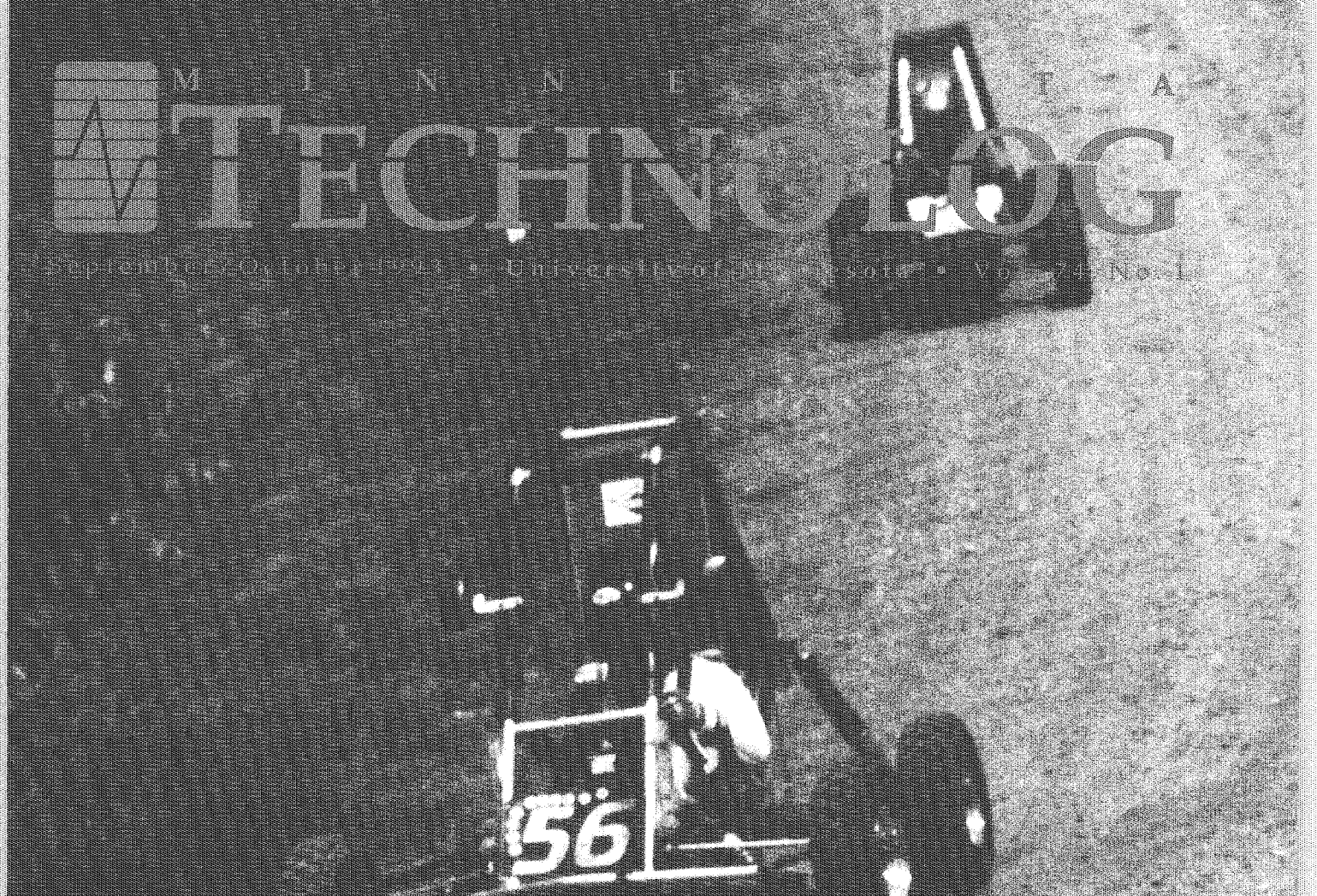
MINNESOTA

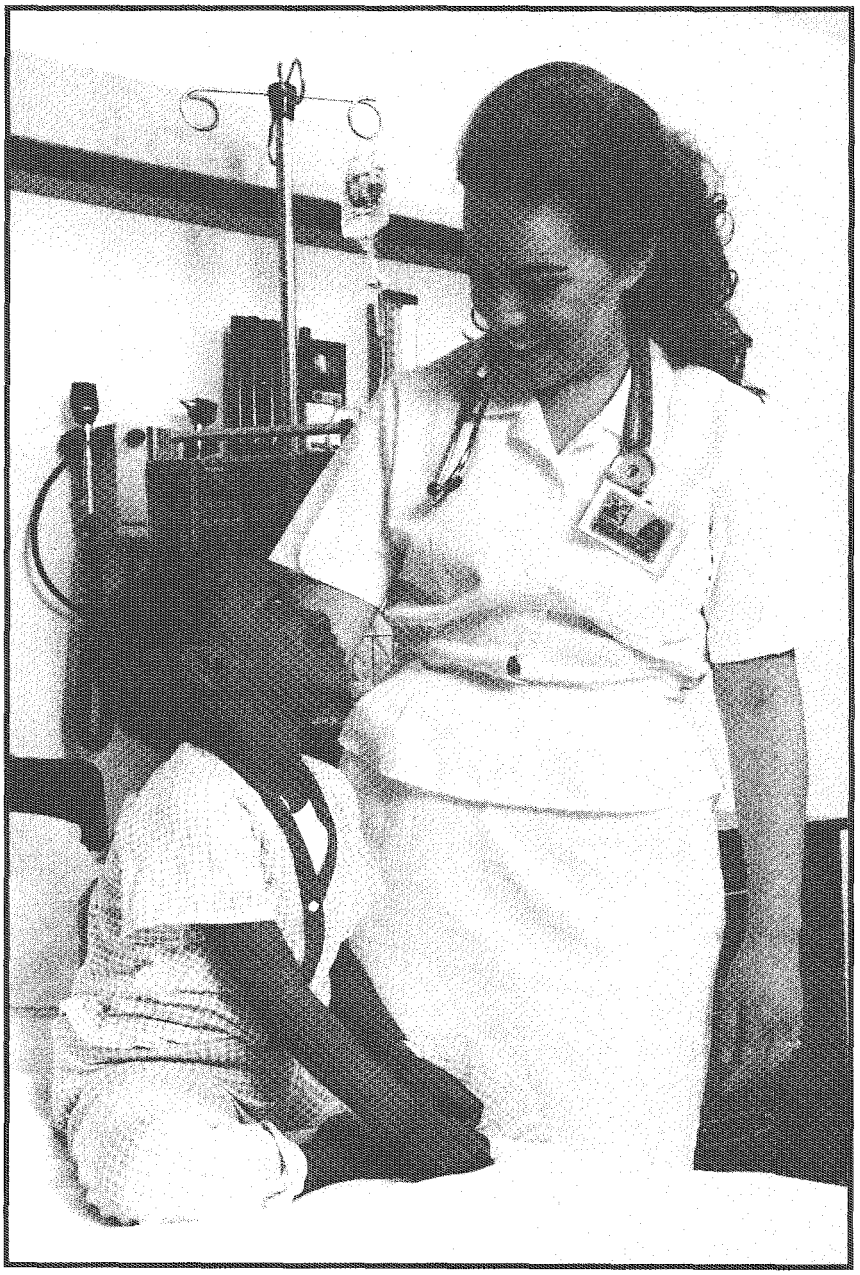
TECHNOLOG

Supplement to Quantum • University of Minnesota • Vol. • No. 1



Minnesota-Grown Technology

- Bioartificial Liver
- Baja Buggy
- and more



Precious Life

Not too many years ago, this nurse was a patient at St. Jude Children's Research Hospital. She fought a tough battle with childhood cancer. And won.

Now married and with a child of her own, she has returned to St. Jude Hospital to care for cancer-stricken children.

Until *every* child can be saved, our scientists and doctors must continue their research in a race against time.

To find out more, write St. Jude Hospital, P.O. Box 3704, Memphis, TN 38103, or call **1-800-877-5833.**

ST. JUDE CHILDREN'S RESEARCH HOSPITAL
Danny Thomas, Founder

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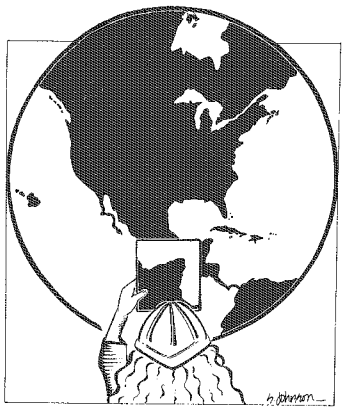

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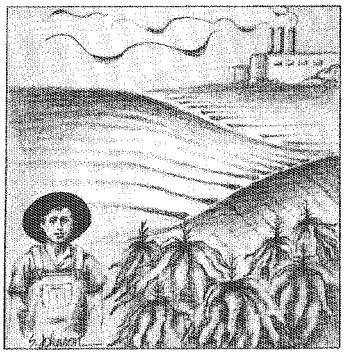

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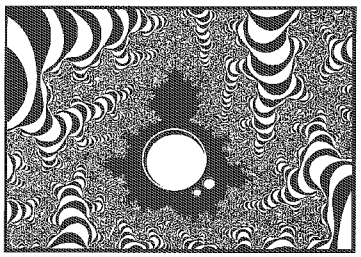

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Departments

About the cover . . .

Minnesota's Baja Buggy roars around a corner in Marysville, Ohio, en route to a strong finish.

Don't Go It Alone

by **Corinna Nelson** ***Editor in Chief***

You know the feeling. You're sitting in a cast-of-thousands Chem, Calc or Physics lecture feeling like just another number, not unlike those blurring before you on the board. You're feeling reduced to a vertical pencil line (that's number two to *you*, pal) on computer-read test forms.

I.T. administrators and faculty, reaching back into their pasts, could identify with the feeling and had a great idea two years ago: break down the isolation. Put students in groups so they could meet each other. Act as if I.T. were a small, personal college. What a great idea.

And so team advising was born. The idea: if freshmen attend the same cast-of-thousands lectures together, maybe they'll get to know each other, form study groups, get better grades...stay in I.T.

The idea was borrowed from the Honors program, where students were doing well in smaller lectures geared specifically toward them. I.T. thought that even if they couldn't have smaller lectures they could replicate the Honors experience by putting incoming greenhorns in groups of 90, assigning them ongoing peer and faculty advisers, setting up social events, giving them a lounge.

It was also based on research indicating that students learn best in groups rather than alone. A study of math students in California showed that students who worked on problems in groups had better test results—taking the test alone—than did students who studied alone.

The results of the first batch of freshmen—the 1991'ers—are beginning to come in. What's the verdict? Can a behemoth school really act like a small college—with similar results? And if it can, should it keep on doing it?

Preliminarily: G.P.A.s are inching up and students seem to be taking more credits per quarter. All good, so far. What's not clear from the statistics is whether more students are opting to stay in I.T. rather than transferring to C.L.A. — or leaving school entirely—and what their I.T. experience is like.

