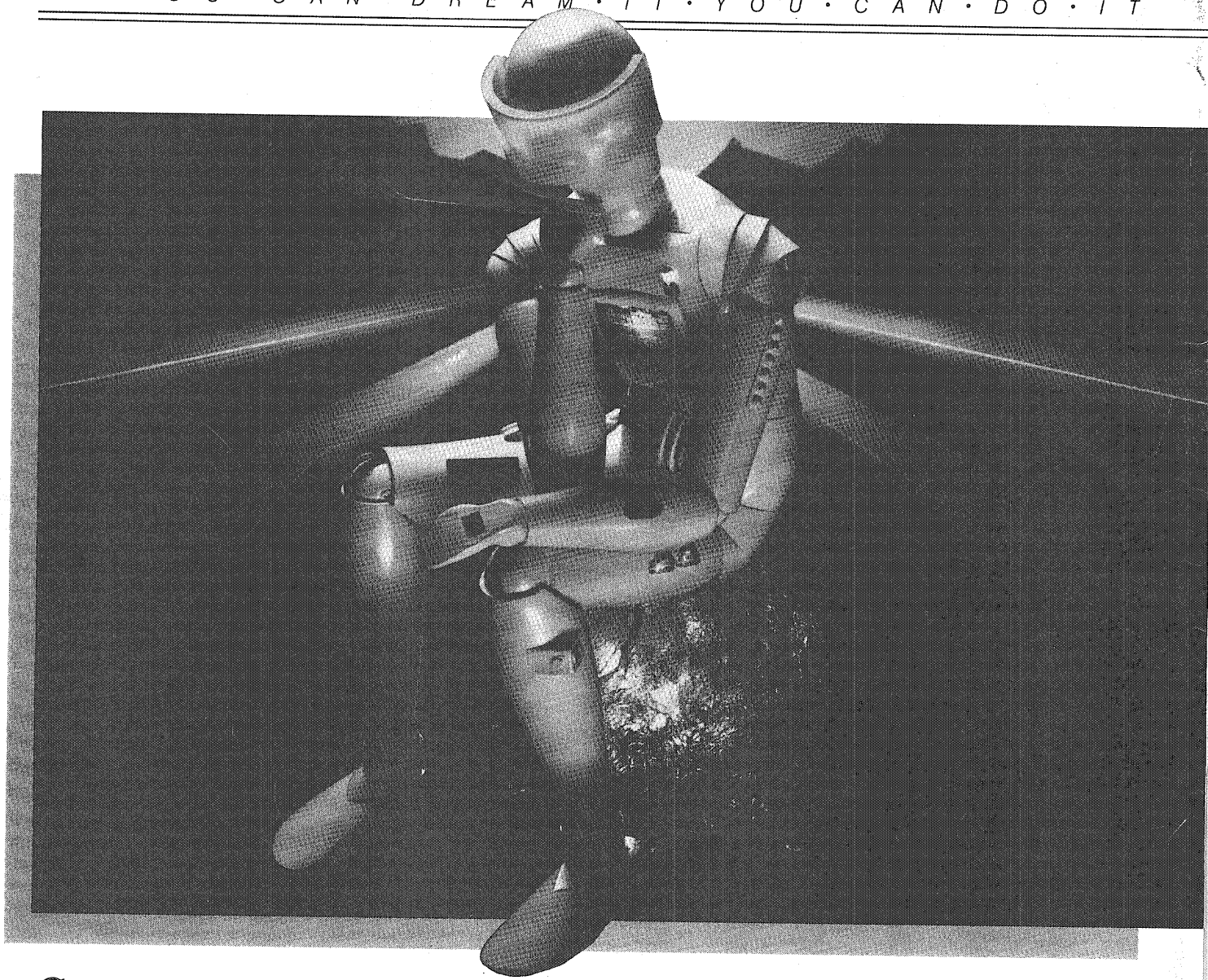

Create computers that capture the mysteries of common sense.

The brain does it naturally. It wonders. It thinks with spontaneity—advantages we haven't been able to give computers. We've made them "smart," able to make sophisticated calculations at very fast speeds. But we have yet to get them to act with insight, instinct, and intuition.

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While extending technology and application of computer systems is important, the real excitement and the challenge of knowledge engineering is its conception. At the heart of all expert systems are master engineers and technicians, preserving their knowledge and experience, questioning their logic and dissecting their dreams. As one young employee said, "At GE, we're not just shaping machines and technology. We're shaping opportunity."

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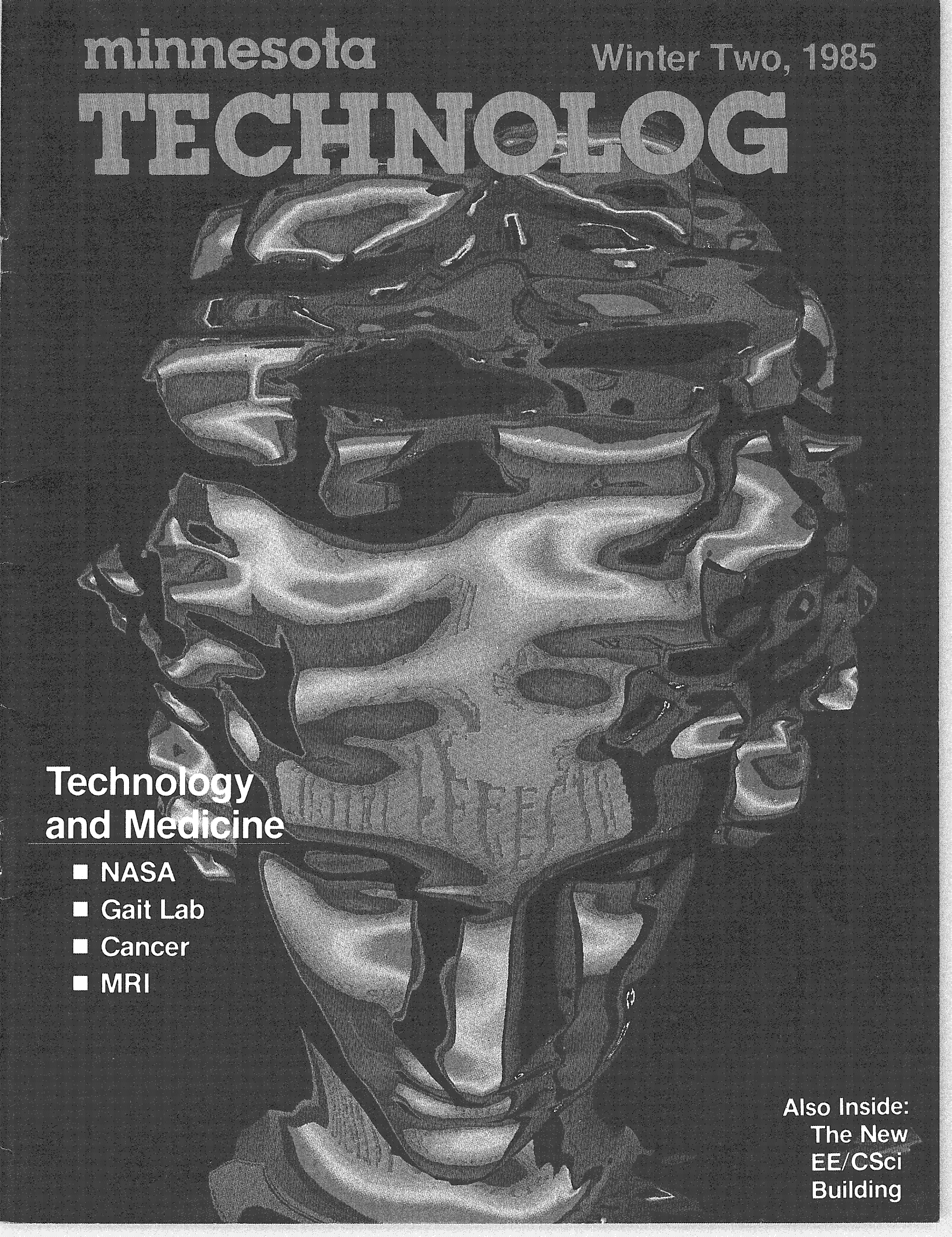
TECHNOLOG



Technology and Medicine

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The I.T. Board of Publications is looking for students to fill the openings for the most important positions on the Technolog and Connection staffs.

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Technolog Business Manager — The business manager keeps Technolog's books. If you have experience with accounting systems and payrolls, consider the opening on the Technolog staff. If you desire, the opportunity to sell advertising to national recruiters and local retailers also exists.

I.T. Connection Editor — Every two weeks the I.T. community looks to the Connection for the news and announcements of the many activities occurring in the Institute of Technology. The editor of the Connection is responsible for collecting that news and publishing it for everyone's benefit.

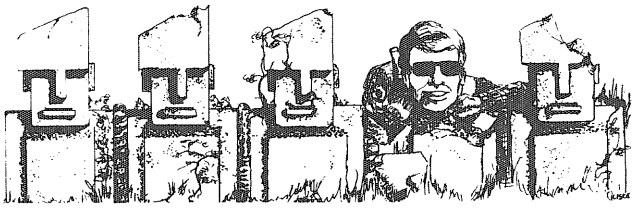
Do not let anyone fool you into thinking these positions will *only* be nice additions for your resume. They will be much more. If you take a "role up your sleeves" attitude, you may learn more about yourself and how to work with other people than the typical I.T. student would ever have the opportunity to do.

If you are interested, stop by Room 2, Mechanical Engineering and pick up the application details. Ask for this year's editors if you have any questions.

Remember, it is only once a year and only three people, do not let the opportunity pass you by.

Minnesota Technolog and the I.T. Connection

Stand out in a crowd, work for us!



minnesota TECHNOLOG

Winter Two, 1985 Volume 65, No. 4

The official undergraduate publication of the Institute of Technology.

Features:

Departments:

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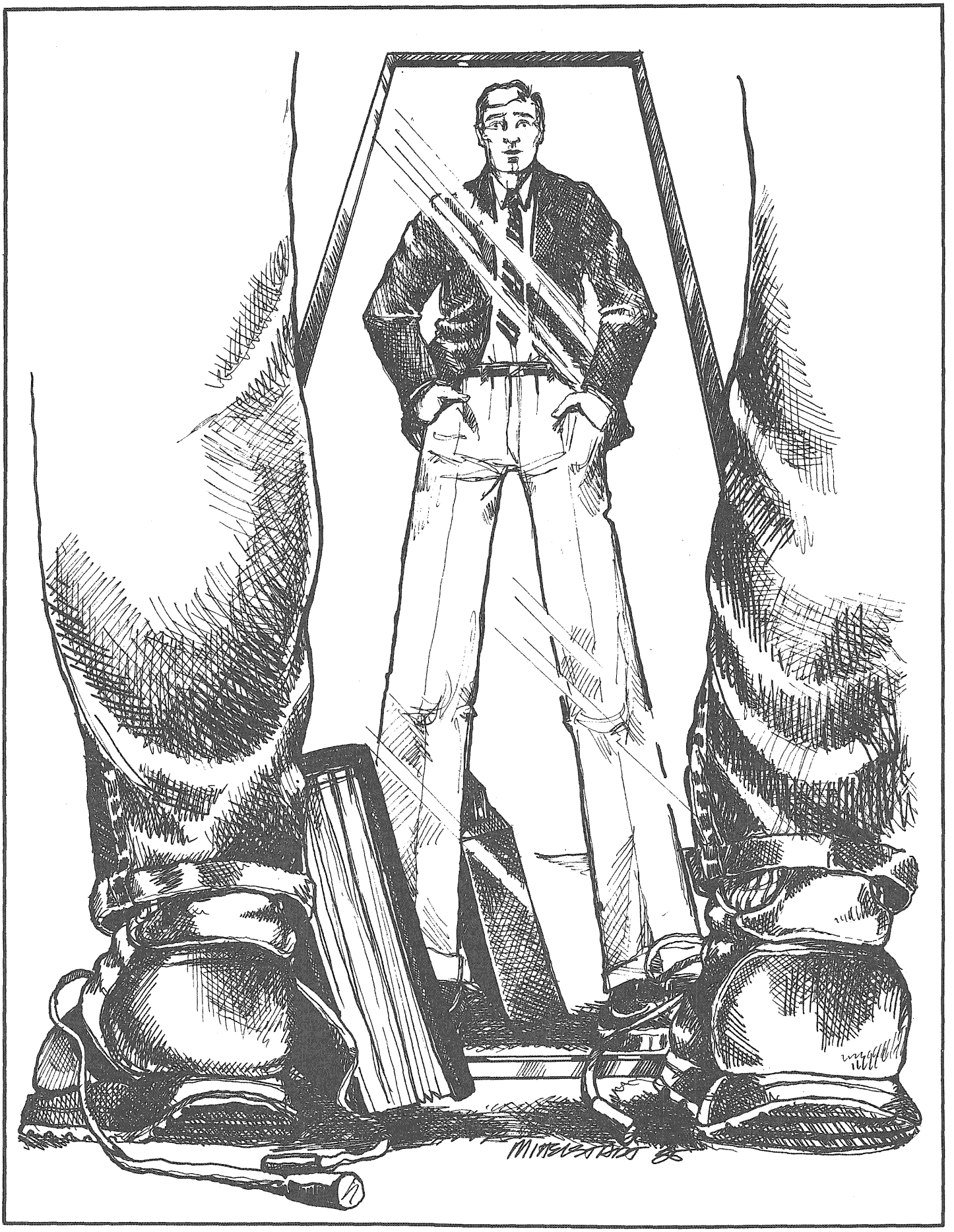

Illustration by Helen Mittelstadt

editor's log

Through the Looking Glass

Maybe it is just me, but I suspect differently. I have come to realize as a senior who is about to step out of academia, that I know very little about where I am stepping. What do engineers do? The question has been bouncing about inside my head, and assuming I am not an anomaly of this institution, it may have been on your mind too. Recognizing this as a question with no one solution listed with the other odd answers, many students opt for the response, "Engineers do everything." This is good for partial credit only.

Craving a more concrete definition, I began where anyone who had spent the last sixteen years in school would, in a book. "The engineering method is the use of engineering heuristics to cause the best change in a poorly understood situation within the available resources," wrote Billy Vaughn Koen from the University of Texas in a recent issue of *Engineering Education*. A heuristic is anything which is used as a guide, but does not necessarily provide a correct solution to the problem, such as the ME's rule of thumb that a bolt should have at least one and one half turns in the threads to be safe.

While the article was rather interesting and probably a reasonable explanation of engineering method, I still did not feel I grasped how an engineer spends the time between nine and five.

I know engineers do not do everything (this may come as a relief to some of the CLA majors reading this), but the problem in defining them does seem to stem from them doing many things. Therefore, I will perform an analytical step common in I.T., I will neglect a few things.

Actually, I will neglect quite a few things, like everything except one thing. Now, instead of asking, "What do engineers do?," the more reasonable question, "What does this one engineer do?" can be asked. If this is done a number of times, an eclectic definition of engineering will emerge.

Enrollment in an engineering school can inhibit your knowledge of engineers if you allow your textbooks to be blinders to everything but your coursework. I.T. offers many opportunities to, in effect, step through the looking glass to the other side of the diploma and see what one engineer is doing.

One service sponsored by the I.T. Alumni Society is the Industry Advisor Program. Students interested in the perspective of a working engineer can request a volunteer industry advisor from 3M, Honeywell, NSP, and soon possibly the Minnesota Department of Transportation by signing up in the Office of Lower Division Programs (23 Lind Hall). Dr. John Clausen, who has overseen the program's growth since it began in 1976 with just 3M, emphasized that it gives the student the insight to make a "wise choice."

However, the programs greatest asset, that you see an engineer in their work environment, is also a drawback because of the logistical problem of engineers being one place and students another. It is an opportunity which can only be arranged a few times with a student's schedule.

Another solution would be to sacrifice some of the "engineer's setting" by bringing him/her to the Institute of Technology. This of course is done all the time by many departments on many topics at many times. I continuously jot down these seminars and discussions in my handy pocket calendar, and I'll confess I tend to miss many of them because they address questions which are one echelon above the ones bouncing about inside my head. General interest speakers, brought in to simply be displayed, not to promote their latest advancement, would be of more use to me.

A colloqium sponsored by the I.T. Alumni Society last fall pursued the general topic of technology and Minnesota, exactly what I propose we need more of, yet nearly no students attended. The lack of student participation prompted one organizer to ask what would attract students next year. At the time I could only manage an apology, but now I have a suggestion. Why can't one or two hours each week be set aside when no I.T. classes would be scheduled to meet. The Dean's office could organize speakers of general interest and the departments could plan seminars of special interest, knowing ahead of time that the entire student body and staff would be free to attend. Eventually, if quality speakers were recruited and promoted, the designated times would be thought of and looked forward to as an opportunity to catch a glimpse of what engineers do.

Perhaps that glimpse through the looking glass into corporate engineering would eliminate the confident I.T. graduate's embarassment of the realization that an engineering education does not make an engineer.

David Herridge

David Herridge
Editor

ENGINEERING: THE KEY TO SURVIVAL

The Society of Women Engineers
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invites you to the
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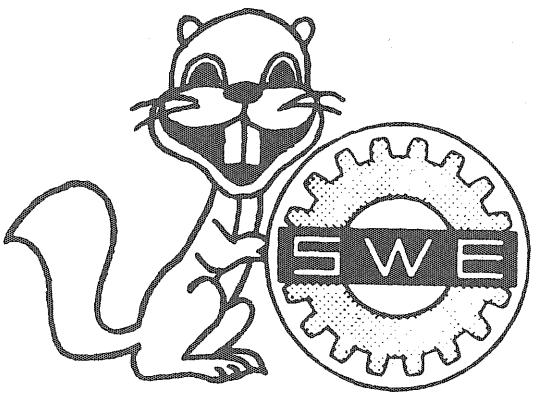
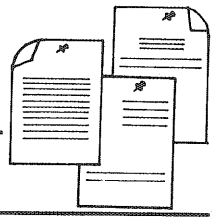


log ledger



Why Does the Moon Look So Big Sometimes?

Ever wonder why the moon looks so much bigger when it's on the horizon than when it's high in the sky? In the second century Ptolomy reasoned that: if two objects at different distances cast images of equal size on the retina, that object which is further away will look larger. Students who have had Psyc 1001 may recognize this as the concept of "size constancy." For example, two people at opposite ends of a long hall are perceived to be about the same size even though the retinal image of the further person is very much smaller. Your brain automatically compensates for distance. How does all of this relate to the moon (and the sun too)? When the moon is near the horizon we are supplied with many strong depth cues such as perspective, and the interposition of buildings, trees and other objects. Our brains assimilate these cues and adjust our perception of size to agree with them. When the moon is high in the clear night sky (haziness affects our impression of distance) there are few cues for depth, and the moon is perceived to be closer, therefore our brains make little or no adjustment in it's size. In all cases the image of the moon that falls on our retina is the same, it is the way that our brain processes that image along with depth cues that creates distortion. The moon illusion is a psychological illusion.

By Jon Soland

Is it Real or Is It Digital Effects?

The technological advances in the areas of medicine and biomedical engineering have changed the way we view man, which is why the very technological view of man was chosen for the cover of *Minnesota Technolog's* biomedical engineering issue.

The image was created by Donald Leich, C. Robert Hoffman III, and Gene Miller of the New York based visual media production firm, Digital Effects. Specializing in two and three dimensional computer animation, graphic illustration, and special effects, the company fuses the state of the art in computer graphics with creative talent.

Since their establishment in 1978, they have produced images for over 200 clients worldwide, including NBC, Walt Disney, McGraw Hill, and the Goddard Institute for Space Studies.

Their office is located at 321 West 44th Street, 5th floor, New York, NY 10036.

Apple, IBM Lead Discount Computers Sales

Still thinking about buying a microcomputer through the University's Discount Program? Many of your colleagues already have. According to the bookstore, the two most popular systems appear to be the 128K Apple Macintosh and the IBM PC. Since its recent release, the IBM PC AT has also showed strongly. It appears many University departments and personnel are purchasing the IBM, while most students are standing behind the Mac. It is not too late to put in your order, just head over to the Microcomputer Research Lab in 125 Shepherd Labs to look at the available models and then place your order with the bookstore.

Mac SIG

For all you Macintosh owners, the "Apple 32" Special Interest Group meets every third Thursday of each month. The next meeting will be March 21, in Room 35 of the Architecture Building from 7:30 to 9:30.

Opportunity Knocking

The I.T. Board of Publications is looking for students to be next year's Technolog Editor, Technolog Business Manager, and Connection Editor. If you are interested, please stop by Room 2, Mechanical Engineering to talk to this year's editors about the demands and the benefits of working on an I.T. publication.

Graduate School?

Are you considering graduate school? If you are, the American Society for Engineering Education offers a 16 page booklet which addresses many questions graduate students typically ask. A single copy can be obtained by writing to ASEE Publications, Eleven Dupont Circle, N.W., Suite 200, Washington, D.C. 20036. Single copies are free, but if you want more than one they are 75 cents each.

IBM, CME Exchange Expertise

Through a five year agreement with IBM initiated in 1982, the Civil and Mineral Engineering department trades educational and industry ready software in exchange for IBM hardware. IBM has loaned them several PC's, XT's and mini computers. All are equipped with printers and some with expanded memory and color screens. According to Assistant Professor Alan Wassyng, the software they produce is geared toward education, but many programs have practical applications such as: geomechanics, structural engineering, fluid mechanics, and computer aided design instruction.

By Mark Werner

NASA's Down To Earth Influence on Medicine

One of NASA's published goals is to apply space science and technology for the peaceful purposes to promote human welfare, medicine has been one benefactor.

By Vernon Thorp

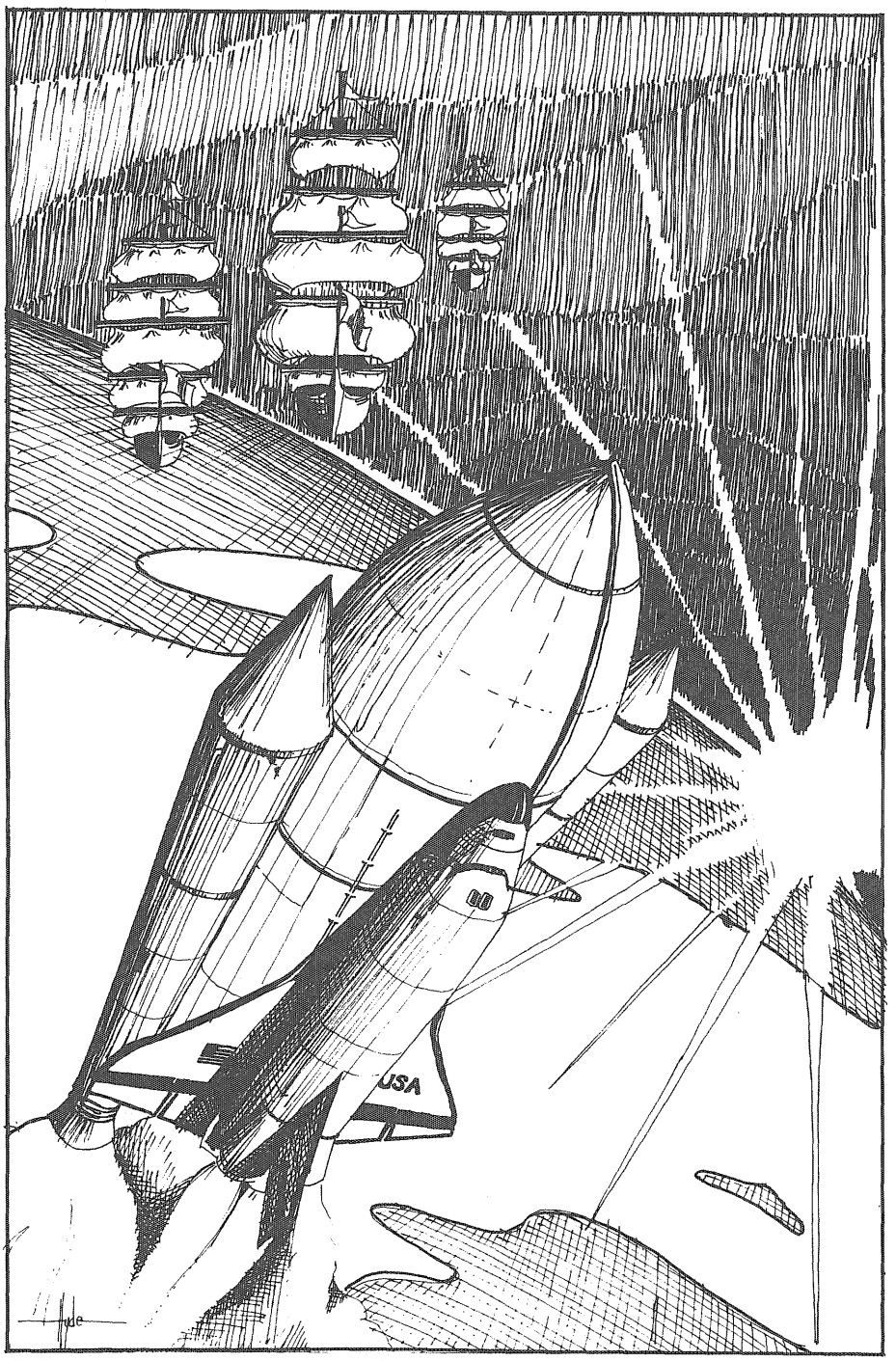


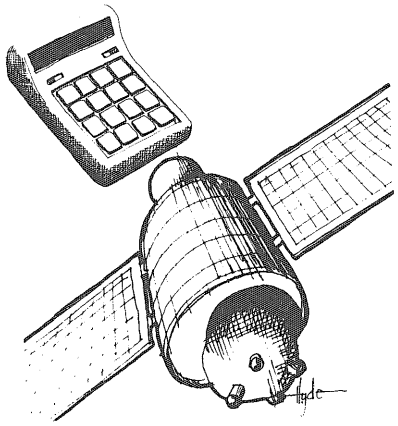
Illustration by David Hyde

"The committee judged the promises and offers of this mission to be impossible, vain, and worthy of rejection: that it was not proper to favor an affair that rested on such weak foundations and which appeared uncertain and impossible to any educated person, however little learning he might have."

This excerpt, from a report written in 1491 by Spain's Talavera Commission, addressed a proposal by a brash young Italian adventurer named Christopher Columbus. Had Queen Isabella not overruled the commission, the history of the Western world would have been drastically altered.[1]

The views of the Talavera Commission are closely paralleled by modern critics of the space program. Some of them ask "Why should we spend this money to explore space when there is so much to be done here on earth?" In response to this question Congressman Olin E. Teague replied "Well, there was plenty to be done in Europe when Columbus left it. And there is still plenty to be done there. If Columbus had waited until Europe had no more internal problems, he would still be waiting, but the opening up of the New World did more to revive the European culture and economy than any internal actions could possibly have done."[2]

The space program budget amounts to just a few percent of the amount spent on social programs such as housing, health, welfare, and education, yet the return on this relatively small investment is very great. Technological breakthroughs due to the space program often can not be measured in dollar amounts. These developments affect us in our everyday lives and touch virtually all areas of industry, science, and technology. The list of benefits and practical applications of space

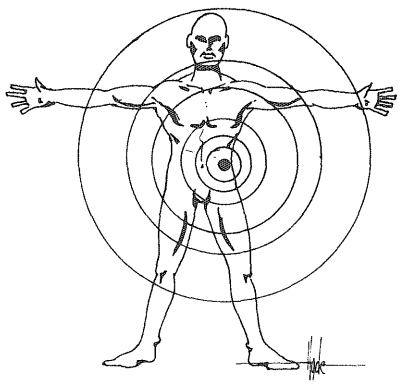


research grows longer every day. For instance: hand held calculators, rapid mass transit systems, satellite weather pictures, and satellites that allow us to avert potential food shortages by spotting crop disease before it becomes significant are four common examples of space technology at work.

Medicine and biomedical engineering have, in particular, benefitted from the space program. One of NASA's published goals is to apply space science and technology for peaceful purposes to promote human welfare. One of the steps NASA has taken to meet this goal is to form a biomedical application team whose specific purpose is to put to use knowledge gained through space research in the field of medical technology. There now exist new pieces of diagnostic equipment, life saving surgical tools, and devices to help the handicapped that might not be here today were it not for the space program.

The diagnostic tools brought forth by the space program allow medical personnel to gather and analyze information on a person's state of health and diagnose their condition faster and more accurately than was possible with previous methods. These tools include improved x-rays and a microwave cancer detector.

Improved x-rays resulted from research conducted at the Jet Propulsion Laboratory of the California Institute of Technology. In the 1960's, doctors Robert Nathan and Robert H. Selzer worked on ways to improve the quality of photographs returned to earth by unmanned space probes. The techniques they developed, using frequency enhancement and pattern extraction, were easily applied to conventional x-ray photographs.[3] As filters used to enhance satellite images evolved, they too were applied to x-rays and it became possible to view soft body tissues previously hidden by bone. This allowed easier detection of both internal tumors and damage to soft body parts. In 1961, x-ray technology made a quantum leap when x-ray machines and computers were combined to create the CAT scanner (Computerized Axial Tomography). This machine shows cross sectional views of the body and is the second generation of x-ray machines. It can detect tumors, cysts, lumps, obstructions, and organ damage that would pass unseen on a traditional x-ray. Since the system uses sensitive filters, optical decoders, and computer enhancement processes originally created for satellite imaging, the CAT scanner requires less patient exposure to radiation when compared to traditional

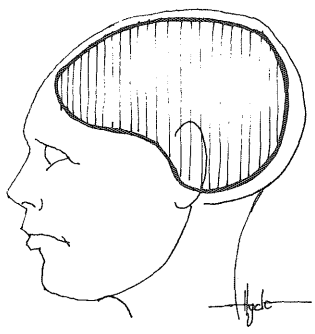


machines.[4] Several years ago the third generation of x-ray machines emerged in the form of the DSR (Dynamic Spatial Reconstructor). Using the latest image enhancement and processing techniques developed for satellites, this technological miracle produces 3-dimensional x-rays with even less radiation than the CAT scanner. It can single out any part of the body, project it 3-dimensionally, and allow a doctor to rotate it, dissect it, or cut if in half: the equivalent of exploratory surgery without the surgery. Dr. Earl Wood, leader of the team that created the DSR, calls it "the most sophisticated equipment ever built for biomedical purposes."

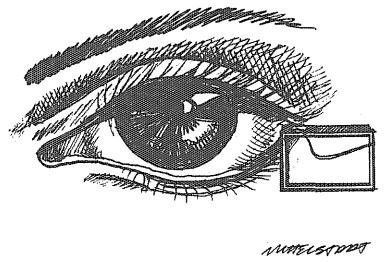
The microwave cancer detector, developed at NASA's Langley Research Center, can identify cancerous tumors inside the body. Traditional methods of detecting cancer from outside the body only sense cancerous tissue near the skin. The microwave applicator, on the other hand, can sense minute temperature variations (less than .1° C) throughout the entire body. Since cancer tumors are warmer than surrounding tissue they are easily isolated by the system.[5] Patients can quickly be tested for many types of cancer as easily as their heart rate is recorded by an electrocardiogram. Tests will determine whether the device can be used to treat tumors. Since cancerous tissue has a higher water content than surrounding tissue, microwaves may be able to sufficiently raise the temperature of a tumor, destroying it without harming the surrounding normal tissue. Research and development work on the detector was done by Microwave Associates, Inc., a company specializing in microwave communication systems for satellites and other space projects.

Along with diagnostic tools, some relatively recent developments in the field of surgery also owe their existence to research done for the space program. Two of these are cryogenic surgery and a new cataract surgery device.

Cryogenic surgery resulted from NASA's experience in manufacturing, handling, transporting, and storing the extremely low temperature gases used in spacecraft engines and cooling systems. In the late 1950's, doctors Irving Cooper and Arnold Lee put to use techniques that had been developed at that time to invent a long needle through which liquid nitrogen could circulate, lowering the surface temperature of the needle to -319° F.[6] The needle destroys diseased tissue on contact. Earlier, engineers had developed a tiny electronic thermometer which could be inserted into the needle. It allows the temperature of the needle to be monitored and kept at a safe level

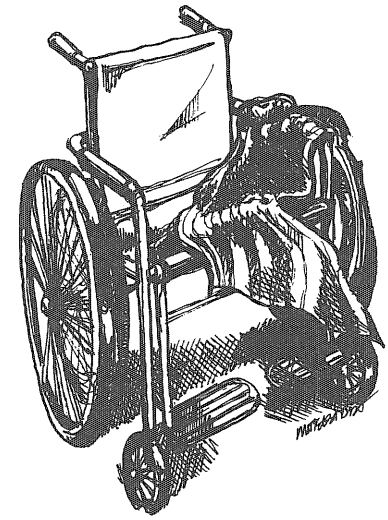


while it passes through healthy tissue. When the tip reaches its destination, the temperature is lowered and the tip of the cryoprobe begins its lifesaving work. The temperature monitoring and regulating abilities make this tool especially valuable in brain surgery.



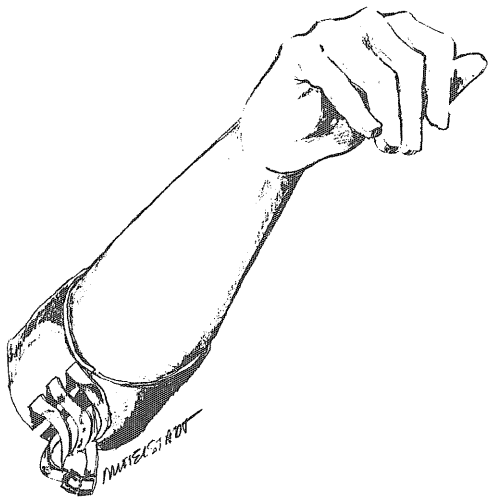
A tool for cataract surgery was created by NASA in conjunction with the Retina Foundation of Boston and eye surgeon Dr. William J. McGannon. The tool draws upon technology in areas of fluid mechanics, high-speed rotating machinery, pumps, seals, bearings, and miniature mechanisms, all originally developed for spacecraft. "The cataract surgery tool is a tiny cutter-pump which liquifies and pumps the cataract lens material from the eye. Inserted through a small incision in the cornea, the tool can be used on the hardest cataract lens. The cutter is driven by a turbine which operates at about 200,000 revolutions per minute."[7] The mechanism has two passages through which saline solutions are pumped. One maintains constant pressure in the eye and the other pumps away the liquified cataract lens material. Previous methods of surgery involve making a 180° incision around the lens, creating a high risk of infection. For the 400,000 Americans each year who need cataract surgery, this device offers a safer alternative with a shorter recovery period.

Alongside diagnostic and surgical tools exist creations to help the handicapped which make use of space technology. Whether someone is handicapped by a disease, birth defect, or injury, chances are that they can lead a more normal life today than would have been possible several decades ago because of these creations. The first special wheelchair for quadriplegics and new types of artificial body parts are two examples of applied space technology.



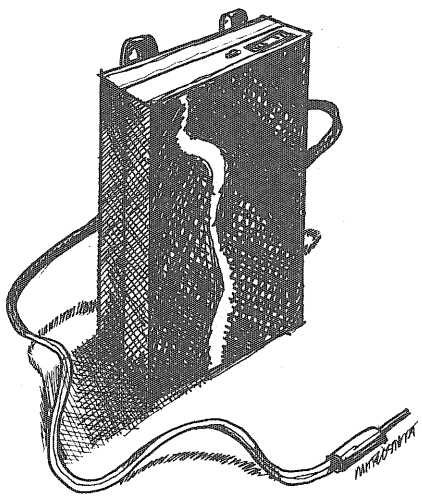
There is no doubt that the space program gives us back more than we put into it, often in the form of unexpected spinoffs from the main projects.

The first quadriplegic wheelchair integrated teleoperator and robotics technology from various space programs and owed its existence to another NASA sponsored program at the Jet Propulsion Laboratory. A microphone on the motorized wheelchair picked up spoken signals, responding to key words in a patient's particular speech pattern. The commands of the patient activated motors to cause movement of the chair itself or of a manipulator arm that could pick up objects, open doors, turn on appliances, and perform numerous other functions. The original chair/manipulator system recognized up to 35 one word commands. Over the last 20 years improvements have been made using updated technology so that a formerly bedridden quadriplegic can now get out and go places independently.



Artificial body parts (not counting peg-legs and false teeth) have been around since the 1940's when Dr. Willem J. Kolff invented an artificial kidney. Traditionally, artificial organs and limbs mimicked only the most basic functions of the original body part, but now scientists working in space medicine are developing devices to tie directly into the central nervous system. Artificial arms and legs can now receive signals from the body's central nervous system and turn them into exact movements. functioning portion of the original arm or leg which translate the neurological signals into exact movements.

New prosthetics may even allow patients to regain their sense of touch. Scientists are now beginning to develop artificial nerves, the most complicated and least understood organs in the body (along with the brain). Currently, the most widespread application of this technology is in controlling chronic pain and tremors. The latest device



used for this is known as the Human Tissue Simulator.[8] Developed under sponsorship of NASA's Goddard Space Flight Center, the system is based on Goddard-developed technology employed in NASA's Small Astronomy Satellite-3. The HTS is the size of a deck of cards and totally implantable with wire leads patched into selected nerve centers. Electrical pulses through the leads provide immediate relief of pain or arrest involuntary motion. Other artificial organs in the works include a totally implantable, nuclear powered artificial heart and artificial eyes using high resolution filters and lenses from the satellite program.

The diagnostic tools, surgical tools, and artificial devices mentioned here represent just a few of the thousands of uses of space technology in the field of medicine. The medical field, in turn, uses few applications when compared to the whole of industry, agriculture, transportation, consumer products, public safety, etc.

There is no doubt that the space program gives us back much more than we put into it, often in the form of unexpected spinoffs from the main projects. New medicines, new alloys, and new food production methods beckon us onward. Space truly holds enormous potential for the country and for the world.

"Those nations...which do not perservere in research and development programs are...those which also fail to develop an economy which adequately feeds, clothes, educates, and houses its peoples."[9]

Medicine and biomedical engineering have, in particular, benefitted from the space program.

[1]L.B. Taylor, Jr., *For All Mankind* (New York: E.P. Dutton and Co., Inc., 1974), p. 273.

[2]Ibid., p. 274.

[3]Frederick I. Ordway, III et all, *Dividends From Space* (New York: Thomas Y. Cromwell Co., 1971), p. 33.

[4]National Aeronautics and Space Administration Technology Utilization Office, *Spinoff 1977, An Annual Report* (Washington, D.C.: GPO, 1977), p. 54.

[5]NASA, "New Device Detects Cancer," *Space World*, February 1980, p. 33.

[6]Ordway, *Dividends From Space, p. 33*

[7]NASA, *Spinoff 1977*, p. 63.

[8]NASA, *Spinoff 1982,* pp. 80-81.

[9]Taylor, *For All Mankind,* pp. 278-279.

Walk This Way

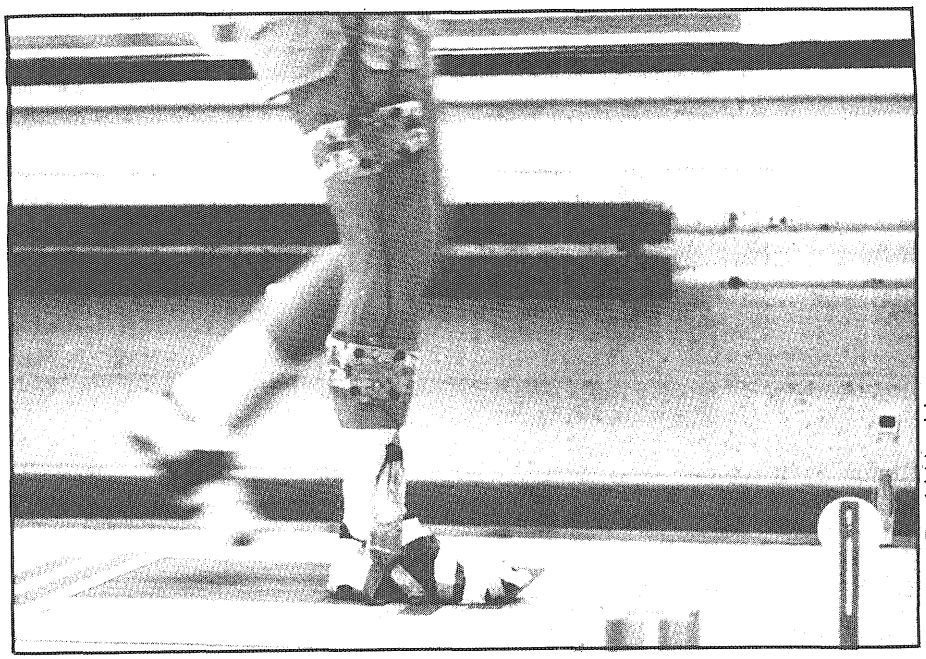


Photo by David Herridge

Some people walk this way and some people walk that way. The Gait Lab run by the Rehabilitation Engineering Center can now quantify the difference.

By David Herridge

Walking, it is something most of us have taken for granted since we were about two years old. Our muscles flex and stretch, and we amble along without giving it much conscious thought. How exactly do we walk? One research project being conducted through the Mechanical Engineering Department hopes to find out.

Two years ago, a Rehabilitation Engineering Center was established here at the University of Minnesota. Their efforts have been directed towards two objectives. One is to develop a general method to quantify human performance, the other is the more specific task of quantifying arthritic disability. The effectiveness of drugs, surgery, and joint replacement therefore can be established by comparing the pre and post therapy performance of arthritic patients.

The center's work has been divided into two areas: the upper and lower extremities. The Physical Medicine and Rehabilitation Department has focused on the upper extremities, developing tests to measure factors like muscle strength and isometric contraction rates. Dr. Max Donath, from the Mechanical Engineering Department, has concentrated on the lower extremities. Using a sophisticated arrangement of lasers, photodetectors, and a force plate, the range of motion, orientation, and absorbed forces in a test subject's legs can be determined during his/her gait cycle.

In many upper extremity tests a routine must be learned, thus throwing another parameter into the governing equations. That is why walking was chosen for the lower extremity research. As Dr. Donath said, "Everybody knows how to walk. Nobody is ever going to question how much training was involved."

The effectiveness of drugs, surgery, and joint replacement can be established by comparing the pre and post therapy performance of arthritic patients

Triangulation is a navigational technique that determines position by measuring the location of two reference points and applying a little trigonometry to discover from where the measurements were taken. The same principle is applied in the biomechanics lab where three carefully aligned lasers mark the angular position of targets attached to a test subject's leg.

The circular light beams from the lasers are refracted into planes by special lenses and then reflected off spinning octagonal mirrors toward the photosensitive diode targets. By sweeping two planes in a vertical orientation and the third in a horizontal, an orthagonal coordinate system is imposed in space. "We get three intersecting planes, which from sophomore linear algebra you can solve for the x-y-z coordinates," said Roland Starr, a Ph.D. student in the Mechanical Engineering Department (see figure 1).

When the target diode is between the two reference diodes, the target position can be determined by the proportional relationship between time and angular displacement. When the rotating laser plane reaches the first reference point, it does two things; it records an indentifying "hit"

on one of the three reference diodes, each of which are fitted with conical "blinders" that only allow it to be triggered by the light from its respective laser, and secondly, it starts a timer. The times for the laser to sweep to the targets on the test subject's leg are then recorded. The measurement is complete when the time is stopped as it passes over the second reference point. These times are combined with the known angle between the two reference diodes to yield the angles to the targets, according to equation 1 (see figure 1).

The three motors, which were specially built to rotate the mirror heads at the same frequency when supplied with the same electrical current, must be carefully mounted so none of the lasers arrive at the target at the same instant. By keeping the sweeping planes out of phase, the individual measurements of the three lasers can be distinguished electronically because each identifies itself as it passes the "discriminating" photosensitive diodes at the first reference point.

Presently, only one side, and therefore one leg, of the test subject is observed on each pass down the walkway. Eight targets, for on a board strapped to the thigh and four on a board strapped the calf, are used to locate the leg. Because only three points in space are needed to define a plane, the orientation of the thigh and calf can be calculated from the relative positions of the targets on each board.

If you put enough lasers around the room you could look at the dynamics of a baseball pitcher's wrist and elbow while he is throwing

Two factors make this procedure the state of the art. One is the speed with which the data can be collected. The motors turn the eight sided mirrors at 60 Hz., panning the lasers through the test volume with a frequency of 480 Hz. Thus, the cycle for the three lasers to "hit" the target is complete in just over two milliseconds.