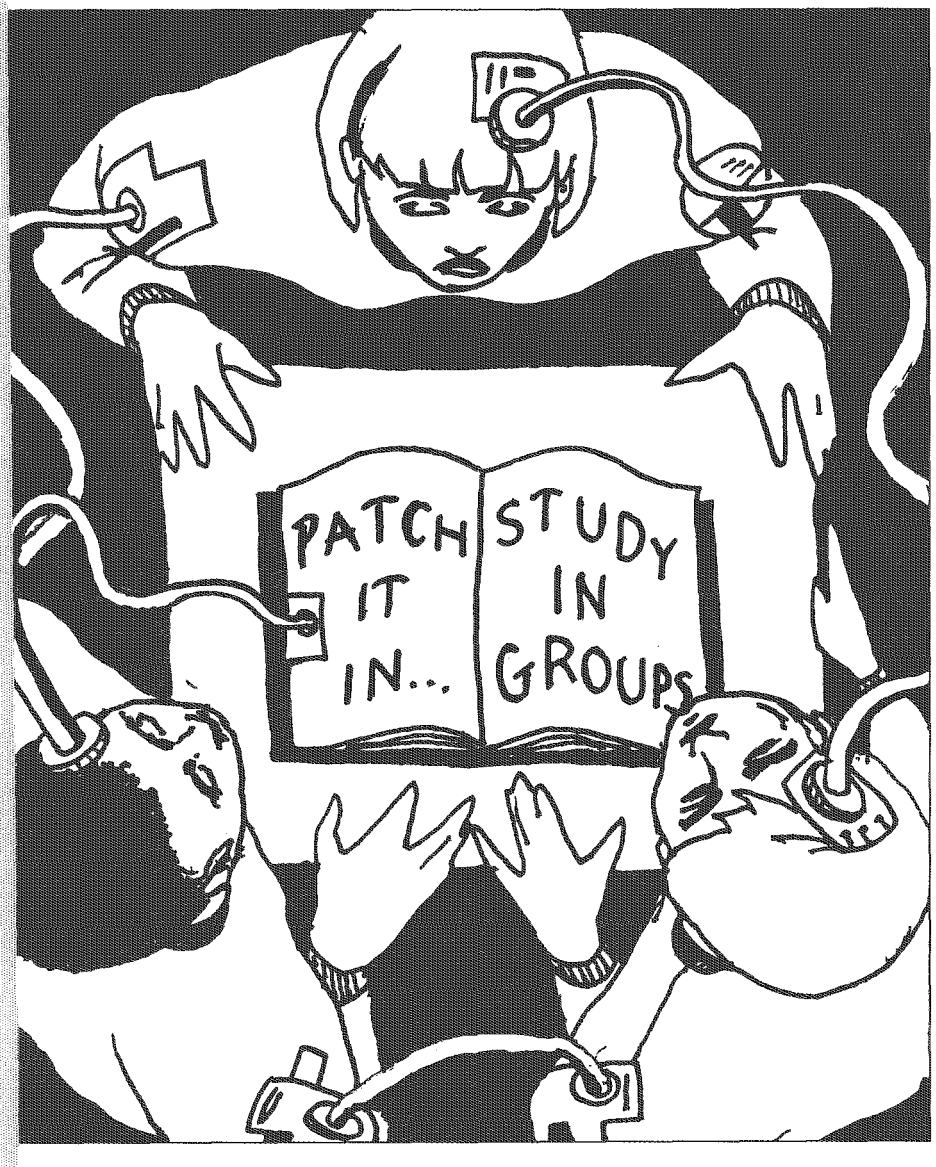
The experiences of the Physics department provide a few more clues on how best to fine-tune group learning, and on how to keep I.T. students motivated. That department divided up students into groups of three in some situations. Interesting patterns emerged: same-sex groups, and groups including two females and one male did fine; however, in groups where there was only one female, the female sometimes tended to get overlooked by the two males. Physics altered groupings in orientations, using sex-segregated tables.

Associate Dean Sally Kohlstedt echoed these results, saying that students who are in the minority in engineering programs—women, and some racial groups— do best if they aren't isolated as the "token" in learning situations. It stands to reason that going it alone is rough on anybody in I.T. Students in the majority here aren't immune from stress either.

The solution? Participate in events with your advising team, but don't stop there. A group of 90 sharing a few advisers hardly receives close,

personal attention. Join a group: the I.T. Board, the Board of Publications, Project Technology Power, the Society of Women Engineers (which, despite the name, welcomes men with open arms—and open test files) or others. Tutor other students. Commuters who leave right after classes miss out big time on opportunities to network with other students and with professionals in the field. Since so much work in science and engineering is done cooperatively, you won't have the option of going it alone once you get into your first professional job, or into grad school. Get into the habit of you working with your colleagues now.

Don't go it alone.



Michael Kooiman

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UROP Marches On

I.T. students are making a splash in the Undergraduate Research Opportunities Program: of the approximately 350 students who participate in a year, at least least 75 come from I.T.

Vicki Munro-Bjorklund, an administrative fellow in the program, has a personal favorite from the projects submitted over the last several years: a computer simulation of lion breeding. Other recent projects have ranged from the cosmic—a study of Minnesota's Lunar Simulant—to the asthmatic—a simulation of lung wheezes.

Bjorklund stresses that there's no G.P.A. cutoff—some UROP'ers are honors students, some aren't. The main qualification, she says, is self-motivation.

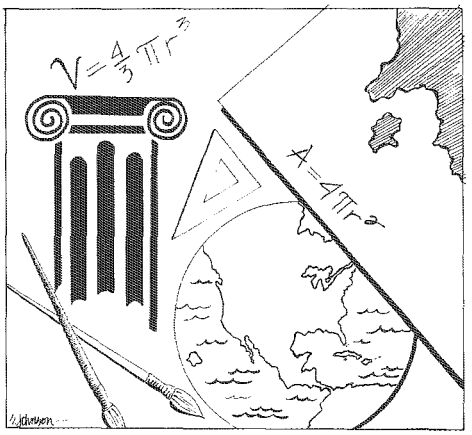
Although Physics, Chemistry and Chemical Engineering have been especially in evidence in UROP, students from any discipline in I.T. may participate. What's required is a faculty sponsor and a research proposal.

UROP accepts applications twice annually. For further information, call 625-3853.

Mariucci Arena: Not a Bad Seat in the House

It's new, it's sleek and there ain't a bad seat in the house.

The new Mariucci arena, which will open for its first season this winter, was designed with the help of a computer system for architects and structural engineers. The system, from McDonell Douglas, has been used widely by architects and structural engineers.



Sandra Johnson

Computer-aided design, or CAD, is run-of-the-mill stuff these days in architecture. The people who designed the arena, OPUS Architects and Engineers, Incorporated, use CAD in many if not all of their projects, said Mike Lederle, manager of the structural department at OPUS.

With the aid of the computer, architects could see what the view of the ice arena would be from each seat in the house. This part of the computer's help was elementary in showing University officials what the new hockey arena would be like for the audience.

To get the one-of-a-kind seating arrangement, the arena has parabolic seating. As a member of the audience walks down the stadium steps toward the ice rink, they would notice the steps flattening out as they got closer to the ice. The seats slope down to the ice so the people sitting up higher can see over the people in front of them and still have a good view of the ice.

What does it mean for the audience?

Gone are the days when the low-priced ticket meant a seat behind a cement column.

Some say that the hockey arena is a contender for being one of the best hockey stadiums in the world. Check it out this fall and see what the computer aided-design of the Mariucci Arena does for your view.

Engineering Education on the Verge of the 21st Century: the Transforming Context

by **F. A. Kulacki,** ***Dean, Institute of Technology, University of Minnesota***

Engineers and applied scientists are on the verge of the most exciting period of history. Graduates of the Institute of Technology will see great change and challenge during their careers.

The engineer who graduates in the 21st century will be a different individual than those of my era some 30 years ago. He or she will face a wholly different context and professional environment for the practice of the profession.

Schools of engineering and science, like IT, are in the middle of this transformation by virtue of their pivotal role in education and the importance of their graduates to literally every aspect of modern society.

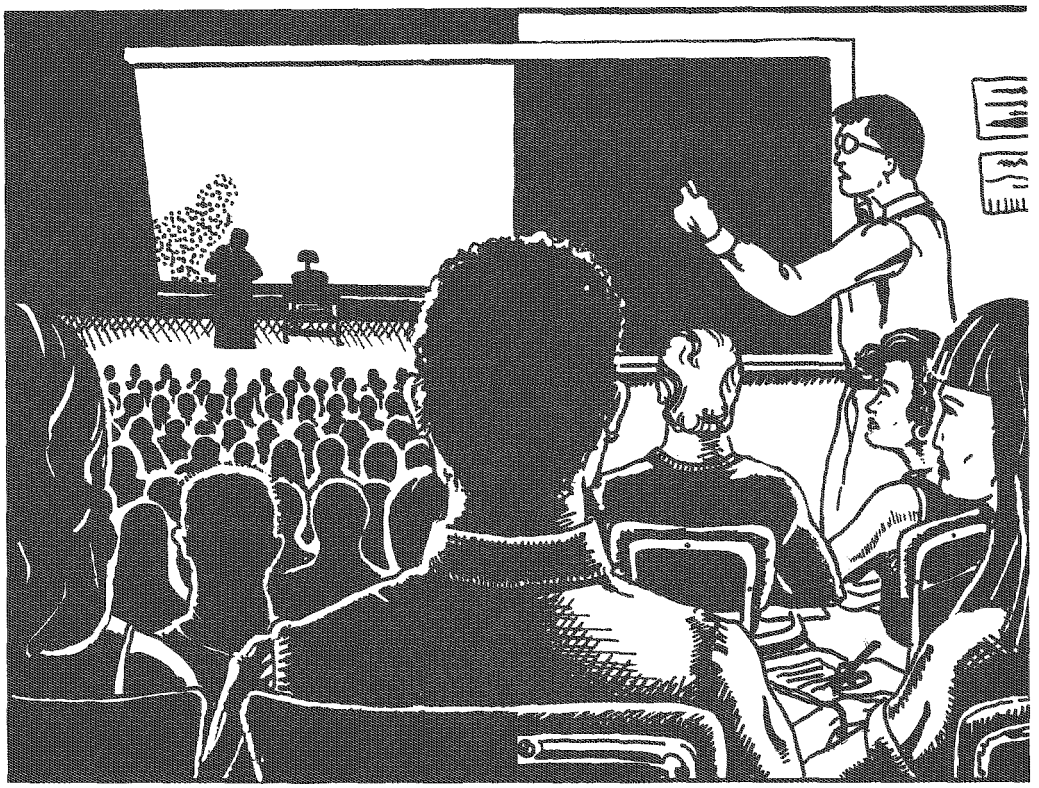
To explore all of this a bit further, let's begin with a bit of history and then take a look at some of the important forces facing engineers in the years ahead.

The Historical Setting

Engineering education in the United States has gone through several periods of development in this century. Curricular philosophies and structures have been produced in response to the primary need of the post-19th-century industrial age: the education and training of entry-level engineers equipped to solve problems in design and product development. But revolutionary scientific and technical developments after World War II reoriented engineers and engineering education toward emerging disciplines. Specialized curricula evolved to meet industrial and governmental needs at both the undergraduate and graduate levels.

To a great degree, the growth of the major industries of the 20th century—chemical production, automotive manufacture, electrical power and a variety of commodity industries—depended on a partnership with engineering schools. So, curricula and research

Len Gostinsky



Michael Kooiman

programs tended to mirror the needs of industry and, during and after World War II, the needs of government and the military.

It must be said that by many measures, engineering schools and their graduates have been extremely successful. Graduates of American colleges of engineering are systematic thinkers, problem solvers and can adapt to management responsibility, a narrowly focused technical specialty or other fields of work.

The growth of the national economy over the generation following World War II has tended to affirm the educational paradigm supported by the academic, industrial and governmental alliance that was so carefully forged out of the industrial expansion of the early years of this century.

Toward a Transformation

In the last quarter of this century, however, many of the assumptions underlying the education of engineers, the manner in which they will be employed by industry and government and the policies under which engineering education and research are supported are being challenged by pervasive changes in engineering practice and the national economy. Part of our nation's response to this ongoing industrial challenge must lie within the engineering schools and their faculties.

The present generation has seen the coming of a new post-industrial age characterized by the emergence of several general trends in the United States and the world. These include:

- A growing dependence on information throughout all aspects of society.
- The movement of the United States toward membership of both regional economies and a global economy.
- A movement to a duality of "high tech" and "high touch."
- An increasing awareness that the nation needs to focus on long-term solutions to problems and to develop coping and adapting strategies for future changes.

Industries that are characteristic drivers of the new era include space and aerospace, telecommunications, computing, information management, biotechnology and environmental management and conservation. A quick comparison to the leading industries of a generation ago gives ample evidence of the changes

that these trends have brought to the U.S. economy.

Interestingly enough, the leading science-based industries of today were spawned, in part, by engineering and science departments supported by grants from the federal government. In some cases, the collaboration between engineering schools and industrial firms was essential to the development of new technology. This happened with the transistor, the integrated circuit and the field of semiconductor electronics.

For engineering schools, there is also ample evidence to suggest that engineering in the first half of the 21st century will be practiced within the context of a global macroeconomic conversion. There will be much greater competition among nations for essential natural resources and emerging global markets. Hence, the theory and practice of engineering may change dramatically over the next generation.

Engineering education will also need to adopt a new basis for structuring curricula. Its development will involve conceptual, methodological, organizational and substantive transformations which will first be felt in society at large and then in academe.

Broadly speaking, these transformations and transforming forces can be characterized by globalization, interdependence, vulnerability, uncertainty and turbulence. These are the trends that I believe will shape the preparation of all professionals, and particularly engineers.

The Future Educational Framework and Context

Tomorrow's educational process for engineers will likely be a curriculum that addresses aspects of interdisciplinarity, macroengineering, cross- cultural sensitivities and the development of an appropriate framework for the exercise of engineering judgment in combination with data and alternatives. Most importantly, the engineer of the next century needs to be more "problem-minded" rather than simply "answer-giving."

The theory and practice of engineering may change dramatically over the next generation.

The window of opportunity to impact the preparation of baccalaureate engineers by the year 2000 is a very narrow one, given the changing climate for financial support for higher education and a national faculty that will experience an increased rate of retirement in the next five years.

Let me suggest that the context for engineering education in the next decade will be built upon the need to develop what I like to call "prudent" engineers—those who can better combine information, knowledge and judgment in their early career assignments. In addition to demanding a heightened sense of professionalism, the future of engineering education will be very much influenced by the ever-narrowing distance between scientific advancement and its application to a technology. A new and enlightened partnership between science and engineering education will be needed to produce the kind of engineer who can quickly grasp the utility of scientific advances.

Schools of engineering also need to improve the social awareness of their graduates through a closer relation with the liberal arts colleges. It may require a rethinking of what liberal education in a technological era means both for the engineer and non-engineer alike. In any case, engineering students should be educated within a more coherent liberal framework than presently exists in most engineering schools.

The idea of life-long learning will also take on a new dimension for engineers. Undergraduate curricula need to be redesigned to reflect the

reality that the baccalaureate degree will not suffice for a career that can span some 40 years and encompass several major shifts in the technologies of a discipline. Moreover, the normal career progression of most engineers takes them from specific, discipline-based assignments to more inter- and trans-disciplinary work. The latter requires that the engineer continue to broaden his or her knowledge base, and this can only be obtained via a regular program of educational activity after formal engineering studies have been completed.

To conclude, curricular redesign for the future should prepare engineering students to manage uncertainty and risk in problem solving, to deal with alternative solution scenarios, to correctly define problems as well as solve them and to work effectively in a social framework much more influenced by cultural and economic diversity than in the past.

Dr. Francis A. Kulacki

Dr. Kulacki is dean of the Institute of Technology, a position he assumed this fall quarter. He received his B.S. and M.S. Degrees at the Illinois Institute of Technology and his doctorate in Mechanical Engineering at the University of Minnesota. Kulacki has been a faculty member at Ohio State University and served as chairperson of the Mechanical and Aerospace Engineering Department at the University of Delaware. For the past seven years, he served as dean of the College of Engineering at Colorado State University.

Building a Better World

by **To Tong**, *Spring 1993 Student Commencement Speaker*

Greetings!

I'm honored to be up here addressing all of you, and I promise to keep it short. So keep all the rotten tomatoes and eggs for someone else. You probably saw the large replica of our world on the Northrop Plaza. That project is called Building a New World. As graduates, we are now entering this new world of fast-paced technological advancement. Our challenge is to make the world a better place. What can we do to ensure this? To excel on an individual level is not enough anymore. We must strive for cooperation on a global scale. This goal will require much long term vision as well as an understanding of cultural diversity. We can take examples of progress from corporations such as 3M, Honeywell, Hewlett Packard, and Andersen Consulting. By forming alliances across international boundaries, these companies are working to unite global markets. By promoting cooperation as well as competition, their global vision contributes to their success. Technology is what has made these changes possible. Political and national boundaries are becoming less important as multinational corporations expand. We cannot allow cultural differences to interfere with this progress.

At the U we've already been exposed to a great deal of cultural diversity. We know it's not always easy to under-

Robert Subiaga, Jr.

stand the English used by some of our foreign TAs. Some of you might even have trouble understanding my accent, but I'm working on it!! We persevere because what we have to say is more important than how we say it. We must carry this attitude with us into our work places.

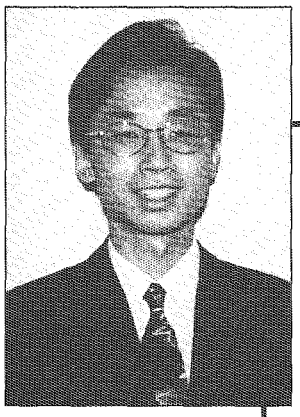
In IT sometimes we tend to focus on the formulas and technology while neglecting some important real-world issues. Just the fact that we are all here together proves that we can thrive in a diverse environment, but we need to be aware of others' opinions and viewpoints. I heard that there used to be a class called Personality 101 for IT students. I believe this class could teach us scientists to be more sensitive — a useful thing. However, there's more to sensitivity than just being approachable.

The world is run by real people, not by machines. To survive in a multicultural society we need to be sensitive and open to people from all walks of life and all corners of the earth. The world is a lot more complicated than solving some of the multivariable Shroedinger's differential equations. Dr. Martin Luther King, Jr. said: "We have guided missiles and misguided men." As countless historical lessons have shown, technology itself does not always benefit humankind. When you work on your future projects and inventions, I'd like to remind all of you to consider the importance of humanity, society, ethics, environment and multiculturalism.

So, my fellow graduates, take pride in your accomplishments thus far. Making it through IT isn't easy — from all-night study sessions to frustrating lab projects, to dealing with wisecracks about our status as IT nerds!

As we begin this next stage of our journey, exploring new horizons and tackling new challenges, we can be confident that we've received top notch training at this fine school. The Institute of Technology has just produced another fine graduating class of future chief engineers, scientists, entrepreneurs, corporate founders, and CEOs. Now we have all the knowledge and aspirations. But all the wonderful plans are just empty dreams without proper execution. Before I go, I'd like to share with you an ancient Chinese saying that my father taught me before I came to the US for school: "A journey of ten thousand miles begins with the first step." Let's take that first step, and begin building a better world!

Thank you very much, and good luck!



To Tong

To Tong, who graduated with a double major in Physics and Electrical Engineering, participated in two undergraduate research opportunity program projects, won several scholarships and participated in numerous IT clubs and academic societies.

Days of Glory: the Baja Buggy

by **Drew Denker**, *Technolog Staff Writer*

Photo by Pat Starr

The Baja Buggy team. L to R : Front row: Dale Lindbeck, Mark Hafley, Steve Smith, Debra Jochum, James Holroyd. Back row: Jeff Meyers, Robb Benson, John Rapheal, Cory Danks, Balazs Vandor, Adam Friedrich.

"Look at 56! It's gonna take 'em in that turn again!"

Eyes and outstretched arms follow an off-road vehicle as it takes the inside of a turn, sliding by several cars. There may be faster cars on the track, but on this June day, car 56 is among the leaders. As the cars disappear from view, the spectators anxiously wait for the drama of the next lap.

Car 56 captured sixth place out of seventy-four entries in last June's Midwest Mini Baja Competition in Marysville, Ohio. The car is also known as the University of Minnesota's Society of Automotive Engineers' Baja Buggy. The student-initiated, student-run endeavor was the product of well over 600 hours of dedicated design and construction work.

The Baja Buggy

The SAE team's Baja Buggy, a four-wheeled, one-person recreational vehicle, first captured the drive and imagination of IT students in November of 1991. As a Senior Design Project, mechanical engineering students spent the winter of 1992 designing a vehicle for the annual Mini Baja Competition. They constructed their vision the following spring. The 1992 raced to a 23rd place finish out of more than 70 entries. They were proud to be one of the few first-year teams to finish the grueling endurance race.

The SAE construction guidelines required two things: uniformity in the buggies' engines, and safety. All vehicles were restricted to an 8-horsepower Briggs and Stratton four-cycle engine. Roll cages, elaborate driver re-

Photo by Pat Starr

Steve Smith (seated) and John Rapheal in a discussion during the race.

straints, and braking and fuel system design constraints were required. Beyond these major specifications, the team could unleash its creativity. The choice of dimensions, suspension, drive train and frame construction remained up to the design teams.

The University's 1992 vehicle, made out of aluminum, came "standard" with four- wheel independent suspension, rack-and-pinion steering, a five-speed transmission and with the buggy's open cage, air conditioning.

Redesign in 1993

The 1993 SAE team set upon the redesign and modification of the Baja Buggy eager to improve its capabilities. Two basic changes didn't require extensive design work: strengthening the axles and softening the rear suspension. As the 1992 team's chances were nearly shattered by a broken axle, this was an important matter. By decreasing the suspension's stiffness, the team also hoped to improve the buggy's handling. If the shocks' spring rates are too stiff, the car's tires bounce off of the ground too easily.