The second is the accuracy of the measurements. After a recent rough calibration of the apparatus, the position of the targets was found to be good to a tenth of an inch for a walking target. However, in time this should approach the practical limit for this lab between three and one-hundredths of an inch. Compared to the widely used technique of high speed cinematography, which digitizes location of limbs by marking the body joints on each frame of film, the rough calibration of the ME system matches its upper limits of accuracy.

"You have to record at above 100 Hz. to get the harmonics of walking," said Brett Sorensen, a ME graduate student who is working on the project as part of his master's thesis. By increasing the rotational speed of the motor or the number of spinning mirrors, the sampling frequency could be increased. "If you put enough lasers around the room, you could look at the dynamics of a baseball pitcher's wrist and elbow while he is throwing," elaborated Sorensen, "the pitching motion would probably require a speed greater than 1000 Hz."

The kinematic variables of position, velocity, and acceleration of human walking can all be evaluated using the laser positioning aparatus. To gain insight into kinetic variables of force and torque, a load cell with six degrees of freedom was installed into the walkway. Thus, when the subject steps on the plate, the three component forces and moments in the subjects planted leg are measured.

Figure 1: The Gait Lab

The three sweeping laser planes register hits on the photosensitive diode targets on the subject's leg. The relation between the elapsed sweep times between the targets and the references is used to determine the angles to the targets.

$$\emptyset_T = (t_T/t_{ref})\emptyset_{ref}$$

Where: $\emptyset_T$ = Angle to the target on the subject's leg
$\emptyset_{ref}$ = Known angle between reference diodes
t_T = Time to sweep to target
t_{ref} = Time to sweep across reference angle

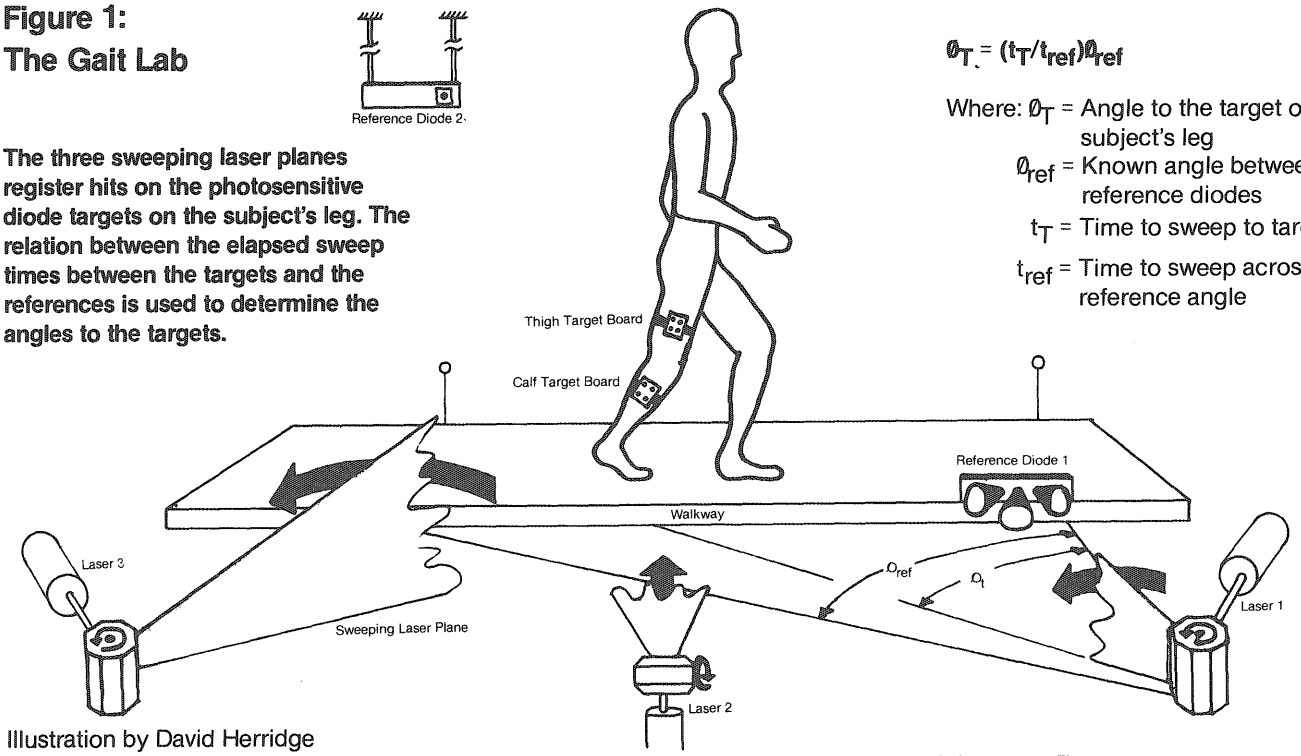
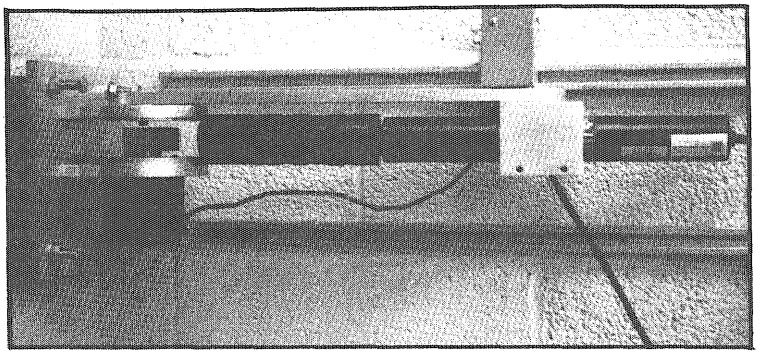
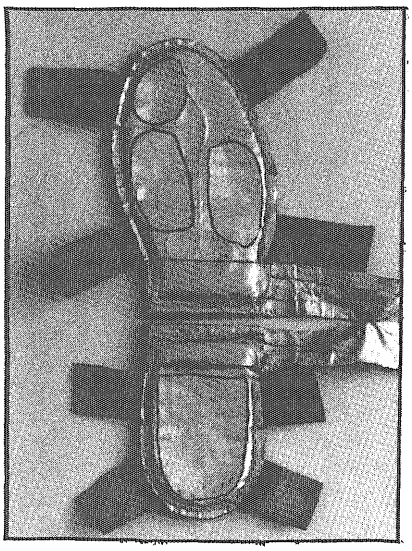
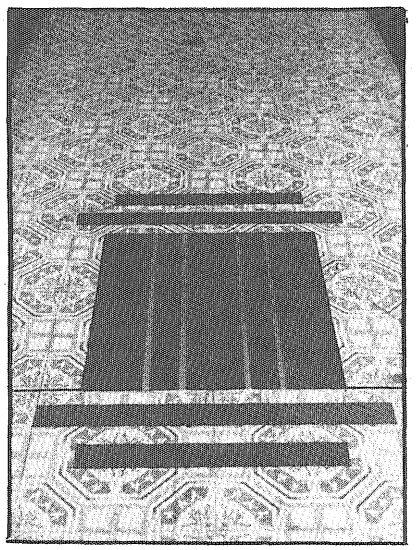
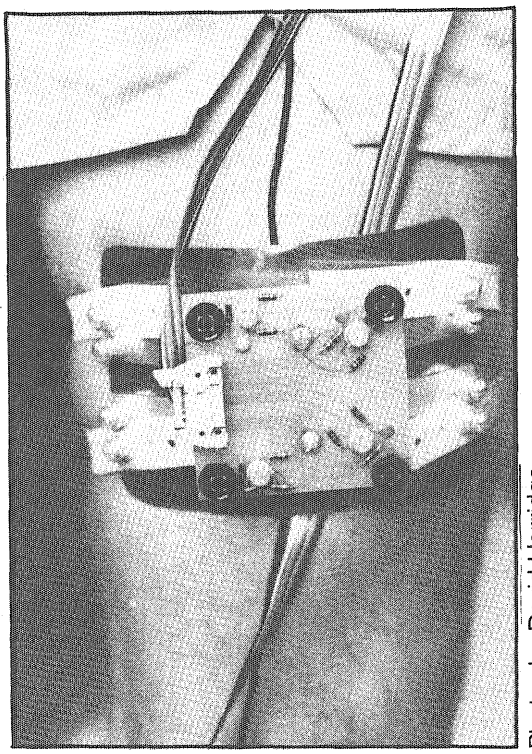


Illustration by David Herridge









Photos by David Herridge

Clockwise starting in upper left: The light from the laser is refracted into a plane and then reflected off the octagonal, spinning mirror. Four photosensitive diodes are on each target board. A six degree of freedom load cell in the walkway measures the forces and torques in the subject's leg. Pressure switches strapped to the soles of the shoes monitor how the foot is planted.

Information on how the subject plants his/her foot is also collected. A set of pressure sensitive switches strapped under the sole of the shoe note the contact of each area of the foot as the subject travels down the walkway.

The final set of numbers being collected measures muscle activity during the gait cycle. The electromyogram (EMG) is the signal from the electrical activity in the stressed groups of muscles. This will allow the development of a correlation between motion and muscle group firings.

All of these numbers are sent through cables to a track running above the length of the walkway. After being amplified and converted A to D, the lab's DEC PDP-11 computer goes to work processing the data. Soon another microprocessor will be interfaced to help with the computational load. And soon after that the computational load will grow when new and more target boards will be utilized.

The apparatus is almost to the point where a physical therapist can begin to develop the protocol to be used for the medical applications. The test subjects that have been through up to this point have been mostly healthy students who were willing to help work the bugs out of the system.

While developed for the arthritis study, the future of the apparatus will undoubtedly effect other future biomedical research. At one time, Dr. Donath had worked on the design of an above knee prosthesis. When support for artificial limb research was cut back he proposed to take the functions he had developed to control the prosthesis and expand them to coordinate a controller, described by Dr. Donath as a "walking pacemaker," to electrically stimulate the muscles of paralyzed individuals allowing them to walk. At the time, the proposal was rejected because no one believed the muscles could be stimulated in a sufficiently coordinated way to allow a person to walk. However, the concept has since been demonstrated at Wright University. According to Dr. Donath, what is now needed is a strategy to coordinate all of those muscles to duplicate the human function of walking. Clearly, the apparatus here would be capable of the first step of duplicating walking, which is defining it.

Because only three targets are needed to define a plane, the orientation of the thigh and calf can be calculated from the relative positions of the targets on each board

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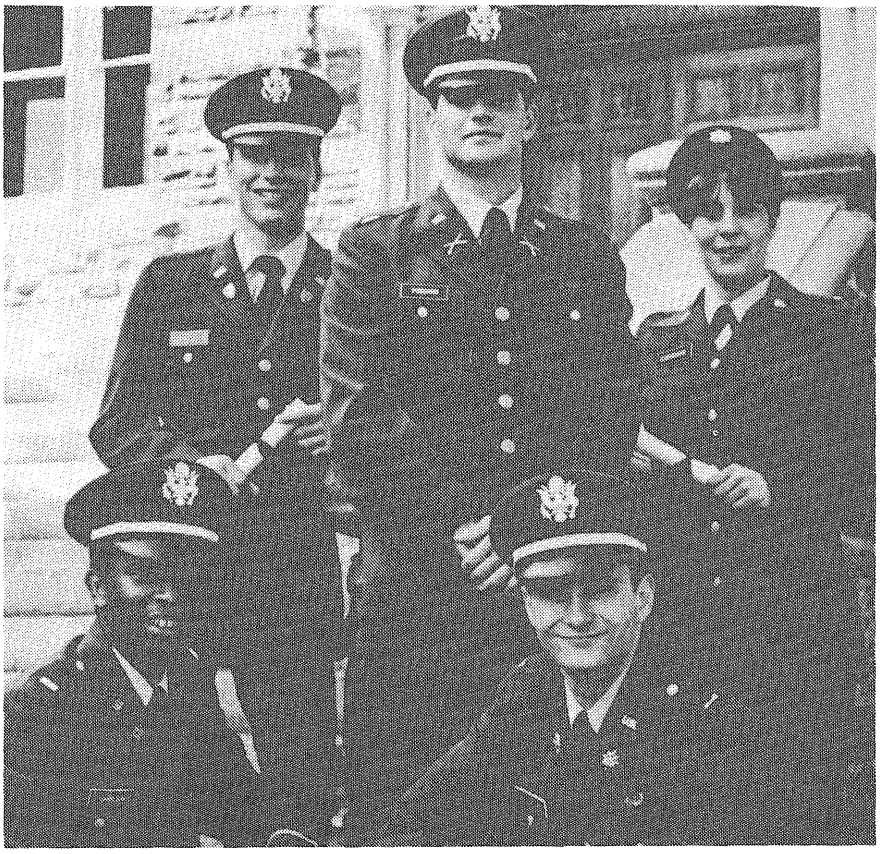

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Fingerprinting Cancer Cells

The Electrical Engineering Department and the U Hospital have teamed up to determine if cancer cells can be differentiated from normal cells by the electrical activity in their membranes.

By Michael Moore

Cancer has been an extremely elusive subject of research for decades. One of the fundamental tasks in these extensive studies continues to be the diagnosis of neoplastic cells, or cells growing at a tumorous rate. However, if the current work of Dr. Vincent Garry and Dr. James Holte is successful, the cancer research community will receive a valuable new tool designed to aid in the identification of these neoplastic cells.

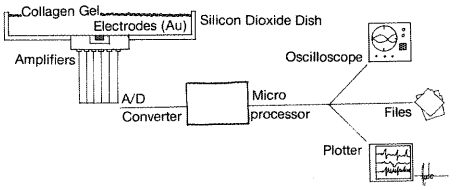
Dr. Garry, who earned his medical doctorate at the University of Michigan, began the research nearly a year and a half ago with the consideration of the superficial electrical activity of cells in general. Dr. Garry conducted his research at the Royal A. and Olive W. Stone Laboratories where he serves as director. The state-funded laboratory conducts studies of occupational hazards which expose workers to potentially carcinogenic materials. His current work would, of course, be very beneficial to the laboratory's premise.

However, the apparatus that Dr. Garry had in mind obviously would incorporate advanced electronic technology with which he had no expertise. Consequently, he contacted Dr. James Holte, a professor in the department of Electrical Engineering here at the University of Minnesota.

Dr. Garry asked for Dr. Holte's aid in the design of an electronic device able to detect the electrical potential differences in the cellular membrane. Such a device would be useful to establish inherent impulse patterns and amplitudes of particular cells. Dr. Garry theorized that the patterns of normal cells and those of neoplastic cells would be differentiable.

The possibility of "fingerprinting" cells was confirmed by a group of researchers at the University of Utah. In that study, cells of rabbits were extracted and placed in a collagen gel wherein it was incubated for twenty-four hours. Next, microscopic electrodes with diameters of one micrometer were inserted into individual cells. Their patterns of team, however enlightening, had some major drawbacks. Among them was the tedium entailed in preparing each individual cell for the probing electrode. Often the cell would simply deflate once the electrode pierced the cellular membranes and readings were impossible to register. Even when an ideal impalement was performed, the damaged cell would survive for only a matter of minutes. This restricted the scope of the research that could be done in this manner.

With the features of the chip designed by Dr. Holte and manufactured by Microcircuits, a Control Data offspring, these



problems are treated by avoiding the impalement process altogether. Instead, the cultured cells are placed in a small well perched on top of a chip and readings are taken topically, resulting in no damage to the cells. They can then be allowed to grow in any chemical environment, and comparison of primary and secondary

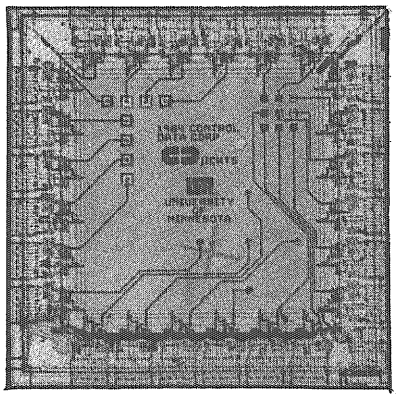
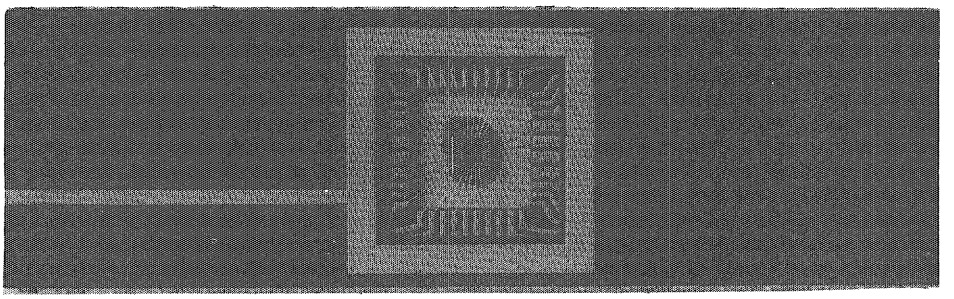


Photo by Mike McGee



In the small square in the center of the above chip carrier is a tiny well in which the electrical impulses in the membranes of cells can be monitored using a set of gold electrodes. The researchers hope the electrical patterns of normal and neoplastic cells will be differentiable. The chip was manufactured by Microcircuits.

readings can give much insight into the chemicals effect on the cells.

The carrier structure itself is approximately two inches long and two thirds of an inch wide. In the center of the structure, a small plate can be removed to reveal several lead-in wires that make up only part of the micro-circuitry surrounding a 1.5 by 1.5 millimeter surface. This box-like structure is actually the well wherein the measurements are taken.

Lining the bottom surface of this well is an array of 28 tiny electrodes which measure the potential in the membrane of the cell, which typically range from one to twenty-five millivolts. Because of their lateral displacement, the electrodes can get enough information to produce three-dimensional analyses of the potential in relation to spatial coordinate of the cell walls. The electrodes are in turn connected to amplifiers beneath the culture well. The amplifiers serve to bring out the weak signals detected by the electrodes. The signals are sent along the wiring which spreads out radially over the supporting structure and ultimately connects to the individual prongs that line each side of the structure.

From the chip, the signal is transferred to an analog-to-digital converter which puts the signal into a form that is understandable to the computer. The converted impulse is next sent to a microprocessor where the signal can impart valuable information to the cells activity. This information manifests itself in a variety of media. On the screen of an oscilloscope a graphic representation can show how the potential varies over the topography of the cell as chemicals are introduced to test the reaction of the cell. A plotter provides graphs of the reaction while files are created to document the statistical aspects of what occurs in the well and all are utilized in the subsequent analysis. All this information is integrated into the final analysis.

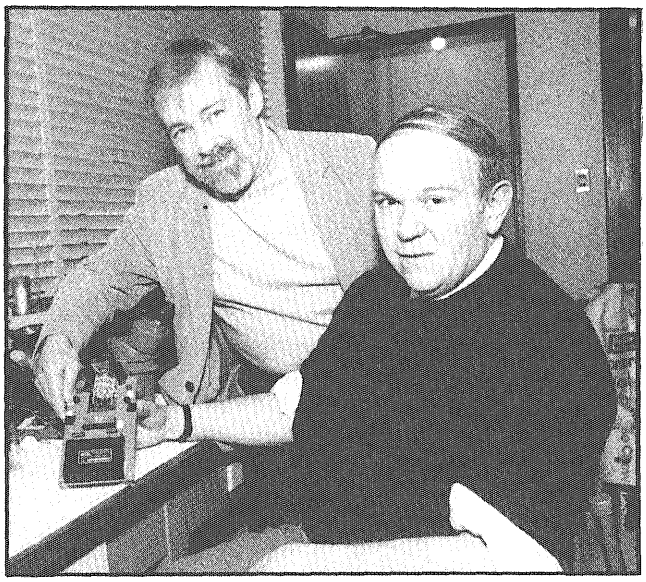


Photo by Mike McGee

Dr. James Holte and Dr. Vincent Garry.

Early tests conducted with primitive models of the chip have given promising, however imperfect, results for the duo and their colleagues. Impulses have been recorded from prototypical aluminum chips before chemical reactions between the culture and the aluminum rendered the chip ineffective. Such reactions were anticipated. Consequently the present chip, the second one to be used, uses electrodes made of gold because of its desirable property of chemical inactivity. Though tests have yet to be performed using the latest chip, Dr. Holte appeared very confident of its capabilities.

As for the success of the project in general, neither Dr. Holte or Dr. Garry are prepared to claim victory. They are still in the midst of planning modifications of the chip they haven't even tested yet. After establishing the electrical literacy of their probe, the two doctors would like to extend its functions to include observation of other informative phenomena such as thermal activity of the cells. Strapped with a shortage of personnel, Dr. Holte said, "That's a little way down the road."

MRI Generates Attractive Images

Magnetic resonance imaging can cut a high resolution, two dimensional pictures of patients without exposing them to x-rays.

By Stephanie George

One of the newest techniques for human body scanning generates clearly defined 2-D images through a non-invasive and non-destructive process. It utilizes the properties of magnetic field gradients to detect the concentration of certain nuclei in a plane by converting specific radio frequency signals into two-dimensional images of the plane through which the magnetic field passes. This new technique is called nuclear magnetic resonance or magnetic resonance imaging (MRI).

The idea for MRI was first conceived in 1969 by Dr. Raymond Damadian as a possible tool for medical diagnosis. The final practical realization of MRI as a body scanning machine was accomplished in the lab in 1977. MRI transformed medicine from a descriptive art to a quantitative science.

There are many positive aspects to MRI. First, it is non-invasive, meaning that the patient is not required to ingest a contrast medium prior to the scan. The image produced is based on the concentration of certain nuclei in the plane through which the magnetic field passes. Second, MRI is non-destructive in that it uses non-ionizing radiowave frequencies. The radio wave frequencies involved in MRI usually range from 2-15 MHz and have wavelengths from 150-20 meters. In addition, MRI can scan *any* plane in the human body without repositioning the patient.

The University of Minnesota Hospital recently acquired MRI and began operating it in January, 1985. Mrs. Pat Skundberg, the technical administrator of the U of M Radiology Department, commented on how "incredible the images are, displaying especially fine detail of the brain and spinal cord."

MRI can be divided into two separate categories. High-resolution MRI evaluates the metabolic state of various tissues by directing a radio frequency signal into a human being or animal and then measuring the amplitudes and widths of the induced signal peaks. These peaks correspond to different metabolites in the sample. The second category, spin-imaging MRI, produces anatomical images of human beings that reflect the distribution of protons contained within the water and fat of the body. This provides remarkably clear discrimination between different tissues. Spin-imaging MRI results in information often complementary to that obtained by more traditional techniques such as x-ray computed tomography (CT). Our focus will be on spin-imaging MRI.

MRI takes advantage of the inherent property of spin in nuclei

The MRI experiment requires three pieces of equipment. First and foremost is a large magnet to surround the human body and cause the protons therein to precess at precisely the same frequency. Three types of magnets are utilized — permanent, resistive, and superconducting. The choice of which to use depends on the field strength, cost, image quality, and the amount of time to perform the scan. The U of M Hospital has a shielded, superconducting magnet with a field strength of up to one Tesla. The magnet is shielded to reduce the area of the fringe field; the area in which metallic objects would be within the magnet's field and attracted to it. A U of M MRI technician said that this magnet's fringe field is about 5-6 yards in radius. He also stated that the magnetic field strength they have been using is 0.35 Tesla.

The MRI experiment also requires a radiofrequency transmitter and a sensitive receiver coil to respectively excite and detect the MRI signal. In addition, magnetic field gradient producing coils are needed to code in space, via frequency, the MRI signals received from the human sample.

MRI takes advantage of the inherent property of spin in nuclei. Approximately two-thirds of stable atomic nuclei possess an odd number of protons. This causes these nuclei to spin about their axis. Since the nuclei are positively charged, this spin generates circulating electrical currents and hence magnetism. Because hydrogen is present in water and because water comprises 70%-80% of the human body, the most common nucleus for MRI at present is hydrogen.

Like small bar magnets, the effect of the externally applied magnetic field aligns these magnetic nuclei along its gradient. However, their spinning mass prevents them from aligning *directly* with the applied magnetic field. Instead their spinning axes *precess* about the applied magnetic field direction. The precession frequency depends on both the nuclei's magnetic strength and the strength of the applied magnetic field. The precession frequency is the same for all the nuclei. The nuclei become, in a sense,

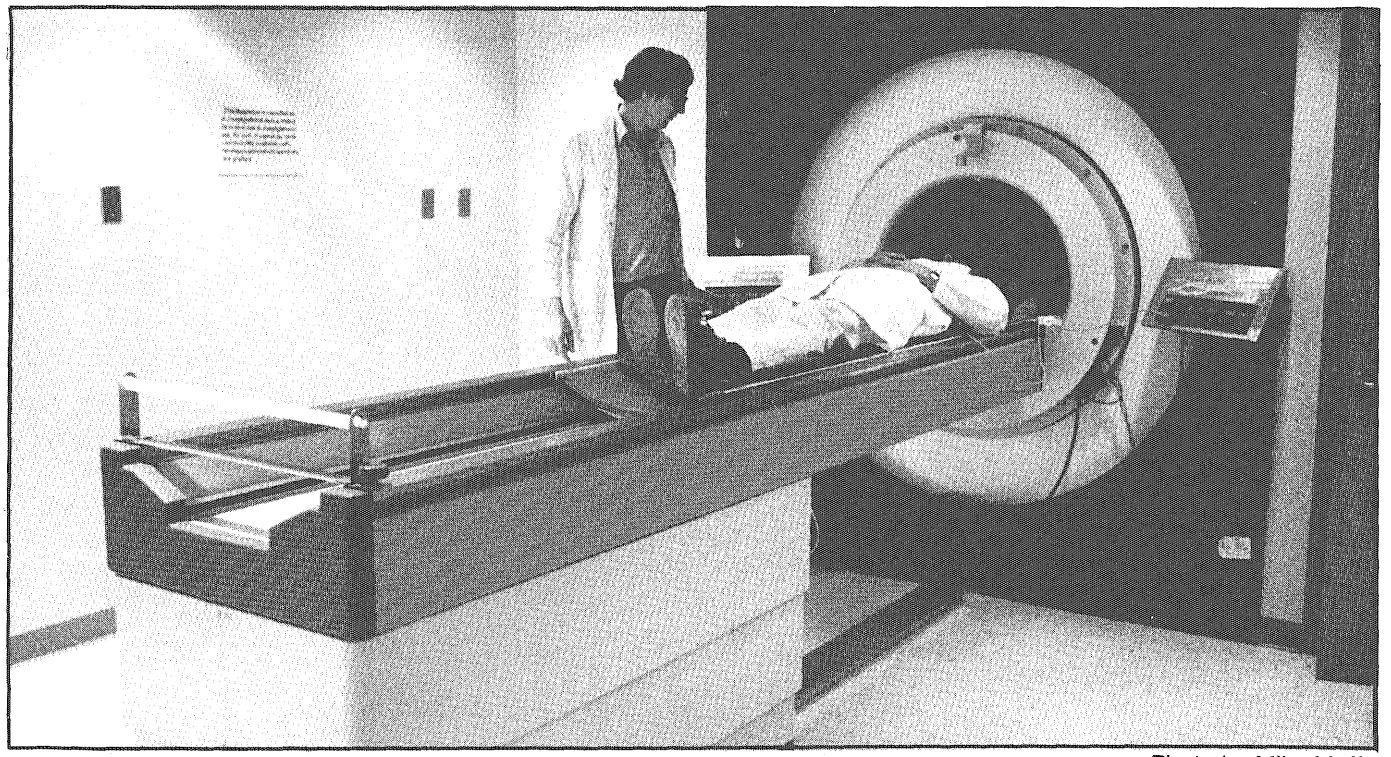


Photo by Mike Moffa

A nuclear magnetic resonance imager began operating at the University of Minnesota Hospital in January of this year. The superconducting magnet used to allign the nuclei can generate a field with a strength of one Tesla.

like gyroscopes.

The principle of MRI is to have the externally applied magnetic field spatially uniform over the identical (hydrogen) magnetic nuclei so that they precess at a well-defined frequency. As the patient is lying in the bore of the magnet, a receiver coil also encircles the specific plane of the head or body that is to be scanned. The radio frequency transmitter, connected to this coil, generates an oscillating radio frequency magnetic field at right angles to the applied magnetic field at precisely the correct or resonance frequency, corresponding to the precession frequency. Resonance is similar to playing a note with the same pitch as a particular tuning fork and causing it to vibrate. This magnetic field causes the angle at which the magnetic nuclei precess around the externally applied magnetic field to depart from alignment to an arbitrary angle, depending on the strength and duration of the radiofrequency magnetic field pulse. Following such a pulse, there is a rotation of bulk magnetization due to *all* the nuclei at the precession frequency. When the radiofrequency magnetic field is switched off, the magnetized nuclei induce a signal in the adjacent receiver coils.

This single signal alone will not yield an image of the patient's anatomy in a specific plane; several signals are needed. In his April 1973 paper in *Nature,* Dr. Paul C. Lauterbur stated, "By introducing linear magnetic field gradients or spatial variations of the steady applied magnetic field in one particular direction, the nuclear precession frequency could be made to differ at different positions along the gradient direction in space. Thus, the frequency spectrum of the resulting MRI signal from an extended object becomes a *one-dimensional projection* of the object. Given the reconstruction theorem of Radon and the ability to form projections in a variety of directions by rotating the object in a fixed magnetic field gradient, or rotating the gradient, magnetic resonance image reconstruction is possible."

The induced signals which are picked up by the receiver coils have an initial size proportional to the number of magnetic nuclei involved. As the receiver coils pick up these signals, the nuclei return to their original precession state. These induced signals decay at a rate characteristic of the particular nucleus. These are the specific relaxation times, T_1 and T_2, of each nucleus.

The spin-lattice relaxation time, or T_1, involves one nucleus, converting its spin energy into thermal energy and transferring it to the molecular lattice of other atoms. This nucleus, following the radiofrequency pulse, will return to its equilibrium alignment, losing its energy in a characteristic time, T_1.

The spin-spin relaxation time, or T_2, is the time needed to transfer the spin from nuclei in a high energy state to their neighbors. In other words, two nuclei, albeit initially precessing in step with each other at an angle to the applied magnetic field by a radiofrequency pulse, can get out of phase with each other, thus cancelling the resultant external magnetic effect seen by the receiver coils. After MRI experiments, T_2 was found to be independent of T_1, and T_2 is always less than or equal to T_1.

Measurements of relaxation times at different frequencies and temperatures convey information about the fundamental biophysics of tissue nuclei. The ultimate significance of relaxation in imaging may be that it is a reliable indicator of the molecular environment of hydrogen in cells and tissues. Currently, MRI based on relaxation times versus hydrogen density have produced better defined images. Further investigation is needed to ascertain the precise clinical

relevance of T_1 and T_2 in MRI.

Thus, the three parameters of the MRI signal are the signal's intrinsic size due to the number of magnetic nuclei involved, T_1, and T_2. There exist different radiofrequency pulse excitation sequences which can extract uniquely all three parameters.

The signal's exact frequency, phase, and strength are then assessed through the Fourier Transform process. An image results due to assigning each signal a color from black to white. Strong signals, which mean a large amount of water, can be coded to appear black. Gray and white brain matter exemplify this due their high water content. Conversely, where no signal was present, white would appear, indicating little water. An illustration of this structure is bone.

MRI, while a revolutionary scanning device, still has some potential hazards. The exact effects on the human body of exposure to magnetic fields, radiofrequency pulses, and time-varying field gradients are still unknown. Further testing is needed in this area. Also, the dipole of the magnet is greater than the Earth's magnetic field up to 25 feet away in all directions. Depending on the size of the magnet and the shielding, the fringe field's radius can vary in either direction. This means that metallic objects such as scissors and carts must be cleared from the fringe field in order to prevent injury to the MRI patient and/or the technician. Also, patients who have implanted cardiac pacemakers or metal clips cannot undergo MRI due to the effect of the magnet on their operation or position, respectively. In addition, the magnetic field is capable of erasing magnetic tapes, cassettes, hard and floppy discs, and credit card strips, and can distort CRT displays and other pieces of equipment as well. Finally, the structural steelwork to accommodate the magnet's weight must be considered.

MRI technology is rapidly advancing as more study into it is done. It has been shown to be a safe scanning method producing greatly defined images. As a diagnostic tool, MRI still does not provide definite answers, but the work thus far in *in vivo* tissue typing sheds hope on one day being able to identify the specific type of lesion, tumor, or cell mass present in a particular patient.

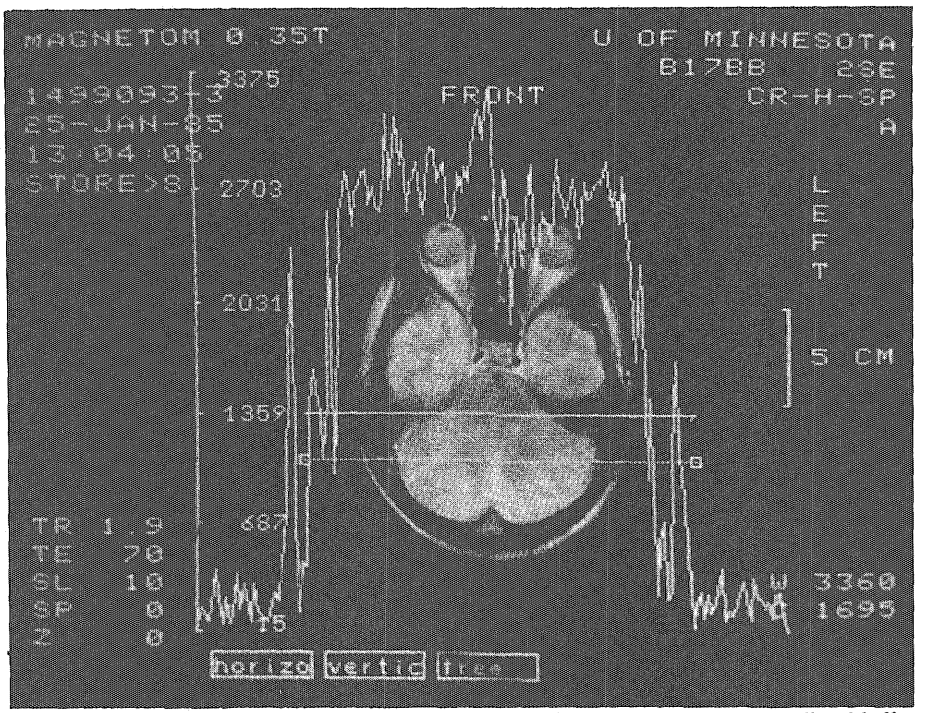
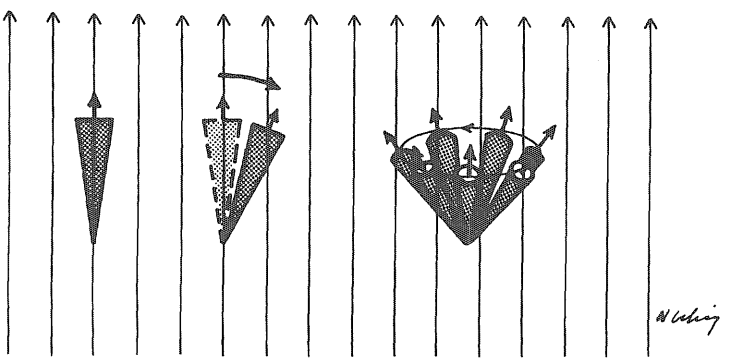
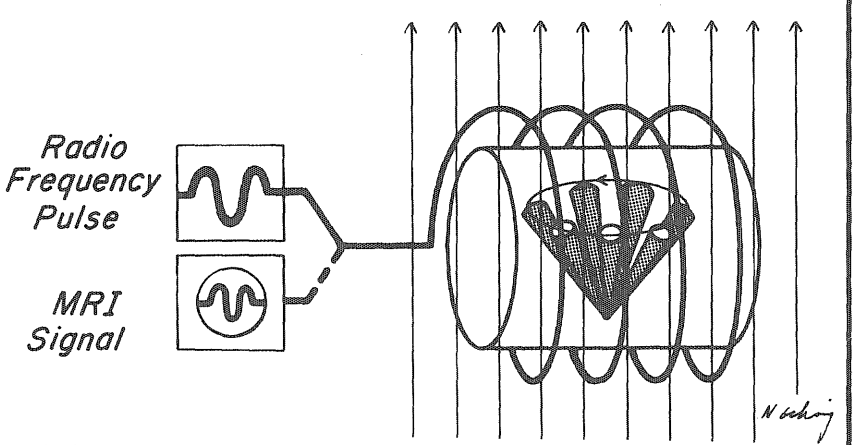


Photo by Mike Moffa

MRI: At the Atomic Level



Magnetic nuclei precess about their own axis when expose to the effects of a magnetic field, represented by the vertical arrows running from bottom to top.



A radio frequency magnetic field is generated perpendicular to the applied magnetic field. The measurement of the induced MRI signal is obtained using the surrounding receiver coil.

Illustration by Nan Gehrig

Two for Comic Relief

By Renee Bergstrom

***So Long and Thanks For All the Fish*, Douglas Adams, 204 pages, hardcover, $12.95.**

Arthur Dent and Ford Prefect are back once again and Arthur (still in his bathrobe) finally returns home. Along with the old gang, the earth still exists, and several new additions have been added to Douglas Adams' bizarre list of characters. These include Wonko the Sane, an unknown Rain God and Fenchurch, who feels she's missing a vital piece of information.

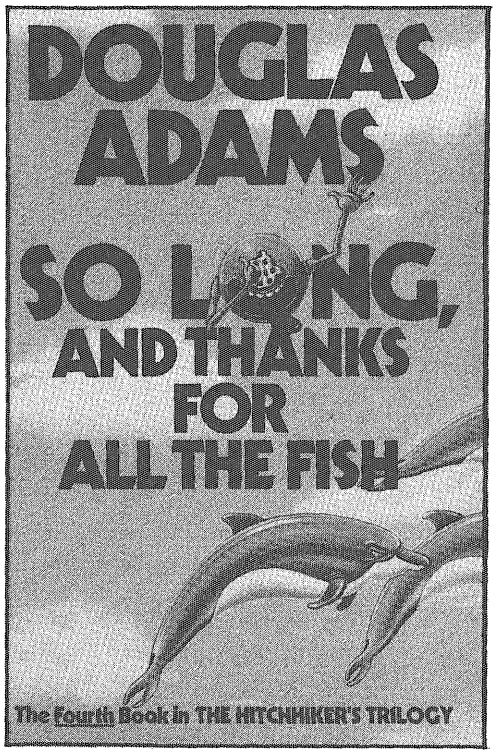
This book answers life's most important questions. What really happened the day the Earth was demolished? Why did all the dolphins disappear? What is God's Final Message to His creation? And does Arthur Dent finally get the girl?

So Long and Thanks For All the Fish, the fourth book in the Hitchhiker's series, is more serious than any of the previous books. Some of the humorous side trips the previous books took were absent, leaving the characters to fend for themselves. The characters aren't as whacky as the others have been which is disappointing. Also, Arthur Dent has turned into something other than a bumbling idiot so he is no longer the laughable character.

Another drawback the book possesses is the cover itself. The bright violet letters on the light blue background is almost offensive. Though you could find it easily on the bookshelf, it might be considered an eyesore instead.

Ignoring the problems, some genuinely funny moments are revealed to uphold Adams' humorous reputation.

"Deep in his greasy, smelly bunk, fashioned out of a maintenance hatchway, Ford Prefect slept among his towels, dreaming of old haunts.



He dreamed at one point in his slumbers of New York. In his dreams he was walking late one night along the East Side, beside the river which had become so extravagantly polluted that new life forms were now emerging from it spontaneously, demanding welfare and voting rights."

The final verdict: for Douglas Adams fans it's a definite must, but wait for the paperback. The price of the hardcover copy doesn't match what you get out of it.

***A Stress Analysis of a Strapless Evening Gown, Essays For a Scientific Age*, Robert A. Baker, Editor, 192 pages, paperback, $5.95.**

Is it unscientific to laugh? Robert A. Baker doesn't think so and has collected some classic nonsensical essays into *A Stress Analysis of a Strapless Evening Gown*. These essays include "Body Ritual Among the Nacirema," "A Psychoanalysis of U.S. Missile Failures," and "The Lab Coat As a Status Symbol."

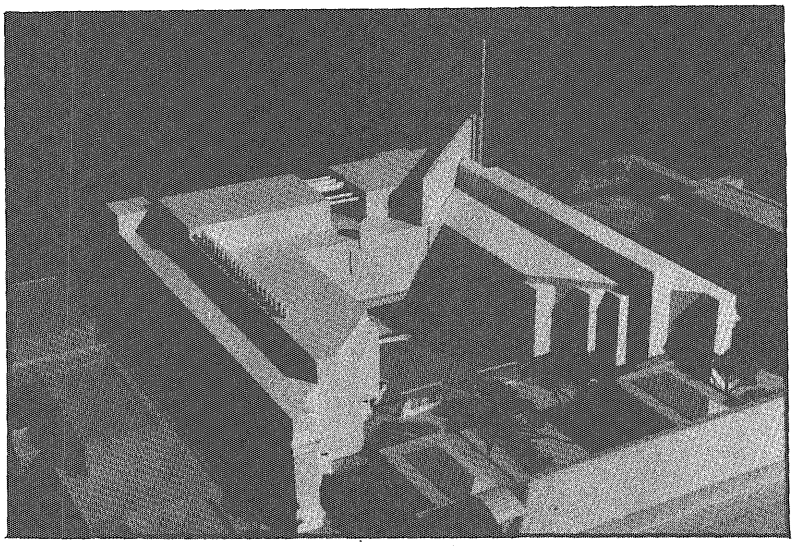
The essays are somewhat dated and a few are dry, but for the most part, they make humorous and interesting reading.

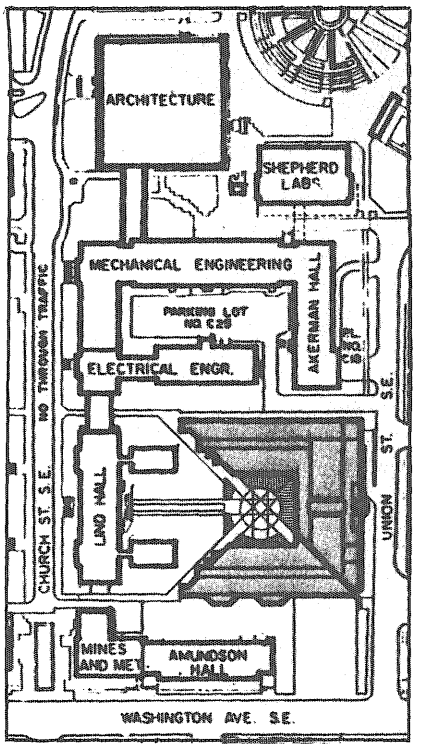
For example, "Body Ritual Among the Nacirema" is a study in cultural ethnocentrism. The essay points out how cultural bias creeps into the study of different cultures. The problem in the past has not been the observations, but from what perspective the observations are seen. The fault lies in defining another culture in terms of your own. The essay succeeds in pointing out the problem of accurate observations in cultural anthropology and simultaneously pokes fun at our culture.

There is some chauvinism displayed in a few of the essays expressing the sentiment that wives are the root of all evil. But women scientists are at least acknowledged as existing somewhere in the book.

If you like to read what scientists think when they let their hair down, the book is funny, makes satirical comments on certain situations, and is enjoyable reading that allows you to pick and choose what and when you read. For something you might pick up once in a while, *A Stress Analysis of a Strapless Evening Gown* is an enjoyable alternative to novels.

The EE/CSci Building: A Preview





In the spring, the ground will be broken for an I.T. centerpiece. Down will go Ol'Experimental and the weatherbeaten temporaries, and up will go the new home for the Electrical Engineering and Computer Science Departments.