The major redesign altered the drive train: making use of toothed timing belts, an idler, and a system that allowed for the vibration and motion of the transmission and motor. The SAE members gained automotive engineering knowledge while determining how to mount the transmission and alter the drive train.

To prepare for 1993's Mini Baja, the SAE team logged nearly 300 hours in the machine shop and an estimated 300 more in design work.

Marysville, Ohio

Last June at the Transportation Research Center in Marysville Ohio, the Baja Buggy faced competition from 72 entries from all over the country, including universities in Wisconsin, Kentucky, Kansas, Michigan, Virginia and Ohio. The team's car was put through a variety of rigors. Cost and design reports, handling, acceleration, braking,

The educational benefits of the project are immeasurable.

top speed, and maneuverability tests, as well as a chain pull and an endurance race comprised some of the evaluations. The Minnesota team fared slightly above average in most categories. Where the University's SAE team and its machine excelled was on the endurance course, finishing in third place. The points gained in the endurance race allowed the Minnesota team to post a sixth-place finish overall.

Member, 1993 Society of Automotive Engineers' Baja Buggy design team.

Employers say that it's this sort of item on a resume that catches their attention. Faculty advisor Professor Pat Starr says the educational benefits of the project are immeasurable.

"Students work in small, highly focused teams developing complete systems," he said. Perhaps a student's response to a post-project survey sums up the importance of the Baja Buggy.

"It is difficult to assess exactly what I have learned working on the Baja Buggy," the student wrote. "On a conscious level I understand much better the workings of ... automotive and power train related items. For this I will be eternally grateful. What was learned more subtly is perhaps more important though."

Drew Denker

When Drew isn't grooving on his favorite tunes, he passes his time studying the theories of Ian Malcolm, allowing himself to become a part of the Jurasso-bandwagon. The main fuel for his daydreams is another trip to the BWCA with a huge can of beans.

I.T. is reaching out to schoolkids across the state in experimental and worldly ways. From the spring globe-building project to summer chemistry labs, I.T. faculty and students are connecting with Minnesota kids from elementary age through high school. Some of those kids are being inspired to continue in careers in science. Here's an update on how the U is meeting kids at their level.

World-building Kids Get Hooked on Science

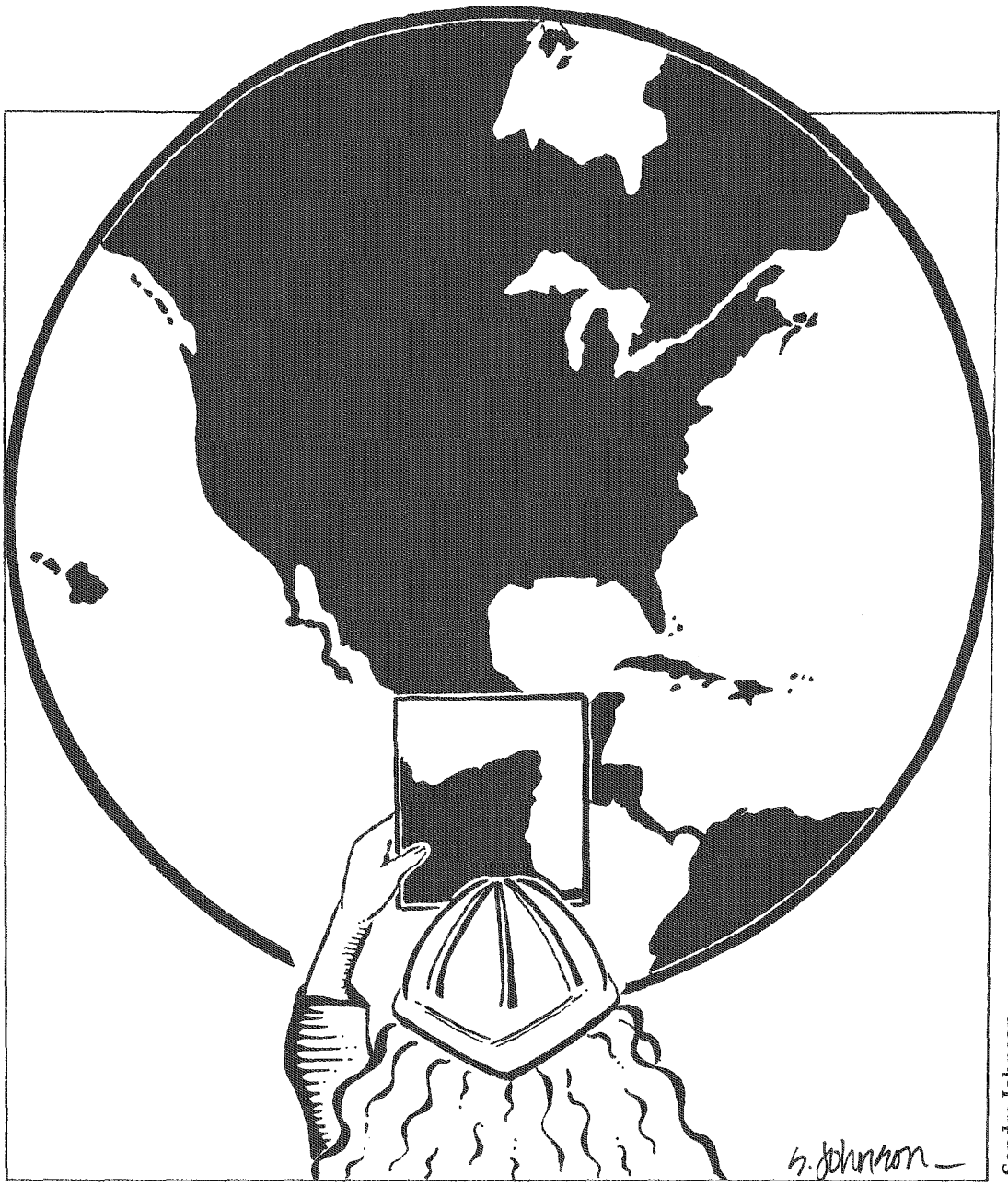
by **Lara Carls-Lissick,**
for Technolog

More than 10,000 Minnesota children pulled together to produce a science project of global proportions at the University of Minnesota in May. Teachers from around the state are enthusiastic about the results of the "Building a New World" project, which involved grade school and junior high school students in the planning, drawing and construction of a 42-foot model of Earth.

Sponsored and organized by the Institute of Technology, the project used a hands-on approach to increase students' interest in technology and engineering, and helped the students learn about distances, weights and the Earth's scale.

Eighth-grade teacher Dave Myers coordinated the project for Scott Highlands Middle School in Apple Valley, and helped 35 students plot and paint one ocean panel and two land panels of Australia and its islands. He says that the project helped increase the students' interest in science—a result he noticed especially in several female students.

"When they were done with the project, there was a career information fair put on {in our school} for women in engineering, and quite a few of the girls who participated in the project went," he says.



Sandra Johnson

After completing the 1,620 triangular panels that comprised the skin of the globe, the students gathered on Northrop Plaza and took turns riding bicycles to provide the power to raise the globe. Myers says that it was important that the students were involved with assembling the globe in addition to plotting and painting the panels.

"I definitely think that one of the best things about the project was going down to the University to assemble it," Myers says. "I don't think they realized how huge the project was until they actually saw it." He says the hardest part was helping the students to understand the task at the beginning, since they had to visualize what their panels and the globe would look like.

"They're really visual learners at that stage," Myers says. But patience, perseverance and much hard work paid off for the students.

The panels included geographical features and political boundaries and were accurate to within one-sixteenth of an inch. Myers says his students were glad that their panels were accurate, especially when they saw clouds being painted over mistakes that were discovered as the globe was being raised.

"They were really happy that they didn't get 'clouded'—they were very proud of that," Myers says.

Katsy Hanson, a teacher of gifted students at Chisago Lakes Middle School, said that her students got impatient during the wait while the globe was being raised.

"Actually, I think their favorite part was painting on the panels," Hanson says of the 26 fifth- through eighth-grade students involved from her school. They got so excited in fact, that she had to slow them down a little.

"They wanted to make a quantum leap from seeing the map to painting the panels," Hanson said. "But they loved researching the panels they painted, and they developed a sense of ownership of that part of the world." Hanson says that the students wanted to learn a lot about the areas in their three panels, which included part of Bolivia and New Zealand as well as one ocean panel.

"They had to learn a lot of teamwork and cooperation," she says, adding that some students may have become more interested in math and geography as a result of the project. She says that it was a great opportunity for an out-state school like Chisago Lakes to take advantage of a learning opportunity in the metro area.

Stacey Kadrmas, a sixth-grade teacher at Frost Lake Magnet School in St. Paul, says the project became especially important to a small group of students from her school.

"The project had a significant impact on about eight to 10 students who were especially interested and involved," Kadrmas says. "The project was hard enough that teachers learned something too. I also think the students really enjoyed the field trip to the University and seeing the globe actually go up and become a reality."

Kadrmas says that much time and energy went into the construction of Frost Lake's 17 panels, and that a great deal of math was used to plot the land panels.

"Plotting the panels was the most challenging part," Kadrmas says. "Knowing you were going to be connecting your panels with some stranger's panels, and the borders were supposed to match up . . . that was very intimidating." She says that an extremely accurate atlas, provided for each school by the Institute of Technology, helped her sixth-grade students immensely.

The globe was originally scheduled to remain on Northrup Plaza for one week, May 4 - 9, but its overwhelming popularity led the University to keep it there longer. The project team plans to make it available for other groups of students to reassemble around the state and the country.

Sources:

Hanson, Katsy; Interview.

Kadrmas, Stacey; Interview.

Myers, Dave; Interview.

Benda, Chuck, "Building a New World," Items, Spring 1993, pp. 9 -11

Lara Carls-Lissick

Lara Carls-Lissick, a Journalism grad student, may be gracing the T.V. screen after graduating with a focus in broadcasting. This is her first article for Technolog.

Photo by Silvana Correa de Faria

Terra Cole discusses her experiment with instructor Nancy Breshnahan.

Chemistry is Fun!

by **Emma Douglas,** *Technolog Staff Writer*

In a Smith hall laboratory, about 25 junior high school kids bend over their lab benches, mashing up Twinkies. No, it isn't snack time; they are measuring the fat content in a Twinkie. One boy goes a step further. Pulling the cake away from the cream, he has decided on his own to compare the fat content of the two critical components (cake and cream that is.)

This analysis of munchies is part of a five-week summer lab program in Upward Bound, a year-round, hands-on learning experience for junior high school students from low-income families. The lab program is one of several in which faculty and students from the Chemistry Department use their talents to stimulate young imaginations.

Team leaders encourage students to think about how to set up experiments, and not just follow a "cookbook recipe." They meet before beginning to talk about approaches and ideas. One experiment requires students to measure the iron in cereal. When one of the young experimenters cannot isolate the iron in an iron-fortified cereal, he goes home and calls the manufacturer to find out why. His curiosity illustrates one of the goals of the program: getting students interested enough in their surroundings to ask questions and to search for answers.

The Chemistry Department is also extensively involved in community outreach. Professor

Louis Pignolet initiated the outreach program in Fall 1989 as a way to get kids from elementary school through high school interested in science, chemistry in particular.