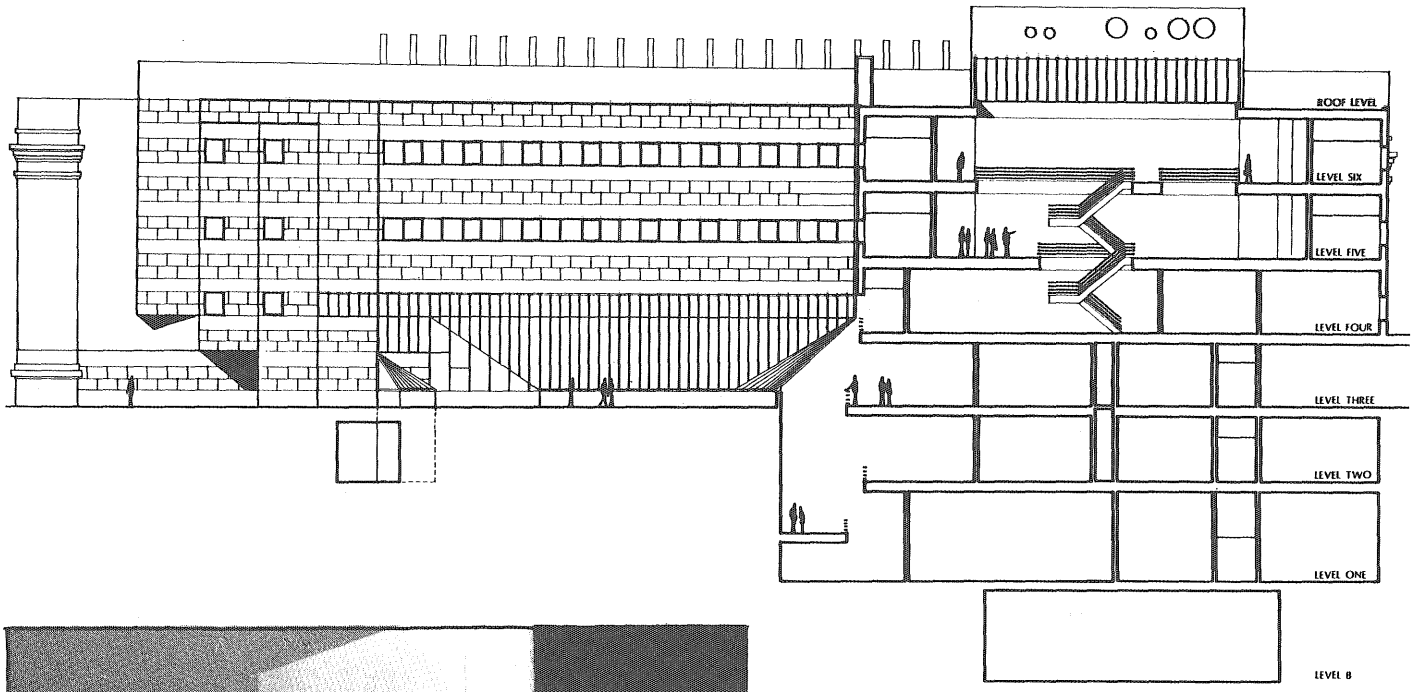
By Jon Soland

The Numbers:

Cost	**$48,000,000**
Gross sq. ft.	**330,000**
Assignable sq. ft.	**180,000**
# of rooms	**429**

We have the background on it . . . We recognize the need . . . I think we have already made the decision in principle . . . I move that we proceed with the project at whatever funding level the Legislature approves. Such was the gist of comments made by the Regents at a meeting held on January 10, 1985. On that date they gave the go ahead for the new Electrical Engineering and Computer Science building. One thing agreed upon by everyone involved is that this building is to be the flagship of I.T., a show case for advanced technology. Meeting these objectives and the many other diverse requirements is no easy trick, but the design is well under way and in the fall of 1987 EE and CSci students should be going to class through a new set of doors.

There is no debate over the need for a new building, but everyone seems to have a different idea of what it will bring. Professor Collins, the Department Head for Electrical Engineering, is looking forward to the consolidation of the Electrical Engineering department. "We are distributed in seven buildings now. That's not effective either for education or administration." He sees a strong need to increase the interaction of the faculty. He also believes in the importance of student interaction and advocates having some area set aside for student commons space. Professor Kurt Maly, head of the Computer Science Department, sees communications as the dominant aspect. The goal is to have all of the different computers connected in a network. There will be one fairly powerful station for every two to four undergraduate students and at least one work station in each of the teaching assistant and research assistant's offices. The proposed networking scheme would allow anyone at a given station to communicate with any other station. In the future Professor Maly would like to have a few classrooms outfitted with a terminal at each desk. This would allow an instructor to call up material for the students to work on. Now that's interactive computing! I.T. Dean Ettore Infante sees the new building's impact as state wide, and hopes it will be the site of major technical conferences and seminars. There is a large concentration of the country's technical community here in Minnesota. Dean Infante wants to provide a place for interaction between the University and industry. He believes that this relationship must be a synergistic one with each part



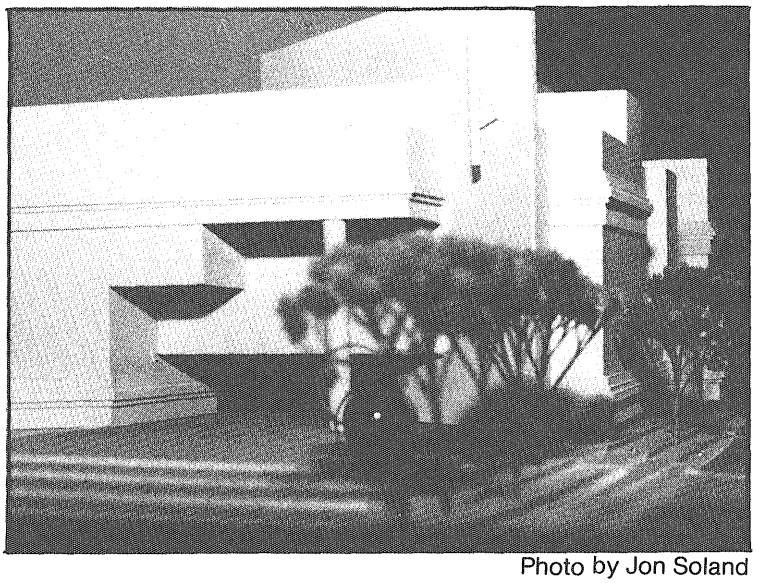


Photo by Jon Soland

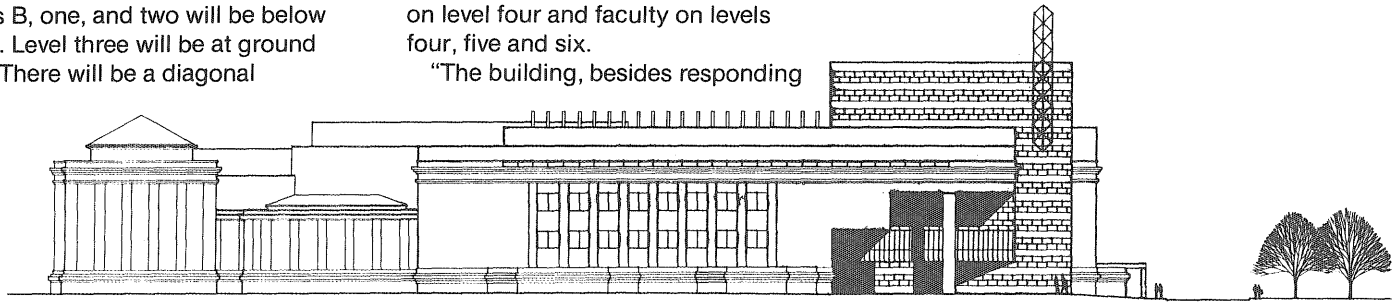
The Dates:

1-10-85	**Regents approval**
4-15-85	**Legislature sets funding**
8-02-85	**Demolition complete**
3-24-86	**Prime Construction begins**
9-21-87	**Ready For Occupancy!**

helping the other. This building will be a focus not only for I.T., but for the entire community.

The new building will be placed where Experimental Engineering and the two temporaries now stand. It will be very large, some 330,000 gross square feet (if funded at $48 million, funding could be set at $40 million). For comparison, Coffman Union has approximately 348,000 gross square feet. There will be six levels plus a mechanical/service subbasement. Levels B, one, and two will be below grade. Level three will be at ground level. There will be a diagonal walkway right through the ground floor centering the building between Health Sciences and the rest of I.T. Along this diagonal, and surrounded by the U shaped building, will be the "I.T. Rotunda," a central meeting space for all of I.T. Students commons space will surround the rotunda on levels two and three. Classrooms and study halls will be at ground level, with two libraries up one floor. Teaching assistant offices will mainly be on level two, administration on level four and faculty on levels four, five and six.

"The building, besides responding to its programmatic needs, must be a pleasant place to work, learn, socialize and interchange ideas with others. Both faculty and students will spend many hours in the building. It will therefore be warm, comfortable, attractive and special. All student commons and lounge spaces have abundant day light, are designed for informal small groupings and have visual excitement." (Excerpt from the architects design narrative.)

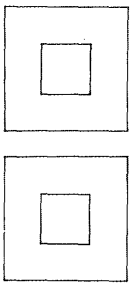


Minnesota TECHNOLOG

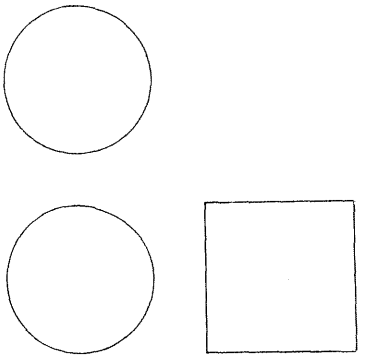
Mind Benders and Brain Teasers

In the past, the correct solutions to the problems presented here could earn you a free T-Shirt. Unfortunately, our supply of shirts has become depleted, so the satisfaction of completion is the only reward we can offer.

1 Draw the right-side view.

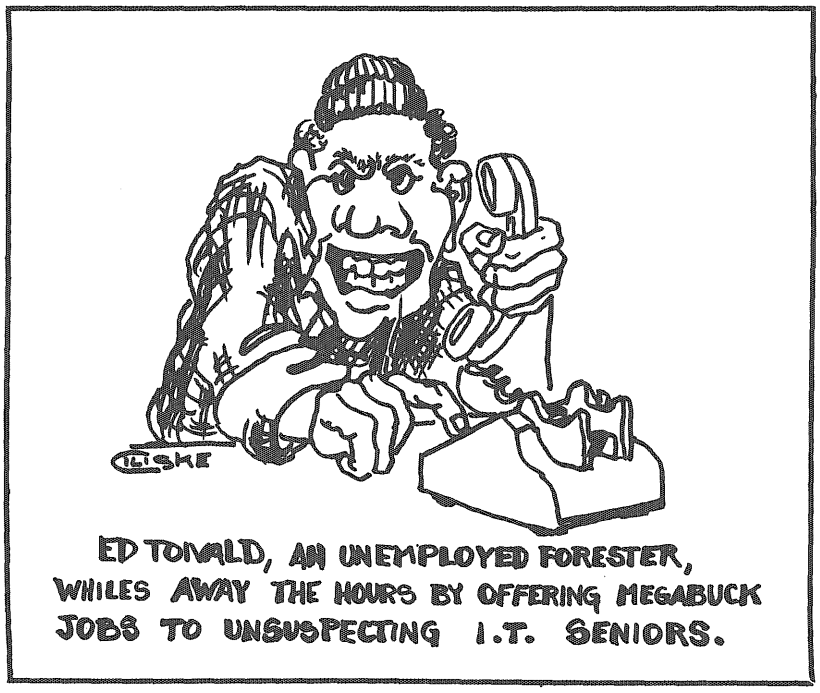


2 Describe or draw in 3-D space.



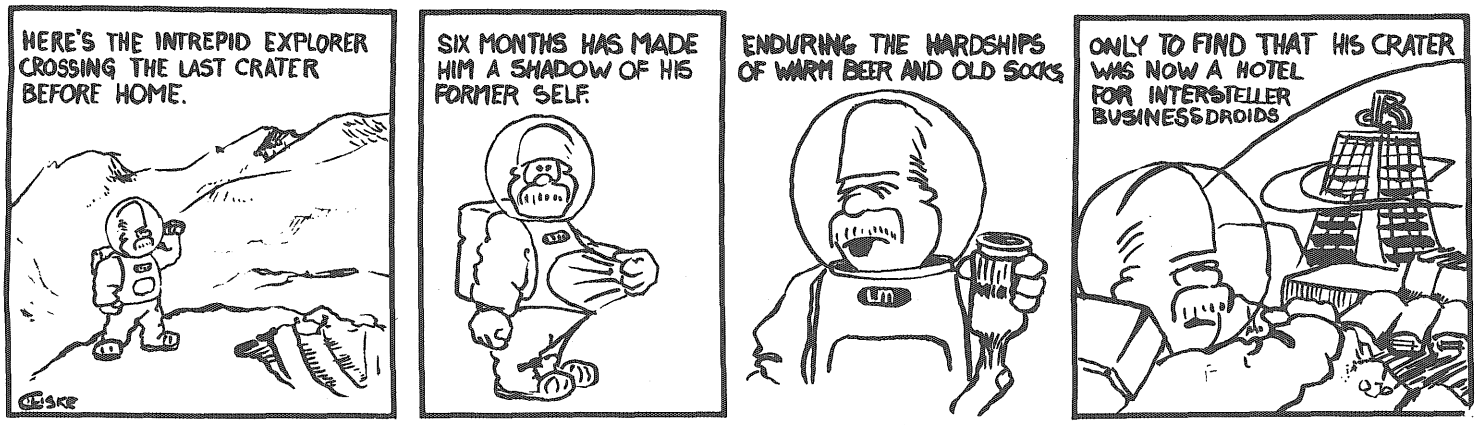
Möbius Strip Kit

(1) Cut
(2) Twist
(3) Tape



BEBOX

By Scott Cilliske



Old Thoughts for New Thoughts

I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.

Issac Newton

technotrivia

By John Krumm

Questions

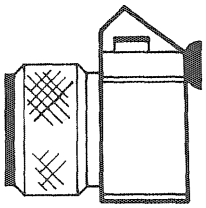
1) After trying many substances, including straw, silk, hair, and cork, what filament did Edison use for his first successful incandescent lamp?
2) Which famous scientist turned down the opportunity to serve as president of Israel?
3) Is reading from left to right innately any more efficient for human beings than some other scheme?
4) Temperature effects the timekeeping ability of pendulum clocks. Do they gain or lose time in hot weather.
5) Lightning strikes the Earth about 100 times every second and kills about 150 people in the U.S. each year. How wide is the average bolt of lightning?
6) Outside of their homes and workplaces, where do Americans spend most of their time?
7) This is for you fashionable people who do not wear hats outside on cold days. What percentage of your body heat escapes through your head?
8) True or false: Except for the numbers one, two, and three, any prime number can be evenly divisible by six if you either increase it or decrease it by one.
9) True or False: If you saw your leg off with a sterile hacksaw, it will grow back in a matter of hours. (WARNING: Do not try this until you read the answer).
10) What physical process explains the old wives tale that hot water in an ice cube tray will freeze faster than cold?

Answers

1). He used ordinary cotton thread in a lamp which burned out after 40 hours. After this success, Edison decided on bamboo filaments for mass production.
2) Albert Einstein was Israel's first choice for president after it was reestablished as an independent nation. He declined, of course, saying that he should continue to study the physical world, of which he described himself as "having a little comprehension."
3) No, not really. It just depends on what you are used to.
4) They lose time because as the pendulum arm lengthens in the hot environment, the period of the pendulum gets longer.
5) The average bolt of lightning is about four inches wide. Take credit for two to six inches.
6) Oh, like wow man, in shopping malls. (Gag me).
7) Eighty percent. Take credit for 70 to 90 percent. See, you should listen to what your mother told you.
8) True. Examples (13-1)/6 = 2 and (29+1)/6 = 5.
9) False. First of all, one should never use a hacksaw on anything but metal.
10) Evaporation, because of the difference in vapor pressures, the hot water evaporates more quickly, leaving less water to freeze. Ice cube trays seem to have the right proportions of liquid surface area and liquid volume to allow the oddity.

Scoring

0 - 1 Take comfort, you can only get better.
2 - 4 Have you considered professional counseling?
5 - 7 Mediocrety is the spice of life.
8 - 10 Why bother with school when you could make a fortune on **Quizorama?**



...a thousand words

Photo by Mike McGee

THE NUCLEAR NAVY. RIDE THE WAVE OF THE FUTURE.

You're deep under the sea. There are 4600 tons of nuclear-powered submarine around you. Your mission– to preserve the peace.

Your job– to coordinate a practice missile launch. Everything about the sub is state-of-the-art, including you.

The exercise– a success. You're part of that success and now you're riding high.

In the nuclear Navy, you learn quickly. Over half of America's nuclear reactors are in the Navy. And that means you get hands-on experience fast.

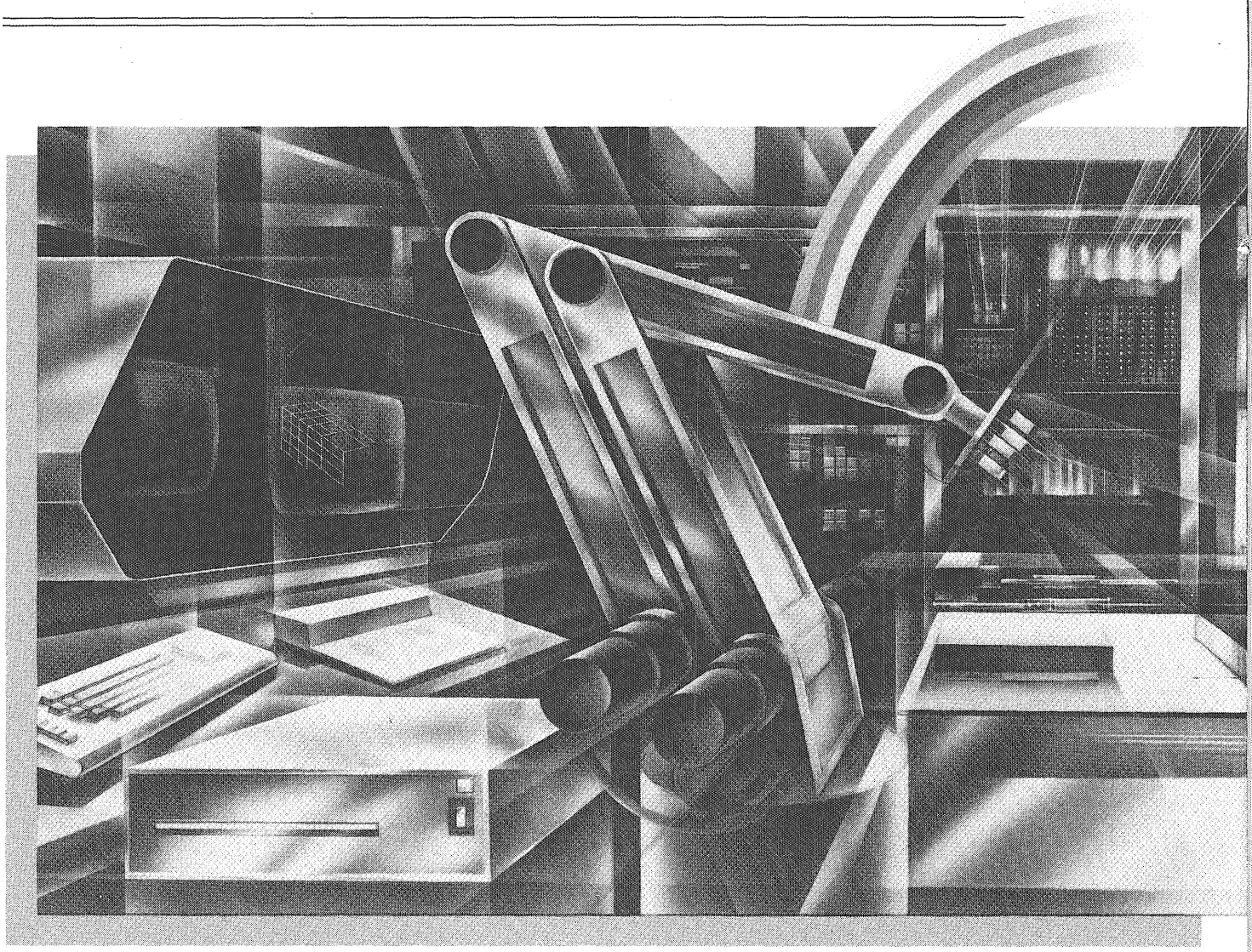
You get rewarded fast, too. With a great starting salary of $22,000 that can build to as much as $44,000 after five years. And with training and skills you'll use for a lifetime.

Then, whether you're in the Mediterranean, the Pacific or the Atlantic, wherever you move around the world, you'll be moving up in your career and in the Navy.

Find out more about an exciting future that you can start today.

See your Navy Recruiter or **CALL 800-327-NAVY.**

NAVY OFFICERS GET RESPONSIBILITY FAST.



Convert the production line into a frontier of creativity.

The cast-iron technology of the factory will soon be silicon technology.

Chips and computers transfer design information directly to the factory floor. Other chips make possible flexible robotics, programmable controllers for machine tools, automated test systems and digital inspection cameras. Local area networks tie together all these systems.

These are revolutionary changes that can result in better-made products, manufactured of new materials at lower cost.

GE is deeply involved in bringing manufacturing into the silicon age. In one plant, electronics and computer systems enable us to reduce production time of a locomotive's diesel engine frame from 16 days to 16 hours. At our dishwasher production plant, a master computer monitors a distributed system of programmable controls, robots, automated conveyors, assembly equipment and quality control stations.

We're working on robots that can see, assembly systems that hear, and machinery that can adapt to changes and perhaps even repair itself.

This transformation of manufacturing from the past to the future creates a need for new kinds of engineers to design and operate factories of the silicon age. They have to be as familiar with the realities of the assembly line as with the protocols of software communications.

They will synchronize dozens of real-time systems whose slightest move affects the performance of every other system. The frontiers of manufacturing technology have been thrust outward. Old ideas have been questioned, new ones probed. Some ideas are now on production lines. Others are still flickers of light in an imagination.

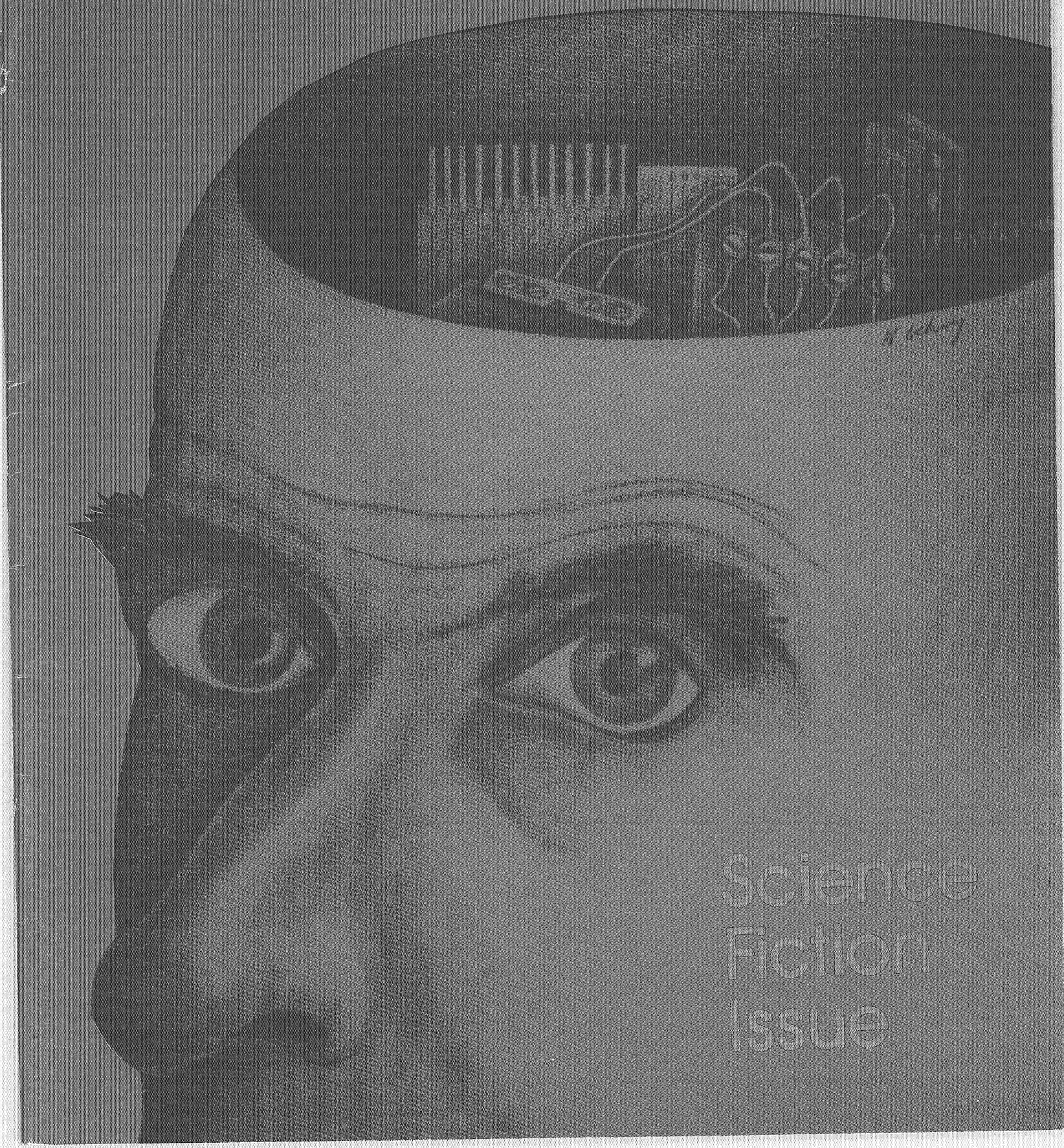
All offer opportunities for you to seek, to grow, and to accomplish.

If you can dream it, you can do it.

minnesota

TECHNOLOG

Spring One, 1985

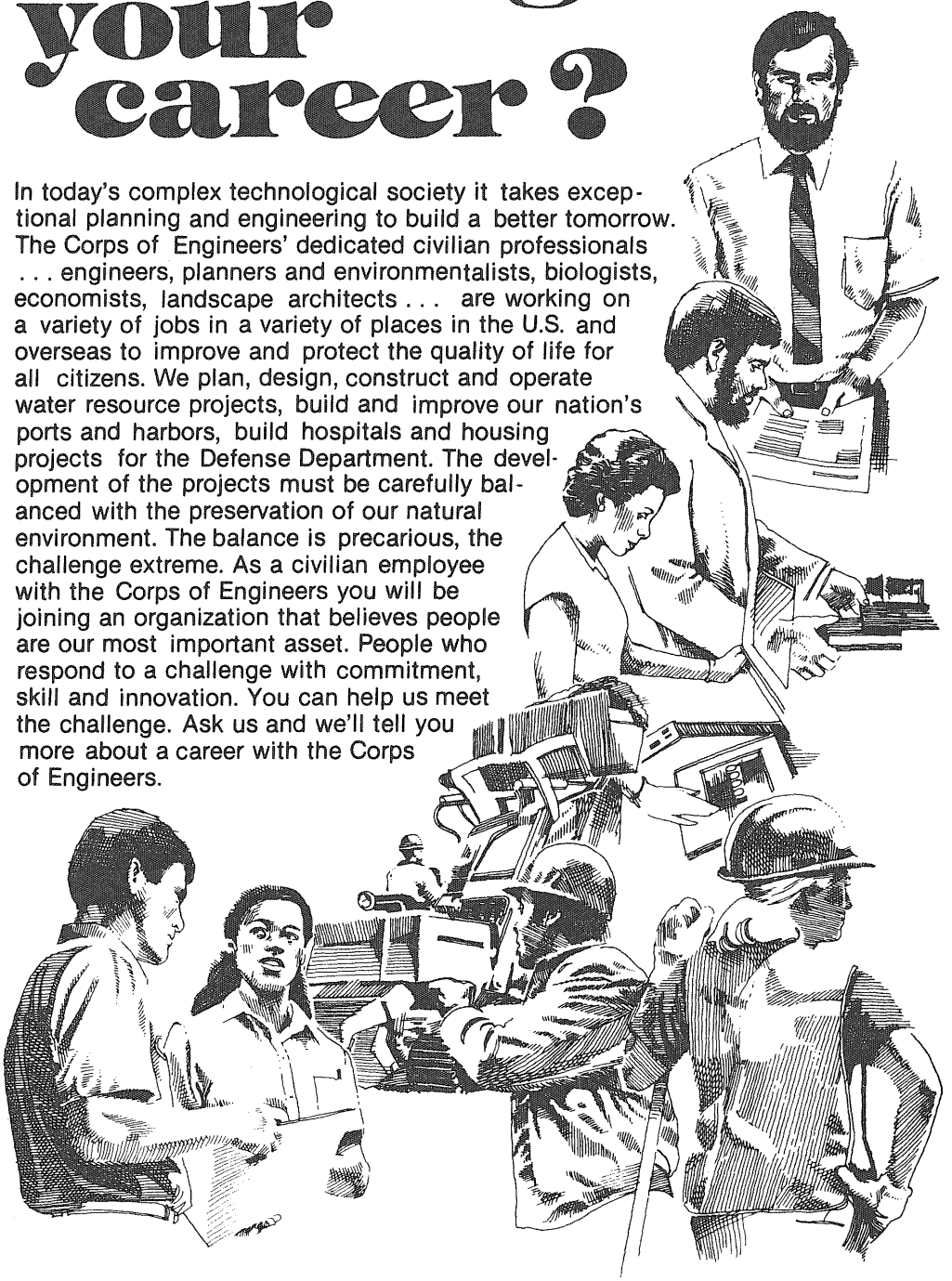


Science Fiction Issue

US Army Corps
of Engineers

Building your career?

In today's complex technological society it takes exceptional planning and engineering to build a better tomorrow. The Corps of Engineers' dedicated civilian professionals . . . engineers, planners and environmentalists, biologists, economists, landscape architects . . . are working on a variety of jobs in a variety of places in the U.S. and overseas to improve and protect the quality of life for all citizens. We plan, design, construct and operate water resource projects, build and improve our nation's ports and harbors, build hospitals and housing projects for the Defense Department. The development of the projects must be carefully balanced with the preservation of our natural environment. The balance is precarious, the challenge extreme. As a civilian employee with the Corps of Engineers you will be joining an organization that believes people are our most important asset. People who respond to a challenge with commitment, skill and innovation. You can help us meet the challenge. Ask us and we'll tell you more about a career with the Corps of Engineers.



Office of Personnel Army Corps of Engineers Washington, DC 20314

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Departments:

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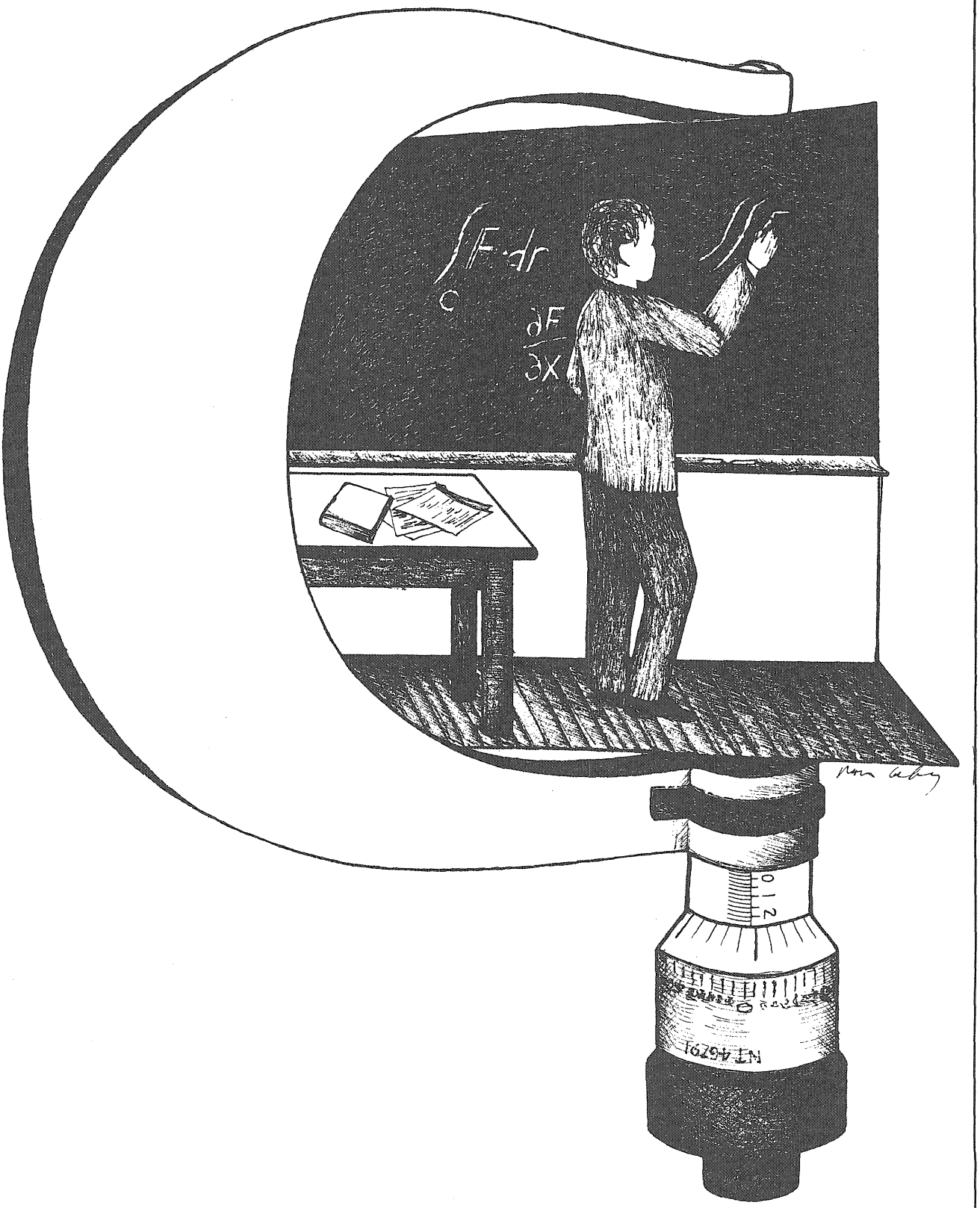


Illustration by Nan Gehrig

editor's log

On Tolerance and Teaching

"Tolerant" is how one I.T. professor recently described students. The context of the professor's words came out of a discussion on the quality of teaching at the Institute of Technology. He recognized, as most students do, that there is a great variance in the teaching abilities of this institution's professors and that students seem to tolerate whatever they get.

On the whole, the quality of the professors in I.T. is very good. What concerns me are two factors in the mechanism to reach even higher quality levels in the undergraduate classroom. First, a professor's abilities to teach are based primarily on periodic checks through sketchy student surveys. Second, if a professor does have poor classroom skills, the solution appears to pass him/her over for tenured positions (unless he/she possesses outstanding research skills).

The surveys which students fill out to evaluate their professors should be evaluated themselves. Students typically spend only the few minutes before the final lecture to crank out their instantaneous responses to the standard questions. The blame for this quick-and-dirty attitude can not be entirely placed on the student. The combination of the pressure from approaching finals, the vagueness of the questions, the standardization of the responses, and the lack of real value some professors attach to the whole process creates an environment where deep reflections and honest suggestions are difficult to write down. If it is the survey's intent to gather suggestions from the students, the present process outdated and ineffective.

That last factor, the professor's attitude toward the surveys, deserves more elaboration. The small sample of professors I spoke with were all genuinely concerned about their teaching. Each one welcomed student feedback. However, at the same time most minimized the value of the student surveys (except for the student's written comments) because the results were usually predictable.

Improving the communication between the professor and the students would obviously lead to a better learning environment. There would be, however, an additional benefit. The students might begin to feel some input to the service for which they are paying. A classic psychological study come to mind on this point. A group of subjects were given a set of puzzles to solve and text to proofread in an environment of loud, random background noises. One group had to simply endure the distraction, another was provided a switch to turn the noise off. The second group was five times more productive than the first. What is surprising is that not one of the second group ever used the switch, it was the feeling of control that made the difference. This is a feeling most students do not experience.

If the surveys cannot be altered to instill a sense of useful feedback in the student's mind and the professor's mind, then alternatives should be considered.

One possible alternative could use an arrangement common in industry today, the quality circle. This is simply a group of employees who periodically meet to identify and solve production problems. Quality circles operate on the assumption that workers have valuable input to their own problems. The biggest hurdle in applying this in a college setting would be the transient nature of students in any one department.

Another alternative already utilized by some departments are peer evaluations of teachers by teachers in the same field. This is definitely a step in the right direction.

What if a poor professor is singled out by the surveys? The use of this information appears to be reserved for the tenure review boards. It would seem more effective if professors who showed poorly were encouraged to improve by attending seminars on teaching techniques. The University of Texas recognized that person "can become a college professor with little or no knowledge of how to do the job for which they are hired." In response, they developed a program of seminars for new faculty. The program received an overwhelmingly favorable response from the participating professors. While everyone stresses the importance of continued education to keep abreast of accelerating technological fields of research, no one seems interested in single, short seminar pertaining to the other portion of a professor's duty, that of teaching.

When you consider the number of students, supposedly trained in problem solving, who pass through this institution each year without any more input than an occasional survey of their suggestions, it becomes apparent that a vast resource is being untapped because of tolerance. Even worse, consider the potentially excellent professor who settles into mediocrity because of tolerance. If the undergraduate classroom is to be included in the University's and the Institute of Technology's push for quality, tolerance of anything short of excellence is one area which deserves attention.

David Herridge

David Herridge
Editor

log ledger

Undergraduate Research Opportunities Program Begins Pilot Phase

The University of Minnesota has entered the pilot phase of a program which will support undergraduate research opportunities. PROJECT re/SEARCH was modeled after similar programs at other schools, like the Undergraduate Research Opportunities Program (UROP) at MIT.

The program was designed to benefit both the students and the University. Addressing concerns about the undergraduate experience at the University, the program aims to increase the individual contact between faculty and students, to provide income for students, to expose students to the research activities of the faculty, and most importantly, to provide a *learning* opportunity, not just a working one. The University will benefit from the added help with its research efforts.

The $70,000 budget (for a period ending 6/30) will fund activity in the College of Agriculture, the College of Biological Science, the College of Liberal Arts, and the Institute of Technology. The $25,000 portion allocated for I.T. should fund approximately sixty students (depending on the costs of accepted proposals).

Students interested in entering the program should obtain a UROP directory of the professors who have expressed interest in the program. These should be available now, contact Associate Dean Russell Hobbie in 106 Lind Hall (373-7775) if you need one.

After reviewing the involved professors, the student will have to arrange a meeting with those who listed research in areas of mutual interest. If after talking, the professor agrees to supervise the student in a research effort, a UROP proposal should be written and submitted with the application. These will be reviewed by the Office of Educational Development Programs.

If funded, the student can get down to work. Each quarter, the student and the faculty member will submit a brief progress report on the research being conducted and an evaluation of the UROP experience.

The student can submit a proposal where work will be completed for either payment (up to $750) or academic credit. However, both credit and money will not be given.

This program presents an exciting an educational opportunity for undergraduate students. If you are interested, do not hesitate, the funding allocated to I.T. will be distributed on a first come, first serve basis for acceptable proposals.

Coming Soon: E Week Starting May 4

Robert Plumb, the director of Plumb Bob revealed his plans for IT WEEK, 1985. May 4-10, IT WEEK "will provide exponential opportunities for students to GET INTO the social and educational celebration of technology," Plumb said. GET INTO I.T. will be this year's theme.

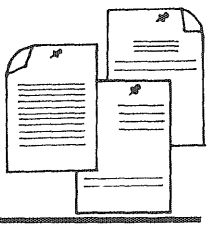
After kicking off IT WEEK on Saturday, May 4 with the Suburbs Dance, festivities continue throughout the following week. Monday, government officials kiss the Blarney Stone while students display their achievements at the Innovation Fair. Tau Beta Pi will incorporate its annual Technology and Society Assessment Program into I.T. WEEK, hosting the National Science Foundation on Tuesday. At the Technology Fair on Wednesday and Thursday, professionals will display their products on the mall and students can enjoy free movies.

Students are encouraged to prepare their teams for the I.T. Olympics on Friday. Be there or be a parallelogram whose sides meet to form 90 degree angles." Watch the Lind Hall bulletin boards for more information.

Nuclear Power Capacity Increased In 1984

The American Nuclear Society reports that 318 nuclear power plants were operating worldwide at the end of 1984, over thirty of these plants began operation in the past year. This represents 206,221 megawatts of power, an increase of 13.7 percent from 1983. These figures include the 83 units that currently operate in the U.S. (five of which began operation in 1984) with a capacity of 67,137 megawatts. Additional large increases in the operating capacity of nuclear plants will be observed in the next few years, due to the heavy ordering that occurred in the 1970's. Ordering has since decreased however, and as a result, there is a global trend for less nuclear plants in the years following. No new reactor orders were approved in 1984 in the United States, and many other countries report slowdowns in their ordering as well.

By Marty Koshiol.



The American Home, Determining Our Preferences

One American dream is to buy a home. But what are modern families looking for in their first home? Stephen Weeks, a professor in the School of Architecture, set out to find an answer to this question. Funded with a $20,000 grant from the Minneapolis/Saint Paul Housing Program, Weeks sent 650 questionnaires to residents of 60 housing projects. These projects included townhouses, condominiums, rehabilitated buildings and duplexes. He received 350 responses, an amazingly high return.

The study, called "Preferences in Dwelling Design," consisted of a two part questionnaire. The first part written, and the second part visual.

In the written portion, occupants were asked to describe what they did and did not like about their homes, including design, floor plan, location, construction quality, and energy efficiency.

In the visual portion, occupants were presented various choices of house designs and floor plans, and were asked to rate how much they liked each one.

The goal of the poll was to find out what residents liked and disliked, so that homes of the future could be better designed and built.

The results showed that residents wanted larger, more family orientated kitchens, added walls so furniture could be more easily arranged, and more energy efficient homes. They also asked that contractors be obligated to fix any defects that appeared in the structure.

In the visual portion, the majority of respondents chose a modern style, which looks up to date, yet has traditional features.

For his work, Weeks won the *Progressive Architecture* magazine's 1985 National Research award for applied research. He is the only full time architecture faculty member to ever win this award.

Stage II of the project is underway now and will concentrate solely on single family homes.

By David Kortenkamp.

Subject Search Service

The engineering library and other IT libraries offer a computerized bibliographic search service. The U has access to most commercially available databases nationwide, and for a fee can provide a large amount of information very quickly. Up to about 50 sources may be obtained within a couple of days (printed online at the U). Additional sources may take a week or two (printed by the database vendor and mailed). At $35 - $50 per search, it may not be the thing to use for short, general research papers, but for more detailed and complete information, it's worth considering. For more information, contact Carol Baldman in the engineering library at 373-2957.

By Jon Olson

SWE Conference

In June 1985, the National Student Conference for the Society of Women Engineers will be held on the University's Minneapolis campus. There will be a variety of lectures, panels, and workshops held during the conference addressing topics on communication, working for small firms vs. large corporations, sales and marketing careers, coping with stress, and working for the government. This is a wonderful opportunity to meet fellow engineering students from across the nation and to help students in the transition from student to professional life. More information is available in the SWE lounge at 230 TNCE, located behind Lind Hall, or call 376-2721.

Human Factor Engineering Examines Information Processing

Human factors engineering concerns the analysis and design of machines and work environments so they are compatible with human capabilities, limitations, and needs. The human factors engineer often uses knowledge from a number of disciplines including many engineering disciplines and the health and behavioral sciences. This is a rapidly growing field in both research and application. Human factors knowledge is being used more and more by industry to increase productivity, to provide a healthier, safer work environment, and even to promote job satisfaction.

Research in human factors is being done at the University by Dr. Tarald Kvalseth, professor of mechanical engineering. One project he is currently working on is in the area of human information processing. How well a human being perceives, retains, and uses information is hypothesized to be a function of the amount of information presented and how it is presented. The goal of this project is to quantify the amount of information a human operator is capable of processing from various informational sources such as dials, digital displays, and computer read-outs. This research may help solve problems encountered in the design of complex instrumentation panels such as those used in the nuclear power industry. Applications of human factors knowledge in this industry will help solve some of its biggest remaining safety problems, those which involve "human error."

Without continued research and application of human factors, our increasingly complex technical world will be harder to live and work in.

By Mike Pfaffinger

Undergraduates Design IE Cells

Professor Edward Barnett and Associate Professor Patrick Starr of the Department of Industrial Engineering are currently supervising several undergraduates in cellular manufacturing research. Cellular manufacturing involves the creation of specialized work stations called cells. These cells contain the equipment necessary to manufacture parts that require similar manufacturing processes.

The research is being conducted in cooperation with five area firms who have contributed a combined total of $25,000 to fund the project. The firms involved are ADC Magnetic Controls, Electric Machinery, Rosemount, The Tennant Company, and Twin City Die Casting Company. In the project, students work directly with representatives from each company to design cells which suit the needs of the individual firms. The undergraduates will also assist in implementing the cells in the various plants.

Professor Barnett hopes that the Industrial Engineering Department will develop a national reputation as a leader in cellular manufacturing research.

By Rich Feely.

NSF Grant Funds Wind Tunnel Construction

Professor Cesar Farell of the University of Minnesota's Civil and Mineral Engineering Department has obtained $400,000 from the National Science Foundation to build a general purpose recirculating wind tunnel at the St. Anthony Falls Hydrology Laboratory. Farell, a specialist in the field of fluid dynamics, and graduate students will use the tunnel to research the basic mechanisms of winds and to test wind behavior around buildings for developers.