"The perception is that chemistry is difficult and that only a genius can do it," Dr. Pignolet said. He wants to show that chemistry is fun and that anyone can do it.

According to Pignolet, when students do badly in school, counselors tend to steer them away from science. He hopes to make students comfortable with science, to encourage them to go into science, and to build confidence. Although it is difficult to assess effectiveness after just four years, some counselors report student improvement in problem areas after participating in the lab course.

About 30 undergraduate and graduate students from the U visit metro Twin Cities schools to demonstrate basic chemical principles. These highly visual demonstrations are designed to impress kids with no prior chemistry experience. For example, by way of demonstrating the properties of liquid nitrogen and various gasses (argon, oxygen, ethane, helium, and hydrogen), demonstrators illustrate differences in flammability and explosiveness.

"The perception is that chemistry is difficult and that only a genius can do it."

. . . Dr. Pignolet

The outreach leaders also do demonstrations in conductivity, polymers (silly putty and Slime), catalysis and memory metal (nickel-titanium alloy). High school students witness a more complex demonstration involving electrolysis of an HC1 solution and a photochemical chain reaction of H2 and C12.

Initially, the outreach program and development of the demonstrations were big investments in time. Stephanie Miller, a principal student personnel worker in the department of Chemistry, juggles schedules for participating students (especially difficult during final exams) and handles the administration of the program.

If community interest is a gauge, the investment is paying off. In the past academic year, approximately 1,000-2,000 students have participated in the outreach program, and there are waiting lists of interested schools. Following one presentation, a teacher wrote a note of gratitude saying, "They really got the students excited about science!" The outreach program has also worked with the Science Museum of Minnesota in St. Paul.

Another outreach effort organized by Miller and Dr. Pignolet focused on stimulating interest in chemistry among high school students, is Chemistry Day. University students and noted scientists participating in the Annual Larry Conroy Memorial Lecture conduct demonstrations, local colleges and companies put up exhibits and provide career information and the Chemistry Department offers tours of their research facilities. About 600 high school students and 30 teachers attend

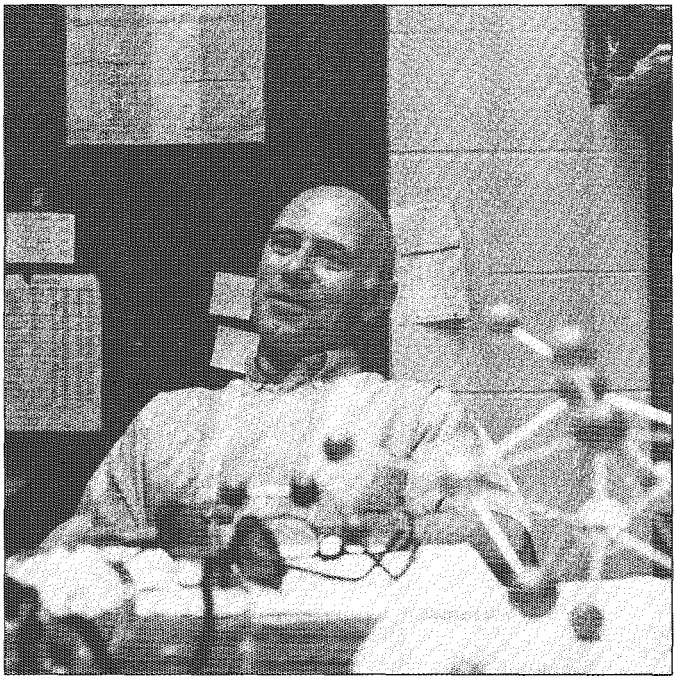


Photo by Silvana Correa de Faria

Professor Louis H. Pignolet in his office at 139 Smith Hall, University of Minnesota.

Chem Day each year.

It's clear that elementary, junior high and high school students benefit from the chemistry outreach program; however, the University students who volunteer benefit even more. He says students learn to teach and to motivate others and that it is "professional training outside of the classroom." It is also impressive to companies, some of whom have their own outreach programs.

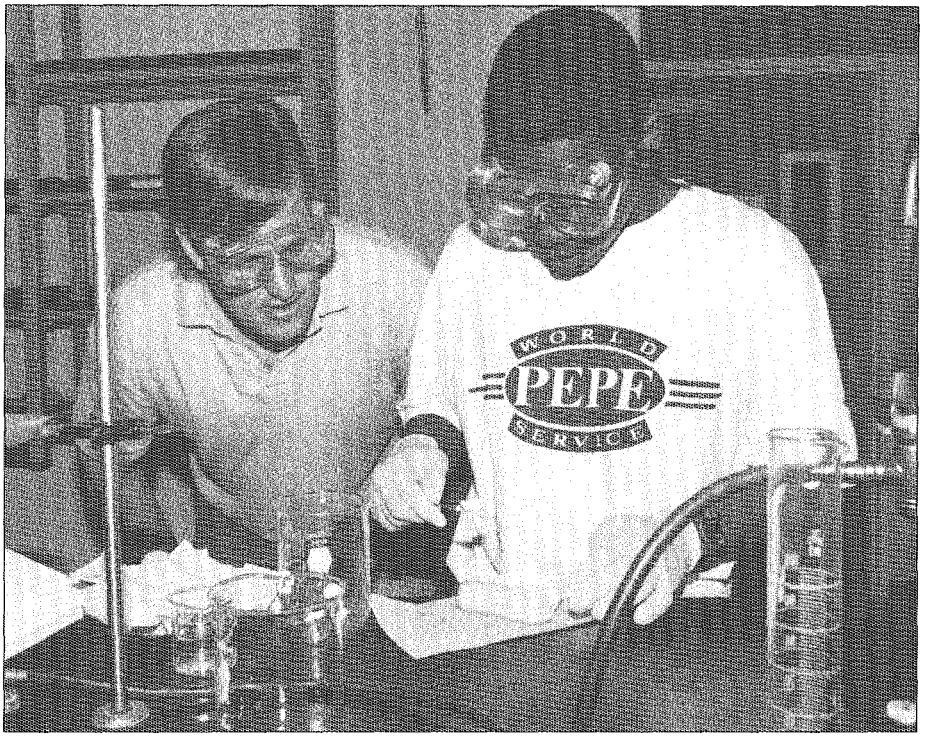
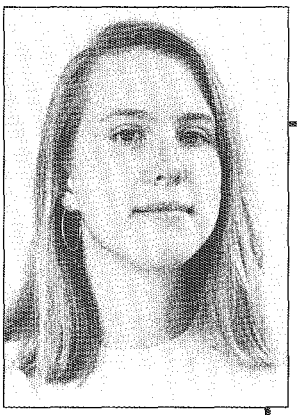


Photo by Silvana Correa de Faria

Steven Skansberg watches Tarik do his experiment with cream cake. Tarik wants to find out whether the cream has more fat than the cake, or vice-versa.



Emma Douglas

Emma, a Chemistry senior, can be found fiddling away—she's played violin since age eight—when she's not in the lab experimenting away. True Brit Douglas—a British citizen thanks to an Irish dad and an English mum—is a diehard movie fan. This is her first piece for Technolog.

Moving Out and Taking Shape: Bioengineering with Cells at the U

by **Tamara Lubic,** *Technolog Staff Editor*

On campus and off, engineers and biologists used to keep to themselves. Oh sure, they saw each other in chemistry and calculus class. But then the bell rang and one group headed off for thermodynamics. The other scooted along to physiology. After graduation, out in the real world, they saw even less of one another.

Then a few years ago, a transformation began. Engineers and biologists were cooperating and collaborating in record numbers. Calling. Writing. Faxing. Doing lunch. Booking their research agendas well into the next century.

They were cooking up a storm. And what was on their cutting board, er ... drawing board? Cells. The newly reacquainted biologists and engineers were slicing, dicing, mincing and peeling cells down to their tiniest fragments and filaments. Swapping DNA and other parts like crazy. The first university bioengineering programs started in the 1950s. In the 70s and 80s, "bio" words sprinkled our language: biotechnology, bioprocesses, biomaterials. Stock prices for "biotech firms" smashed through the ceiling. Biologists told 'em how to keep things alive; engineers told 'em how to scale up and manufacture. Chemists helped bridge the disciplines. Competition was fierce, and riddles became big and very, very scary (what do you get when you cross the genetic material of several species?)

Biotechnology has experienced both successes and setbacks. One enduring concept that has emerged is: "Natural" often works better than "artificial/synthetic." The body is sometimes its own worst enemy, a suicidal sniper on the road to getting well. A healthy immune system may attack foreign substances—even helpful, physician-prescribed substances—faster than a person can say saccharomyces cerevisiae. Animal cells. Artificial substances. Cells and tissue from other humans with different blood types and antibodies. All of them are in danger of getting zapped.

But if researchers were able to culture or grow real tissue, stuff that the body would not resist, amazing things might be possible. Maybe researchers could trick healthy cells into destroying tumors. Perhaps they could replace scarred skin with healthy, unblemished flesh, rejuvenate cardiac muscle, give an athlete a new kneecap or elbow.

Two researchers at the U who are working in tissue engineering are Dr. Wei-Shou Hu and Dr. Robert Tranquillo, Chemical Engineering and Materials Science. Collaborating with Dr. Frank Cerra, Surgery, Hu is designing an artificial liver for providing short term support outside the patient's body. Tranquillo is researching the way that cells migrate through the body, a process critical to wound healing and inflammation.

With biologists and engineers combining their know-how, making spare or replacement parts might one day be almost as easy as saying,

"Hand me a tissue, will you please?"

Cells Hit The Road

The cells in our bodies are social creatures. They like to network and form committees. They also like to travel. By studying the road maps that cells follow and the "choices" they make, medical researchers and clinicians are steering toward better treatments for wounds, inflammation, tumors and other tissue glitches.

Tissues (skin, bone, muscle, etc.) are clusters of task specific cells, so it follows that the behavior of individual cells affects the group. Dr. Robert Tranquillo of the Department of Chemical Engineering and Materials Science researches the cues that prompt cells to migrate.

"We study how cells in the body crawl in response to cues in their environment and the role of cell forces in that process," he said. "Cell and tissue forces are coupled. Cells can generate forces in their cytoplasm. They can transmit their force to tissue fibers and it's that transmission of force which allows them to crawl."

Characterizing the way cells "crawl" and then making them do it (or stopping them from doing it) on cue could one day help slow the spread of cancer, reduce scarring and lead to living, functioning replacements for skin, bone and other tissue. Dozens of human body repair jobs would become more efficient.

But cells can be stubborn. Tranquillo says, "One of the challenges to creating tissue analogs is getting lab-cultured cells to crawl to the right places and stay there." To get them to shape up, he creates mathematical and experimental models for testing their migration patterns. The models also help characterize the forces cells generate and transmit.

Cells live within a support structure called the extracellular matrix (ECM). Information from the ECM helps determine the behavior and characteristics of cells, including the paths they take when they migrate and the types of proteins they produce.