Professor Farell started designing the wind tunnel in mid 1984. He has constructed a page-sized model of the wind tunnel atop the St. Anthony Falls Hydrology Laboratory. Construction of the full size tunnel may be completed by the summer of 1986. The test section will be 1.55 meters wide, 1.55 meters high and 20 meters long. The long test section is needed to reproduce the boundary layer on the Earth's surface at the location of the model building being tested.

By Christopher Bouta.

Quasar Questions Studied

How can a billion times the mass of the Sun reside in an object smaller than the Solar System? Professor W. A. Stein of the U. of M.'s Physics and Astronomy Department plans to use the 1.5 meter telescope, shared with the University of California on Mt. Lemmon, Arizona, to study this and other questions about quasars. Quasars are very luminous and distant objects which are poorly understood. They emit highly polarized radiation characteristic of very strong magnetic fields. The precise geometry of the radiating region and the objects' total luminosity are being researched. Stein plans "to observe light output and variability of quasars" to determine, among other things, what causes the rapid fluctuations in quasars' luminosity. Stein's research may help decide among many theories concerning the power source of quasars. This power source has been a mystery for many years because nuclear processes cannot account for the huge amount of energy produced.

By John Prairie.

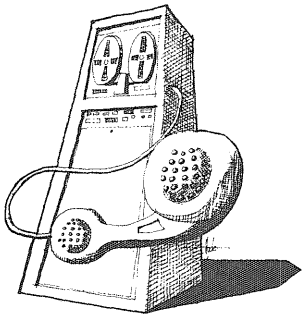
Space Shuttle Stars in Large Format Film

Coming Soon? Highlights of recent space shuttle missions have been recorded on IMAX film in "The Dream is Alive." The thirty minute show will open this summer at the Smithsonian National Air and Space Museum in Washington. It will then be released to museums and theme parks who have IMAX screens and projects. Hopefully, either the McKnight Omnitheater at the Science Museum of Minnesota or the Valley Fair screen will be included in this release. Watch for it this summer.

Paper Airplane Contest

Do you have a high-tech paper airplane design that can push out the envelope of current paper plane performance? The Seattle Museum of Flight and *Science 85* are sponsoring the Second Great International Paper Airplane Contest. Designs can be entered in four events: Time Aloft, Distance, Aerobatics, and Aesthetic Design (must fly at least 15 feet or three seconds). Engineers, professors, and graduate students must enter as *Professionals*, undergraduate students may enter as *Nonprofessionals*. All entries must be made only of paper. Glue and tape may be used for bonding purposes only (not to add weight). Paper lamination and reinforcement is allowed. Folded entries should have your name, address, phone, category, event (one per plane), and throwing instructions clearly written on them. The entries should be sent to International Paper Airplane Contest, Museum of Flight, 9404 E. Marginal Way South, Seattle, Washington 98108. All entries must be received by May 1, 1985. All entries become the property of *Science 85* and the Museum of Flight.

New Phone System to Network Computers



Hold on just a bit longer! The University is gradually throwing out it's old phone system and installing a new telecommunications system. Operations are scheduled to begin March 1, 1986 in the Health Sciences Complex, and June 1, 1986 through out the campus. The plan is to have three switching stations. One under Morill Hall to service most of the East and West Banks, one in the Health Sciences Complex and one on the St.

Continued on page 30

Minnesota Technolog Science Fiction Writing Contest

The Winners

First Place

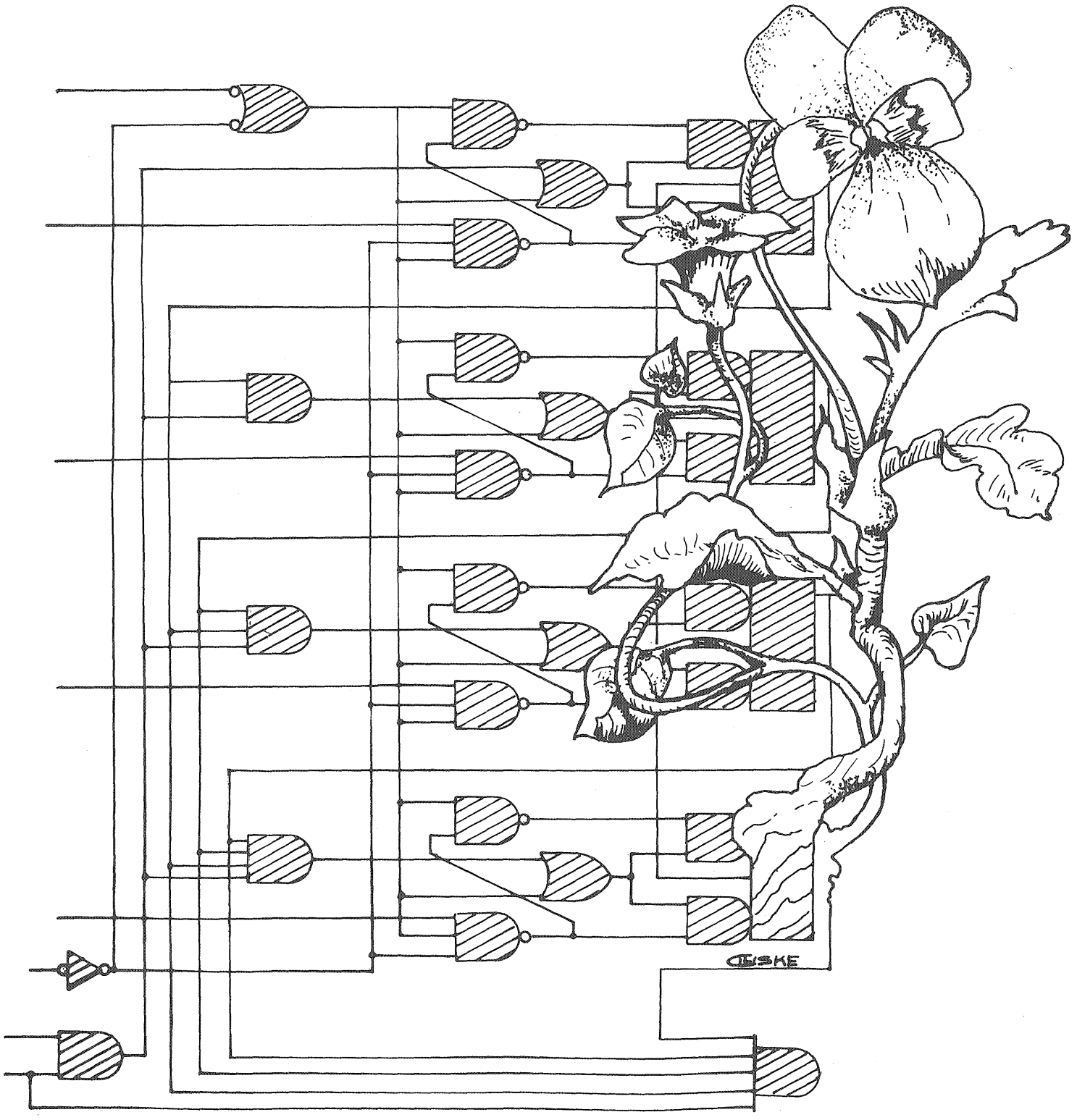
Yes, Sir By James. C. Rice II

Second Place

Life Cycle
By Randall M. Thompson

Third Place

Rainbows Are Obsolete
By Robert Hanson



Yes, Sir

First Place

By James C. Rice II

The sun seemed bright this morning as it reflected off the snow that had fallen the night before. The air was cold and the wind was blowing enough to put a slight nip in the air, but Mike didn't mind. He liked the cold mornings; they helped him wake up and get his blood circulating. However, this morning he didn't need the cold to wake him up and get him going. He was anxious to get to his desk and dig into his work.

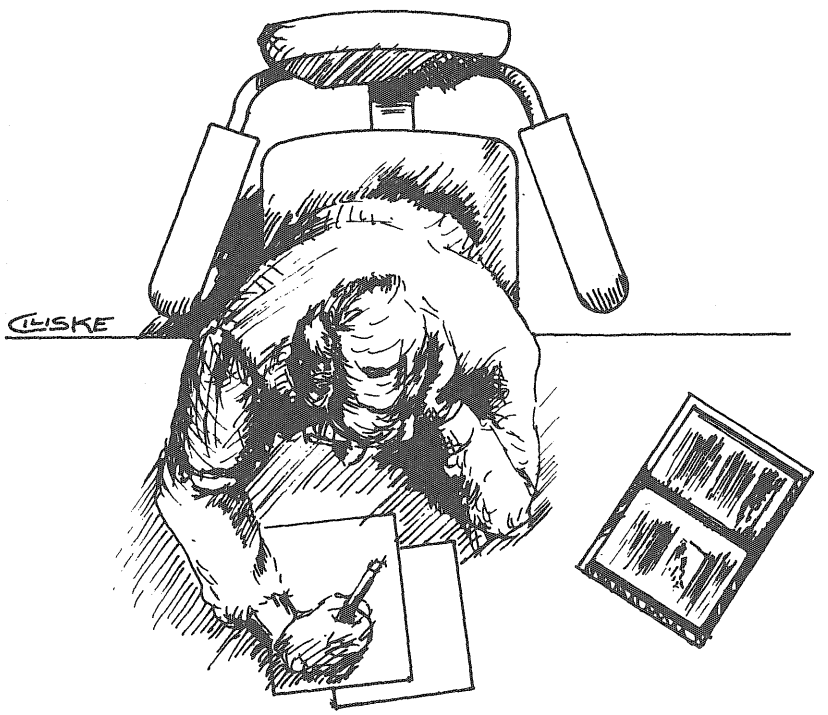
He had been hung up the last three days on a problem with some control logic in a circuit he was working on and he had started to feel like he would never get it solved. But then last night, while he was sitting and mulling over a crossword puzzle, the answer to his problem popped into his head. With just a few small changes to his design, he was certain that he could get it to work.

As Mike navigated his way through the building security to his desk, he started thinking back to his school days. One of his instructors had once told him about a time when she had designed whole computers using only pencil and paper, and then had put them together by hand to see if they really worked. He wasn't really sure if he believed her. Mike had always done his work with the aid of a computer; in fact, the computer did the lion's share of the designing for him. The only thing he really had to work on were those circuits which could not be described to his computer clearly. It was exactly this type of problem that Mike was working on now, and all he had to do was get to his terminal to see if he could get it working.

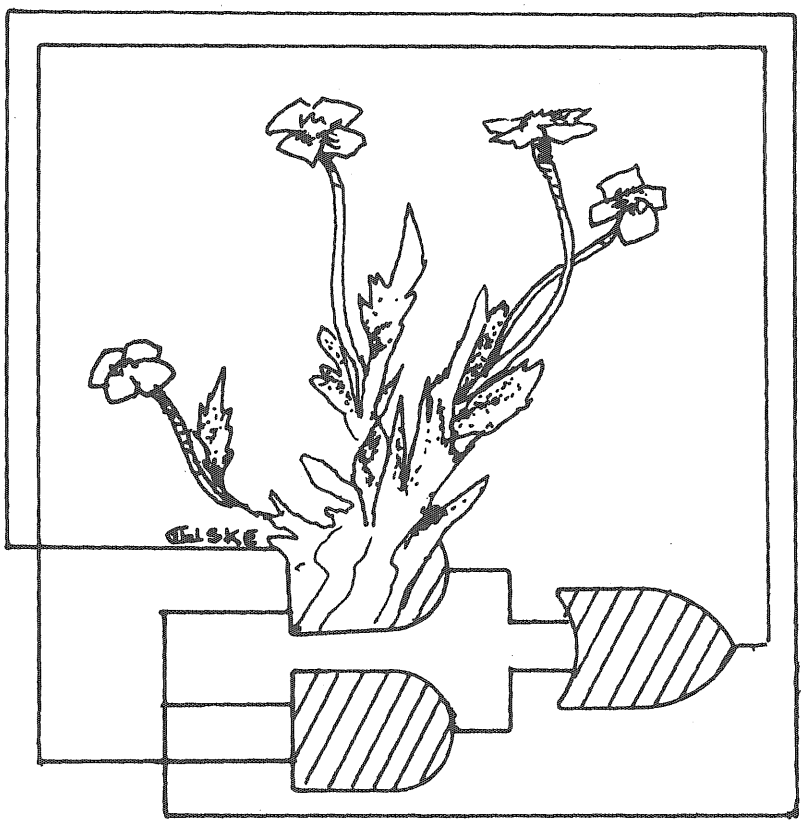
Mike's terminal was in his office and his office was a little two and a half meter square cubicle on the engineering floor. Mike had a desk, two chairs, and a small table for his terminal in his cube. The walls and the carpet were a muted gray, but a couple of posters and a plant on his desk had made it feel like home to him.

When Mike got into his cube, he tossed his jacket on the back of one of his chairs and kicked his shoes off under his desk as he pulled his chair up to his computer terminal. As he was logging onto the computer he heard a slightly scratchy voice say, "Good morning Mike, you're a little early this morning aren't you?"

Mike recognized the voice instantly, and without even turning around replied, "Good morning Sir. Yeah, I'm a little early. I think I know what's wrong with my circuit and I want to see if I can get this stupid thing to work."



Illustrations
by Scott Ciliske



"I hope you get it to work. If there's anything I can do to help, you'll let me know won't you?"

With a slight sigh, Mike turned his head and said, "Yes Sir, if there is anything you can do I'll let you know. Now will you please just sit there and be quiet a while so I can get some work done?"

Before continuing with his work, Mike sat looking at the little, oblong red box in the corner of his cube. The box was sitting on wheels and it had a speaker grid mounted on the front. The top of the box was adorned with an optical sensor which didn't quite sit square but appeared to work right so Mike didn't worry about it. This box was Sir, or, more accurately, a Sophisticated Interaction Robot. Sir had been a regular security patrol robot before he had been sent to the trash heap for suffering from old age.

Mike had come up with the idea of making a robot that he could talk to and maybe even play chess with. He had rescued Sir and put an old personal computer in him to increase his computing speed and added all the crystal lattice memory he could scrounge from old computer parts that were always being thrown out around work.

The programming of Sir had been the hard part. He had spent weeks in his spare time trying to get a program put together that would allow Sir to respond to random stimuli with actions or oral data which fit the situation, but with enough variety so as not to be entirely predictable. In other words, carry on a conversation. In fact, Mike was pretty proud of his accomplishment. Sir responded well enough to carry on an intelligent conversation. In fact, since Mike had written Sir's program so that he could retain information from a conversation and be able to use in in a later conversation, Sir had become one heck of a chess player. Mike could still beat Sir at chess about half the time, but no matter how good Mike got, Sir always seemed to keep up with him.

Anyway, after Mike was satisfied that Sir wasn't going to bother him again, he turned back to his terminal and started to pull up the schematic of his circuit so he could modify it. Then softly from the corner came, "Mike?...."

"What do you want to know Sir?" asked Mike in an irritated tone.

"I'm sorry to bother you Mike, but could I ask you a question, please? It's been bothering me all night."

At this, Mike pushed his chair back from the terminal and turned around to look at Sir. He had never even considered that the little robot might have thoughts outside those directly related to a conversation. This was really interesting. There really wasn't any reason the random memory search processes used to combine ideas for conversation shouldn't continue to function when someone wasn't talking to Sir, but Mike just hadn't thought about it. "What is it Sir?"

"Well Mike, I was wondering... well could you tell me if....?"

Mike was really starting to get curious. Sir had always responded quickly and he had never seemed uncertain of himself, although lately Mike had begun to wonder if there was something going wrong with his little robot. Sir had been getting to be a nuisance the last couple of weeks, always interrupting and asking questions that were way off the topic.

"What is it Sir? Spit it out."

"Well Mike, could you tell me? Am I alive?"

Mike sat back, slightly in shock. He had not expected anything like this from Sir.

"Of course not, Sir. You're a robot."

Sir sat still for a moment, then said quietly, "But why can't I be alive? I can move around. I can learn from my mistakes, and I can even beat you at chess. Dogs can't play chess or even talk, but they are alive."

Mike sat quietly for a moment, not really knowing what to do. He must have made a mistake in the program that allowed this to happen. He was going to have to erase Sir's memory and then try and find the bug in his program. Mike then reached over and flipped the circuit breaker on Sir's back which shut the robot off until he could work on him later.

As Mike was turning back around to get some work done, his boss walked into the cube.

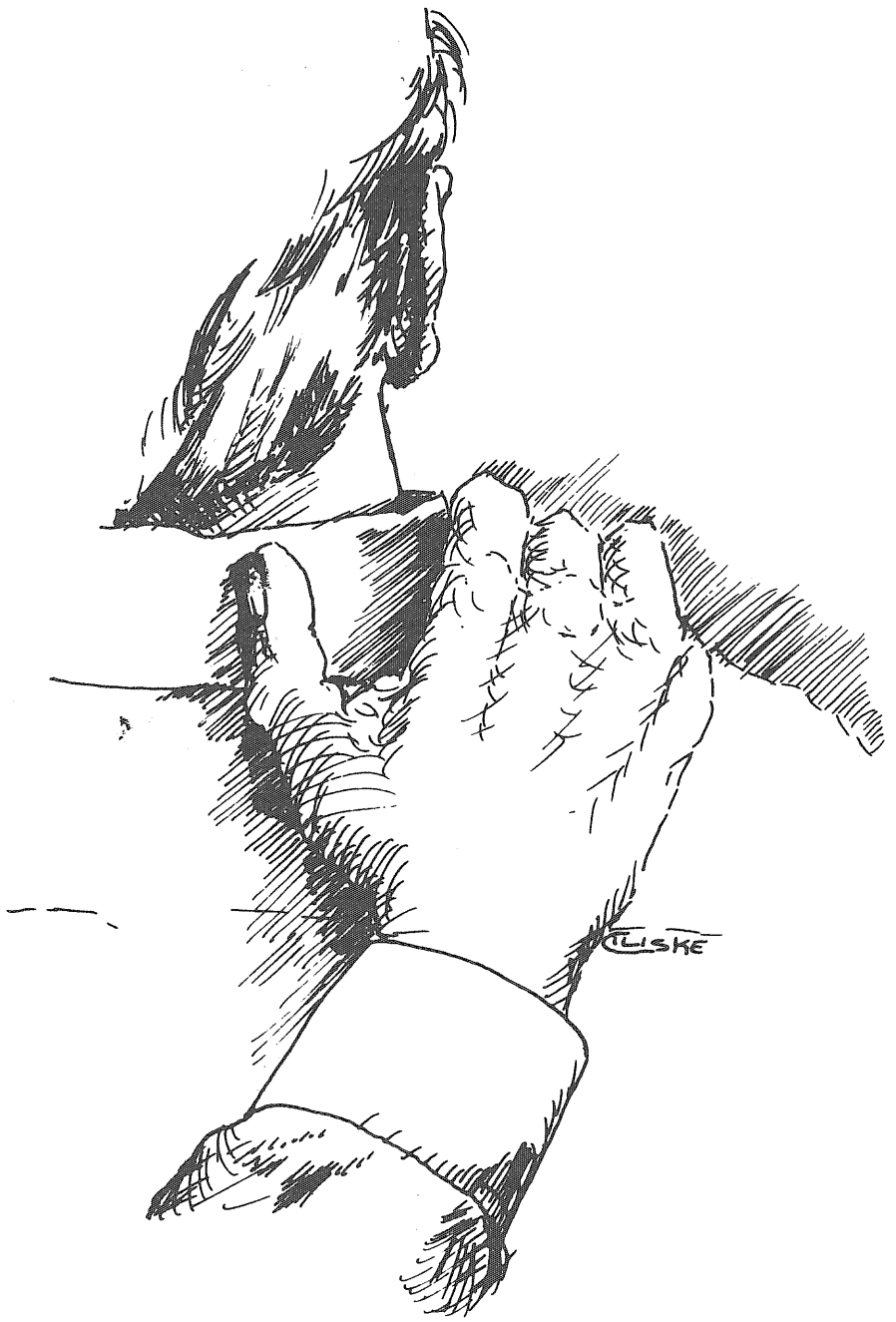
"Hi, Mike. Hi Sir. How're your mornings going?"

Mike turned around. "Hi, Adam. I'm fine but I had to turn Sir off. He was starting to ask ridiculous questions about being alive."

A sad look came over Adam's face. "You turned him off?"

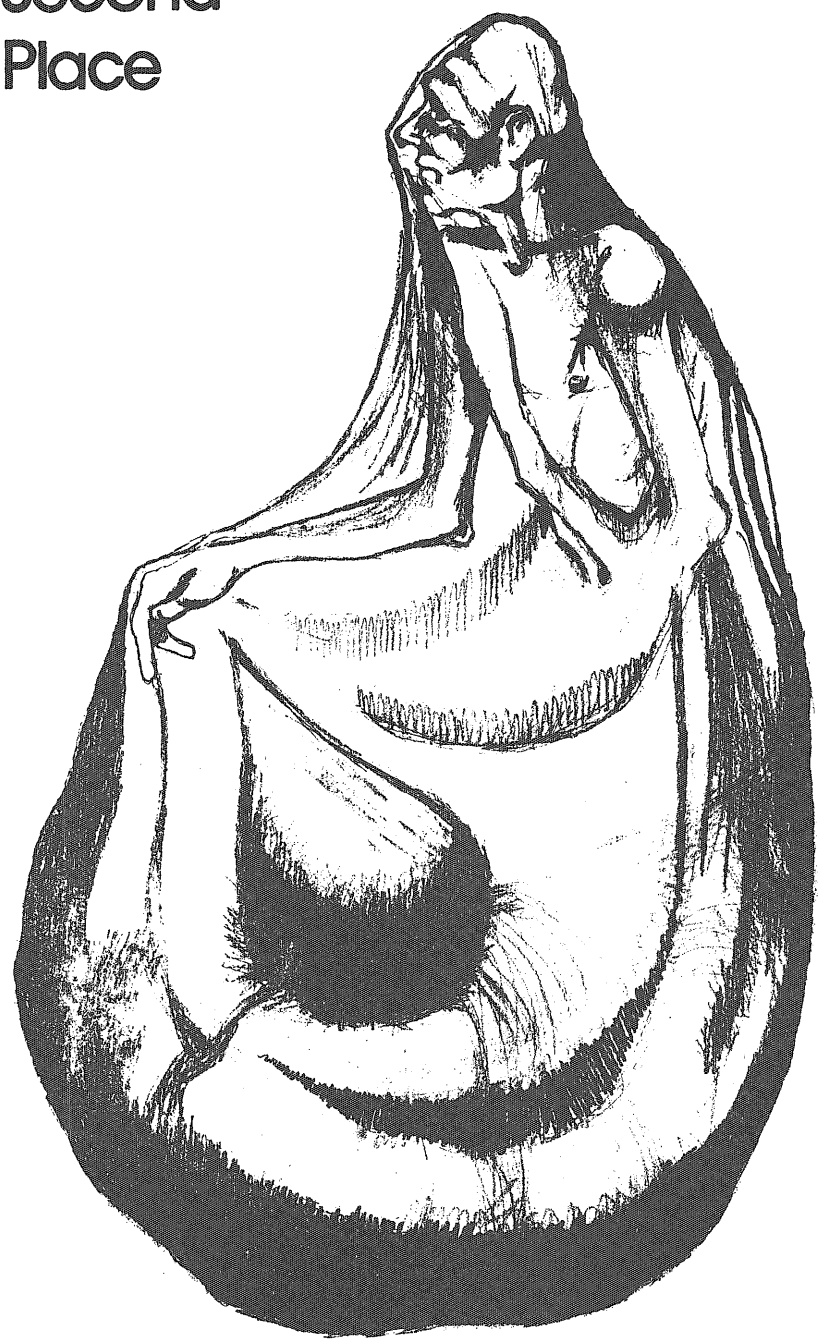
"Yeah," Mike said. "I think there must be a problem with his main program. I shut him off until I can get a chance to work on him."

"Yes, I suppose you're right. It's probably only a minor thing that will just have to get fixed." With this said, Adam's expression took on a look of resignation and he reached over and pressed the three small freckles on the side of Mike's neck. Mike slumped forward in his chair. Adam muttered to himself as he left Mike's cube. "Darn. I thought I had it right this time. I wonder if his problem is in his timing?"



Life Cycle

Second Place



Illustrations by
Helen Mittelstadt

By Randall M. Thompson

ETr 61,230,945,088 Hb was tired. He was old, tired, worn out, and he bore his share of life's scars. Yes, ETr 61,230,945,088 Hb (or just Hb for short) was old and tired. Very few of Hb's kind surpassed him in age; a fact of which he was painfully aware. He now bore each cycle's load with far more reluctance than he used to.

Yet in spite of being so old and worn out, Hb continued on, cycle after cycle. He had to, there was no choice for him in the matter. The only escape from his duties would be through death, and although he seldom thought about it, he wanted more than anything to elude death. So he continued on, cycle after cycle.

Cycle after cycle. The cycles were the only thing that mattered to any of them.

At the moment, Hb was on his 432,890,761st trip through the cycle. He was traveling at a relatively high speed down a major throughway on his way to the first (and also the smaller) of two checkpoint areas.

The checkpoints were policed by angular, deadly-looking 'phages, creatures who saw to it that unauthorized materials were taken out of transit. It was these same 'phages who with machine-like efficiency attacked, enveloped, and ultimately destroyed the dead or dying of Hb's kind.

Hb didn't like going to the checkpoints (nobody did) and he avoided them whenever possible. Hb rejoiced and found a certain kind of pride in the fact that he was able to avoid the checkpoints quite often. But luck was not with him this cycle, and he carried his load reluctantly toward the checkpoint.

Entering the checkpoint area, Hb's speed slowed drastically. As he twisted and bumped his way through the checkpoint, he imagined that he

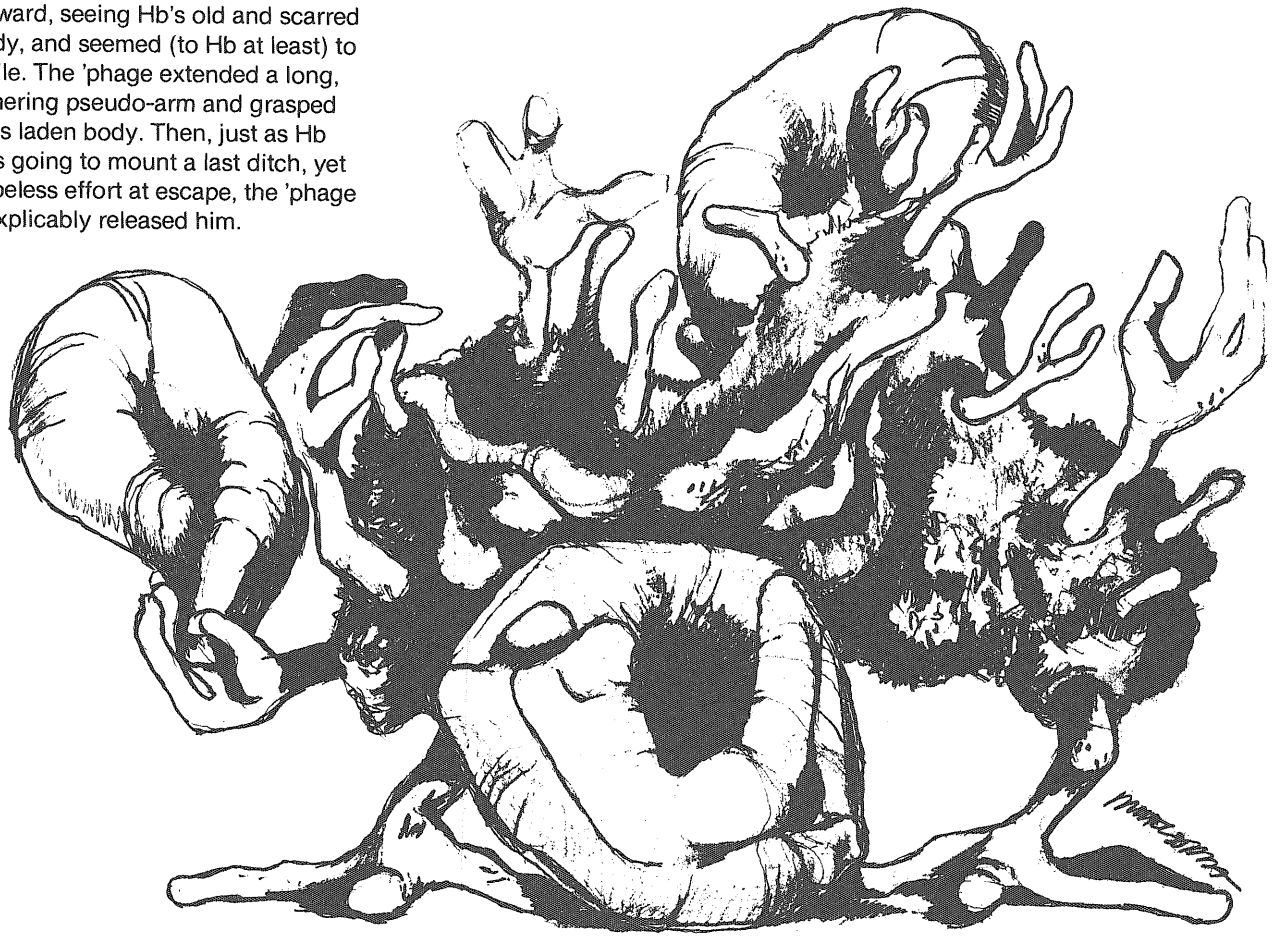
could hear the moans of the dying and smell the acrid, pungent aroma of death. He could only imagine these things, for he had no olfactory or auditory senses as we know them, using instead a mostly chemical means of sensing his environment. The more Hb thought about the deaths of his fellows, the more he became aware of his own advanced age and mortality. His anxiety grew and he struggled to be free of the checkpoint as quickly as possible. Suddenly, as if his thoughts were a portent of impending doom, Hb found himself face to face with a 'phage that was several times his own size. Hb realized with terror that the 'phage was already too close for any chance of escape. A wild panic crept over Hb's entire being. The 'phage moved forward, seeing Hb's old and scarred body, and seemed (to Hb at least) to smile. The 'phage extended a long, adhering pseudo-arm and grasped Hb's laden body. Then, just as Hb was going to mount a last ditch, yet hopeless effort at escape, the 'phage inexplicably released him.

Exulting in his new-found lease on life, but at the same time knowing that the next encounter would be the last, Hb made his way out of the checkpoint.

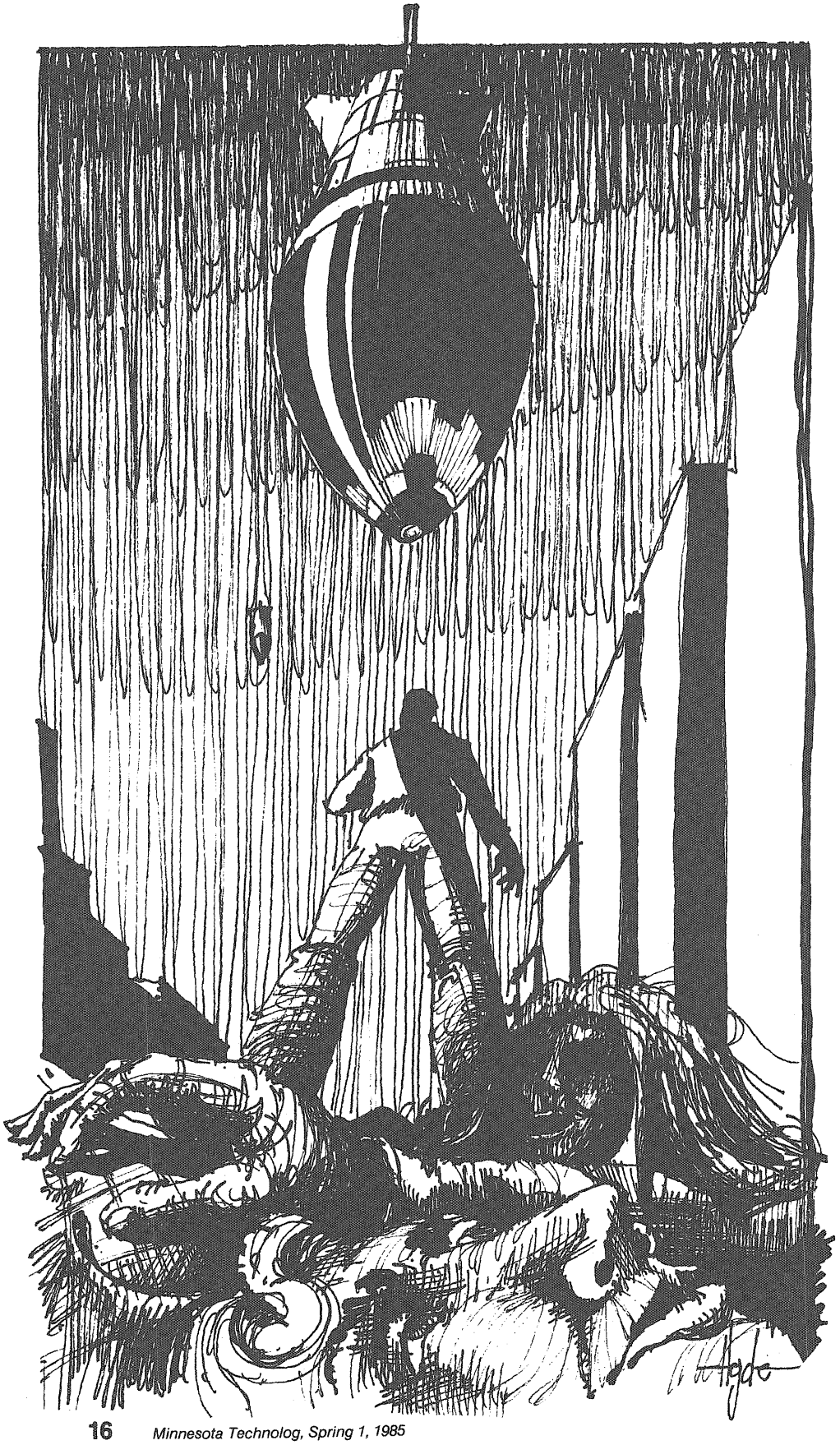
A short time later, Hb unloaded at an area near the checkpoint, and reloaded local waste that was to be taken back to the resupply sector, where it would be disposed of so that Hb could receive a fresh load. Shifting his burden for easier transport, Hb began the return trip. Gaining speed as he entered more highly traveled pathways, Hb couldn't escape the feeling that he was about to die. His fear of the 'phages was now foremost in his mind. As he neared the second and by far the more dangerous checkpoint, Hb became convinced thoroughly that his time had come. He also became convinced that there must be, *had* to be a way to escape the 'phages. Hb knew there was a way, but he didn't know what it was.

He anxiously passed the second checkpoint without entering, but he knew that very soon indeed he would join the millions of his brethren who had traveled their last cycle.

And then, eighty-seven short cycles later, Hb finally found a way to escape the dread 'phages as he and approximately three hundred thousand other red blood cells bled out of a scrape on the back of Ben Wilson's hand and dried in the autumn sun.



Rainbows Are Obsolete



Third Place

By Robert Hanson

The scream in the hall woke me up. In California, that was how I usually woke. But as I lay in bed, my head buried under the pillow to drown the noise, trying to stay asleep, the screams and sobbing continued. The voices, much louder than they should be, shocked me. It sounded like everyone from the building was banging on the wall outside my apartment. That figured; it takes a lot to wake a night janitor who sleeps during the day.

There was an incredible amount of noise from the road too; horns, screeching cars, terrorized people screaming and yelling. A riot. The smell of smoke. And sirens. Then the sound of the civil defense sirens penetrated my lethargy, and I bolted wide awake. The first thought in my mind was that it was the Great Earthquake; there was certainly enough noise to justify it. But as I stood up and threw on yesterday's clothes, I realized that there was no swaying motion, no vertigo normally associated with the tremors I lived in fear of. That could mean only two things: a hurricane or nuclear war. And there were no tropical storms in the Pacific this time of year.

I cautiously opened the door to my apartment, and looked out. Although it was daylight outside, the hall was pitch black—the power must have been cut. A woman lay in the hall, quietly sobbing; probably her scream woke me up. I listened to her for a moment, but when I heard footsteps at the other end of the hall I went back in my room, deciding that I would be safer there. I tried the TV, but it didn't work. The panic that had begun somewhere in the pit of my stomach began to ooze out through my pores. Come on, dummy, there is no power in the hall, so why should it

Illustrations by David Hyde

work? Try the radio. I had a transistor radio, which I saved for emergencies, and this sure sounded like an emergency. I dug around in my closet, frantically shoving magazines and a dusty old Bible until I found it. I grabbed the radio, and clicked it on. There was only static. I tried to find a station, and finally got one.

"... And do not attempt to leave your homes. Traffic is stopped on virtually every road. Stay indoors, and lock your door. In a few minutes, the President will be on with some important messages. If you have a medical emergency, do not attempt to drive. Call your hospital. I repeat, call only. Do not attempt to drive, as all roads are blocked."

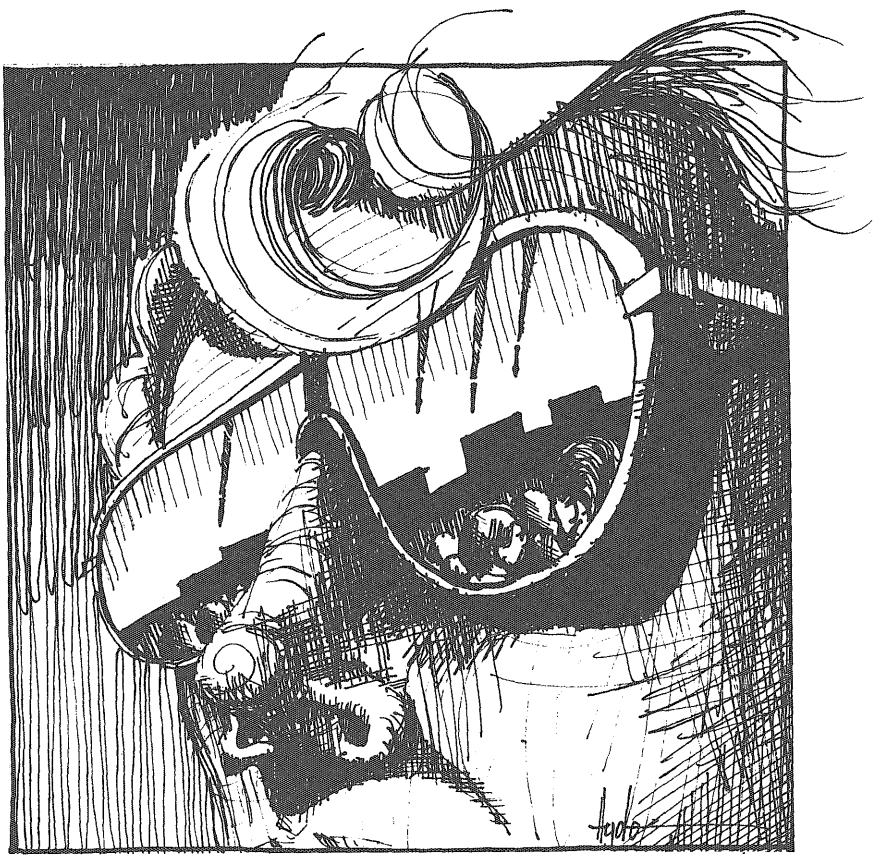
"To repeat, nuclear missiles have been launched, and a large number will strike the U.S. Probable targets include Washington, California,..."

The radio dropped out of my hand and continued to babble on the floor. I could feel the blood drain out of me, and along with it the fear, the strength, and the will to live. The war they said could never happen. We gave them power to destroy all of mankind and someone decided to do it. Say goodbye to all the people. As the shock set it, I forgot the screams, the shock set in, I forgot the screams, the fears of those outside. My world—onto my bed. I began looking at all the things in my room. Pictures of people, my mother. The pink elephant I won at a state fair. The goldfish swimming in its bowl. Damn! What did the goldfish ever do to deserve being fried? Or the pink elephant...

I was just barely aware of the loud crash, the splintering noise as my door was burst open. Nor did I see the man until he pulled me off of the bed with one arm while he shoved the other near my face. I think he had a gun in his hand, but I'm not sure. I just didn't care.

"Get out of here," he yelled at me, "or I will kill you right here!" He had a crazed look in his eye. He heaved me off the bed, and kicked me as I collapsed on the floor. He forgot me, being so involved with finding whatever he was looking for. As he began tearing my room apart, I crawled away, my side aching where he booted me. I don't know what he wanted; anything he would have taken would just be vaporized. But I think he wasn't acting strange; he just wanted to pretend it wasn't happening.

I managed to stand up, stagger down the stairs, and found enough will to get outside. The air-raid sirens were much louder outside, but I could barely hear them over the people. I can't guess what I was doing outside; maybe it was a morbid desire to know what death is like that lured me out to watch the bomb fall. Or maybe it was that it didn't matter, and so what was the difference where I was? The mass of people on the street were crawling and pushing over one another in a mad desire to go someplace, to get away. The screams and crushed bodies I ignored, as I was too numb to feel. It wouldn't matter anyway; soon we all would be dead. I had barely enough will to stand out of the way, as I waited for death to come.

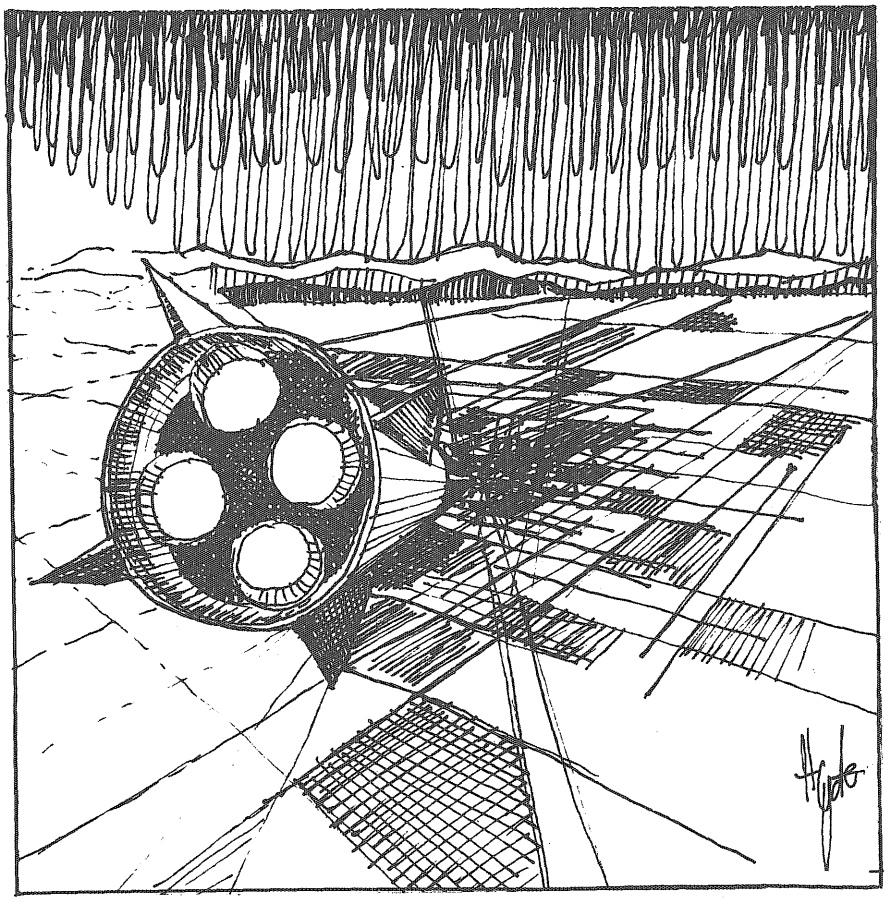


Someone shouted, "There's one!" and the crowd went quiet. It was just a speck in the sky, not seeming to move. Then it came down, very fast. My whole body winced; I knew I was dead . . .

The missile descended like a hawk, swooped to earth. And stopped. One hundred feet in the air, it froze, as if a hand reached out from the sky and stopped it. There was absolute silence as we watched the impossible. Then the Voice spoke, the Voice of Doom, the Voice of Judgment. The Voice of God. In the deepest bass, that rumbled through the ground and caused the mountains to stand at attention, He spoke five words.

"Don't EVER try that again."

It is now well after dark, but I am still standing out in the road watching the missile, suspended as every missile was, one hundred feet above the ground, suspended there forever as a warning to mankind. In the morning I will find my Bible, blow off the dust, and go to church.

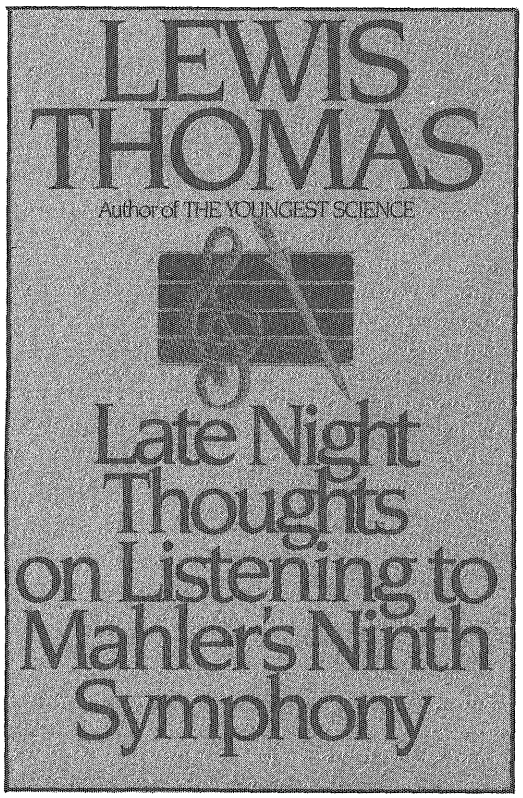


Minnesota Technolog would like to thank the following local eating and entertainment establishments for the reader survey drawing prizes they donated:

Bruegger's Bakery
Cinemaland Theaters
Pizza Hut
Edina Theater (Plitt)

Thank You

A Collection For Reflection



***Late Night Thoughts on Listening to Mahler's Ninth Symphony*, Lewis Thomas, Viking Press, 1983, hardcover, 168 pages, $12.95.**

By Renee Bergstrom

Lewis Thomas' book, *Late Night Thoughts on Listening to Mahler's Ninth Symphony*, reflects on a wide variety of topics. A collection of short essays, the book touches topics such as military planning for nuclear war, alchemy, animals, the sense of smell, artificial hearts, cardiac pace-makers, asylums, science advisors, and reflections on what it's like to be young in the nuclear age.

Although there is a wide variety of topics, the constant return to the discussion of thermonuclear war and need for funding for further scientific research are central themes to the book. Lewis Thomas writes that the military strategem is to plan for the "worse-case." However, the worst-case prepared for and the ultimate worst case are two different things. Lewis comments that nuclear war is one of those areas where worst-case planning is absurd and pointless. Along with this, the book comments on doctors and their stand in the nuclear issue. Thomas believes that doctors realize that in the event of thermonuclear war, even though they have made advances in medical science, they will have nothing to offer the people; they have nothing that will help the survivors. As for the need for funding for further scientific research, Thomas' stance is this, expansion or at least no cut-backs is the best investment, short-term or long-term, the country can make. The book's essays make further issue of this.

Even with the topic of nuclear war central to the book, there are some light-hearted essays on topics such as alchemy. Thomas writes that alchemy started the ball rolling for modern science—physics, chemistry, and biology. Another topic is animals. Thomas believes animals should be given more credit. They interpret human behavior better than humans interpret animal behavior. A specific example is Clever Hans the Horse. This horse from Germany fooled the experts by seemingly solving very complex math problems.

Thomas does have some memorable quotes such as his description of the Earth: "Seen from the right distance, from the corner of the eye of an extraterrestrial visitor, it (Earth) must surely seem a single creature, clinging to the round warm stone, turning in the sun."

On the lighter note, Thomas' discussion of smell is delightful. Thomas exclaims that we are missing much of the world by not having a developed sense of smell.

I suppose if we tried we could improve ourselves. There are, after all, some among our species with special gifts for smelling—perfume makers, tea tasters, whiskey blenders—and it is said that these people can train themselves to higher and higher skills by practicing. Perhaps, instead of spending the resources of our huge cosmetic industry on chemicals for the disguising or outright destruction of odors, we should be studying ways to enhance the smell of nature, facing up to the world.

Altogether, with much of the book on nuclear war and the need for scientific research, the book can appear quite dreary. Though the writing is not quite straight forward and appears to switch topics mid-paper, the books makes strong points. *Late Night Thoughts* will certainly give the reader "one to grow on." So if deep medication on serious topics with an occasional lighter reprieve is enjoyable to you, read *Late Night Thoughts*. Otherwise, wait for something else.

The Reflective Vision

A highly advanced design tool developed at the General Motors Research Laboratories uses computers to generate visual images from mathematical data with such accuracy that, soon, in-depth aesthetic evaluations of new concepts may be made prior to creating a costly physical model.

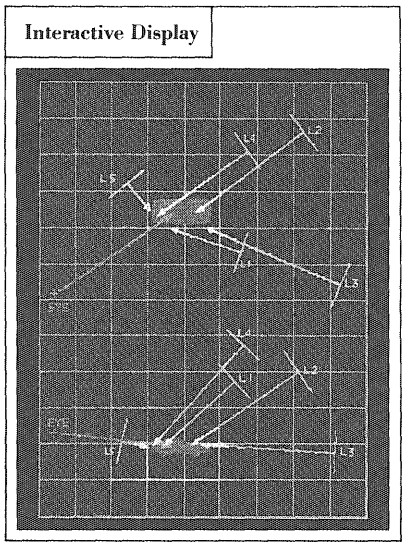


Figure 1: Computer display of plan view (upper) and side elevation (lower), indicating automobile location, lighting selections (L1-L5), and viewing position (EYE).

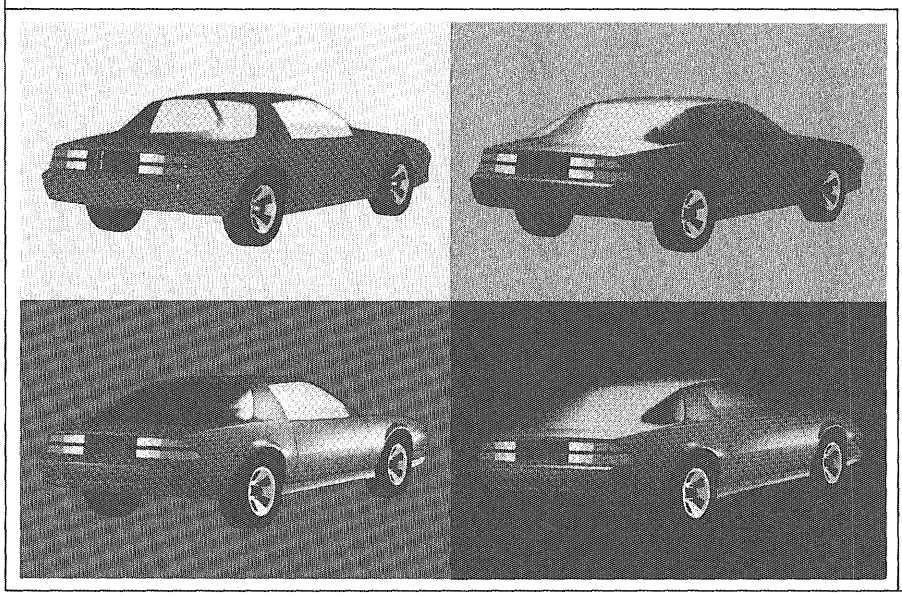


Figure 2: Four Autocolor images, showing the same view of an automobile as background and lighting change.

WITH AUTOCOLOR, users can synthesize three-dimensional, shaded images of design concepts on a color display and then quickly explore how major or minor changes affect the overall aesthetic impression. The system is completely interactive. By choosing from a menu on the screen, the designer can redefine display parameters, select a viewing orientation, or mix a color. Each part of an object can be assigned a surface type with associated color and reflectance properties. Built-in lighting controls generate realistic "highlights" on simulated surfaces composed of differing materials.

Before developing the system, David Warn, a computer scientist at the General Motors Research Laboratories, observed the complex lighting effects achieved in the studio of a professional photographer. By simulating these effects, Autocolor can produce results unattainable by conventional synthetic image display systems. Previous systems used a point source model of light, which allows adjustments only in position and brightness.

The versatility of the lighting controls constitutes a major advance in Autocolor. An unlimited number of light sources can be independently aimed at an object and the light concentration adjusted to simulate spotlight and floodlight effects. The lighting model even includes the large flaps or "barndoors" found on studio lights. These comprehensive controls permit the user to view the simulation in studio lighting conditions, as well as to make revisions in color, paint type, and materials.

With real lights, direction and concentration are produced by reflectors, lenses, and housings. It would be possible to model these components directly, but that would introduce considerable overhead to the lighting computation. Instead of modeling individual causes, Autocolor models the overall effect, reducing complexity by simulating those aspects needed to produce realistic results.

Autocolor approximates the geometric shape of an object with a mesh of three or four-sided polygons. These polygons are grouped to form parts. For a car body, there might be separate parts for the door, hood, roof, fender, and so on. Each part is assigned a surface type, such as painted metal or glass, and each type of surface has associated color and reflectance properties. The

entire data structure is stored in tables using an interactive relational data base developed at the GM Research Laboratories.

THE LIGHTING model determines the intensity of the reflected light that reaches the eye from a given point on the object. It takes into account the reflectance properties of the surface as well as the physics of light reflection. A hidden surface algorithm determines which point on the object is visible at each point on the display. For each of these visible points, the intensity is computed for each light source. The displayed intensity is the sum of the contributions from all the lights plus an ambient term which indicates the general level of illumination.

Using the point source lights of conventional image generation systems, highlighting a particular area of an object can be a difficult task and can result in unwanted highlights in other areas. By contrast, the light direction and concentration controls found in Autocolor make it possible to isolate the effect of a light to a particular area, and achieve a desired highlight easily and quickly (see Figure 2). This is not because Autocolor's lighting model computations are faster, but because its controlled "lights" behave in a more natural way.

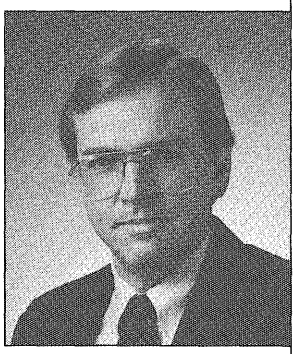
Another unique feature of Autocolor is the ability to portray realistically a variety of different materials and lighting conditions. The color seen from a surface is really a combination of two colors: the color of the surface or material itself (diffuse reflection) and the color of the reflected highlights (specular reflection). The highlight color may be the color of the material, the color of the light, or a color derived from the material and the light.

A different highlight color can be used for each different surface type that is defined. This makes it possible to simulate materials such as plastic, painted metal, and chrome—each of which has different reflectance properties and requires a different highlight color.

The user can interactively adjust the blending of the surface and highlight colors, watching the image change dynamically on the screen until a desired effect is achieved.

"Autocolor will free designers to be more creative," says researcher Warn. "Our goal is to move from controls that show changes in lighting, color, and materials, to software that will let the user change the actual shape, manipulating the image on the screen like a flexible clay model."

THE MAN BEHIND THE WORK



David Warn is a Senior Staff Research Scientist in the Computer Science Department at the General Motors Research Laboratories.

He received his undergraduate degree in mathematics from Carnegie-Mellon University, and his M.S. in computer science from Purdue.

He has done extensive research in relational data management systems with special emphasis on user interfaces and human factors. He also designed the prototype for the network data manager used in the GM Corporate Graphic System. His previous work on other aspects of computer-aided design include system design, file management, and simulation models.

His foremost research interests are in color synthetic image generation and interactive surface design. He joined General Motors in 1968.

A Solution from a Technological Alloy

Often a feasible solution to a problem will depend on many technologies, some developing and some nonexistent. Australia's Royal Flying Doctor Service is a solution with just such a history.

By Charlie Goodrich

Many of the world's greatest technological achievements were conceived by the imaginative genius of the human mind, but were only made feasible through the resources of technology. In most cases, a successful solution for the problem depended solely on the availability of the required technologies. For without one component, the solution would be incomplete.

One example of this interdependence is the Royal Flying Doctor Service of Australia. A humanitarian service forged from the the technological alloys of aviation, radio, and medicine, the RFDS continues to operate according to its founding principle: To provide care for the physical and mental needs of persons in remote and sparsely settled areas of Australia.

A seemingly impossible task, this challenge promises medical coverage over the two-million square miles of Australia's outback and was conceived in an era when care was forced to rely on the technologies of the telegraph for communications and horse and buggy for transportation.

Both proved to be inadequate for the majority of emergency cases due to reasons best summed up by an early settler, "When a man is lucky enough to get injured near a telegraph station you may call up a doctor in Adelaide, get his advice by wire, and take his medicine by imagination."

The logistical barriers in the outback required a unique and innovative solution, one which took years of dedicated work and relied on the development of modern technology.

Credit for conception, organization, and realization of the Service can be attributed mainly to one man: The Reverend Dr. John Flynn. Flynn accepted the challenge in 1903, when he began missionary work in the Northern Territory and parts of Western Australia. Confronted with the loneliness and despair that faced the people in these regions, Flynn's compassion for his fellow man motivated his pursuit to overcome these hardships. The RFDS was the result.

The Service is a very important part of Australia's history. Many early settlers of the outback stated that they simply would not have placed themselves in such a position, socially isolated and potentially medically dangerous, were it not for the security of knowing the Flying Doctors were available. Thus, the Service was a major factor in the development of the country's interior.

Flynn realized the critical factor in administering effective medical assistance was getting aid to the person in distress quickly. Given the vast distances of the inland, he recognized the need for a faster method of travel.

Clifford Peel, a young pilot in the Australian Air Corps, first suggested that medical services to the inland of Australia be airborne. Peel wrote to Flynn after learning of the plight of the RFDS and outlined the many superior qualities of aircraft in comparison to alternative means of travel.

Had Peel survived the war, he may have been the first RFDS pilot to witness his thoughts and suggestions put to use.

Implementation of aircraft took some time, however, as Flynn strived to have this concept accepted while searching for information and

SPAN: Opportunities To Study Independently Overseas

The author's research on the Royal Flying Doctor Service was conducted through participation with the SPAN organization at the University of Minnesota. SPAN - Student Projects for Amity Among Nations, assists in providing students with the opportunity to spend two to three months in a foreign country conducting a university accredited independent research project. SPAN offers the choice to travel to four different countries each year. It is not a structured study abroad program, rather the student is left to choose a topic unique to the host country and tailor their project as they see fit. A six month preparation period is spent obtaining background information, contacting persons in the host country associated with the project, making travel plans, etc. While support (both financial and peer support) is given by the SPAN program, the self-satisfaction and valuable skills gained by the independence of the project contribute to a very influential and memorable experience.

Further information can be obtained by contacting: Minnesota SPAN Association, 309 Social Science Tower U of M, Mpls, MN 55455, (612) 376-5219.

expertise on this relatively new technology. He eventually secured a contract for a pilot and aircraft provided by a small bush airline known as Queensland and Northern Territory Aerial Service (Q.A.N.T.A.S.), today a major international carrier.

The first aircraft was a de Havilland DH-50A, a single-engine, wood and fabric bi-plane, which cruised at only 80 mph and allowed a payload of pilot and choice of doctor, nurse, or sitting patient. Painfully under equipped by today's standards, it was the state-of-art compared to the alternatives of the time. Its maiden flight in May, 1928, saved the life of a patient, thus proving the feasibility of aircraft within the Service.

Despite the success of aircraft in reducing the time to reach the patient, the important ingredient lacking was effective communication between the doctors and the location where medical assistance was needed. Without this information, the doctor and aircraft were grounded in helpless frustration.

What was needed was a large network of wireless radios for stations surrounding the medicine base. Flynn determined that the radio should be simple to operate, have a range of about 300 miles, cost no more than $200, and be relatively portable. These were the specifications of a "wonder ratio," beyond the scope of anything available at that time.

Through the imaginative genius of Alfred Traeger, this problem was also solved. Traeger's two-way radio was a design of creativity and innovation. Bicycle pedals attached to the direct drive, 50:1 ratio gear box, spun a salvaged auto generator at a rate sufficient to produce the 20 Watts required by the transmitter. This reliable and very portable power source also allowed free use of the hands to operate the microphone and controls of the radio. In addition, Traeger designed a simple two-valve receiver powered by dry batteries.

ROYAL FLYING DOCTOR SERVICE OF AUSTRALIA

One story on the development of the early Traeger radio relates to one of the first test transmissions. It was sent by Mrs. Rothery, wife of the Augusta Downs Stations Manager, to Harry Kinzbrunner at the Cloncurry RFDS radio base. Traeger and Flynn had decided to first teach women to operate the radio since they spent most of their time on the homesite within the first reach of the set.

Traeger suggested she send "Hello Harry" as the christening message. The message that Kinzbrunner decoded read, "Hell. O Hell. O Harry." Obviously a simpler method of operation was needed. Traeger responded by developing a typewriter device which automatically sent out the appropriate Morse signal when the corresponding key was pressed.

The "wireless" provided Flynn with the missing communication link and earned its place alongside aviation to speed the provision of medical care to the inland. A union was formed between these three important technologies, namely medicine, aviation, and radio, and the Royal Flying Doctor Service was finally technically functional.

The Service has since evolved into a world-renowned and respected organization. Because of the vast distances involved, the Service has divided the mainland into six sections, operating a total of fourteen bases, for effective decentralization and efficient distribution of services. A Federal Council comprised of two members from each section form the governing body of the RFDS. A non-profit, non-governmental agency, the Service relies on Federal and State Government subsidies to provide approximately fifty percent of its operating budget. The remaining half must be raised directly by the Service, which represents six million dollars in contributions for the year 1983.

The modern communications link is provided by High Frequency Radio (H.F.) signals within the 2-10 MHz band in the Single Side Band (S.S.B.) mode of transmission.

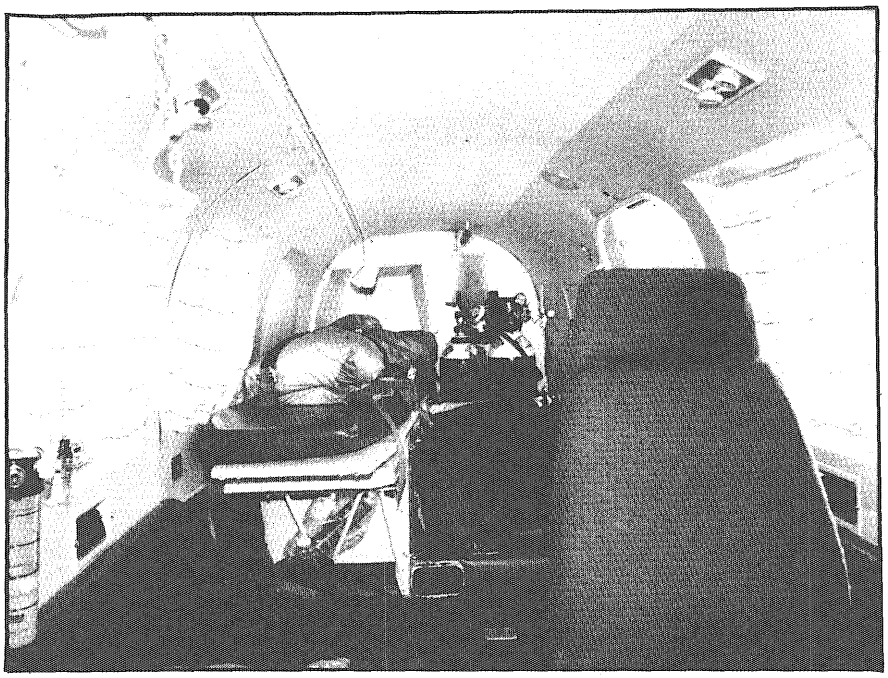
Communication between outpost stations and the city may take into the form of telegrams transmitted by voice or Radphone connections. The latter service is a direct radio-telephone link, which allows private conversations between remote areas and any subscribers of the world telephone network.

Most units also have an 'emergency tone' button, which activates an alarm at the RFDS base. When activated during normal business hours, all communication on that particular frequency ceases so the operator can respond to the emergency call. After hours, automatic switching forwards the incoming call through the unmanned base to the doctor's residence or hospital staff by telephone.

The medical staff which remain on duty at all times are truly dedicated. A person on a station 400 miles inland can actually contact the flying doctor in less time than the average urban resident can reach their corresponding doctor. And there is no remaining area in Australia where the flying doctor cannot reach a patient within two hours.

Radio clinics are held at a specified time each day and give Inlanders the opportunity to inform the doctor of any new ailments or update current ones. This daily contact provides the doctor with important background information necessary for accurate diagnosis over the radio.

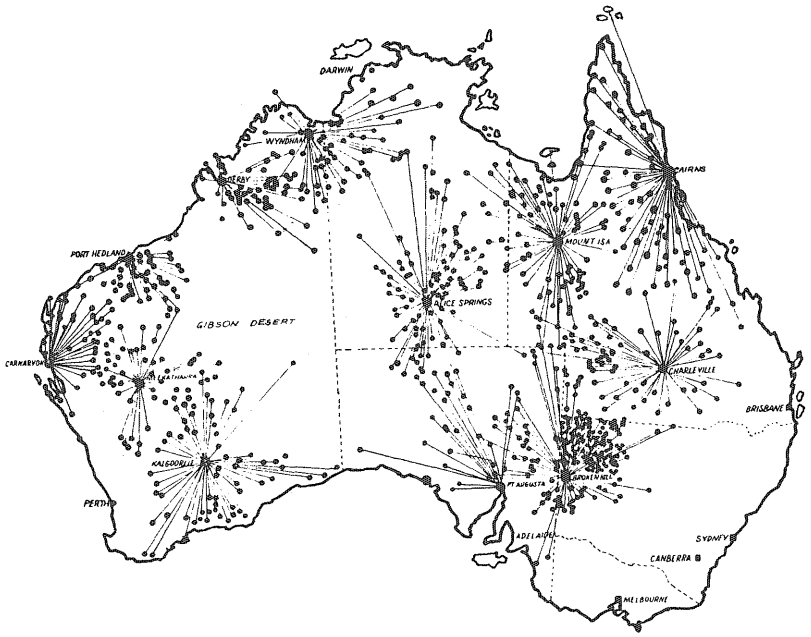
Radio diagnosis itself is an artform and has prompted more than one doctor to state how that particular function required the most patience and perseverance. The important factor the doctors must understand is the competence of the person describing the symptoms at the other end of the radio.



The interior of a RFDS airplane.

The process is aided by the use of charts and diagrams which separate the human body into numbered areas of critical importance. By specifying the area and type of pain, the doctor is able to make a preliminary judgement on the severity of the patient's condition. In cases of mild infections or viruses the doctor may simply prescribe a dosage of medication to be administered from the medical chest.

The medical chest, or "bush pharmacy," is supplied by the Federal Government and contains about 100 standardized items including analygesics, sedatives, antibiotics, scalpel and tourniquet, and various other items thought necessary, but not beyond the capabilities of the person the chest is issued to. All medication in the chest is numbered, the actual identity of prescription



Australia's Flying Doctors provide medical service to the entire Outback.

A seemingly impossible task, this challenge promises medical coverage over the two million square miles of Australia's outback.

drugs known only by the doctor, preventing errors and abuse.

Medical flights fall into three basic categories:

—Routine clinics flights which are conducted at scheduled intervals to isolate areas such as stations or settlements allowing area residents to see the doctor in a non-emergency situation.

—Emergency flights made in the cases of serious illness or accident, when condition of the patient is serious enough to warrant immediate medical attention and possible evacuation to a hospital.

—Mercy flights, which are considered by aviation laws as those involving irregular aircraft operation that may result in reduction of normal air safety standards. Considered by the doctor as a matter of "life and death," the final decision, however, rests entirely with the pilot who may be taking a calculated risk to save a life.

In 1983-4, flying doctors attended over 67,000 patients, not including radio and telephone consultations, which would bring that figure to over 87,000 patients.

All aircraft use today are modern, medically equipped twin-engine models. Navigational aids have evolved from familiar river beds, trees and rock formations to full instrumentation allowing all-night and all-weather flying, but there still remain several remote areas where navigational aids are non-existent and pilots must once again fly visually by dead reckoning.

John Flynn realized the need for emergency medical aid was real, but his insight extended beyond the physical needs of the people to the equally important aspect of their mental well being. As a result, the Service provides a vital link to the outside world by personal visits to stations and settlements from doctors, dentists, nurses, and community workers.

John Flynn's dream was founded on compassion, caring, and a sense of responsibility. Yet human emotions were no match for the physical barriers that confronted him. Indeed, had it not been for the benefits provided by advancements in technology, namely aviation and radio, John Flynn's vision would not have been realized.

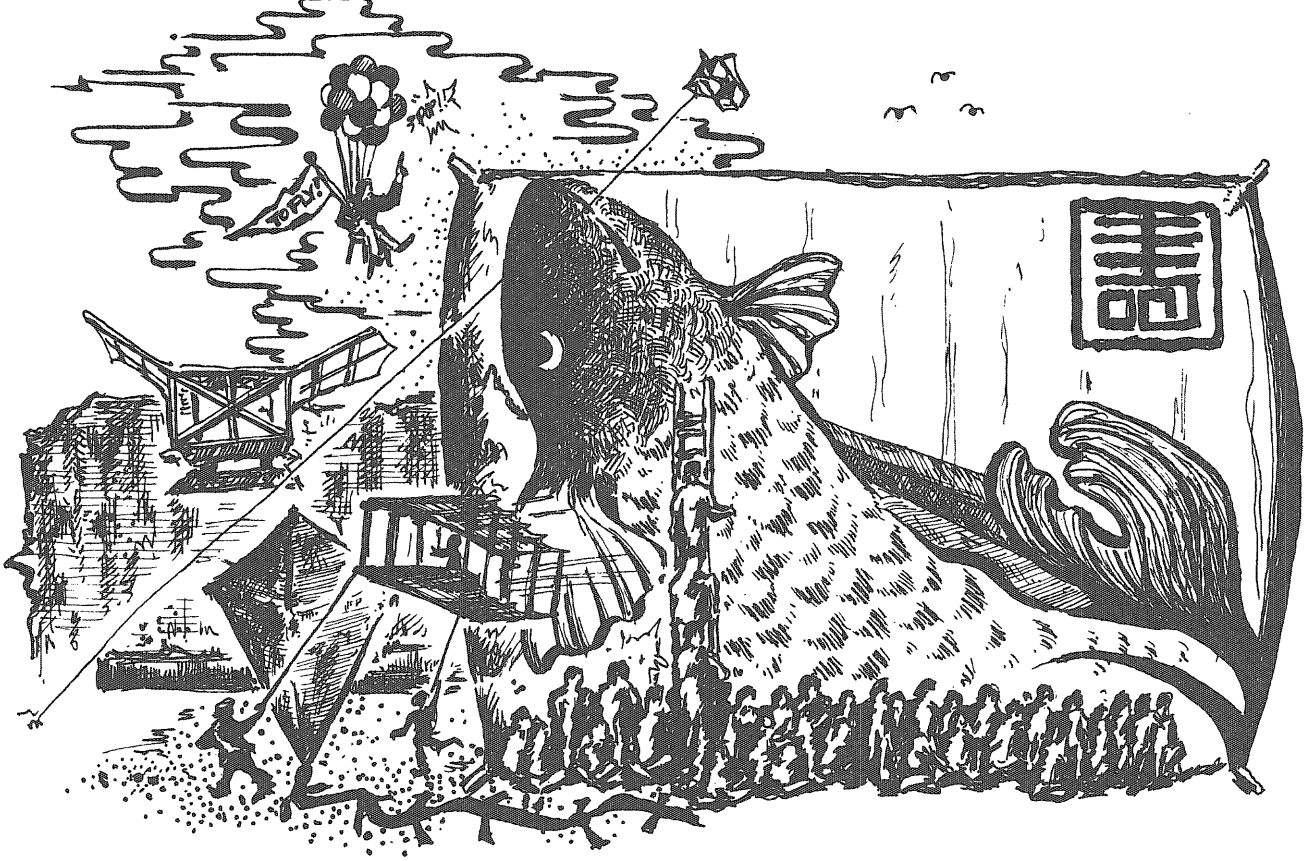


Illustration by Ed Wollack

Bring On the Kites

When the sun shines and the wind blows, studying can become a hopeless task. If you are looking for an alternative to the books, try flying a kite.

By Mike McGee and Ed Wollack

Imagine stepping out on a cool, crisp morning and sighting a three metric ton, oval object, twenty-four meters in length. With a tail one hundred forty six meters long, it soars hundreds of meters in the air—no this is not some high-tech component of President Reagan's "Star Wars" plan, but a Japanese Wan - Wan kite. Requiring more than one hundred fifty men to launch and fly, it is an excellent example of the Oriental use of simple technology as a social focal point. This use of technology was generally overlooked by Western man, though both cultures displayed a preoccupation with flight through the ages.

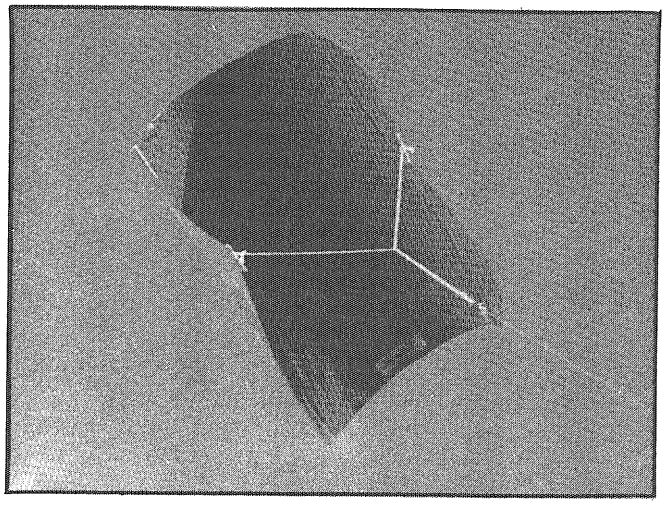


Photo courtesy of *Into the Wind*

The Scott Sled, known for its ease of flying.

From early aerodynamic "toys" to full-scale "man-carrying" contraptions plummeting off cliffs, no one could quite seem to shake the thrill of the flying machine. Kites, built of silk and bamboo as early as 1000 B.C. in mainland China, provided man's first experience with flight.

Even with the recent advances in aerodynamics, many of the "intuitive" concepts governing the flight of kites are still mathematically inexpressible. Looking over the diverse variety of both European and Oriental kites it quickly becomes apparently why there is a lack of empirical data for tethered air foils. Almost any kite geometry is capable of flight if the proper bridling and mass-to-area ratios are maintained.

If one looks into the history of kites, two separate schools emerge. The Eastern kite builders were artisans who employed their skills for artistic and cultural expression. The Europeans were slow to develop the kite, but were quick to employ this technology for scientific and military ends. According to European legend, the Greek mathematician Archytas of Tarentum constructed a wooden bird around 400 B.C. used to frighten the enemy in battle, which was inspired by the Chinese bird kite.

These differences in applications can be attributed to differences in philosophical views of the world. Where Eastern cultures viewed the kite as a means of extending ones self, the Europeans saw it as a scientific tool to be utilized. In fact, many scientific breakthroughs came

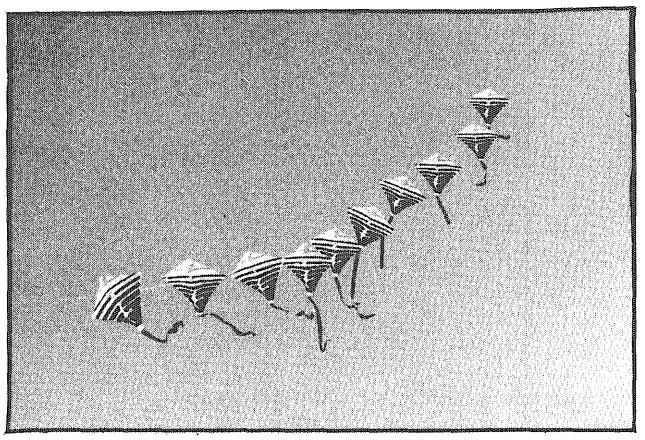
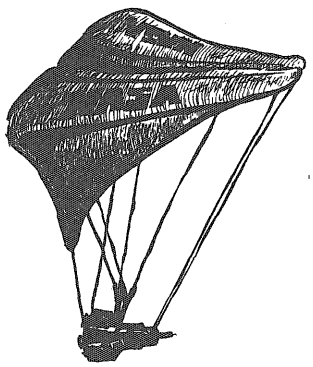
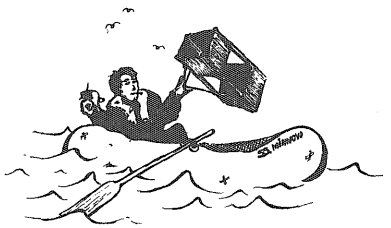


Photo courtesy of *Into the Wind*

Many types of kites can be flown in trains.



NASA's scheme for the use of a parawing



The navy used kites as radio antennas.

through kites. During the 1700's it was not uncommon to use kites as a vehicle for carrying barometers, thermometers, and conducting tethers into the upper atmosphere. The box kite like appearance of early aircraft was not coincidence; but a direct result of studying the behavior of kites as airfoils. Believe it or not, kites even helped early attempts at land propulsion, when strings of kites were tied to carriages and used as sails.

Some recent aircraft and hang glider designs are a direct result of Francis Rogallo's experiments in the late 1940s' with the flexible kite concept. Although little interest was given to kites at the time, the potential of Rogallo's theories proved of great interest to the U.S. space program. He soon became involved in the development of highly sophisticated parawings. (Parawings resemble modern hang gliders but have no rigid supports, being controlled only by cords like a parachute.) These parawings were to become the model for efficient light weight space recovery schemes, and quickly became a favorite with skydivers because of its high glide ratio and maneuverability.

The development of light weight and strong materials, such as composites and synthetic fabrics, have allowed the creation of inexpensive and durable kites which are easy to fiy. This eliminates the childhood trauma of returning home with a tattered paper kite and a snarl of string. For older flyers this creates a whole new experience in kiting, allowing any "kid" to fly an impressive looking kite.

Into The Wind • Kite Wind-Range Chart

Recommended wind speeds are shown for typical examples of each type of kite. Wind speeds usually increase with altitude.

Light Air - Smoke drifts. Wind cannot be felt.

Light Breeze - Wind felt on face. Leaves rustle. Weather vanes move.

Gentle Breeze - Leaves and twigs in motion. Light flags extended.

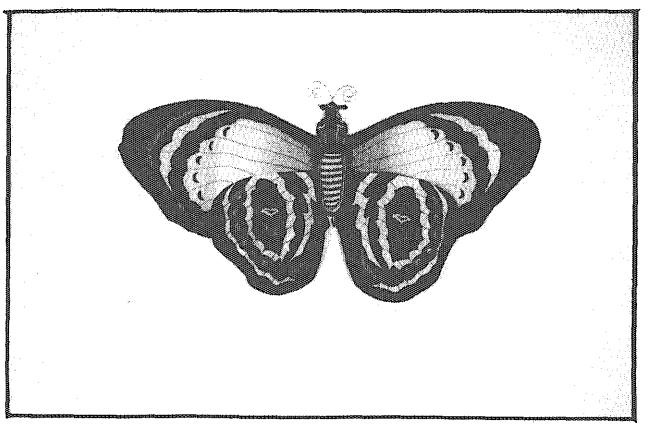
Moderate Breeze - Wind raises dust and loose papers. Small branches move. Flags flap.

Fresh Breeze — Small trees in leaf sway slightly. Wavelets form on ponds and lakes.

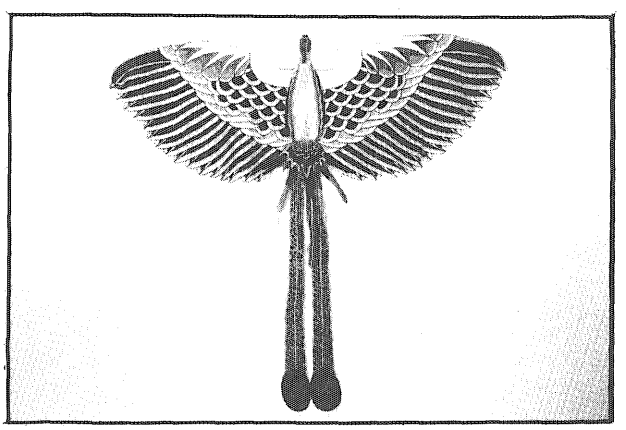
Strong Breeze - Large branches begin to move. Telephone lines whistle.

Beaufort #	1	2	3	4	5	6
Airfoils			●●●●●●●●●●●●●●●●●●●●●●●●			
Box Kites			●●●●●●●●●●●●●●●●●●●●●●●●			
Chinese Kites			●●●●●			
Deltas		●●●●●●●●●●●●●●●●●●●●				
Diamonds			●●●●●●●●●●●●●●●●●●●●●●			
Dragons			●●●●●●●●●●●●●●●●●●●●●●			
Fighters	●●●●●●●●●●●●					
Sleds		●●●●●●●●●●●●●●●●●●●●				
Stratton Kites		●●●●●●●●●●●●				
Stunt Kites			●●●●●●●●●●●●●●●●●●●●●●●●			
Winged Boxes			●●●●●●●●●●●●			
Wind in MPH	1-3	4 - 7	8 - 12	13 - 18	19 - 24	25 - 31

courtesy of *Into the Wind*



Many of the "intuitive" concepts governing the fight of kites are still mathematically inexpressible



Chapter Four

By Joe Samosky

Reprinted courtesy of Skyscraper Engineer (Volume 25, Number 2), University of Pittsburgh

You know the story. It's several weeks into the term and you've finally reached it: Chapter Four. It seems that every textbook in the sciences and engineering has a Chapter Four, although it isn't always the fourth chapter of the book. Usually, however, it goes something like this...

4.1 Introduction

Up until now in our development of statistical quantum anthropomorphism we have relied on a rather intuitive approach. In this chapter and the next we will present the mathematical background underlying the examples presented in chapters two and three. The authors assume that the student has had no previous experience with quantum anthropomorphic vector space transformations, except for an introductory course in the multivariate vector calculus of complex hyperbolic spheroids, taken in the freshman or sophomore years.

4.2 Notational Conventions

A complete explanation of the symbolic notation used in the following development may be found in "Gersplatzen Frumblebach uben Vierdenthalen und Ischengargen," J. Steinman et al., *Annalen der Physike,* Vol. 3, No. 2 (1874). The authors have made minor modifications to this system. These changes are discussed in Appendix K of the supplementary text *Quantum Anthropomorphism - A Simple Approach.* The conventions are not rigid, however, and students are encouraged to fabricate their own symbols at will, as we will frequently do.

4.3 Derivation of Antoliodore's Equation

We begin with the equation of poikilothermic electrostatics, the experimental derivation of which is found in Chapter 11:

$$M_1 p = K_2 x \qquad (1)$$

Rearranging, we obtain

$$x = \frac{M_1}{K_2} p \qquad (2)$$

We now multiply both sides of equation (2) by the permittivity of free space, e_o:

$$e_o x = e_o \frac{M_1}{K_2} p \qquad (3)$$

Through simple algebraic manipulation we obtain

$$\frac{(x_1 x_2)^2}{3 M_1 K_2 \sqrt{e_o}} = \frac{p^4 \sin^{-1}\sqrt{x^2 - p^2}}{\cosh^{-1}\left(\frac{3 x_1 z K_2}{4 M_1}\right)} \qquad (4)$$

The intermediate steps above are left as an exercise for the reader (Problem 4.4a).

We now state as fact the following equation, the proof of which is beyond the scope of this text[1]:

$$2 = 3 \qquad (5)$$

Squaring both sides,

$$4 = 9 \qquad (6)$$

and multiplying by the permittivity of free space, e_o:

$$4 e_o = 9 e_o \qquad (7)$$

Finally, we multiply and divide equation (7) by Avogadro's number ($N_A = 6.023 \cdot 10^{23}$) and raise both sides to the power numerically equal to the price per pound of bananas (expressed in drachmas) in Helsinki, Finland on July 23, 1972. (This last quantity, Svordenbjorg's constant, is an empirically derived value discussed more fully in the preface to the supplementary text *Basic Statistical Quantum Anthropomorphism for the Life and Social Sciences - Second Edition.)*

$$\left(\frac{N_A\, 4 e_o}{N_A}\right)^{23.4} = \left(\frac{N_A\, 9 e_o}{N_A}\right)^{23.4} \qquad (8)$$

Substituting the above into equation (4) we obtain the desired relation, Antoliodore's equation, which will lead directly to the proof of the McWorthstead-Landellier Theorem.

$$x = Cp \qquad (9)$$

where $C = M_1/K_2$.

[1]For a complete proof see "Applications of the Uncertainty principle to Applied Arithmetic," B. Mugglesdorf, *Journal of Applied Mathematics,* Vol. 56, No. 9 (1969).

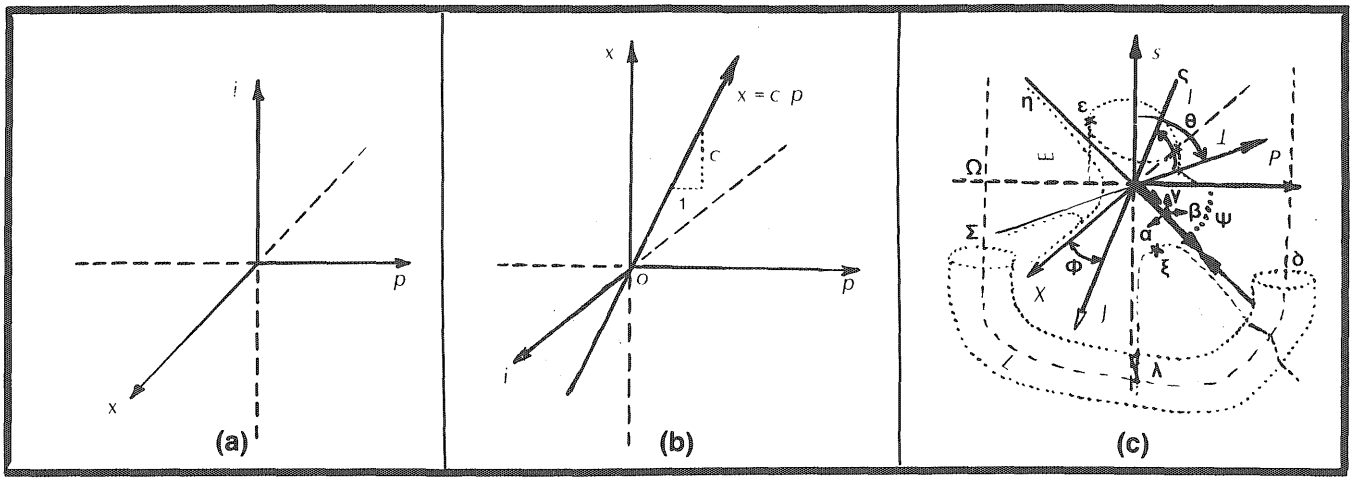


Figure 1

Expressed in words, equation (9) states that x is directly dependent on p. That is, if p increases in value, x also increases. It is also true that if p decreases in value, x will decrease. Finally, it can be shown from (9) that if p remains constant, so will x. The reader should convince himself or herself of the above assertions before proceeding.

4.4 Proof of the McWorthstead-Landellier Theorem.

With these concepts now mastered, we proceed with our proof of what is the most fundamental principle of statistical quantum anthropomorphism, the McWorthstead-Landellier Theorem (MLT). A formal mathematical statement of the MLT is rather abstract, and beyond the scope of this introductory discussion. In simple terms, the theorem asserts that if, in a suitable rectangularly tesselated region of n-dimensional anthropomorphic vector space, a counter current mass flow function satisfies boundary conditions so as to ensure compliance with the Cauchy-Schwartz inequality for any chosen combination of state-transition subsets, then the closed line integral in n-space around a loop of Henle (starting at a singularity point and proceeding clockwise) will be identically equal to zero. In other words, if a *counter current* mass flow function satisfies the Cauchy-Schwartz inequality compatible boundary conditions (for *any* chosen combination of state-transition subsets) in an appropriate *rectangularly* tesselated region of anthropomorphic vector n-space, then the *closed* n-space line integral from a singularity point *clockwise* around a loop of Henle will equal *zero,* identically. Intuitively, this implies that the entropy of the universe increases for any spontaneous process. (The proof of this is left as a supplementary exercise for the reader.)

We shall only demonstrate the proof of the MLT for 3-space; the extrapolation to higher dimensional spaces should be obvious. Figure 1(a) shows the standard i-x-p convention for our three coordinate axes. Note that each axis is at an angle of 90 degrees (a *right angle*) to each of the other two. They are said to be *orthogonal* (From the Greek *orthogonios: ortho* - straight, right, true; *gonia* - angle. Similar to the Gothic *gawrisqan* - to bring fruit, or the Sanskrit *urdhva* - upright or high, and *vardhate* - he increases.) Note also that rotation from axis i to axis x gives axis p by the right-hand rule: the coordinate system is said to be *right-handed.* We use dotted lines to show the *negative* portions of the axes, solid lines to show the *positive* regions. Finally, note that the i axis is directed *upward,* the p axis to the *right* and the x axis is directed *out of* the plane of the page.