According to Tranquillo, when cells within the matrix begin to migrate, they follow certain directional cues. For example, they move up chemical concentration gradients (chemotaxis) or adhesion concentration gradients (haptotaxis); they also tend to move back and forth along aligned fibers. By setting up gradients or aligned fibers in the lab, and comparing predicted movement to actual movement, Tranquillo can begin to characterize cell behavior. "The matrix presents certain information to the cell, and the cell responds to it," he says. "The fascinating but complicated thing is that the cells can modify the matrix. They can align the fibers while migrating through them. It would be like the road changing directions depending on how you and those around you are driving your cars."

Tranquillo explains that an important part of creating effective tissue analogs is engineering a fiber network in such a way that cells "populate it in correct fashion." If the

Traction-induced Migration Cues in Fibrous Matrices

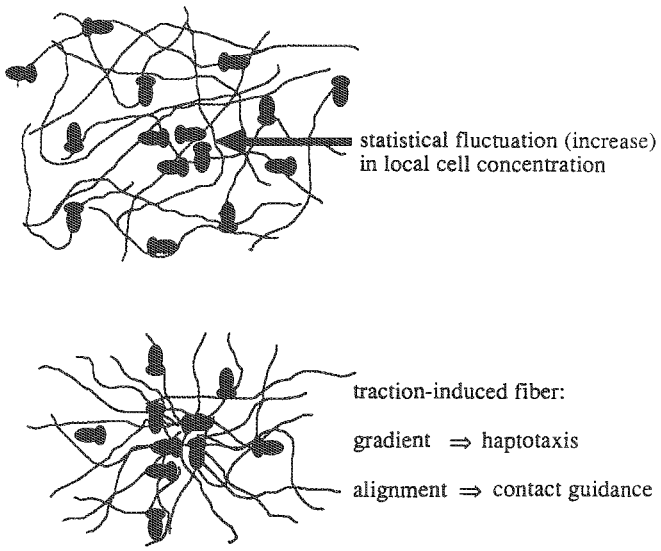


Illustration courtesy of Dr. Robert Tranquillo

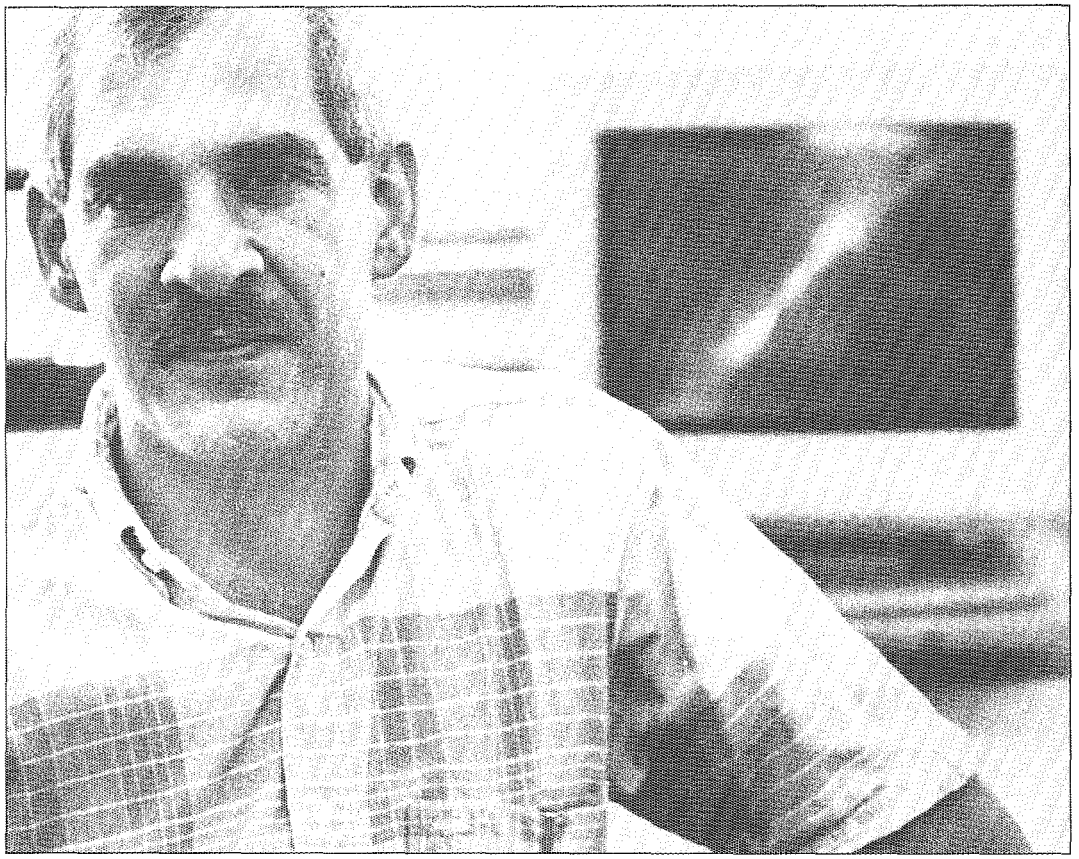


Photo by Dilip Vishwanat

Dr. Robert Tranquillo of Chemical Engineering and Materials Science

cells don't form the right connections, if their spacing is off or they don't reproduce, instead of functioning as a unit (tissue), isolated cells will stay scattered and die out. Tranquillo says, "Most of our attention is on the mechanics and dynamics of cell populated networks."

He notes that the experimental models involve a very common technique. "It's a relatively simple matter of causing the collagen material to assemble into long fibrils that entrap the cells, so you end up with a tissue-like network. The big question is how similar is this to real tissue? Can it be used as a tissue analog?"

Tranquillo measures the rate that tumor cells invade the collagen-based gels. To a degree, the rate depends on the composition of the gels. He says, "We ask how much these rate constants we measure depend on cellular properties and how much they depend on proteins with which we supplement the collagen. One of the great unknowns is how closely the gels resemble real tissue."

> If researchers were able to culture or grow real tissue, stuff that the body would not resist, amazing things might be possible.

Getting a grip on cell behavior in the laboratory should eventually lead to improved products in the marketplace. As an example, Tranquillo mentions wound-healing agents that are applied to the surface of the skin. "I'd say that in 99 percent of cases, the [existing] products are not being systematically characterized in objective, quantitative ways."

But understanding the relationship of connective tissues and the forces cells exert would offer new possibilities. "The goal is to enhance or inhibit some facet of that process, to promote or diminish a particular cellular

activity. We [in research] focus on cell migration behavior and must leave it to clinicians to apply what we're doing."

Tranquillo says that an exciting still-to-be-explored question is how cells at the molecular level actually sense and respond to signals. He terms it "the marriage of molecular/cell biology and cellular/tissue engineering."

This union will explain not just what a cell does but how it does it. How does it sense environmental cues over its whole surface? "If you know that," says Tranquillo, "in principle, one day, via some means of genetic engineering, someone will design a drug to alter a cell in a way that will correct a defect in [its] ability to sense and respond to a particular signal or to enhance its normal ability."

Tranquillo describes his research as bridge-building. "Our work," he says, "is a link between phenomenological mathematical models and cellular mechanisms, a bridge between the micro and macro levels. We develop these models by conferring the cells and matrix with certain properties and mathematically making these links. But we can only go as fast as our understanding of molecular and cell biology allows."

Liver Cells Provide Support

The liver is neither as tangible nor as romantic as the heart, not as exotic-sounding as the spleen. But what it lacks in glamour, the liver makes up many times over in complexity. It is a metabolic powerhouse that accounts for 3 percent to 4 percent of our total body weight and performs more than 500 separate functions.

Identifying, let alone reproducing, essential liver functions is a Herculean challenge. Humbled by this complexity, Lewis Thomas writes, in Lives of A Cell: Notes of A Biology Watcher: "For I am, to face the facts squarely, considerably less intelligent than my liver."

A multi disciplinary team of Minnesota researchers led by Dr. Wei-Shou Hu of Chemical Engineering and Materials Science and Dr. Frank B. Cerra of Surgery is matching wits with this genius of the organ family. They are developing a non-implantable bioartificial liver (BAL), for short-term support of patients in acute fulminant liver failure, meaning comatose and close to death.

Unlike patients in kidney failure, patients in liver failure have no options other than transplant. But only a few receive one. Many patients do not qualify; a shortage of donor organs and a long waiting list make the problem worse.

As Hu has noted, there is "no substitute for the failing liver to either buy time for the ... liver to recover or to find a suitable organ for transplanta-

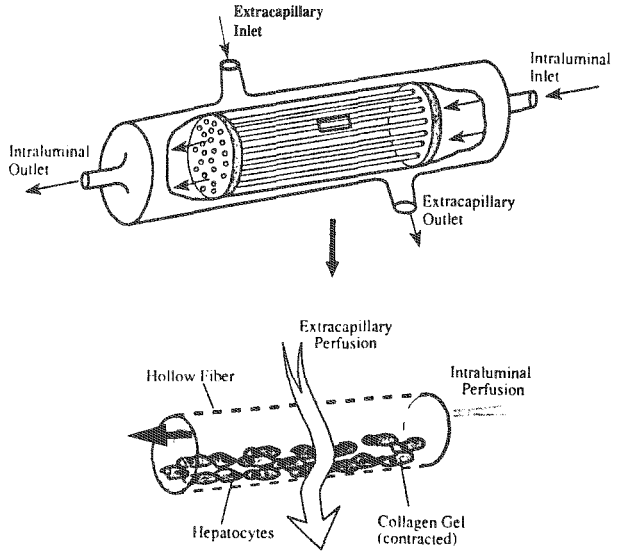


Figure 1. Schematic diagram of hepatocyte entrapment in the hollow fiber bioreactor. Top: Bioreactor with both extracapillary and intraluminal flows. Bottom: Single fiber with hepatocytes entrapped in collagen gel.