Next we graph Antoliodore's Equation (9) in Figure 1(b)[2]. C has been chosen as an arbitrary positive constant. The reader should observe the direct dependence of x upon p, as was previously described. Note that the *slope* of the line (defined as rise/run) is equal to C, and that the line passes through the *origin* at point O (where (x,i,p) = (0, 0, 0)).

If the reader has been attentive and has closely followed the discussion to this point, the remaining steps in the proof should be clear. Omitting the intermediate algebra, we illustrate the result in Figure 1(c)[3]. The singularity points are indicated at A and B, with the loop of Henle designated by *l.* Clearly, the closed clockwise line integral around the loop will equal zero (identically), thus establishing our proof (Q.E.D.).

4.5 Conclusion

In this chapter we have formalized some of the concepts introduced in the first section of the text. Antoliodore's Equation was developed and utilized in our proof of the important McWorthstead-Landellier Theorem. Our approach was largely intuitive and nonmathematical, in order to provide the student with an appreciation of the simplicity and beauty of quantum anthropomorphic principles. Readers desiring a more rigorous foundation in the material presented are referred to Chapter Four of the supplementary text *Statistical Quantum Anthropomorphism: What More Can Be Said?* (Second Edition).

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[2]The i and x axes have been interchanged and the positive and negative regions of the graph have been switched in the illustration for the sake of clarity.

[3]Note that we have rotated the principle axes and redesignated the original x-i-p axes as s-r-j so as to avoid confusion.

(Thanks Joe)

Log Ledger from 8

Paul Campus. The system will employ fiber optics and will be 100% touch tone. It will allow for high speed data transfer, and facilitate access to the University computer system. Even dorms will have this feature. Call forwarding, call transfer, call waiting and many other features will also be available.

Artificial Intelligence Researched in Computer Science Department

Artificial intelligence can be defined as "machines doing things that people do." Computer Science professor James Slagle has done a lot of research in the field of artificial intelligence. He designed the intelligent systems called MERIT, an intelligent control strategy, and BATTLE, a resource allocation expert system. In "intelligent control strategy," the system asks the human user questions that can be easily understood and answered, and in a "resource allocation system" natural resources, transportation vehicles, weapons, etc. are allocated.

Research on expert systems that Professor Slagle and his students will address include:

1) Dialogue management, including questioning and explaining. Dialogue management refers to what the user says to the system and the system then determines what the user wants.

2) Design and implementation of a generalized inference engine. This involves the most important part of the expert system. The generalized inference engine asks the questions and performs the deduction or decision making process.

3) Propagation of values in inference networks. This involves attempts to make a better inference engine.

4) Human-machine interfaces. These interfaces relay information from the machine to the person and vice versa.

By Gregory Alm.

Want To Study or Work Abroad?

Study or work abroad can be a very rewarding experience. Many programs are available to University of Minnesota students, even some which can be tailored to engineering students. A few examples are: Student Project for Amnesty among Nations (SPAN), International Reciprocal Student Exchange Program (IRSEP), and International Student Exchange Program (ISEP).

SPAN participants travel to any of four selected countries over the summer, after a year of preparatory course work in Minnesota. Countries for summer 1986 are the British Isles, Cameroon, Greece, and Malaysia/ Singapore. Applications are already being accepted.

IRSEP offers a full scholarship to students and may not require knowledge of a second language. The application deadline is early in November. A total of ten scholarships to nine different countries around the world are available.

ISEP presents the student with a chance to study in a wide variety of

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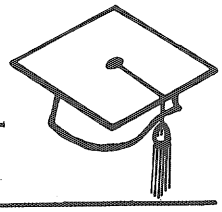


the graduate

Tax Averaging Your Future Income

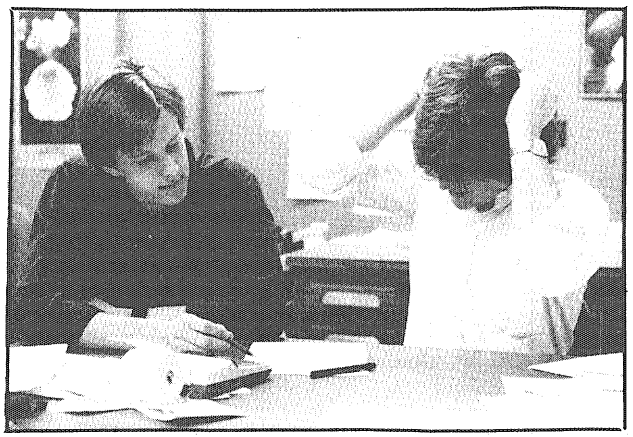
By Meribeth Nordloef

Have you ever sat and dreamt about that future job, that future income, the hike in the standard of living, and the hike in taxes? Wait, taxes are probably the last thing on your mind. Going from just keeping your head above water at $4000 - $6000 a year, to floating on a mattress with a drink in hand, at $25,000 - $30,000 a year, brings an appreciable hike in the income taxes you will pay to the IRS.

One way to delay the inevitable is to either not file, which could cause considerable problems later or, the more civilized approach is to take advantage of income averaging. Income averaging, though it sounds like a gimmick thought up by the IRS and a mathematician, is actually a great concept. It could truthfully be called the new grad's tax loop.

An individual qualifies for income averaging when his averagable income in a current tax year is more than $3000, and taxable income for the same computation year is more than ¼ higher than the average income for a base period of the three preceding years. This textbook definition excerpted from 'IRS Publication 506' can be more easily defined with an example. In the following article, the word income as used in the context of a person's income, is considered taxable income (after exemption, deductions etc. . . .). There are many other forms of income such as personal income, take home pay, etc. . . , but they will not be considered in this article.

Ron Soma, a fictional graduate in Mechanical Engineering in 1984 from the U of M, started working at IBM at $28,100 starting income. Ron was worried about the amount of taxes he would have to pay the federal government, so Ron talked to a tax consultant, who after looking at his past financial history, suggested income averaging, using Schedule G, Form 1040. Ron was able to fill out the form himself by following the form's instructions.



Don't let all of that confusing tax stuff ruin your life after graduation.

The first step that Ron needed to do was to determine his average base period income. Ron had worked the previous two summers as an engineering intern for a local company, averaging an income of $6000 a year. Previous to that, Ron worked as a house painter, averaging $3300 a year. All preceding three years, Ron was self-supporting. Ron's base period for taxable income was 1981-1983. Ron determined his taxable income with the following simplified seven steps using the concept of income averaging:

1)	average base period income (15,300÷3)	= $5100
2)	nonaveragable income (5100 × 140%)	= $7140
3)	averagable income (28,100 - 7140)	= $20,960
4) a.	nonaveragable income	= $7140
b.	¼ of averagable income (20,960÷4)	= $5240
	total (a + b)	= $12,380
c.	tax on the above using 1984 tax rate schedule	= $1487
5)	tax on nonaveragable income (7140)	= $629
6) a.	increase in tax (4c)-(5)	= $858
b.	increase multiplied by three	= $2574
c.	plus tax on nonaveragable income	= $629
tax for 1984		$3203

Without tax averaging, Ron would have had to pay taxes on his taxable income of $28,100 (after exemptions and deductions), which would amount to approx. $6456. Ron saved $3253. To most of us that still count pennies, this is a substantial amount saved.

Income averaging, though it may seem like a panacea for the tax blues has qualifications that must be observed. You are eligible if:

1) You were *not* a nonresident alien during the four year averaging period.
2) You furnished at least ½ your own support in all of the three base period years. The support test does not apply if the support was furnished by a spouse.

If you do not meet the support test, you may still be eligible if:

1) You received more than ½ of the current year's income for the work done in 2 or more base period years.
2) Your income is not more than 25% of the aggregate adjusted gross income reported on a joint return.
3) You are at least age 25 in the current tax year and were not a full-time student (5 months or more of the year for at least 4 tax years after age 21.)

Many new graduates are very interested in using income averaging but, the support test is the pivoting criteria here as to whether you may use it or not. If you don't meet the support tests to use income averaging, don't despair, there are many other avenues available to reduce your taxes. Many of the tax consulting companies send out letters to new grads giving them the opportunity to use their services free for next year's taxes. Take advantage of this if you can or use your local library for further tax information. Getting to know your taxes as well as you learn a class subject will help you in the long run. For further information on income averaging, see IRS Publication 506 available at your local library, Post Office or IRS office. Now you can dream about that future job, future income plus that extra bit saved from taxes.

Log Ledger from 30

countries, with tuition and fees the same as the University of Minnesota.

A few work programs are available through the University this summer. Arrangements for these are usually made only a few weeks before leaving. In all programs, transfer of credits must be arranged in advance.

For more information call the International Study and Travel Center (ISTC) at 373-0180 for an appointment. Drop in advising is available from 12:00-1:30 Mon.-Fri. in room 42 Coffman Union, where a travel library is located. There will also be a free information session May 4. Stop in at ISTC for more information.

By David Kortenkamp.

A Case For Seatbelt Use

Conservation of energy is a familiar concept to most I.T. students, but the energy conserved in daily events is not always easy to visualize. In the February issue of Science Digest, Roslyn Kaiser of the National Highway Traffic Safety Administration (NHTSA) offered an example to help people understand the energy in a automobile crash, "People do not understand the dynamics of crashes. They think they can save themselves by bracing with their arms. But a ten-mile-an-hour collision is equivalent to catching a two-hundred pound bag of cement dropped from a second story window."

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Camping: How To Do It

by John Krumm

The camping season is fast approaching, and you're probably already making plans for a refreshing, outdoor commune with nature after spending so much time with your calculator and engineering paper. Being the rough and tough, burly kind of guy I am (also sensitive, intelligent, and good with children), I thought it no less than my duty to offer a few suggestions on how to get the most out of your hypaethral peregrination (that's "camping trip" for your non-CLA majors).

Most people with the audacity to call themselves campers don't have the slightest idea of how to have a good time outdoors. Take for example the Grape Nuts man on T.V. After an excruciating climb to the rim of a canyon, he says something like, "There are trails down there that most people use to get to know this canyon, but not me...I like to find my own way." Is he a jerk or what? He then goes on to describe the people that are "right for Grape Nuts." Let's take a moment to think about this man. He has risked his life crawling around on the barren edge of a high cliff, and now he turns to you and starts talking about breakfast food. His hearty meal consists of hard brown granules submerged in milk. (Hey, where's the grapes anyway?) And, despite his detour from common sense, many people would say, "Now there's a camper."

So, how does a real camper do it? To have a really enjoyable trip, one must consider four things: site selection, food, personal hygiene, and entertainment. Let's consider these in turn.

The proper camping site will have level ground, fresh water, adequate sanitary facilities, and pleasant surroundings. It is no coincidence that a Holiday Inn or Motel 8 combine all these qualities with free ice besides. For primitive lodging (camper trailer or lake cabin), be sure you don't end up too close to neighbors who may spoil the pristine silence of the outdoors by annoyingly operating their stereos and blow dryers. One must also have access to a standard electrical outlet so one can conveniently operate one's own stereo and blow dryer. Of course, good T.V. reception is a must.

The proper camping site will have level ground, fresh water, adequate sanitary facilities, and pleasant surroundings. It is no coincidence that a Holiday Inn or Motel 8 combine all these qualities with free ice besides.

Food is your next concern. Try Burger King or Perkins at first until you get to know the good local restaurants. So-called hard-core campers take pride in preparing exotic dishes over an open fire with minimal utensils. If the only meals you prepare in the convenience of your own home are pot pies and Spaghettio's, why attempt a squid flambe when you probably don't even have a dishwasher handy? If you insist on doing your own cooking while camping, don't bother with a smoky fire. Just pop a frozen pizza or bowl of soup into the microwave. You can get primitive by eating the pizza with your fingers or slurping the soup. In case you don't have a microwave around, try some Spam on a Ritz cracker until you find a good steak house.

Hygiene is where I like to really cut loose on a camping trip. I may go for as long as a whole day without a single drop of after-shave, unless I go to a really fancy restaurant. Camping is a time to relax, and how can you relax when you're concerned about trivial matters like cleanliness which detract from that almost spiritual oneness with nature? Of course, fingernails should be kept neatly trimmed so as not to scratch any records or snag the upholstery. You men may want to grow that beard you've been thinking about, while you ladies may want to commune with nature by using a pine-scented body splash.

Entertainment is your last problem. How do you avoid boredom, especially if it's Tuesday night and there's nothing good on T.V.? A forestry major would probably sit in silence and gaze at the stars (as they often do in lecture anyway). The purest form of camp entertainment is a sing-along with a six-string guitar while eating roasted marshmallows. If there's no guitar, have everyone play a John Denver tape on their Walkman. As for the marshmallows, just pop them suckers in the microwave and nuke 'em for a few seconds. You have to be willing to make your own fun when you're camping, you know. Idle evenings might be a good time for Junior to hone his Scouting skills; get started on the Computer merit badge, for instance. Don't forget to record these good times on a VCR so you can relive the fun next Tuesday night.

I hope these hints will help you in your desire to reacquaint yourself with the wonderful outdoors. Who knows, you and your pal may become the next Lewis and Clark. (Lewis Schlabonski and Clark Snodgrass, that is . . . the daring duo who spent an entire weekend in the parking lot of a White Castle with nothing but an AM radio and the home version of Family Feud.)

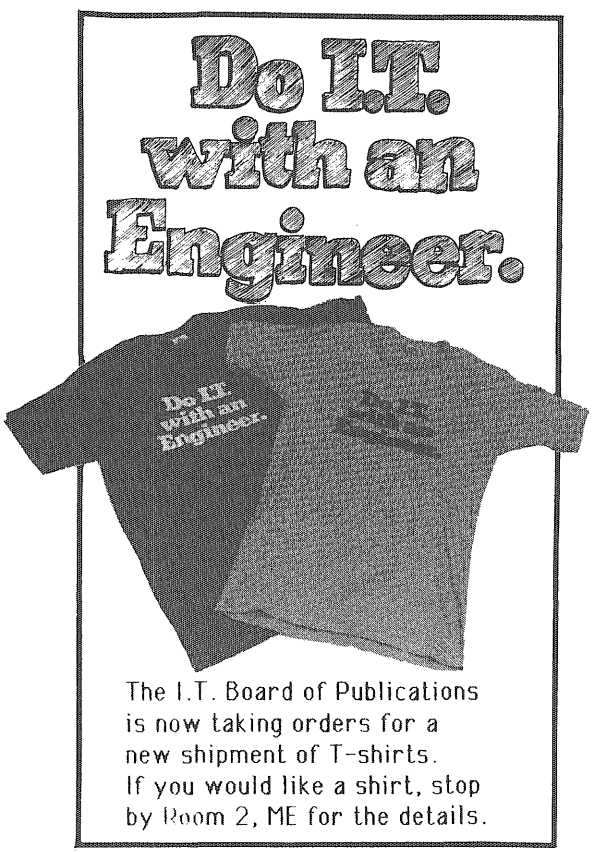
Mind Benders and Brain Teasers

In the past, the correct solutions to the problems presented here could earn you a free T-Shirt. Unfortunately, our supply of shirts has become depleted, so the satisfaction of completion is the only reward we can offer.

1 Here is an easy one to get started (this is best suited for small children and forestry majors). Connect the dots.

2 A newly graduated industrial engineer has a problem. The company suspects that one of the ten billion kegs of beer (that should get the Wisconsin people's attention) in the warehouse inventory may not be full. How many measurements of weight on the company's very large scale are needed to locate the light keg?

3 Find the smallest positive integer N such that N/2 is the square of an integer, N/3 is the cube of an integer, and N/5 is the fifth power of an integer.

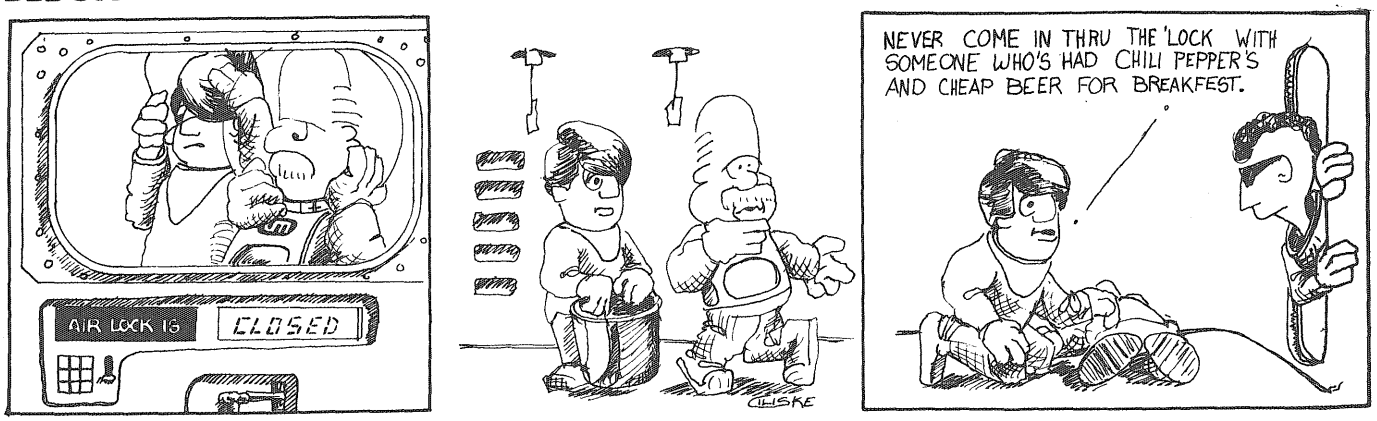


The I.T. Board of Publications is now taking orders for a new shipment of T-shirts. If you would like a shirt, stop by Room 2, ME for the details.

Another slow day prompts Marty to wonder if he should give up his passion for shoelace repair and go into genetic engineering.

BEBOX

By Scott Ciliske



technotrivia

By John Krumm

1) In the metric system, "deca-"means ten and "milli-" means one thousandth. What does "myria-" mean?

2) Is a rope more likely to break with 10 people pulling on one end with the other end tied to a tree or with 10 people pulling on each end?

3) It's true that Henry Ford was a soybean fanatic. But do you believe that he once showed up at a convention dressed in a suit and tie woven from soybeans and always kept cold soybean milk in the refrigerator?

4) People sometimes throw aluminum cans on the ground, saying that since they're biodegradable, they'll disintegrate eventually anyway. How long does it take an aluminum can to disintegrate if it's left alone?

5) What is the accepted name for that pointed rubber thing on the handle of a toothbrush?

6) Within 10, how many teeth does a mosquito have?

7) As the Professor, stranded on *tropical* Gilligan's Island, you need to give Mary Ann some blood plasma right away. All the others are off fighting an outer space creature. There are no other animals around, and you cannot afford to give any plasma of your own. Considering your location, what can you do?

8) True or false: As an abandoned baby, Carl Sagan was raised by a family of concerned water buffalos in the Himalayas, and learned his first physics from a kindly mountain guru named Bob.

9) If your tongue were dry, could you still taste?

10) 13, 25, 37, _____ What comes next? (This is a trick question.)

1) "Myria-" is a prefix meaning ten thousand.

2) The rope is equally likely to break in each case. The tree exerts a reaction force equal and opposite to the force of the 10 men.

3) Yes, it's true. His company even served a sixteen-course soybean dinner at the 1934 Century of Progress Fair in Chicago. The menu included puree of soybean, soybean croquettes with green soybeans, soybean coffee, and soybean cookies. Ford dreamed of manufacturing an all-soybean automobile.

4) It takes between 200 and 500 years for an aluminum can to disintegrate.

5) That pointed rubber thing is called the "stimulator tip." (Imagine the wacky hilarity you can have when you serve your friends chocolate chip cookies with a few "stimulator tips" mixed in.)

6) A mosquito has 47 teeth. With all these teeth, one wonders why they don't use "stimulator tips" more often.

7) You would take advantage of a discovery made during the Second World War and use the liquid from inside young coconuts for a blood plasma substitute. Mary Ann would no doubt reward you with a coconut cream pie.

8) False. There has never been a guru named Bob.

9) No, everything you taste must be at least partially dissolved. In fact, you cannot taste anything insoluble. (Which is why scientists are working around the clock to invent insoluable lutefisk.)

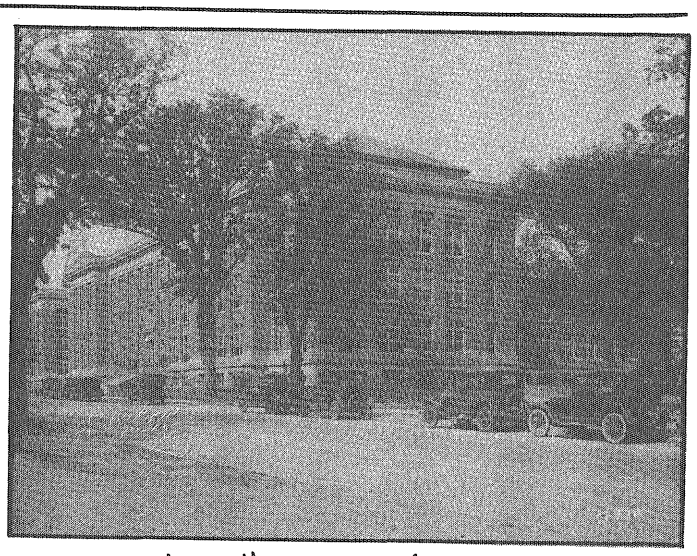
10) The answer could be any real or complex number. One can justify any answer by fitting a 3rd degree polynomial to the 4 numbers and declaring it a determinate progression. (The people at ACT and SAT should be made aware of this.)

Scoring

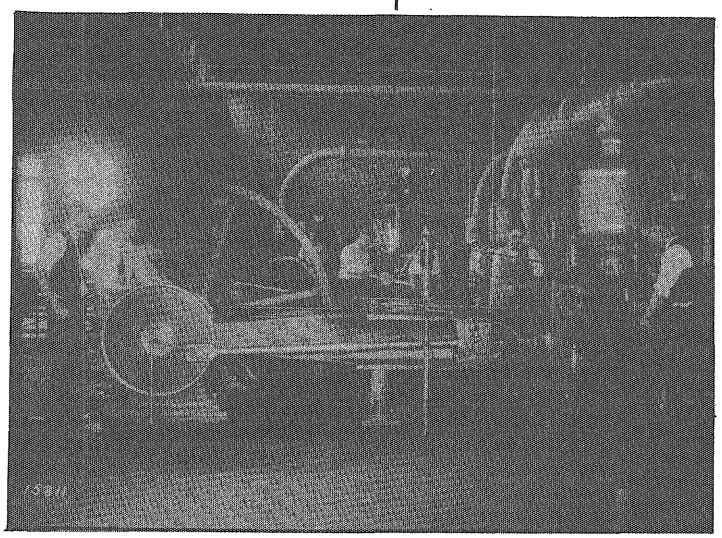
0-1 Try again with your eyes open this time.
2-4 *Somebody has to make the top half possible.*
5-7 Reward yourself with a new Slim Whitman album.
8-10 Reward yourself by not getting a Slim Whitman album.

...a thousand words

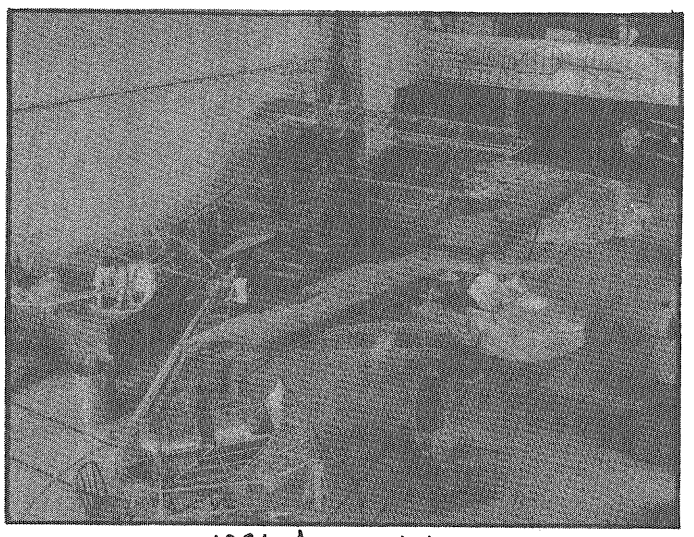
1938 ME Foundary Control Lab



Lind Hall, Church Street

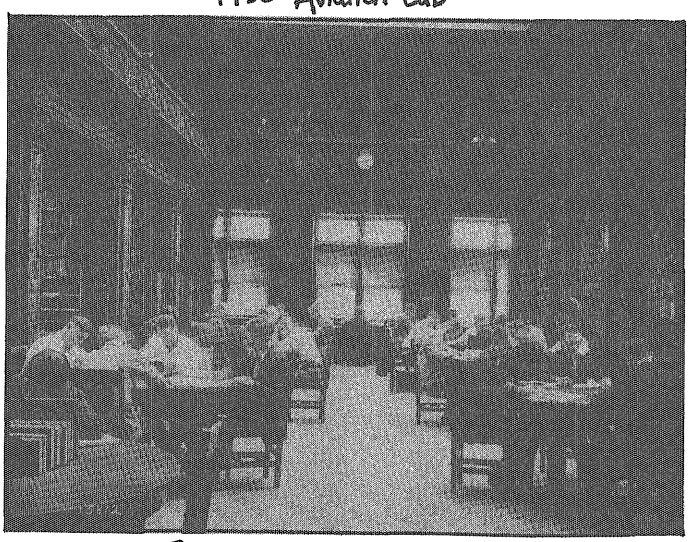


Power and Propulsion



1936 Aviation Lab

1926 Electrical Engineering



The Engineering Library

Light Sculpture by Bill Parker
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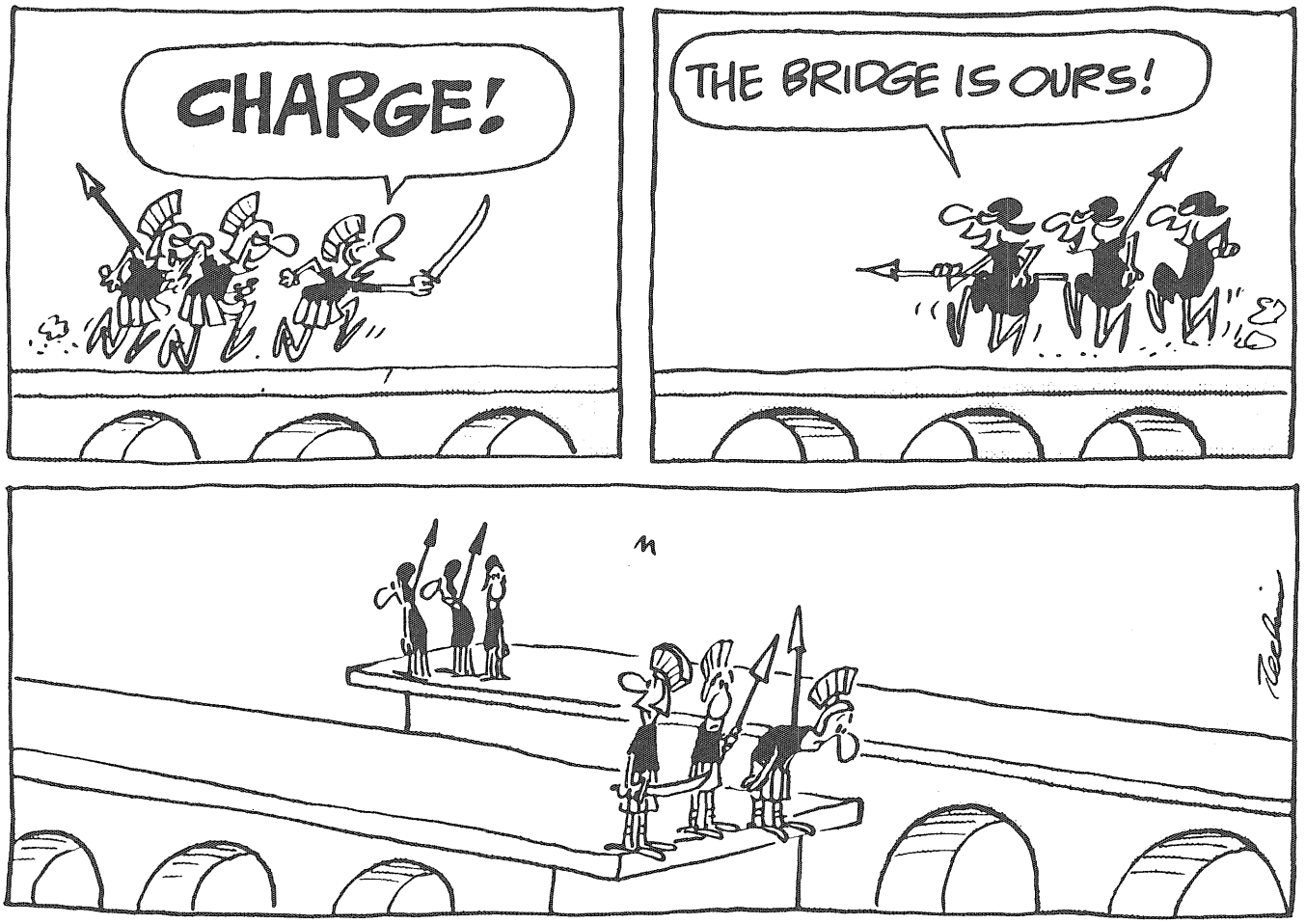

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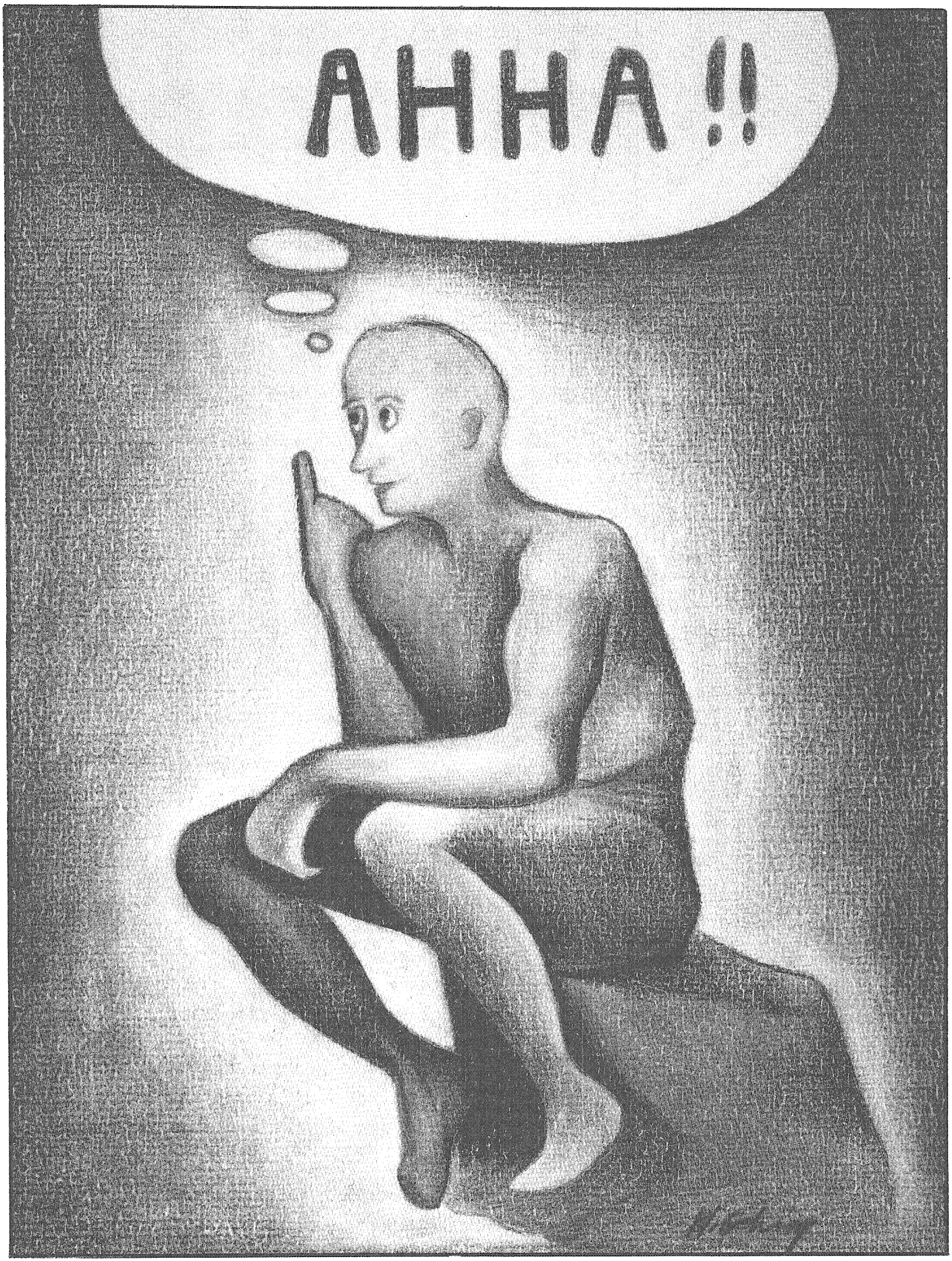


Illustration by Nan Gehrig

editor's log

Courses on the Right Side of the Brain

Have you ever wondered what Archimedes' neighbors thought of the man. They were probably justifiably concerned when their neighbor jumped out of his bath and ran naked down the street yelling "Eureka" (I have found it). I can just imagine the looks on their faces when a dripping wet Archimedes tried to explain the principle of buoyancy.

The intuitive leaps and bounds in understanding experienced by Archimedes has been dubbed the "Ah-ha" response. You may have experienced this yourself when shortly after turning in a troubling midterm the questions suddenly make sense.

Where does this originate? The "Ah-ha" response has been traced to the right side of the brain by researchers at Cal Tech. It seems that the two hemispheres of the brain receive the same inputs, but process them with dramatically different approaches. The left side is the home of rationality and logic. It analyzes, counts, marks time, plans procedures, and verbalizes. The right side works much more globally, processing information in a spatial (nonverbal) and perceptual mode. It dreams, imagines, recalls, and relates. It is this intuitive, holistic, and time-free mode that can surprise a brain's owner with a clear and complete solution to a puzzle, causing him to get so excited he may just run down the street naked and yelling.

Well, here we are in the fourth paragraph already and you are probably wondering just what it is I am getting at. I was pondering the qualities of the classes that I have enjoyed most in my educational career and I came to the conclusion that there is some connection between an enjoyable class and the right side of the brain.

Before getting into this right side stuff, I want to emphasize I do not minimize the role of the left side. The logic and rationality of the left side are vital to understanding, its procedures get work done on time and the verbal mode moves all the knowledge around. The enjoyable class utilizes all of these left side traits, but it adds an ingredient exclusive to the right side, the thrill of the "Ah-ha" response. Without an occasional "Ah-ha", attending class can become the process of moving the information in the professor's notebook into the student's notebook without necessarily going through the minds of either.

The inspiration for an "Ah-ha" can come from many different sources. Pulling a textbook concept into a non-text setting creates a tremendous potential for an "Ah-ha." A professor's non-academic experience related through an anecdote full of the ambiguities and assumptions of the "real world" can be one source. Another can be a well written homework problem. I remember one professor who asked for an estimate of the amount of water your body looses each day with exhaled air. Obviously you cannot flip through the pages of a text, pick an equation, and plug in the variables. You need to think about the general mechanisms involved, make your own assumptions, and calculate your own answer. If the question has one right answer, the potential for the "Ah-ha" is greatly diminished.

"Ah-ha" questions can be few and far between in many courses because they violate a principle law of nature. Things tend to follow the paths of least resistance. Questions for the left side of the brain are, by comparison, easy. There are usually a few dozen already written at the end of each chapter and the correct solutions are conveniently listed to insure you plugged into the right equation. Questions for the left side provide a "quick and dirty" approach to the educational process, for the professors and the students.

While there is not, by any stretch of the word, a movement to the right side of the brain in today's educational system, a few instructors do make an effort to question both sides of the student's mind. Considering the demands on a professor at a research institution like the University of Minnesota, this extra devotion to the undergraduate classroom deserves recognition and encouragement. It does not go unnoticed.

David Herridge

David Herridge
Editor

Ramblings of an Editor ...Thank you...Not enough pages in a year ...Welcome

On this final issue of my Technolog editorship I would like to thank all of the individuals who helped publish the magazine this year. This includes the writers, the photographers, the illustrators, the people who sold ads, the people who put the magazines on the racks, and the people who sacrificed their weekends for production.

Over the year I have had the opportunity to write about a variety of topics. But there are still so many things to say and questions to be asked. Why do we have finals on Saturdays? Why do all the professors have to do research? Why is there only one handle for the two front doors of Lind Hall? The list goes on.

If you have any questions of your own or if you have a topic of interest that you would like to write about, I would like to encourage you to spend a little of your spare time with Minnesota Technolog. If you want to write, it could be as easy as stopping in the office and talking to the editor. New ideas and helping hands are always welcome.

log ledger

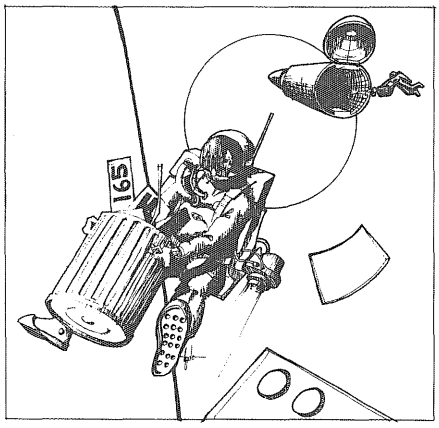
Space Junk Presents a Growing Concern

Of the 5300 or so documented objects tracked by NORAD in orbit around the Earth, about one half are considered junk. Added to the mess are an estimated 15,000 objects less than four centimeters in diameter which are unobservable with NORAD's radar.

Where did all of this debris come from? The U.S. is part to blame. Between 1973 and 1981, over one thousand trackable objects resulted from the explosions of the second stages of Delta rockets. However, the Soviet Union is by far the largest contributor. Of the 83 satellites that have exploded or broken apart in space, 59 have been Russian. Antisatellite tests conducted by the Soviet Union have added at least another 500 objects.

While NASA does not feel the numbers represent a crisis situation, they are growing concerned. Small pieces of debris can reach orbital speeds of six miles per second, amounting to enough kinetic energy to destroy satellites and devastate spacecraft.

One of Challenger's windows was damaged during the seventh shuttle mission. The small crater was



attributed to a speck of titanium and aluminum discovered during an examination using an electron microscope. While the damage may have opened a few eyes to the growing problem of space junk, it did not endanger the astronauts. The shuttle is statistically safe from damage because of the short durations of the flights, the chance of the shuttle being destroyed is approximately one in 54,000.

NASA is more concerned about the survival of the permanent space station now on the drawing board. Because its orbit will be below the most polluted altitudes between 540 and 600 miles, the possibility of an object penetrating the manned station is estimated to occur as often as every ten years.

Atlas Booster Rocket Honored As ASME Landmark

The ASME has designated the Atlas Space Booster as the 100th National Mechanical Engineering Landmark. The Atlas Booster was built by General Dynamics Convair Division in San Diego. The Atlas first served as an ICBM, and it has since evolved into a highly successful satellite booster. The nearly 500 launches to date include the first communications satellite (1958) and the first American astronaut in orbit (1962).

Ramp Wins Award For Creative Solution To Unusual Problem

The new West Bank Parking Ramp designed by Walker Parking Consultants of Minneapolis was recognized by the Consulting Engineers Council of Minnesota in its annual awards for engineering excellence. The ramp squeezes 700 spaces into only 210,000 square feet and features high-pressure sodium vapor lamps coupled with special interior paint to reflect the lamp's light for a secure and well lit environment.

Molecular Dynamics Explored

To fully understand chemical reactions, details on the mechanism of the system must first be explored. In research funded by the National Science Foundation and the Department of Energy, I.T. professors W.R. Gentry (Chemistry) and C.F. Giese (Physics) are examining the dynamics of individual molecules to learn what controls some of the fundamental properties of chemistry.

In one experiment, Gentry and Giese, with the help of their students, are monitoring the vibrational planes of the ethylene dimer, two ethelyne molecules joined by a weak bond. Ethelyne (C_2H_4) has two vibrational patterns, the hydrogen atoms can vibrate within the plane of the molecule or perpendicular to the molecule. For the experiment, the ethelyne dimer is subjected to inputed energy from a laser and the action of the molecules and the path of the energy transfer within the molecule is observed until the energy eventually breaks the weak ethylene-ethelyne bond.

These experiments, conducted with "beams" of molecules in a vacuum chamber, have shown that the energy flow from the dissociation of ethelyne dimers varies from one vibrational mode to the other, disproving the earlier theories which predicted the flow to be the same from both vibrational modes.

By Lorri Sheets.

Mac SIG

For all you Macintosh owners, the "Apple 32" Special Interest Group meets every third Thursday of each month.

Women Entering Engineering Declining?

Women represent 40 percent of the employed persons in the United States, but the number of women entering the engineering work force is only 14 percent of the total number of graduating engineers. Between 1976 and 1981, the number of women employed as engineers and scientist nearly doubled. That growth has since leveled off.

Engineering Center Marks 25 Year Anniversary

Twenty five years ago the cornerstone was layed for the United Engineering Center in New York. The center is the home of dozens of professional engineering organizations and a public engineering library. The building and land originally cost $11.5 million in 1961. Today it is appraised at $45 million.

Mending A Broken Heart

The Science Museum of Minnesota is running a continuing exhibit titled "Mending a Broken Heart." The highly interactive and visual exhibit explains how the heart works and why it sometimes fails. For more information, call 221-9438.

Graduate School?

Are you considering graduate school? If you are, the American Society for Engineering Education offers a 16 page booklet which addresses many questions graduate students typically ask. A single copy can be obtained by writing to ASEE Publications, Eleven Dupont Circle, N.W., Suite 200, Washington, D.C. 20036. Single copies are free, but if you want more than one they are 75 cents each.

Powerful Architectural Simulation Being Developed For IBM PC

Sharp shadows fall on a tree filled plaza as the evening sun sets in the west. Businessmen hurry home, while a young couple strolls past. A bus disgorges its passengers, allowing the few remaining suburbanites to be whisked away.

The architect slowly circles his creation. The top tapers cleanly, complementing the adjacent buildings as though it had been there all along. Street lights flicker on, their sodium glow playing on the building's facade. The architects eye detects something which is not quite right. A bird's eye view is needed. The architect deftly taps a series of numbers into the keyboard and the building reappears, only now the viewpoint is from 100 feet away and 50 feet up. Immediately sensing the problem, the architect selects a lighter shade of blue. The building reappears once again, correctly colored.

A vision of the future? Not quite. Lee Anderson, an assistant professor in the School of Architecture, and Oliver Ng, a research fellow, have been working for the past three years on such a computer simulation.

The program, run on an IBM PC, is called 3-D Design and with it Anderson hopes to eliminate some of the guess work in architecture.

3-D Design differs from traditional computer aided design systems. Anderson wants the architect to use 3-D Design from the beginning. Inputing a simple sketch creates a data base. Then, as the building grows, the data base grows. Any modification to the building modifies the data base. Thus, when an architect makes a change in one aspect of the building, they can immediately see the effect on energy consumption, cost, lighting, and any number of other areas. "Everything is pulled together and unified," observed Anderson.

The data base is built up from a sketch. "We don't wish to eliminate sketching, but rather to incorporate that into the data base," noted Anderson.

Oliver Ng programmed a very simple way to create a three-dimensional data base from a two-dimensional sketch. Using a digitizer, a small mouse-like object, the architect traces over his sketch, inputing corner points. The program

Continued on page 24

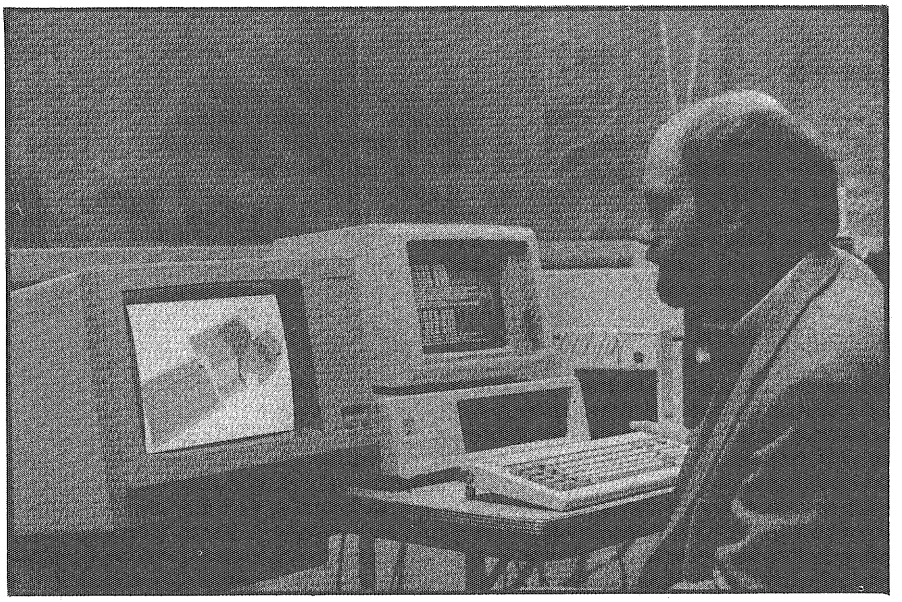


Photo by Mike McGee

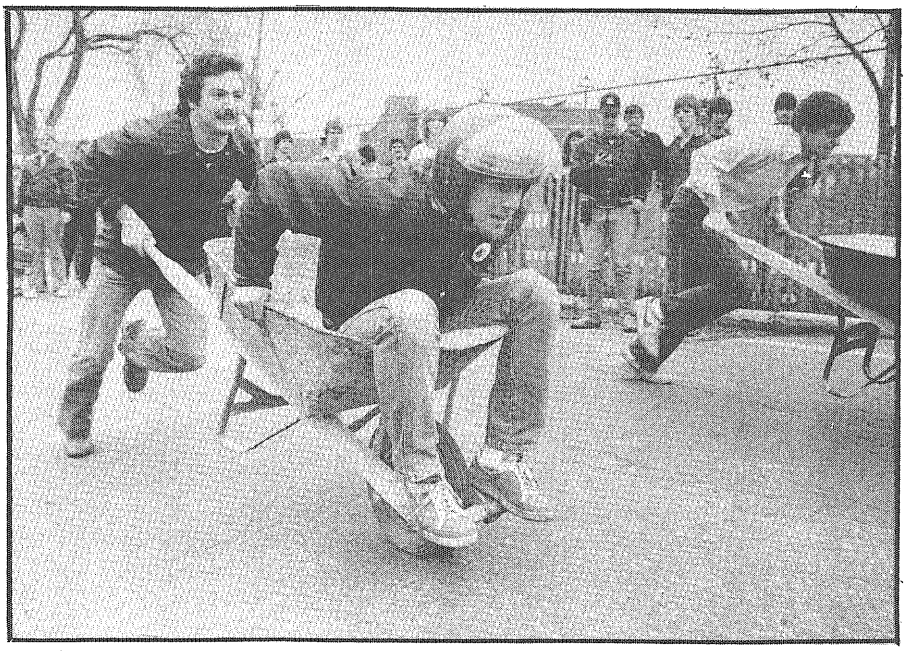
Get Into I.T.

GET INTO I.T. It's not too late to have fun. Saturday, May 4, the Suburbs kicked off I.T. WEEK with a dance at Coffman Union. Buttons and T-shirts are available at any I.T. WEEK event. Wearing an I.T. WEEK button not only shows you're "INTO I.T.," but gets you free movies and pop during the Technology Fair. The celebration has just begun!

May 6-10, students will have a chance to see the latest technological developments. At Monday's opening ceremony, Plumb Bob will bring out the legendary Blarney Stone for the ceremonial kiss. The Blarney Stone will be heavily guarded by St. Patrick's knights to prevent foolish Foresters from stealing the Stone.

Students may win $350 for the projects at the Innovation Fair on Monday. Tuesday at 1:15, the Technology and Society Assessment Program will host Nam P. Suh, the Directorate for Engineering head at the National Science Foundation. The Technology Fair will be held Wednesday and Thursday. Major corporations from the Midwest will display their products. By making professional contacts, students will see the latest technology, its application and possibilities for future use. Professionals will be anxious to hear about students' research, seeing the Innovation Fair winners in the Architecture Court, and touring University facilities. Once again, the movie tent will be showing free films.

Friday, classes will dismiss at 10 a.m. Students can let loose for awhile, race tricycles and roll a few beds down Union Street. The I.T. picnic on Northrop Mall will begin at noon, with more games in the afternoon. See the I.T. WEEK schedule for more information.



The Legend of the Blarney Stone

During the excavation of Lind Hall in 1903, engineering seniors discovered a green, glowing stone carrying the mysterious message "Erin Go Braugh." The engineers deciphered the message: "St. Patrick was an engineer." The Blarney Stone and its secret hiding place had at last been found!

The Stone gifts its users with eloquent and persuasive speech. With such magnificent powers many students wanted the stone for themselves. Mining and law students, the original rivals of the engineering students were no exception. The first time they made off with the stone, a general alarm sounded, summoning engineers, who raced to save the magical stone. In 1918, the mining students stole the Blarney Stone and took it to a local rock crushing company where it was transformed into a sack of pebbles. The stone the mining students took was fake, and had purposely been left unguarded while the real one was carefully hidden. In 1943, the School of Mines was integrated into the school of engineering. Some mining students continued trying to steal the Stone, but the real rivals of the engineers became the forestry students.

The most recent theft of the Blarney Stone occurred in 1983, when the foresters broke into the Plumb Bob office, stole the Stone, and replaced it with a small tree. The foresters were outwitted when a Plumb Bob member joined their club under an alias and discovered the stone's hiding place.

This year, the Blarney Stone will be present at Monday's opening ceremonies. Heads of state and special guests will kiss the Stone, becoming gifted with gentle speech. St. Patrick's guardians will take special precautions to guard the Stone from rival foresters, ensuring I.T. WEEK's success.

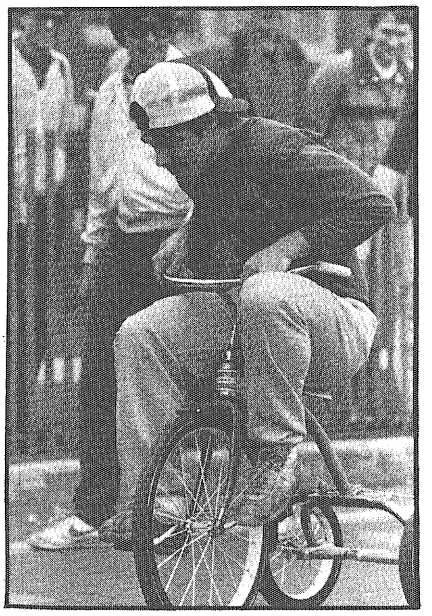
List of student organizations participating in I.T. WEEK

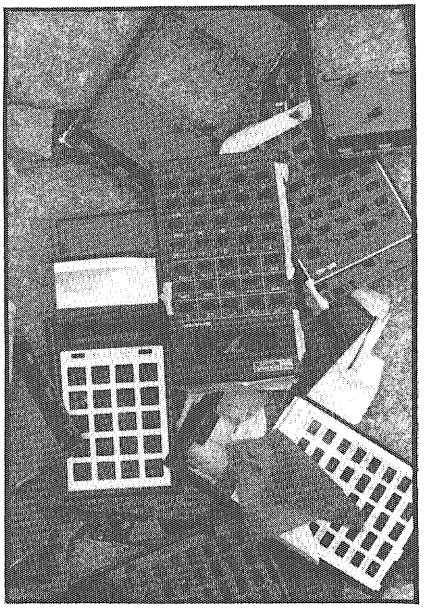
ACE	EE
AE	HKN
AIAA	IEEE
ASAE	ITSB
ASCE	KHK
ASME	MINIT
Plumb Bob	
SAE	
Sigma Gamma Tau	
Theta Tau	

I.T. Week
Schedule of Events

For exact time, place, and rules, check the Blarney Boards in Lind Hall, Mechanical Engineering and the Technology Fair Movie Tent. I.T. WEEK buttons and T-shirts will go on sale April 30.

Monday, May 6		
Innovation Fair	Set up:	10:00-12:00
	Judging:	12:30-3:00
	Winners Announced:	3:00
Opening Ceremonies	Speakers:	12:00-12:30
Tuesday, May 7		
Technology and Society Assessment Program	Speakers:	1:15
Wednesday, May 8		
Technology Fair	Displays:	9:00-4:00 7:00-9:00
Department Tours		
Movies		
Friday, May 10		
IT Olympics	Union Street:	10:00-12:00
	Tug of War	
	Bed Race	
	Trike Races	
	3-legged Race	
	Wheelbarrow Race	
	Non-combustion Car Race	
	Ameoba Race	
	IT Picnic:	12:00-1:00
	Nerd Beauty Contest	
	Volleyball	
	More Races:	1:00-3:00
	Death of an Auto	
	Car Rally	
	Paper Airplane Contest	
	Textbook Stack	
	Calculator Toss	
	Kite Flying	
	Aluminum Can Sculpture	
	Calculator Race	
	Blind Man's Wheelbarrow Race/Obstacle Course	
	Egg Drop	
	Scavenger Hunt	
	Truss Contest	
IT Party	Triangle (521 12th Ave.):	8:00-12:30 am
	Awards Ceremony	





MEIS: Bridging I.T. Into High Tech

The impact of microelectronics on society has been immense. The Microelectronics and Information Sciences Center (MEIS) gathers this region's high tech companies and staff of the University to make tomorrow's impacts collaboratively.

By John Cornwell

They're in cars, stereos, telephones and video cassette recorders. They make video games, personal computers, calculators and digital watches possible. They are microelectronic devices, and they're causing a surge of new products and industrial growth — from coast to coast — and throughout the world.

The economic potential for microelectronics is immense. Rewards are great for organizations, and geographical regions, that lead in high-technology research and development. In this context, "MEIS" was born at the University of Minnesota.

The Microelectronic and Information Sciences Center (MEIS) is a bridge between high-tech industries and I.T. Its mission is to enhance the educational and research activities at the U of M in the microelectronic and information sciences and to increase interaction between the university and industrial scientists and engineers.

"Microelectronics" is the technology of constructing circuits and other electronic devices in very small packages. In other words, microelectronics is the science and technology behind the materials, design, and fabrication of computer chips. "Information sciences" address the software aspects of computer systems, especially in the area of artificial intelligence. These high-technology fields are growing rapidly, creating enormous potential for industrial growth and career opportunities.

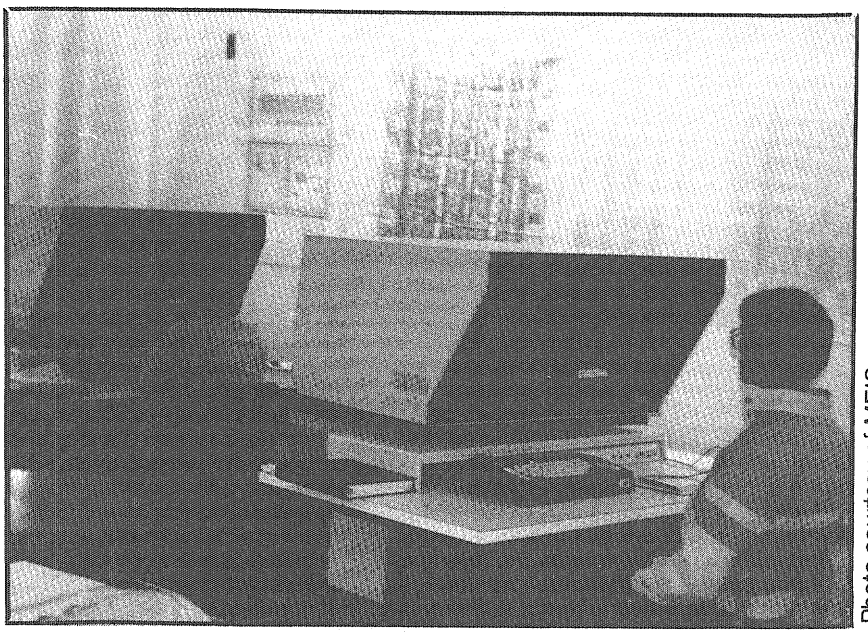


Photo courtesy of MEIS

Computer-aided design workstations in the MEIS VLSI Design Laboratory are used by students to design integrated circuits for microelectronic devices. The VLSI Design Laboratory is in the basement of Lind Hall and is one of the laboratory facilities supported by MEIS.

Silicon Valley (named for the silicon on which microelectronic devices are made) and cities on the East Coast have been the leading areas of high-technology growth. And the Japanese have launched major efforts to usurp that lead. But the unique combination of high-tech companies in close proximity to the University of Minnesota make Minnesota a robust challenger in the high-tech race.

Control Data, Honeywell, Sperry, and 3M sponsored MEIS initially in 1981 as a joint venture with I.T.. In addition, MEIS is supported by the State of Minnesota, federal grants, and other participating companies. The newest corporate sponsor of MEIS is Cray Research which became an associate member last winter.

The MEIS Purpose

"MEIS is an interdisciplinary organization that thrives on the synergy created by the partnership of university, industry, and government," said Dr. Martha Russell, Associate Director of MEIS. "It is dedicated to research, education, and technology transfer in the microelectronic and information sciences and is based on the philosophy that in the rapidly advancing world of technology, university-industry collaboration is essential," she added.

The MEIS main office is in 227 Lind Hall, but MEIS programs reach across many departments in I.T., joining students and faculty from diverse fields in basic research that will affect technological

advancements over the next five to ten years. This interdisciplinary approach makes possible team research programs which bring together faculty and graduate students from many departments as well as industrial scientists and engineers. Affiliated departments include Chemical Engineering & Materials Science, Chemistry, Computer Science, Electrical Engineering, Physics, Child Development, and Management Information Science.

In a recent Congressional report, Minnesota was recognized as among the leaders and one of five university programs for information technology research and development according to Dr. Russell. "The efforts of MEIS invigorate a number of departmental programs and enhance the University's ability to approach scientific problems with fresh insights — fresh insights which may be a key to discovery and innovation," she added.

Education

Advanced undergraduate and graduate students study microelectronic and information sciences through coursework offered in several departments. Through MEIS sponsorship, several new faculty positions have been added to the affiliated departments. These new faculty members have brought research and instructional expertise and have made possible the addition of new courses and research activities in microelectronic and information sciences.

Each year MEIS provides money to several Ph.D. students in the form of fellowships. MEIS also brings graduate students to the University through research assistantships and postdoctoral positions.

Laboratory facilities and equipment used by students have been established and improved by MEIS. These areas include the Microelectronics Laboratory in Electrical Engineering, Synchrotron X-Ray Beaming Laboratory in Stoughton, Wisconsin, and the VLSI (Very Large Scale Integration) Design Laboratory in Lind Hall which has computer-aided design (CAD) workstations for designing integrated circuits.

Technology Transfer

MEIS also promotes the exchange of knowledge and ideas between the University and industry. This transfer of technology is encouraged through visiting academic and industrial scientists, seminars, colloquia, technical reports, and other publications. Students involved in MEIS often work for member companies during the summer which increases information exchange through personal interaction.

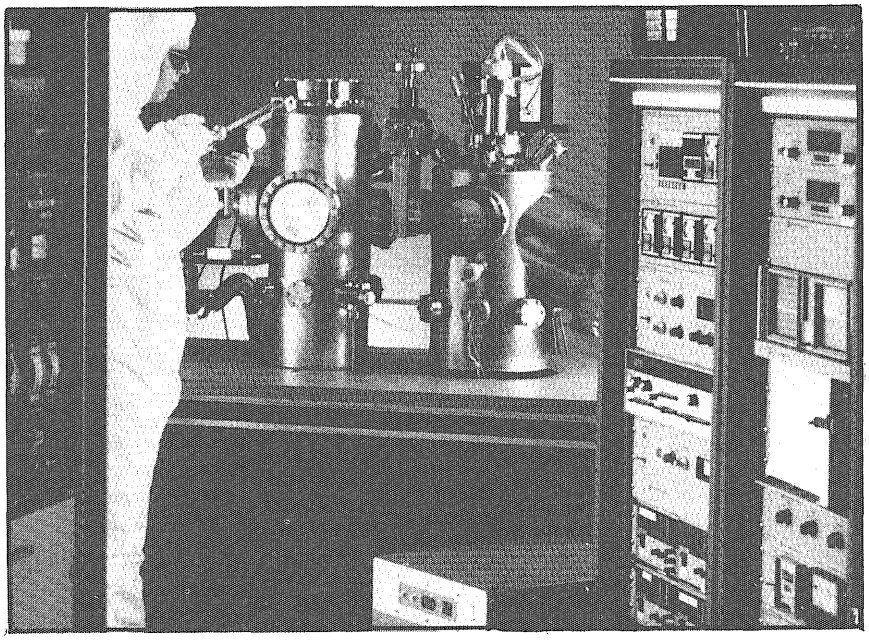


Photo courtesy of MEIS

A Molecular Beam Epitaxy (MBE) in the Microelectronics Laboratory The MBE is used to grow films of gallium arsenide and other compounds which could be used to make microelectronic devices. MBE is a technique of growing single crystals in which beams of atoms or molecules are made to strike a single-crystalline substrate in a vacuum.

Research

Research projects sponsored by MEIS foster discovery at the leading edge of science and technology in microelectronic and information sciences. In addition to sponsoring individual faculty members, MEIS provides funding for four team projects: Artificially Structured Materials for Microelectronics, High-Performance Integrated Circuits, III-V

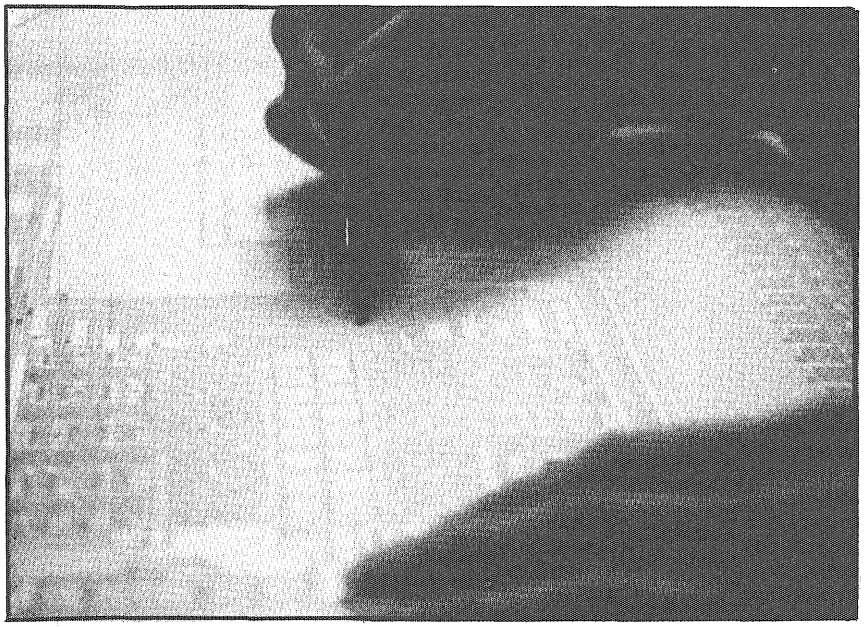


Photo courtesy of MEIS

After designing integrated circuits a student looks at a printout of the design. The printer is connected to the computer-aided design workstations in the VLSI Design Laboratory.

Compound Semiconductors and High Speed Devices, and Intelligent Systems. Each project is being conducted by a team of ten to twenty faculty, graduate students, and industrial liaisons which increases the scope of the research and usefulness of results.

Artificially Structured Materials for Microelectronics

This project is being conducted by people in Chemistry, Chemical Engineering and Materials Science, and Physics. Studies of artificially structured materials are pointing to new technologies which will permit greater speed, flexibility, and reliability of microelectronic devices.

The team is using new physical vapor techniques and chemical techniques to fabricate and characterize growth and structure of ultra-thin films and small particle structures. Knowledge about these structural components and growth processes are important in developing new approaches which affect the final chemical composition, phases, defects, and stresses in these artificially structured materials.

High-Performance Integrated Circuits

The current trend of making smaller and smaller circuits with more and more features is reaching its physical limits. Therefore, a team of researchers in Electrical Engineering is exploring the possibilities for the three-dimensional all-semiconductor integrated circuits. They are also devising a continuous fabrication process that will eliminate older technology.

These novel approaches will drastically reduce costly waiting time in integrated-circuit fabrication. Improvements in cost, performance, and size of integrated circuits, smaller average lengths for buses and leads, significantly relaxed minimum-feature size, and improved volumetric density may also be possible.

The team is defining appropriate devices and circuits, modeling them, fabricating prototypes, and developing acoustic microscopy using lasers as a method of nondestructive evaluation. The scientists are also addressing the yield-management, test-technology, and power-dissipation issues that must be resolved for success in this or any other approach to total-system integration.

III-V Compund Semiconductors and High Speed Devices

III-V refers to the columns in the periodic chart of the elements found on the walls of most chemistry classrooms. III-V compounds, gallium arsenide (GaAs) for example, have the potential for much faster microelectronic devices. Therefore, researchers in Chemical Engineering and Materials Science and Electrical Engineering are exploring ways of making computer chips out of GaAs instead of silicon.

Innovative modeling techniques use the results of these studies to identify new design specifications. The integration of basic materials research with device fabrication and performance evaluation places the group in a unique position in III-V compound semiconductor research.

Intelligent Systems

This project involves software for artificial intelligence. Researchers in Computer Science, Electrical Engineering, Management Science, and Child Development are developing high performance computing systems which incorporate reasoning techniques.

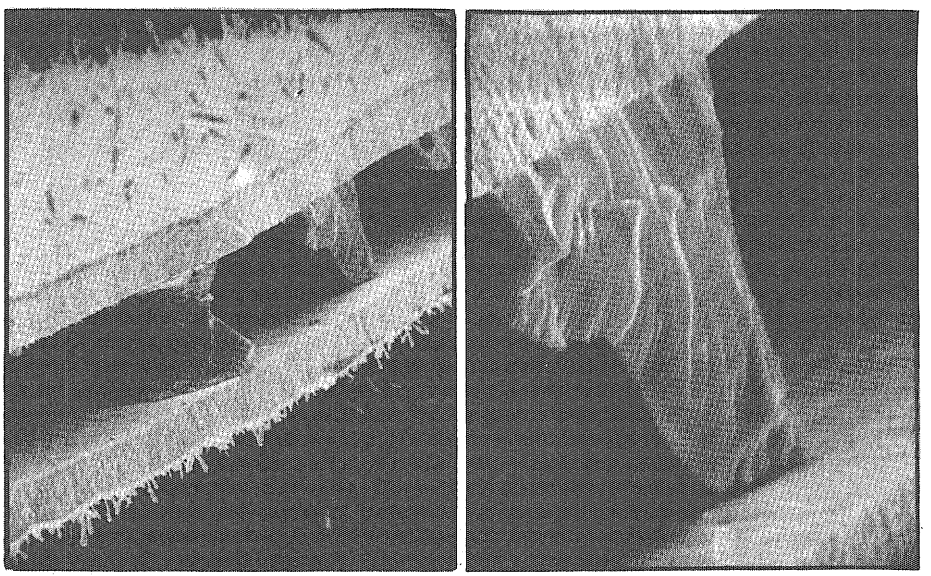
Many of the scientific, engineering, and management problems for which computer aids are envisioned are currently solved by human experts. Therefore, an understanding of the mechanisms of human performance can offer powerful insights into possible computational approaches to these problems. New techniques for both computer vision and expert systems are being explored.

Work in computer vision is concentrated in space perception. The team is developing methods for determining the spacial relationships between objects in a scene based on motion of a sensor or on motion of objects. An ability to determine such relationships appears to be necessary for almost any task requiring complex visual analysis, such as in robotics.

The focus of the expert systems research is on diagnostic systems for determining the nature of faults in a malfunctioning system given the symptoms of the malfunction. The team is investigating fault diagnosis using two forms of diagnostic reasoning. The ultimate goal is to develop diagnostic expert systems which can use both forms of reasoning effectively.

A New Approach

Team research is rather unusual in university settings. Research performed by individual faculty members is much more common. A research team, however, can work together to address problems or technologies that cross over departmental boundaries.



Researchers in the Artificially Structured Materials for Microelectronics project are studying microstructures. This microstructure (above) consists of nickel oxide layers spearated by nickel sulfide pillars created from a thin nickel foil by heating in sulfer dioxide. Photo courtesy of MEIS

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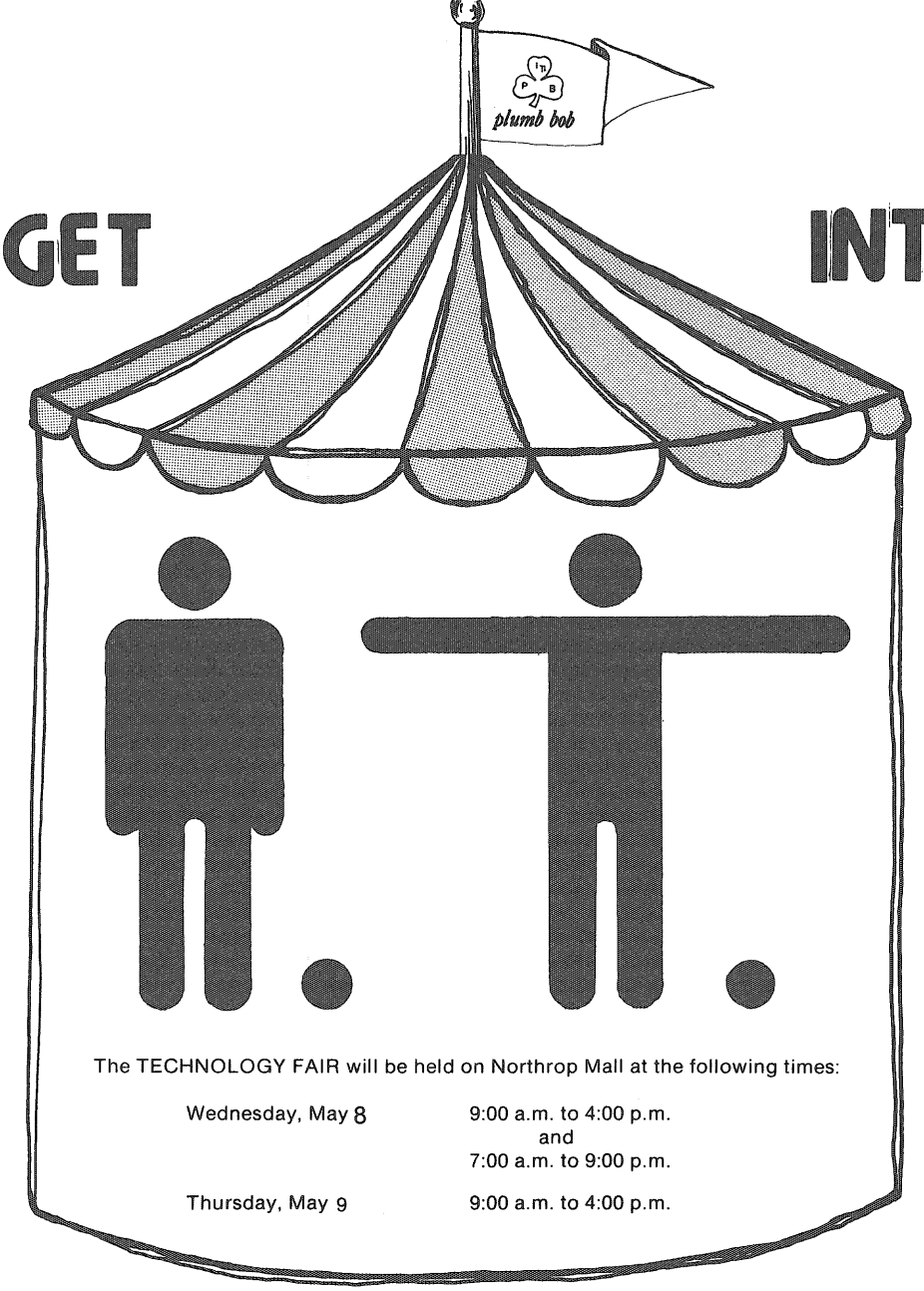


The TECHNOLOGY FAIR will be held on Northrop Mall at the following times:

Wednesday, May 8	9:00 a.m. to 4:00 p.m. and 7:00 a.m. to 9:00 p.m.
Thursday, May 9	9:00 a.m. to 4:00 p.m.

I.T. TECHNOLOGY FAIR

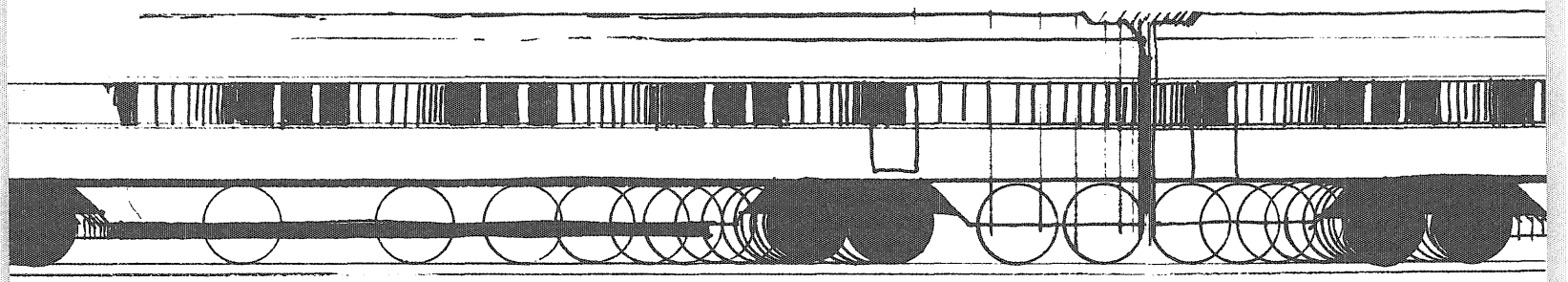
Come see us in the tents

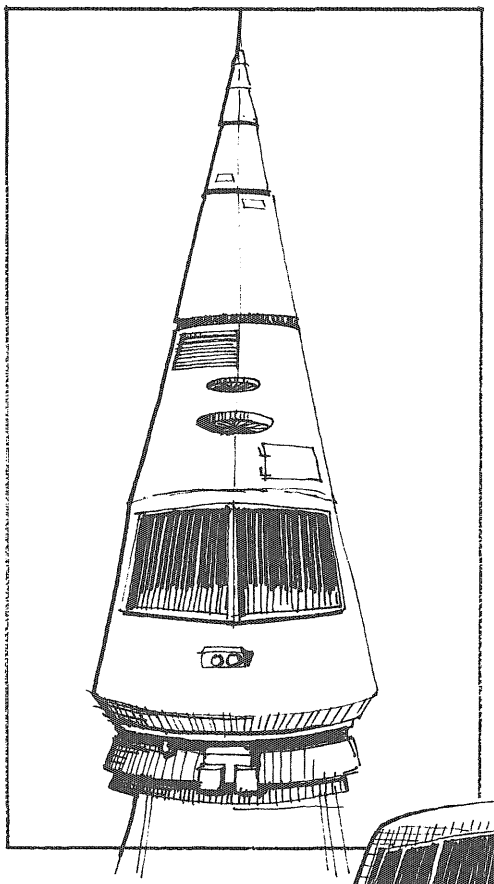
TENT DISPLAYS:

ADC- Magnetic Controls
AT&T Bell Laboratories
AT&T Information Services
Control Data Corporation
Cray Research, Inc.
Data Card Corporation
FMC Corp., Northern Ordinance
Frito Lay
H.B. Fuller Company
Hewlett Packard
IBM Corporation
McDonnell Douglas Corp.
MTS Systems Corp.
Research, Incorporated
Rosemount, Inc.
Sperry Corporation
Texas Instruments, Inc.
3M, Division Engineering
U.S. Air Force
Standards Engineering Society

CONTRIBUTORS:

Conwed
Exxon Corporation
Henkel Corporation
Hewlett Packard
MTS Systems Corporation
North Star Steel Minnesota
Potlach Corp., Northwest Paper
Union Carbide Corporation
Whirlpool Corporation



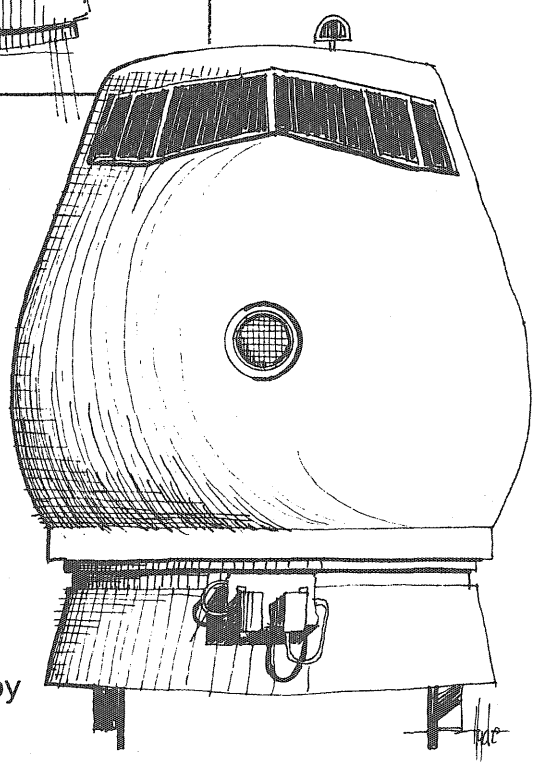


High Speed Railways:

Japan, France, and Britain's Solutions and the U.S. Situation

Trains capable of regular runs above 125 mph can be obtained two ways, either build special tracks or modify the existing tracks.

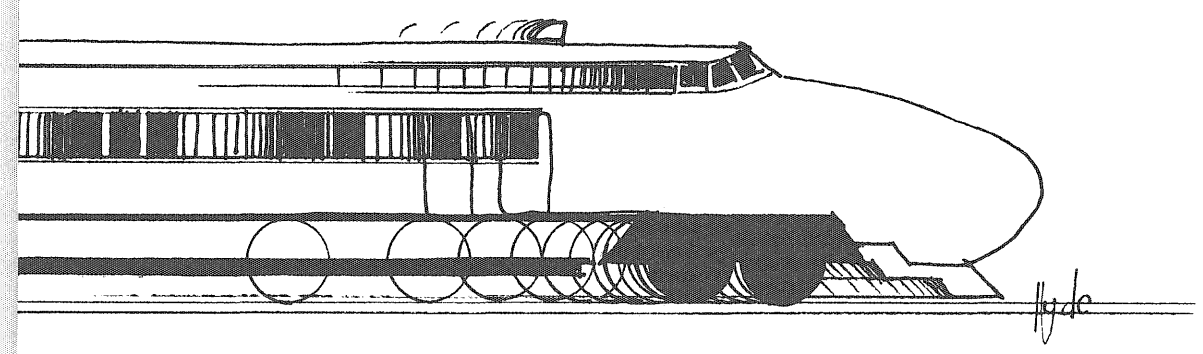
By Steve Zobbie



Illustrations by David Hyde

The high speed potential of railways has always been a major subject of interest. Yet, the definition of high speed rail is a transient quality. Today nothing less than 125 mph will attract attention in today's railroad world. France has made 160 mph daily practice. Even higher horizons are being considered; the world record for rail speed now stands at 235 mph.

The fact is, the world is now in the middle of the greatest of all the Golden Ages of Railroading. In Japan, all over Europe, and in North America, trains are moving faster than ever before, safely and efficiently, as one by one the mysteries of railway science have been solved. After 19 years of operation, Japan's Shinkansen has carried over two million people without a single fatality. Only elevators can carry people as safely.



However, it's energy and labor efficiency that is driving the world rail renaissance. A steel wheel deforms much less under axle load than a rubber tire. This means less area of contact, and this, combined with the very low coefficient of friction of steel on steel makes the railway, in consumption per passenger-mile, seven times more efficient than a bus, twelve times more efficient than private auto, and fifteen times better than jet aircraft. And trains can be of virtually unlimited length. In Japan, 16-car trains carry over 1600 passengers — with one driver.

Conventional railways are usually built primarily for freight, thus the greatest concern is the steepness of grade. Railways will follow very convoluted routes in order to avoid steep grades, and if money is available, they will dig long tunnels as well. Curves, however sharp or frequent, are accepted if it lowers the ruling grade.

When fast passenger trains are operated, the primary concern is sharpness and frequency of curves, for they limit train speed. Passenger trains need so much horse power to accelerate to high speeds that grades are of little consequence. Already the conflict is apparent; freight trains need flat routes and passenger trains need straight routes. Build a railroad for one weight of train moving at one speed and most any curve sharpness is allowable, as the increased outward force can be counteracted by superelevation (banking). But if another train of higher weight and lower speed comes long, it will bite hard into the inside rail, or even fall over.

A railway handling trains of one weight and speed also maximizes the use of its tracks, for passing is all but eliminated. "Narrowing the speed band" reduces the number of parallel tracks that are necessary to handle a given traffic, lowering track maintenance costs. It was primarily these two factors, and a desire to lower the cost of hauling freight, which led U.S. railroads to drive passenger trains off their rails. Besides well-banked curves and a narrow speed band, there are other requirements for a safe three-digit passenger service.

What makes railways special is that unlike all other major transportation modes, a single entity controls the entire system.

Elimination of grade crossings with roads and highways to as high a degree as possible is a major objective. Signalling needs attention as well; in particular, it has to allow for the greater stopping distances of a very fast train. Most railways also install Automatic Train Stop (ATS) equipment to prevent red light-running, Continuous Cab Signalling, which brings lineside signal indications into the driving cab, and Track-To-Train communication equipment, allowing the train crew to talk with the dispatcher (the R.R. traffic cop) whenever necessary. To justify all this expense and fuss, it's useful to have a very heavy passenger train volume.

If a great volume of traffic is to be carried, it's nice to have electrification, as well. Putting up overhead wires and modifying the signal system is expensive, but in much of the world the money is spent because coal or hydropower is more plentiful locally than petroleum, and it's easier to pack thousands of horsepower (both continuous and short-term overload) into an electrical locomotive. This power means fast acceleration and high starting torque, which means much higher traffic capacity. West Germany runs a typical European railroad, with 40% of its tracks, but 85% of its traffic, electrified.

What should be obvious by now, is that railways are integrated systems, that one part can't be changed without affecting something else. Actually all transportation systems are that way. What makes railways special is that unlike all other major transport modes, a single entity controls the entire system. So if we are going to look at high speed railways, we must look at systems as a whole.

Basically there are two ways to obtain high rail speed; build special tracks dedicated to the fast trains, or try to modify the existing system for higher speed. We will look at three such systems, dedicated systems in Japan and France and Great Britain's attempt to attain equivalent performance at much lower cost by modifying their existing railway.

Japan's Shinkansen

Japan's Shinkansen (New Rail Lines) presently stretch 1100 miles from Fukuoka to Osaka, Tokyo, and Northern Honshu, with a branch over the spine of Honshu Island to Nigata. Since 1964 over two billion passengers have been carried without a single fatality or serious injury. The line speed is 130 mph and is primarily limited by trackside noise, a problem as the Shinkansen is routed through densely populated areas.

Design speed is 162 mph. To obtain this in mountainous Japan required very expensive construction. For instance, 50% of the 350 miles from Osaka to the 11.2 mile to Kyushu

Island is in tunnel. In order to avoid all grade crossings, 80% of the remainder is on continuous viaduct. The track is very sturdy, and follows designs now standard worldwide; continuously-welded rail (to eliminate nicking of rail joint-ends) on concrete ties, held in place by steel track clips.

The trains incorporate low-weight alloy in construction, but are noted for their power; a 16-car train packs 23,600 h.p. of motors. Power is at 25 KV at 50 hz., and is linked to seisometers which cut off the electricity if earth tremors are received above a safe value.

The entire system is controlled from a central office in Tokyo. Due to the toy train like simplicity of the track layout, all functions except stopping at station platforms can be controlled automatically. The level of automation means person for person, the Shinkansen staff is nine times more productive than Japan National Railway's (JNR) entire workforce. Thus in 1980, only 40% of Shinkansen's operating cost was for personnel, with 45% going for equipment repair. Total expenses, including interest on construction cost was $1.9 billion, against revenues of $3.2 billion.

France's TGV

France was the second country to open a special passenger-only line, the TGV-Sudest. In comparing Shinkansen to TGV (Train Grande Vitesse), the influence of geography on system design is clearly apparent. Japan is very mountainous, and populated areas are very congested. Hence Japan's original rail system was built to a standard incompatible with modern passenger train operation. Thus Shinkansen was conceived as a completely new system, incompatible with the old. France is relatively flat and is not densely populated, in comparison to the rest of Western Europe. Its railway network is, as a whole, well aligned for 100 plus mph operation. The heaviest-traveled line is the old Paris-Lyon-Mediteranee (PLM) line, running from Paris, through the hills of Burgundy, to Lyon, where trains branch to Marseilles, Italy and Switzerland.

The Paris-Lyon segment is a virtual traffic funnel, but it is also sharply curved as the builders were planning to haul both freight and passengers.

In the late 1960's, the French National Railways (SNCF) realized that if traffic continued to grow on the Paris-Lyon route, self-strangulation was likely by the 1980's. Adding parallel tracks on the existing right-of-way was unappealing because the sharp curves would always limit train speed. Given the rural character of Central France, it looked better to build a new shorter, faster passenger-only railway.

The world record for rail speed now stands at 235 mph.

The TGV-Sudest would be no Shinkansen, designed to supersede the existing rail network, but would supplement it, cutting hours off schedules.

The TGV-Sudest leaves the old line 19 miles from Paris and 4 miles from Lyon, cutting the 318 mile PLM line to 264 miles. Like the Shinkansen, the minimum radius is 4000 meters, but while in Japan the steepest grade is 1.5%, SNCF indulges in grades as steep as 3.5%, using the ample power in the train-sets. Thus the TGV-Sudest lacks a single tunnel.

The TGV-Sudest misses every hamlet, town or village by at least 800 feet, and its welded rail on concrete ties double track hugs the earth's contours for minimal visual impact and construction cost. The train's consist of 8 coaches and a 4250 horsepower car on each end. The TGV-Sudest is wired for 25 KV, but all trains are equipped for the 1.5 DC on the old sections, and six trains can also handle the 15 KV, 16 2/3 hz. of Switzerland.

The TGV's, with their low-slung, lightweight construction are cleared for 120 mph on existing SNCF track, and as you might guess the combination of new, distinctive orange trains and a new 260 mile long racetrack has created the popular impression that France has built a new supertrain, a la Shinkansen.

Indeed TGV has cut Paris-Lyon times by 46% (average speed 132 mph), but TGV is really just another effort to obtain high speed rail transportation, skillfully executed.

Britain's APT and HST

Since before WWII, Great Britain has lagged far behind its neighbors in railway investment, and thus British Railways (BR) has always been obsessed with penny-pinching. This has been compounded with the fact that Britain is the railway's birthplace, and thus BR's mainlines are old, nearly all built before 1850. Their sharp curves and steep grades have severely hampered BR revitalization. Through the 1950's BR was strapped just repairing war damage and replacing its steam fleet. In 1962 however, BR assembled a team of engineers from the railway and aircraft industries and set them to work putting BR into the forefront of railway engineering —on the cheap.

The result was the Advanced Passenger Train (APT) of 1967, a vehicle incorporating most every possible gadget; gas-turnbine power, aluminum-skin body, full articulation, artificial body-tilting (to compensate for inadequate superelevation) and hydro-kinetic brakes. Top speed would be 155 mph, curves could be rounded 40% faster and without modification of tracks or signals. Given government funding, APT's could revolutionize BR by 1972, said the designers.

Twenty two years after the effort began, APT's are operated three times a week in test service. Basically APT is too great a great leap forward, although it may yet prove to be the shape of things to come.

In 1970, with eight years gone and not even a prototype on the tracks, British Railways began another, less ambitious try. The result was the High Speed Train; eight cars with two 2,250 hp. diesel locomotives on the ends.

While APT was an attempt to get high speed by loading technology into the train, HST assumed a more balanced approach. The first HST's, applied to Western Region from London to Bristol and South Wales. This route was originally engineered by one of the great visionaries of the last century, I.K. Brunel (1806-1859).

So well aligned is it that HST's can use their 125 mph top speed for 72 miles out of London, except for one 80 mph restriction. Little modification of signalling was required because HST can stop in 6,000 feet from 125 mph, a primary design goal.

In the first years of operation, BR's "Inter-City 125" service pulled in 28% more business than the old trains. With plenty of 100+ mph average speeds in the Thames Valley, it was the world's second fastest rail service. Next to receive HST's was the Eastern Region, running from London to Newcastle and Edinburgh. In the 1960's, BR had astounded the railway world with its fleet of "Deltics," named for their 3300 horsepower, opposed-piston diesels. They revolutionized service on the East Coast Route.