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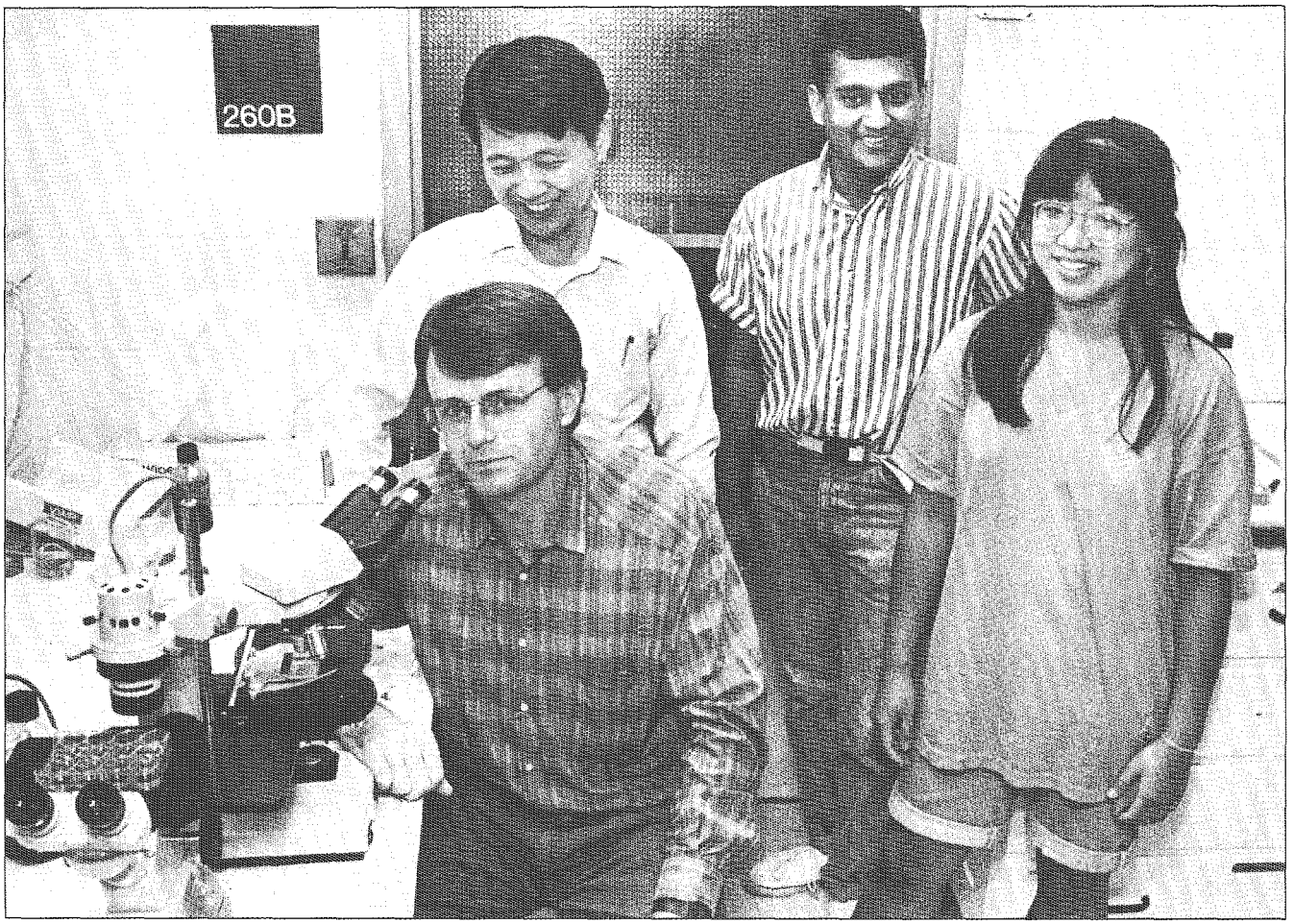


Photo by Dilip Vishwanat

Dr. Wei-Shou Hu (back left) with researchers Dr. Scott Nyberg, medical fellow, Surgery, (seated), Madhusudan V. Peshwa (back right) and Florence Wu, Ph.D students, Chemical Engineering and Materials Science.

tion." According to Hu, if patients can be supported during failure, many conditions can be reversed.

The heart pumps, the kidneys filter. What does the liver do? For starters, it metabolizes, synthesizes, detoxifies and gets rid of waste. To perform as many essential processes of the natural liver as possible, Hu's BAL is a hybrid, a combination of bioractor system and living animal liver cells. This inclusion of living cells distinguishes the BAL from a kidney dialysis machine which has the single objective of mechanical filtration.

Though human cells would be the ideal for the reactor, they aren't available; given the shortage of transplant organs, when a liver becomes available it is transplanted immediately rather than separated into cells. So far, getting cells to grow in a lab and keeping them healthy hasn't worked either. This leaves no easy way to get cells.

For the time being, researchers are using animal cells. They are the key ingredient in the system. The bioreactor is based on a tube-within-a-tube hollow-fiber system. Hepatocytes (liver cells) are inoculated into the cavities of a bundle of semi-permeable hollow fiber that behaves like capillaries. The fiber creates a membrane between the cells and the circulating blood, keeping them separated. This prevents the immune system attack that would normally kick in if animal cells entered the human bloodstream.

After the cells are inoculated into the lumen of the hollow fiber, the temperature inside is raised to entrap the liver cells in a fibrous, porous gel matrix that allows a nutri-

ent solution to flow through. In the experimental model, solution also flows through the extracapillary space. But when the BAL reaches clinical trial, the patient's blood will flow through this outer chamber.

As testing and refinement of the experimental device continues, Hu's and Cerra's team will evaluate it from several disciplines. They will look at the biological aspects (making cells more functional), engineering aspects (scale-up and improved efficiency of the reactor design) and surgical implications (catheter size and installation).

The BAL has been tested on small animals (rats and rabbits) and is about to be scaled up for dogs. Already, it has become an example of technology transfer between the University and industry; the University owns the patent but has licensed its application to a private company. However, if the BAL ultimately proves viable for short term support of liver failure in humans, the device will also raise ethical issues.

"We have to ask, what should be our long-term goal?" Hu said. "It should not be prolonging the life of a patient to wait for an organ because of the shortage of organs. Also, if a patient is in a trial, and the machine doesn't work, should the patient be moved to a higher priority list? If so, would people sign up for the trial for this reason?"

Satisfactory answers will require time and consideration. The prospect of providing a support mechanism for liver failure patients is still some distance from availability. But today's BAL testing may pay off for animals as well as humans. Hu points out that because one major function of the liver is detoxification, an important aspect of developing the BAL is its potential as a substitute for animal testing.

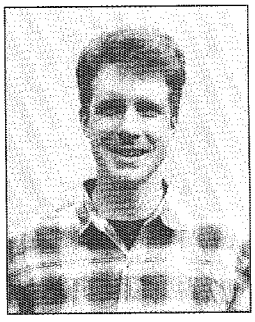
If successful, Hu says, "You would have a more controlled system that could be used [instead of live animals] for metabolic studies for drug development as well as for screening and testing."

Tamara M. Lubic

Tamara M. Lubic is extremely interested in how people decide what is right, wrong, or unavoidable. A Journalism grad student with a minor in Biomedical Ethics, she sees a writing career as a way of getting answers.

As the world's oil reserves get closer and closer to that big 'E' on our world gas tank, more and more people are thinking of ways to turn natural resources into fuel. Corn and natural gas have been used for a long time for fuel, but we are now poised to begin using both at an unprecedented rate. Farmers in Minnesota are dealing in a new trade: putting corn in our gas tanks. And University of Minnesota researchers have found a ground-breaking process for turning natural gas into methanol and diesel fuel. Before we enter the next era of fuel consumption, the alternative era, we should strive to better understand both exciting technologies.

Going Mobile?
Think Alternative



by **Matt McKinney**
Technolog Staff Editor

Down on the farm: Ethanol production is helping farmers, but what about the environment?

The sun is just coming up, and already John Nelson can tell it will be another day before he can go back to work. The floods in southwestern Minnesota have put his corn planting weeks behind schedule. It may be that no corn will get into his fields this year.

Despite the gloomy beginnings to the season, Nelson has one thing on his side that most other farmers don't: membership in an ethanol-making plant. The Minnesota Corn Processors plant in the town of Marshall, Minnesota is owned by hundreds of farmers who turn the stuff most people would eat into fuel for cars and trucks all over Minnesota.

Ethanol has become big business. With profit-sharing from the sale of ethanol, and added incentives from the state government, many farmers have seen ethanol turn corn farming into something unusual for a farm: lucrative. It's so good, in fact, that other farmers in the state are turning a curious eye toward Marshall. Some 15 ethanol plants like this one are under construction throughout the state.

Ethanol is a highly combustible fuel made from the cellulose found in corn and many other substances. Many things can be used to make ethanol. At Nelson's Marshall plant, some 15,000 gallons

Sandra Johnson

of ethanol are turned out every year. For every gallon produced, the state government pays the farmers 20 cents. In addition, state government grants helped to fund the plant's start-up.

Last winter, the state government required that gasoline sold in the Twin Cities metro area be blended with ethanol to reduce carbon monoxide emissions. For three months, from Nov. 1 to Jan. 31, gasoline sold in the Twin Cities was 10 percent ethanol.

The period will be lengthened this winter and again the following year. Eventually state lawmakers say that ethanol will be sold throughout the state, every day of the year.

The Environmental Protection Agency said that, this year, Minnesota did not exceed health codes for carbon monoxide levels, a strong testament to the environmental benefits of ethanol. But to most promoters of ethanol, the findings were not surprising.

The Minnesota Agriculture Commission, charged with the duty of protecting

Minnesota's farmers, says ethanol protects the ozone layer. The crop helps farmers, reduces the nation's dependence on foreign oil and uses a reusable energy source. In fact, it seems too good to be true. Maybe it is.

EPA evidence suggests that ethanol, which evaporates much more quickly than gasoline, leads to higher levels of ozone in the air. That's right: the same stuff we don't have enough of in the atmosphere. But while ozone is good up there, it's hazardous to our health down here.

"It's not a clear winner," said Paul Hansen of the Izaak Walton League of Minnesota, an environmentally minded organization. He said the Twin Cities are already barely in compliance with EPA ozone standards and that ethanol use may push us over the edge.

"If we continue to keep putting cars on the road (with ethanol) it seems very likely that we will be way out of compliance," Hansen said.

What gives?

Some people argue further that the ethanol alternative is tricky because so much fuel is used to make ethanol. From tractors plowing the fields to trucks transporting the product, ethanol may use more fuel than it produces.

"This is not a popular message in the heart of the corn belt ... however, we need to face the reality that ethanol is not an efficient option," said Iowa Professor Lon Drake in Iowa Groundwater Quarterly.

With this winter fast approaching, Minnesota's thirst for ethanol will soon push production levels at the Marshall plant well into overdrive. But it seems the question more people should be asking is: does ethanol fix as much as it claims?

Alternative fuels: University researchers go natural (gas).

It's a simple little process that could really ruin your day. To turn natural gas into methanol or diesel fuel, run a mixture of methane (the burnable part of natural gas) and air over a rhodium- or platinum-coated catalyst.

One miscalculation and the explosions would level you, if not the laboratory. But do it

Photo by Mitchell Hanley

Professor Larry Schmidt and graduate students Marylin Huff and Paul Torniainen are working on a process that will turn natural gas into methanol or diesel fuel.

right, and you could revolutionize the energy industry.

That discovery by Institute of Technology researchers Daniel Hickman and Lanny Schmidt is being heralded throughout the petroleum world as the latest breakthrough in alternative fuels. If used widely by petroleum companies, the process could be used to turn the vast U.S. reserves of natural gas into methanol and diesel fuel.

Here's how it works: a mixture of methane (from natural gas) and oxygen flows through a ceramic monolith coated with rhodium. The catalyst looks like a gray, pitted golf ball. It is heated up until the chemical reaction starts, turning the methane and oxygen into "syngas." The syngas is easily converted into methanol or diesel fuel by known chemical processes. Hickman and Schmidt discovered a faster way of converting the natural gas into syngas. The work of the researchers was published in the January issue of Science.

Syngas used to be produced with big steam reactors. Schmidt said that Germans used the technology to turn natural gas into fuel for tanks in WWII. But the process was largely inefficient and produced an unhealthy dose of carbon monoxide, a widely cited cause of global warming. Hickman and Schmidt's process is 1,000 to 10,000 times faster than the old steam process. Engineering problems still remain, Schmidt said; the syngas is highly explosive and flammable.