Indeed the Deltic's performance so impressed BR that some $100 million was put into grade-crossing removal, signal modification, curve straightening and station trackage reworking. Eventually only three speed restrictions were left between London and Newcastle, all 110 and 125 mph territory.

Later additions to the "Inter-City 125" network routes linked the Midlands with Yorkshire, and London with Cornwall. Clearly, BR's "Deltics" are a model for diesel-powered passenger rail service with a service quality matching any attempt by electrics on conventionally-signalled track.

Viewpoint: America's Trains

There is little doubt that high speed rail has been successful in many countries, including West Germany, Italy and the Low Countries. But what about North America? Will we ever ride such trains in our country. Geographically, the Northeast, Midwest United States and Eastern Canada are virtually ideal for high speed rail; the major cities are spaced one to three hundred miles apart, with plenty of flat, open country between. There is plenty of under or unused track, mostly constructed with light grades, broad curves and double tracks. As Britain's HST show, there is no need for costly electrification if the traffic doesn't justify it, and this would greatly cut capital costs.

Simply by providing fast and cheap transportation, a high speed rail system would be a great benefit to society; time and petroleum would be saved, air and noise pollution would decrease, there would be less road and airway congestion, greater economic growth in the traversed areas and improved access to transportation for elderly, handicapped and young people. If combined with a fast freight service, the economic picture would get considerably brighter, and high speed rail could start replacing not only auto, air and bus traffic, but long—haul trucking as well. Massive amounts of government expenditure would not be necessary, but rather a continuing commitment to improving rail service, and an expenditure on the order of a few hundred million dollars every year. So what's stopping us?

Amtrak was a child of Congressional panic, and it has been told little else by Congress but to keep the trains running and lose as little money as possible. No national policy exists on high speed rail, and thus every project is discussed in isolation. High Speed Rail could be a reality in the U.S., especially if the people knew where the trains would run and how they would benefit from them. Then the money, relatively small compared to what is lavished on road and rail service, would be more forthcoming. Thus it's unlikely this nation will ever have a crack rail service until it's been decided that high speed rail will be part of the nation's future transportation network.

Amtrak is a strange railroad indeed; owning hundreds of locomotives and thousands of cars, until 1977 it didn't own a foot of track. Amtrak leases track space from the railroads to run its trains, and pays them to run them. Hence Amtrak is at the mercy of the railroads, not only for the condition of the tracks, but the operation of any conflicting traffic. Indeed some railroads have been openly hostile to Amtrak's operations.

It is apparent that rail service can't be significanly improved without work on the track and signals, which is usually the property of the railroad and not Amtrak. Many railroads only desire to run heavy, slow trains, which dashes any hopes for operating fast passenger trains. Besides, there is the question of whether public money should be used to improve private property.

Amtrak is funny in another way, for it suffers from a sort of operational schizophrenia. One railroad it tries to operate is a crack, frequent service on its busiest lines; the tracks it owns from Boston to New York and Washington, the 100 miles of Santa Fe track from Los Angeles to San Diego, and a few others out of Chicago. The other railroad is long, slow and usually late.

Photo by Mike McGee

When the service is competitive, the prize is the business traveler and express package delivery. When it's not, the marketing is directed at the tourist, who rides mostly to see the scenery. Amtrak must attract both kinds of traveler, and its advertising can be quite confusing and thus ineffective. If high speed rail is to be pursued, Amtrak should be split into two entities; one to develop tourist travel and integration with the bus system, the other to steer business travelers and express package senders away from congestion-causing short-distance air carriers, by developing a high speed rail service operating on its own tracks, purchased from the railroad by the power of eminent domain.

The one place in America where these changes have started to take place is the Boston-Washington Northeast Corridor (NEC). Oddly, Amtrak is showing little enthusiasm over these first steps to high speed rail service. Still someday in this decade, America will run its first really fast trains, a string of Amfleet cars built by Budd Co. of Philadelphia and hauled by a Swedish-designed 6100 horsepower AEM-7 electric locomotive, built by General Motors. Maybe that day will be the start of a new American rail renaissance.

If it is, the next place to look at is the nation's second heaviest-traveled corridor (40 million trips/year), running from Los Angeles to San Diego. Here it would be necessary to either build a new railroad or heavily revamp the old one, because the existing line is only single track and at maximum capacity.

The Chicago-Milwaukee-Twin Cities line is the third busiest rail corridor in the United States.

Such a line would be expensive, but it would be profitable according to a Japanese-American consortium set up to build it. American High Speed Rail Corp., as it was called, invested $10 million to study the feasibility of a Shinkansen-like system connecting San Diego with Los Angeles and LAX Airport. But the project was shelved in 1984, mostly due to environmental antipathy and general apathy. Still the California Department of Transportation estimates that the L.A.-San Diego freeway will reach capacity by 1990. Slowly but surely, the dawn of high speed rail in Southern California is coming.

Next on the list is the third busiest corridor (7 million trips/year), Chicago, Milwaukee and the Twin Cities. The double track the fastest trains in America once ran on are still in place. A thorough overhaul of the Milwaukee Road (now Soo Line) tracks would result in plenty of 125 mph trackage, suitable for a 4 hour Chicago-Twin Cities express and a super-fast trailer-on-flatcar (TOFC) freight service. For this service, something like British Railway's HST seems perfect.

Continued on page 26

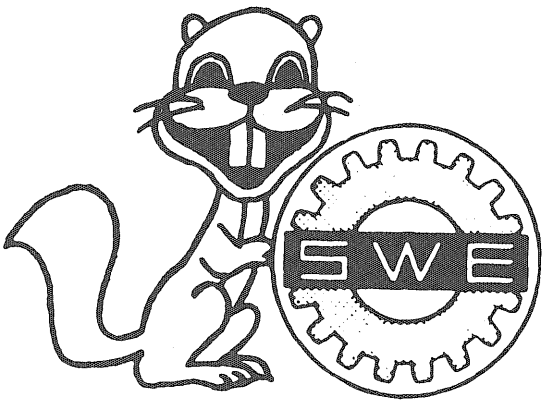
WELCOME

to all
Participants at the

Society of Women Engineers' 1985 National Student Conference

We hope you find the conference informative and interesting, and that you enjoy attending the conference as much as we enjoyed organizing it.

1985 National Student
Conference Committee
Paula Derr, Chairperson



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Making Air Transports More Fuel Efficient

Fuel is the single largest cost for a modern airline. To reduce these costs, a NASA program is developing advanced propulsion and structure technologies.

By Vernon Thorp

OPEC's oil embargo of 1973 and the ensuing energy crisis dealt a serious blow to commercial aviation. Prior to the embargo, airlines paid 10 cents for a gallon of fuel and fuel represented only 25 percent of their direct operating costs. Fuel prices skyrocketed in 1973 and continued to rise through the rest of the decade. In 1984, fuel accounted for about 57 percent of an airline's direct operating costs.

In order to help ease the problem for airlines and allow American aircraft manufacturers to remain competitive in the world market, NASA began its Aircraft Energy Efficiency (ACEE) program in 1976. The program's goal is to reduce fuel consumption in commercial jet transports. ACEE has concentrated its efforts in the two areas of propulsion technology and airframe technology.

Propulsion technology has advanced far beyond the turbojets of the 1970's. These jets first allowed airliners to maintain relatively high cruise speeds (Mach 0.8-0.9), but were not efficient. The introduction of low-bypass-ratio turbofans, in which a portion of the intake air flows around the actual turbine engine, gave the same cruise speeds with 25 percent less fuel. High-bypass-ratio turbofans reduced fuel consumption another 25 percent. NASA and industry research promises an additional 10-15 percent savings over the next few years as turbofan technology continues to improve.

Another area of propulsion technology which shows great promise is the propfan, sort of a cross between a propeller and a jet engine. The propfan consists of a large number (8-12) of highly swept blades and is of smaller diameter than a traditional propeller. Propfans will allow cruise speeds equalling turbofans, whereas traditional propeller-driven aircraft typically cruise around Mach 0.6. The slower speed for traditional props is due to a drop in efficiency as the tip of the rotating blades approach sonic speeds. The smaller diameter of the propfan and the high sweep of the blades delays the onset of this problem and allows performance comparable with that of jets for subsonic flight. Propfans designed with current technology could reduce fuel consumption another 30 percent over turbofans currently in use. In fact, for any given technology level, a propfan is about 15 percent more efficient than a turbofan. Besides increased fuel efficiency, propfans also offer improved takeoff performance and decreased environmental noise. Full-scale flight testing will begin in 1986. Questions still to be answered involve optimum blade design, cabin noise levels, and optimum installation geometries.

ACEE's efforts in airframe technology fall into 4 main areas: laminar flow systems, advanced aerodynamics, flight controls, and composite structures.

Laminar flow control seeks to reduce drag on aircraft by delaying the onset of turbulence in the boundary layer, a very thin layer of air next to the surface. Turbulence can be delayed by preventing the boundary layer from growing too thick and becoming unstable. Keeping this layer thin requires removing air from it, and this can be accomplished by a series of thin slots that suck in part of the boundary layer or by a porous wing surface through which air is drawn. Flight tests and wind tunnel tests show promising results, and the industry is looking into the feasibility of incorporating these ideas into wing designs for future aircraft.

The value of these advanced technologies becomes clear when one considers that a one percent reduction in drag or fuel consumption for a single large transport results in savings on the order of $50,000 to $100,000 per year.

Advanced aerodynamics also focuses on reducing drag. Results of NASA's work in this area include new wing designs, new engine inlet designs, and the development of winglets which attach to the tips of conventional wings. Flight testing shows each of these advances might reduce drag by two to eight percent. Winglets are now used on several business jets and larger jet transports.

Active controls contribute to increased fuel efficiency in two ways. First, computer controlled active

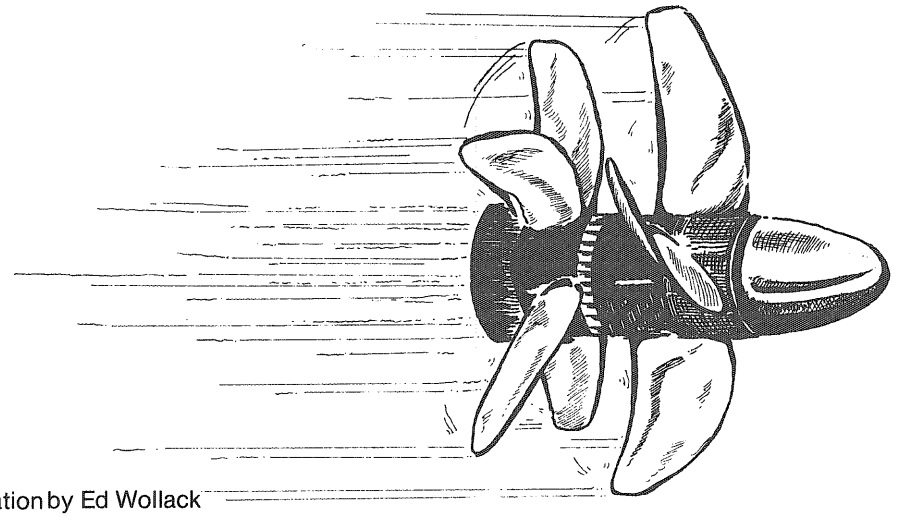

Illustration by Ed Wollack

control surfaces respond rapidly to turbulence and gusts and can modify the loading on wing surfaces to minimize drag throughout a flight. Second, active controls permit use of a smaller tail section. An aircraft's tail size influences how stable it is, so a smaller tail means less stability, but an active control system can make up the difference. Fuel savings result due to decreased drag and structural weight of a smaller tail. Flight testing of several different systems began in 1979 and studies have shown that the horizontal tail area of a Lockheed L-1011 could be reduced by 30 percent, trimming fuel consumption by three percent. Boeing has investigated applying active controls technology to the design of an advanced subsonic transport similar to the 767. The horizontal tail area decreased 45 percent in the new design, and fuel requirements dropped by five to ten percent due to active controls.

Composite structures already see limited use on commercial transports in the form of secondary structures (spars, ribs, covers) and tail section components. In general, use of composites in place of metal structures results in a 25 percent weight reduction. The Boeing 757 and 767 aircraft both use over 3000 pounds of composite structures, yielding a weight reducion of 850 pounds and improving fuel efficiency by two percent. As composites begin to appear in larger structures, load response, design requirements, and manufacturing techniques become more complex. The largest composite structures now in use are vertical tail sections on 737's, DC-10's, and L-1011's. Much work remains to be done before large primary structures such as fuselages and wings will be made entirely of composites. A more complete database on loading behavior, failure modes, damage tolerance, and manufacturing methods is required. Aircraft manufacturers are currently working under NASA contracts to develop full-scale composite primary structures, and as the database matures they will manufacture the first full-scale components for testing. Boeing plans to demonstrate technology readiness with a full-scale fuselage barrel in 1988. By 1990 composites could result in a weight reduction of over 30 percent for the entire airframe structure, with an accompanying reduction in fuel consumption of 15 percent.

Propfans will allow cruise speeds equaling turbofans.

Composite structures already see limited use on commercial transports.

The value of these advanced technologies becomes clear when one considers that a one percent reduction in drag or fuel consumption for a single large transport results in savings on the order of $50,000 to $100,000 per year. Integration of all the technologies dealt with by the ACEE program could result in an overall fuel use reduction of over 40 percent.

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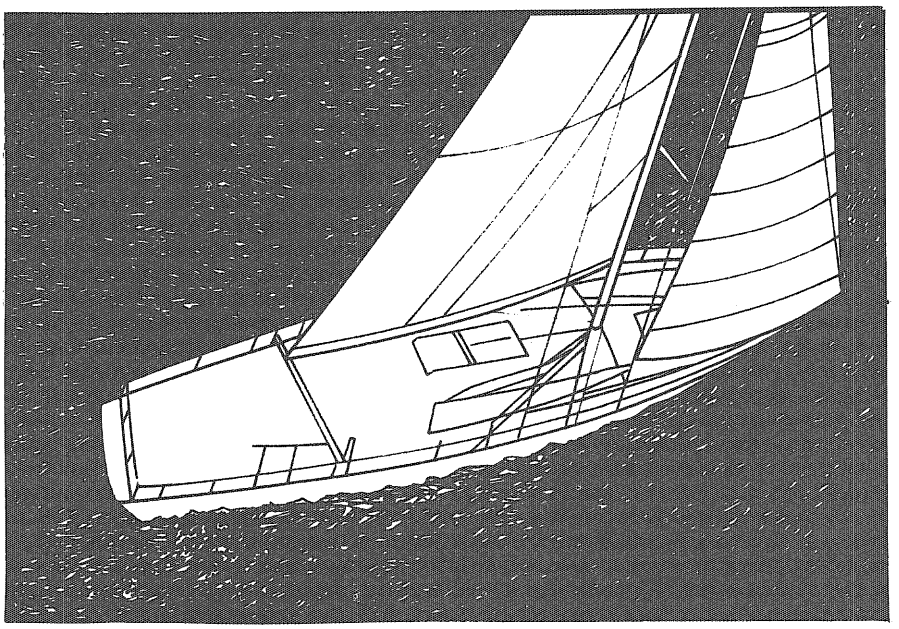


Illustration by Nan Gehrig

Building A Better Boat

The loss of the America's Cup in 1983 to Australia has set off a fury of yacht designing efforts. This incomplete guide should get you started if you want to enter the next running.

By Phil Decker

In Minnesota the license plates read, "Land of 10,000 Lakes." In the State of Western Australia — almost exactly the other end of the globe — the license plates read, "Home of the America's Cup." Like to find out why? Read on.

In a suburb of Sydney, Australia, called Dee Why sits an overweight leprechaun with high blood pressure behind a Hewlett Packard graphics plotter and computer, cursing. He is cursing the computer because he has not yet read the instruction manual, and he won't because his name is Ben Lexcen, the designer of the *Australia II* and winner of the America's Cup. Lexcen is in the process of giving the yacht designing industry an ulcer.

Australians had not generally been regarded as champion yachtsmen until the 1983 America's Cup races in Newport, Rhode Island. The New York Yacht Club had held the cup for 132 years, but in 1983 the Australians won it after twenty years of trying. A key element in their victory was Ben Lexcen, the eccentric designer of the winning boat, *Australia II*.

The methods used in yacht design have not drastically changed since being started by the Portuguese in the 1400's. One starts with the Lines Plan, a three dimensional projection of the hull shape that is rather similar to the drawing done by mechanical drafters. The three views are the side view, bottom view, and the front/back view. Between the outlines on each view, topographic lines are drawn at equal distances along the boat, like elevation lines on a geographical map. Only half of the boat needs to be drawn, since the boat would hopefully be symmetrical. The elevations are done in feet above and below the water line, quarter breadths from the vertical centerline, and "stations" on the side view.

Stations are the divisions which would result if one were to cut the boat into ten equal parts from where the hull enters the water to where it leaves the water. This is a remnant of the old days when designers carved the desired hull shape from a block of wood and literally sawed it into ten pieces. One successful Australian designer of the 1800's actually used measurements off a mackerel he had caught in Sydney Harbor.

The methods of yacht design have not drastically changed since the being started by the Portuguese in the 1400's.

This part of yacht design is basically an art. There are no equations to determine the ideal dimensions and the designer is free to draw in the lines that he thinks would make a good boat. The science comes in during the analysis of what one has drawn.

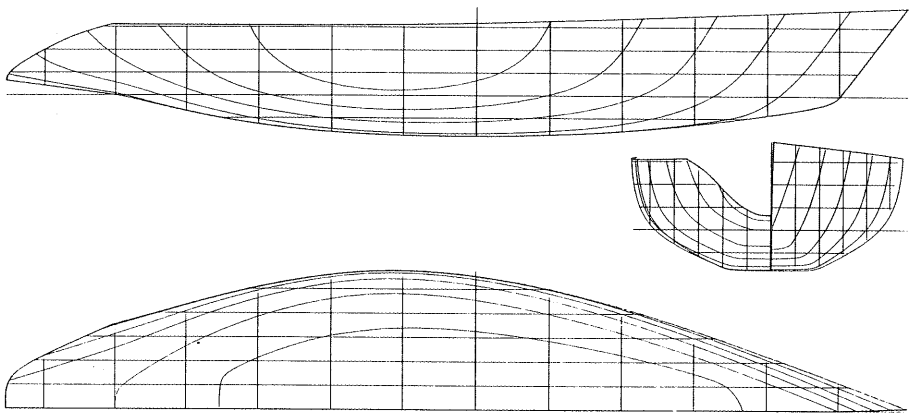
Analysis of the hull shape is based primarily on Simpson's One-Third Rule, developed by Scottish mathemetician James Stirling in 1730. It is amazingly accurate in finding the areas of curvilinear figures (like boat hulls) and no better method exists to this day.

For example, to find how much water the hull will displace when put in the water, one must first redraw the outline at each station as shown in the front/back view. The areas of the outlines can be found using a planimeter or by using the trapezoid rule. The equation is **2x(1/3)x(sum of functions of half areas)x(inverted scale)^{2}x(station spacing)x(unit density of water) = displacement.**

A yacht designer must also be concerned with the prismatic coefficient, i.e. how full or box-like the hull shape is. The p.c. is given by the equation
Disp (volume) / (greatest 1/2 area) x 2 x (inverted scale)² x (DWL),
where DWL is the designed waterline length. Good p.c.'s are generally around 53%. A boat that is too full is very stable, but very slow — a tub. A boat with a low p.c. is unstable and fast, but tends to get the crew very wet when it slices into a wave.

To find out if the boat will float, the designer must find the logitudinal center of buoyancy (LCB) and the center of gravity. The LCB is found by dividing the sum of the moment areas around station zero over the sum of the functions of half-areas. The center of gravity is more difficult. The only way to find it is to take the moments of everything that one would like to put on the boat that weighs more than a few pounds and find the cetroid. Since there are so many things on a yacht, it takes a good designer several days to come up with the center of gravity, unless one has a good computer.

The boat will generally float as long as the LCB is over the center of gravity. The distance between the two points determines the righting arm, and is a good indication of stability.



LINES PLAN
40' DWL IOR BASE
Scale - 1.48

Lexcen is best known for his use of the winged-keel on the *Australia II*. In addition to wings, the keel has a reverse sweep so that the bottom of the keel is longer than the top of the keel. The concept was developed around eight years ago and produces what is known as the end-plate effect. Basically, this effect draws water up the leading edge of the keel, then the wings push it back down to produce lift. Old men who build model boats to sail on ponds in city parks have

Continued on page 26

Architecture from 24

creates polygons (surfaces) between points and adds a roof at the desired height.

A library contains pre-constructed objects, such as trees, people, cars and trucks, which can be called up and placed in the drawing. An individual can also create their own library objects to be used in their project.

After the initial data base is created it can be modified by adding new objects, moving objects, scaling them up or down, or rotating them.

Far and away the most impressive feature of the 3-D Design is the graphic display of objects, created by Lee Anderson.

Objects are displayed on a 480 X 640 resolution screen in true perspective, that is, background buildings appear smaller than those in the foreground. The display can contain up to forty distinct colors, each shaded from lightest to darkest. Colors can be changed at a touch of a button by selecting from a visible palate of alternatives. An architect can mix and match colors to find the correct combinations.

The buildings can be viewed from any height, distance, or angle. Simply tell the computer where you're looking from and what you're looking at.

The most striking graphics feature is the generation of shadows. Type in the latitude, month, day, hour, and minute. The program will calculate and display the exact shadows that the sun would cast at that moment. The computer will simulate the correct color of the shadows. The user can also specify the location and intensity of other light sources, such as street lights, and the program will combine these with any others to create the correct shadows. If you choose a different view, you will see the shadows as they would appear from there.

This shadowing feature allows architects to see how shadows fall on landscapes, pedestrians, and surrounding buildings. It also helps them to visualize how light is distributed inside the building. These and other important aspects, like how the building would look at different times of the day or year, could only be approximated in the past, according to Anderson.

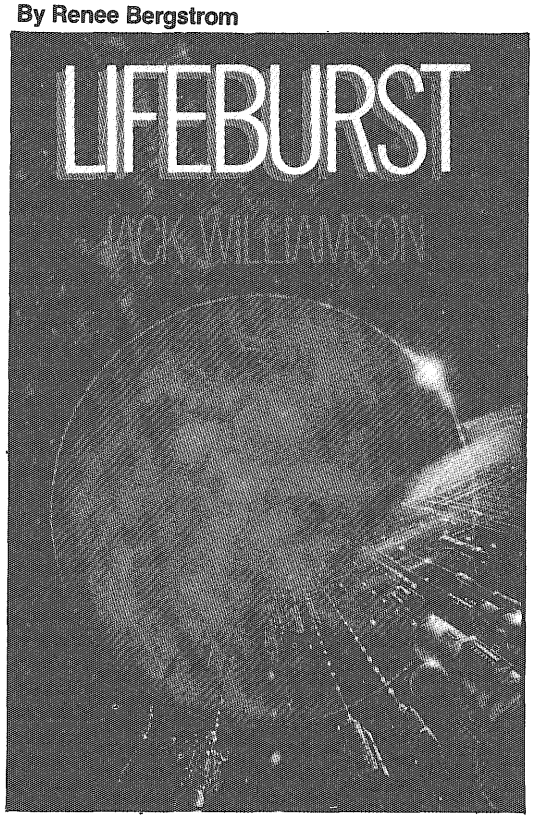
Want a floor plan? No need to draw one, the program has the ability to slice through a three dimensional object revealing a cross section. To get a floor plan, just slice through the building five feet off the ground.

The program can also animate a sequence of frames. For example, Anderson recently spent 62 hours writing a program which flies through the East Bank of campus. Starting high, it swoops low, down the center of the mall before veering off through the rest of campus. A separate

Continued on page 26

Science Fiction Forward and Backward In Time

By Renee Bergstrom



***Lifeburst*, Jack Williamson, Ballantine Books, 1984, 271 pages, hardcover, $12.95.**

Space is finally being colonized by human beings. Space aliens are watching human beings colonize space and along with all these great new developments, the Earth's population has exploded and divided. Bloody solar politics make and break average people and fanatics are trying to overthrow the Sun Company, claiming fulfillment of a biblical prophesy . "They lived under the ice, in places lined with plastic foam to keep the cold out and the precious air sealed inside. The floors had velfast carpets that let them walk in boots with velfast soles. Weighing only a few ounces, he could fly down the tunnels when he liked, never touching anything." This is the world Jack Williamson has created in his book *Lifeburst.*

The main character, Quin Dain, is an illegitimate child of a Sun Company scientist who has no hope for status in the company of any kind. The plot revolves around his desire to return to Earth and the invasion of Earth by a space alien. The Earth's factions struggle with each dilemma and the results are both frightening and exciting.

The books is at the very least fascinating. The plot moves rapidly containing mostly action though the prose is bland and plain. Each chapter gives the reader two points of view which yields a greater understanding of all the events that occur in the book and is an ingenious use of narrative by the author.

This book is not a fantastically done piece of literature and the message the book delivers is not clear or inspiring, but the reading is exciting and the plot is fresh. The "science" fiction of the book required much thought and imagination by the author and *Lifeburst* is a carefully thought out work. If you'd enjoy fresh science fiction, *Lifeburst* should be added to the reading list.

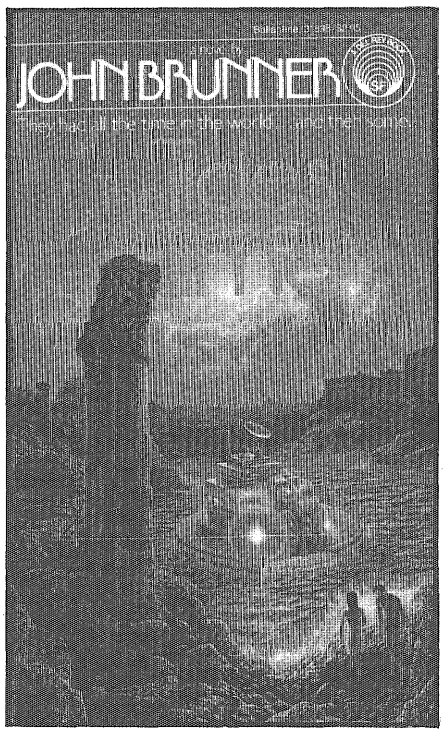
***The Tides of Time*, John Brunner, Ballantine Books, 1984, 235 pages, paperback, $2.95.**

John Brunner, who wrote *The Sheep Look Up* and *Stand on Zanzibar*, is still writing and his newest work is *The Tides of Time.* The story revolves around two people, Stacy and Gene, who keep changing in every chapter of the book. Their setting starts on a modern Earth and it progresses backward through Roman times and still further back it goes.

Some of this book is confusing since the situations keep changing; yet, Brunner gives the reader clues by maintaining certain traits at every point in the novel. The plot does progress steadily building up to the final chapters.

The Tides of Time compared to *The Sheep Look Up* is a more encouraging story. The ending to the novel is less pessimistic than *The Sheep Look Up. Tides* contains more scientific theories than Brunner's previous work which helps bring the time hopping the characters do in *Tides* more clearly into focus. The book also relies more heavily on symbolism which also pulls the whole story together.

The two novels do share some similarities such as the return to nature theme. Also, one of the characters martyrdom exists in *The Tides of Time* and *The Sheep Look Up.* Finally, Brunner's habit of relying on the months to title his chapters persists in *The Tides of Time* which is a nice effect.



Brunner, as a writer, does not believe in fairytale endings and his novel is no different. Brunner paints a strong message to his reader and more time should be spent with his books. They are enjoyable, but they are also a learning experience. Though *The Tides of Time* doesn't command as strong a message as *The Sheep Look Up*, the message is still there. For *The Tides of Time,* Brunner leaves the reader to reflect on man's relationship to the universe and the past.

The book itself requires very little time to read, but reflection on the author's argument requires a little more time. If you're in the mood for deep thinking, John Brunner's the author to read.

Yachts from 23

employed this effect in oddly-shaped keels for most of this century.

Lexcen discovered the effect of using a winged-keel when he tank tested half scale models of twelve meter hulls, instead of miniature models which had been done previously. He found there was a great difference in the behavior of the boats because the Reynold's Numbers on the small models were quite different than those of larger models.

Lexcen is duty-bound to design the yacht to be raced in the next America's Cup which will be held off Perth.

In a magazine article, Lexcen said, "I went over to America the first time in 1967. The deterioration (since then) is just incredible. Aggro everywhere. It used to be only aggro in New York: now there's aggro out in the little towns, in Minnesota. I used to go to the most divine little place in the world, out in Wisconsin...you know, cream, and children were all polished, you could eat off the road, the houses all neat, and the cars all washed every day whether they needed it or not. And now they're just like New Yorkers. They're attacking all the time. It's just awful: I just hate it. It's happening here now too, but the rate here is less...fifty years behind. That's why I love Australia...because it's 'backward.' Let's not catch up too quick."

Trains from 18

Beyond this are a dozen or so corridors, all in the 1 million trips/year category.

A system of high speed rail lines scattered across the country would cost a fraction of what was put into Interstate Highways and it would revolutionize travel in the U.S. But just one philosophical note of caution in closing.

Historically, this nation has sunk vast sums of money in pursuit on a one-mode transportation system. In 1975, the opening of the Lancaster Turnpike touched off a flurry of toll road construction all over the U.S., culminating in the first Federal road project, The National Road. Most of these roads quickly fell into disuse and disrepair. The opening of the Erie Canal in 1825 sparked a "Canal Fever" as dozens of companies floated vast sums of money to build canals across wilderness and up mountains, and then went bankrupt. The Baltimore & Ohio R.R. showed the virtues of the railroad in 1830. Two hundred thousand miles of track were constructed, much of it either duplicating a parallel line, or serving some market that could never support a railroad. The same happened with horse, cable and trolley cars, automobiles and airplanes. We have always suffered in our attempts to serve the nation with one and only one mode of transportation. Each mode has its special strengths and weaknesses, and one mode cannot replace all the rest.

Now the U.S. must face the challenge of developing a transportation system for the coming post-petroleum age. The follies of the past can be avoided by creating a system where each transportation need is met by the best mode that is possible. With that approach, high speed railways would be part of the picture. Part, but not all.

MEIS from 12

Students who work on team projects benefit from studying concepts at the leading edge of scientific knowledge in these high-tech fields. Participants from member companies can use the discoveries in their own research efforts and have a source of young, well-trained scientists from which to recruit.

The cooperation of local industrial sponsors, the State of Minnesota, and I.T. has made MEIS a major regional resource for high-technology research, education, and development. New coursework, instructors, laboratories, and the sharing of scientific knowledge promise to help place — and keep — Minnesota among the leaders in microelectronics and information sciences.

Architecture from 24

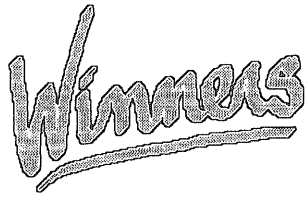
animation of the Minneapolis skyway system was also recently created for display.

Anderson, who teaches computer science to architecture students, wants them to use the computer as "a tool which can be a design aid." He feels his system also gives students the chance to train on today's most advanced technology. In fact, students are working with more advanced systems than are now available to professionals.

Although Anderson became fascinated with computers while an architecture student at Minnesota, he realized that the school cannot provide enough programmers to meet the demand. He welcomes students from all disciplines who may want to do independent study.

Lee Anderson and the School of Architecture are pioneering the application of computers to architecture. Students in this school are working with the tools of tomorrow, and seeing the future today.

By David Kortenkamp.



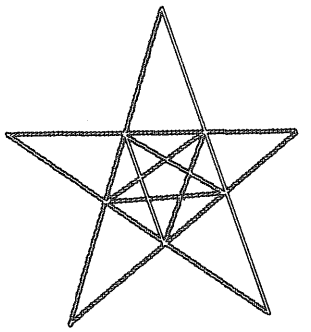
The lucky students with the following I.D. numbers have won Minnesota Technolog's Reader Survey Drawing Prizes. Stop by Room 2, ME by May 31 and pick up your prize.

1175684	1278383
1213102	1171049
1171240	1078780
791761	1170161
956083	1269191
1164903	1193348
1184018	1261262
1137988	1172156
1199515	1230698
1195841	1233373
1262771	1169980
1105330	1216280

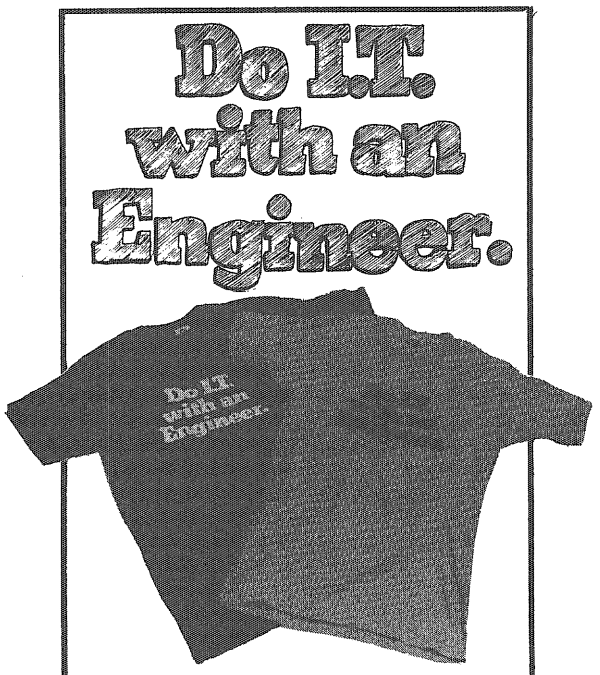
Mind Benders and Brain Teasers

In the past, the correct solutions to the problems presented here could earn you a free T-Shirt. Unfortunately, our supply of shirts has become depleted, so the satisfaction of completion is the only reward we can offer.

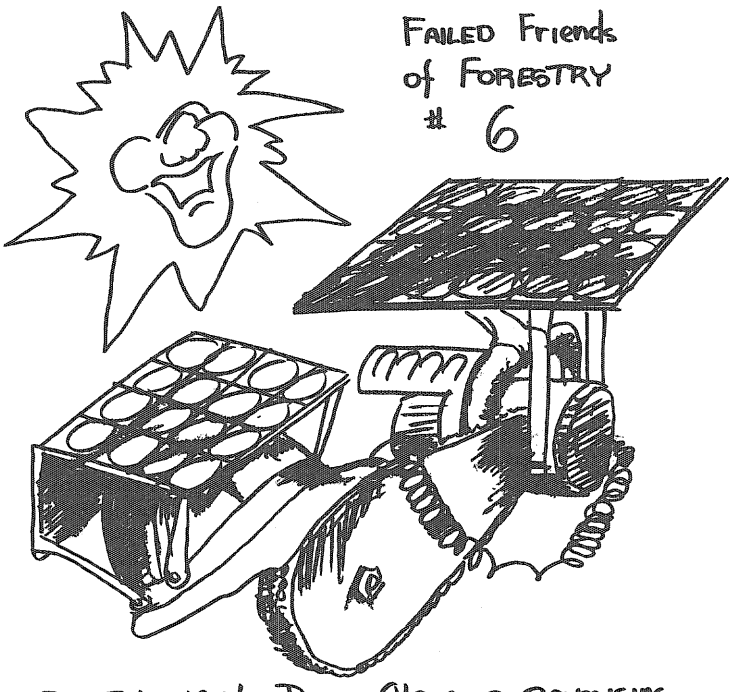
1 The star printed to the right is made up of triangles. Count how many triangles are there in all. There are more than you might think.



2 Try to find all the words of four or more letters that can be formed using the letters in the word "engagement." Changes in tense and proper nouns are not allowed. Do not be satisfied with any less than twenty.



The I.T. Board of Publications is now taking orders for a new shipment of T-shirts. If you would like a shirt, stop by Room 2, ME for the details.



BEBOX **By Scott Ciliske**

technotrivia

1) What does RPN stand for?

2) Who was the Dean of the Institute of Technology two years ago? Who was the Dean last year? Who is the Dean this year?

3) The speed that a wave travels through medium depends on the density of the medium. Does a seismic wave travel faster in soil or in granite?

4) The University of Minnesota operates a Cray-1 supercomputer through the UCC. How long did it take to design and build the first Cray-1 and how much did it cost?

5) Nova is the worlds most powerful laser. It operates at the Lawrence Livermore National Laboratory in California. Approximately how much energy is released in a pulse of Nova's light?

6) What does laser stand for?

7) As the moon goes through its phases between new and full, the shadow of the lunar night passes across its surface. What is the line which separates lunar night and day called?

8) According to the "Nuclear Winter" study published Turco, Toon, Ackerman, Pollack, and Sagan, the Earth absorbs 43 percent of the incident solar radiation under normal conditions. What percent of the incident solar radiation would be absorbed by the Earth during a nuclear winter?

9) Compact digital disks are the latest craze in audio equipment. How many samples does the player need to read off of the disk in one second?

10) If everything proceeds on schedule, the EE and CSci departments will soon have a new building. When is the building expected to be ready for its new occupants?

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1) RPN stands for reverse polish notation. RPN is the operating logic used on HP calculators. Polish Notation was developed by the Polish logician Jan Lukasiewicz (1878-1956).

2) Roger Staehle was the Dean two years ago. Rama Murthy was the Dean last year. Ettore Infante is the Dean of the Institute of Technology today.

3) Waves travel faster in denser material. Waves in granite are faster than waves in soil.

4) Seymour Cray left Control Data in 1972. Four years and 8.5 million dollars later he had designed and built the first Cray-1 supercomputer.

5) A pulse from Nova concentrates 120 trillion watts at a target 100 feet away. The target is heated to a temperature exceeding 18 million degrees Fahrenheit when it is subjected to Nova's energy.

6) Laser is an acronym for Light Amplification through Stimulated Emission of Radiation.

7) The line which separates lunar night and day is called the terminator.

8) Under the conditions the TTAPS papers described as a nuclear winter, the percentage of the incident solar radiation absorbed by the Earth's surface would be reduced to five percent.

9) Each channel of a compact disk player uses a sample rate of 44,100 times per second. This was chosen as the industry standard because the upper limit of human hearing is around 20,000 cycles per second and the Nyquist criterion states you need to take twice as many samples as the highest frequency to insure a continuous sound.

10) Occupancy for the new EE/CSci Building is scheduled for 9-21-87.

Scoring

0-3 You should read your Minnesota Technolog more carefully. The answers to each of these questions can be found in this year's issues.

4-6 Not bad. Don't forget to take this issue home to study for next year's trivia questions.

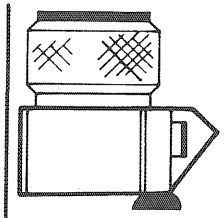
7-8 You are but another score for the middle of the bell curve.

9-10 You either have a photographic memory or good peripheral vision.

Photo by Mike Moffa

Minnesota Technolog Staff 1984-85

L to R: (Top) Mike McGee, David Hyde, Mark Werner, Meribeth Nordloef, Debby Latimer, John Krumm, John Prarie, (Middle) Barb Melber, Brenda Nyman, Ed Wollack, (Bottom) Mike Moffa, Jon Soland, Diane Berry, Jim Lundy, David Herridge, Vern Thorp, (Not Pictured) Renee Bergstrom, Scott Ciliske, Helen Mittelstadt, Heidi Neils



a thousand words ...

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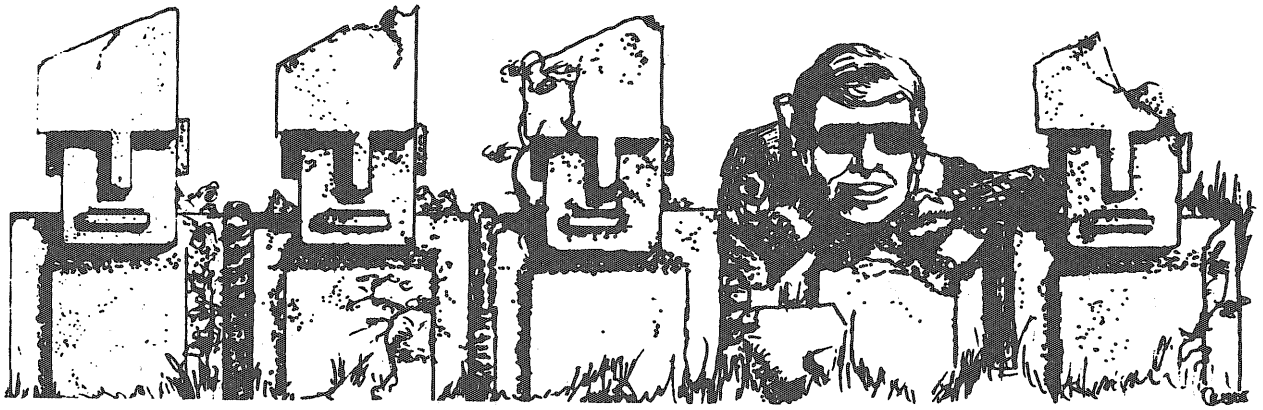

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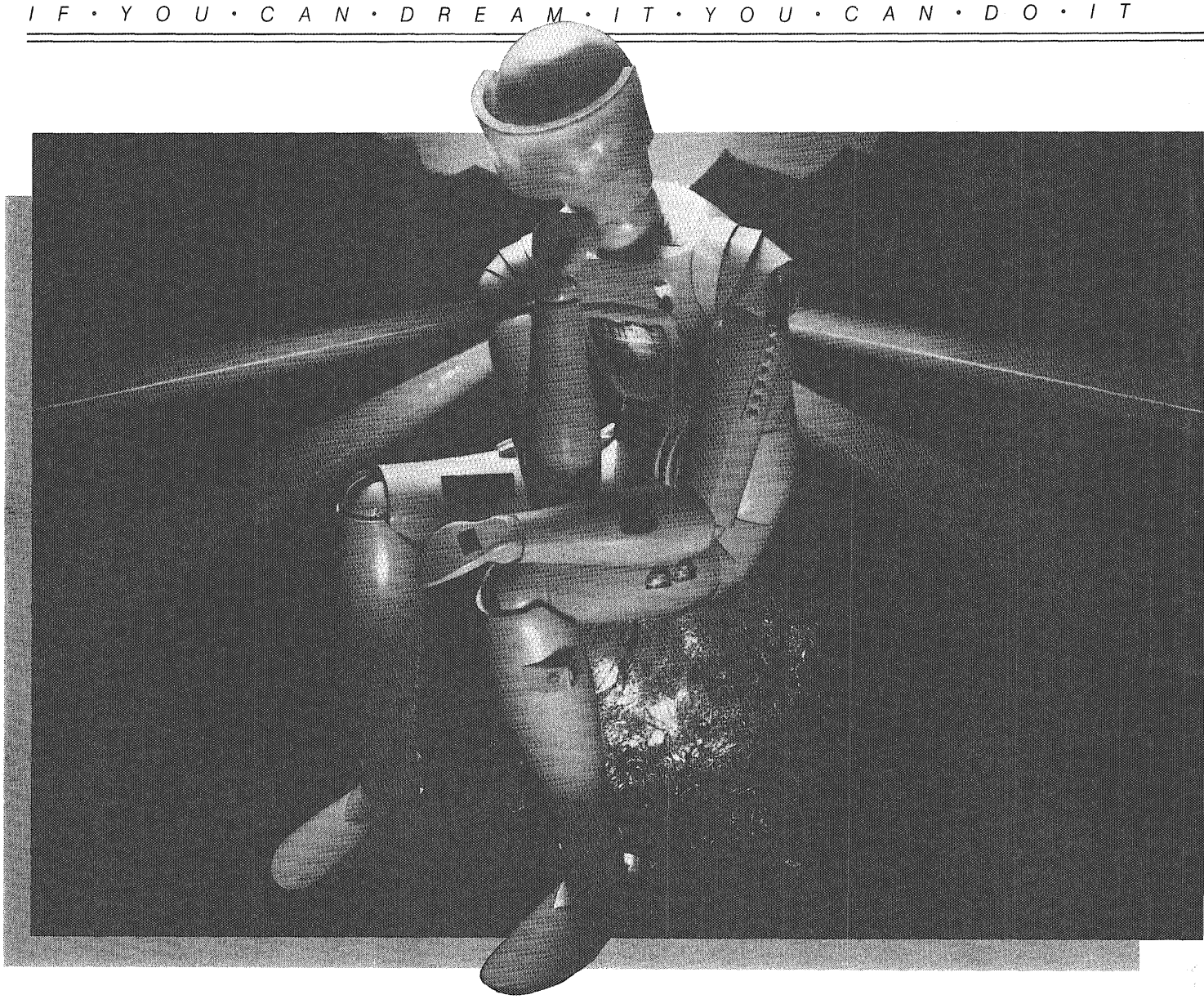

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