"You've got to know what you are doing or you will blow it up," he said.

The greatest advantage to the new process will be in the fast production of thousands of gallons of methanol or diesel fuel from the syngas. The fuel is easily stored and transported, unlike natural gas, which must be cooled down, converted into a liquid, then transported in insulated carriers.

The crop helps farmers, reduces the nation's dependence on foreign oil and uses a reusable energy source. In fact, it seems too good to be true. Maybe it is.

Petroleum companies aren't waiting for engineers at the University to work out the bugs. In fact, Schmidt has been courted by companies around the nation as they inquire about the new process.

For Schmidt, the attention is flattering, but he's not about to leave his students for a job at the big oil companies.

"The oil companies will have to do the pilot work to find the most feasible way to do it," the professor of chemical engineering and materials science said. He added, "I am here to teach graduate students."

Matt McKinney

When Journalism grad student Matt McKinney isn't piloting a boat through Alaskan waters or rooting out corruption, he can be found squinting in front of a computer in his quest to become an even further-evolved editron.

Detecting Neutrinos—

Pushing the Frontiers of Particle Physics in Minnesota

by **Chris Kasic**,
Technolog Staff Writer

It lies deep in the heart of 27 Montana, underneath a half mile of Minnesota. 27 Montana is not actually in Big Sky country, it's the lowest level of the Soudan Underground Iron Mine, 2,341 feet below ground.

The Soudan underground mine is home to the largest neutrino detector of its kind in the US and one in which University of Minnesota physicists hope to find some of the secrets of the exotic world of particle physics. Why take the trouble to cast tons of electronics a half mile below the surface and into the dank caverns of an abandoned iron mine? Iron's high density is one of the best shields for stopping all but the smallest particles of the physics world. The neutrinos, however, get through.

The University began construction of the detector at the deepest level of the Soudan Mine in 1985. Mining there stopped back in 1962, when imported ore became cheaper, and now in place of skipjacks and Granby ore cars, a small portion of Soudan has a dizzying array of wires, cables, shielding, and detector innards.

The detector sits under a half mile of rock to shield it from the showers of other particles received from outer space. When you're looking for a particle as small as the neutrino, you can't be too far underground. Since their mass is so minute, physicists have the best chance of finding neutrinos deep underground, where larger particles cannot easily penetrate. Imagine trying to hear a whispering friend a few meters away while in the middle of rush hour in Minneapolis. The sound exists, but it's drowned out by much louder noises. At midnight, chances are better you'll hear at least something. Similarly, searching for neutrinos deep underground, where few particles can eventually tunnel, is most likely to result in success.

Neutrinos themselves result from collisions at high speeds. They can be produced by the sun (solar neutrinos), or remain as remnants of the Big Bang (cosmic ray neutrinos), or even be created in supercolliders. The essential difference in such neutrinos is the measure of their energy, with cosmic ray neutrinos being the weakest, and supercollider-produced neutrinos the most energetic. The Soudan detector has the ability to detect all three. The only way to really detect them, however, is to watch for the energy they produce upon collision. The 900-ton detector provides ample mass for such a collision. Since neutrinos

When you're looking for a particle as small as the neutrino, you can't be too far underground.

interact essentially with mass, increasing target size, or more accurately, target mass, increases the likelihood of a strike.

The detector itself is a conglomeration of 208 interconnected modules. Each module is a honeycomb of 17 mm. plastic tubes separated by steel plates. The tubes, which are filled with a mixture of Argon gas and carbon dioxide, serve as highways to transport the results of microscopic collisions with the steel plates. Incoming particles collide with iron nuclei inside the steel plates, and result in a shower of high-energy particles which then ionize the gas in the tubes. The ionization is recorded by an array of electronics at either end of the tubes. These electronic receptacles pick up the signal and amplify it. A computer then receives a signal from the electronic array, denoting the exact time, place, and pattern of the collision. This type of detector is also able to reconstruct a three-dimensional picture of the event within, and the resulting pattern of interaction among the particles is crucial to determining their masses, among other things. In this case, mass translates into distance traveled within the resulting particle shower.

What makes neutrinos so interesting is their supposed quirkiness. Neutrinos are nearly massless or may even be massless—no one knows for sure. Neutrinos are hard to catch, but far from rare. Trillions of neutrinos are produced every day in the sun's thermonuclear oven, and the overwhelming majority pass through the earth without hitting a single atom. Of anything. Metaphors tend to pale in such situations, but winning the lottery on consecutive weeks is more likely than a single neutrino colliding with something on Earth. Millions go through our bodies every day, but don't worry—they're not harmful. It's only because of the sheer numbers of neutrinos that we catch them striking anything at all. Particle physicists are gradually bettering the odds of catching more neutrinos, and placing a detector where few other particles penetrate is one such strategy.

The most profuse local source of neutrinos is the sun. The extreme temperatures inside the sun create a variety of ionized particles, which streak toward Earth constantly. Radiation from the sun and extra-solar radiation called cosmic rays buffet earth's upper atmosphere. Once a cosmic ray strikes something in the atmosphere, it creates a shower of high-energy particles. Some cosmic rays reach the detector in Minnesota. "Even with half a mile of bedrock, a cosmic ray manages to enter the detector about every four seconds," says Earl Peterson, University

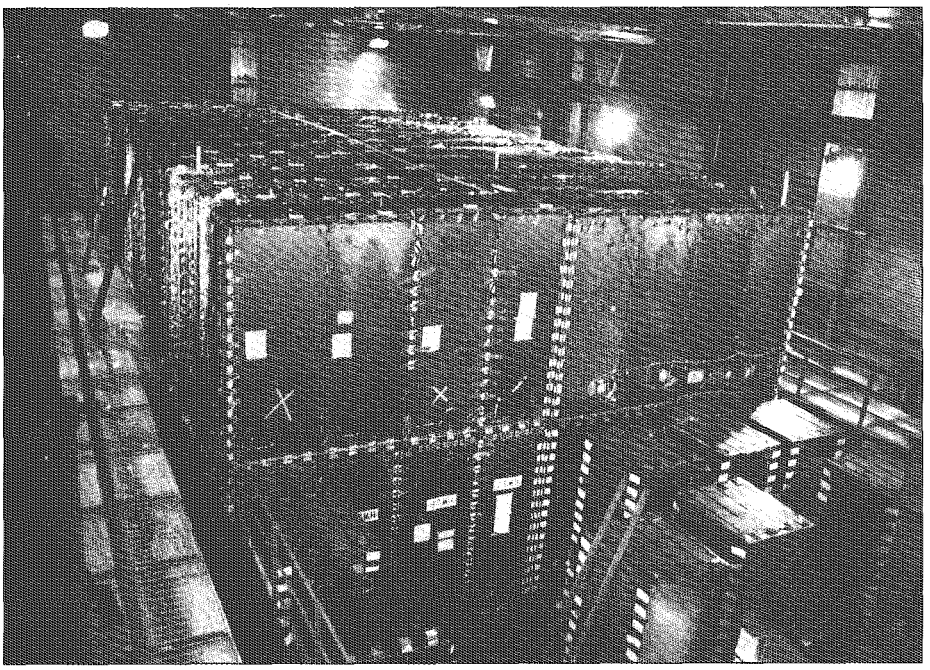


Photo by David DeMuth

The Soudan neutrino detector

of Minnesota Professor in the School of Physics and Astronomy. They're hoping to catch a few of the scores of neutrinos which pass through the detector.

Neutrinos could be the sprites that account for the missing mass problem.

How many of these neutrinos ever leave a trace of interesting sub-microscopic collisions? About 40 per year. Peterson estimates 50% of the events detected are simply snakes, the physicists' whimsical name for a false alarm. Particles that come in through the top and exit through the bottom of the detector, such as muons, aren't really what particle physicists are after. A contained event, something which begins and ends in the detector and produces a spray of particles, says Peterson, is most likely to contain what the physicists are looking for.

Peterson admits much of the searching is a matter of probabilities, and particle physicists know almost any collision or reaction comes with some probabilistic and relativistic baggage. What that boils down to, says Peterson, is a matter of getting repeatable data.

Some applications of the data from the Soudan Detector lie in the realm of cosmologists' research. Physicists and astronomers have been trying to determine just what holds our universe together—with current detection limits, according to the latest theories, the universe doesn't have nearly enough mass to even hold itself together. Unless we're just not good enough at looking for small particles, we should be flying apart at the seams. Neutrinos could be the sprites that account for the missing mass problem. Given its ubiquity, even a neutrino with very small mass could account for the missing mass of the universe. Craig Bode, a Physics graduate student, combs through reams of data produced by the detector, hoping to pin the neutrino down as the ghostly mass-carrier of the universe.

Other physicists, like Professor and Physics Department Head Marvin Marshak, use the data to try to prove that proton decay really does happen. Breaking a proton into its constituent parts hasn't yet been done, and is something that not all physicists agree **can** be done. A spontaneously decaying proton theoretically produces pure energy from mass. Marshak believes witnessing such a decay would mean the eventual disintegration of all mass into energy. But don't hold your breath hoping the mass of parking tickets under your seat will burst into light anytime soon—cosmic time scales go by the billions of years.

Other major projects use the detector to study cosmic ray events, magnetic monopoles, and other intractable beasties of the particle physics world.

Although you may not lose sleep wondering if anyone will ever see a magnetic monopole, physicists who study these particles are aiming at nothing less than a more complete explanation of the origin of the universe. "It's much easier to understand where you're going," says Marshak, "if you know where you came from." Furthering Einstein's theory of relativity and gaining a better understanding of the interactions of matter and energy are

"It's much easier to understand where you're going," says Marshak, "if you know where you came from."

some of the banners flying on the horizon. Some cosmologists have long been speculating on a "Theory of Everything," and particle physics will no doubt supply some crucial pieces to the puzzle.

Some interesting projects lie in store for the Soudan Detector in the coming years. A project sponsored by the U.S. Department of Energy and Argonne National Laboratory in Illinois may fire man-made, high-energy neutrinos at the detector before the turn of the century. These neutrinos are produced at much higher temperatures than the sun's core, and result in higher-energy, more "likely to be caught" neutrinos. Minnesota physicists hope then to see proton decay in action, and perhaps even prove that the neutrino has mass, and is in fact the particle holding our universe together.

Sources:

Personal Interview with Dr. Earl Peterson, Soudan, MN, 17 Jul 1993.

Personal Interview with Craig Bode, 22 Jul 1993.

Personal Interviews with Dr. Marvin Marshak, 1 Jul 1993, 2 Aug 1993.

Chris Kasic

Chris is currently completing his Master's Degree in Scientific and Technical Communication in the Rhetoric Department. He recently moved to Minnesota from Ann Arbor, Michigan and Detroit Red Wing hockey, only to watch his second-favorite team, the North Stars, leave town. He is a technical writer at Fisher-Rosemount Systems in Burnsville.

Chaos in the UNIVERSITY

by **Robert Subiaga, *Jr.*, *Technolog Staff Writer***

One can scarcely avoid mention of Chaos Theory nowadays. In Jurassic Park, for example, Jeff Goldblum plays a prophetic mathematician with an expertise in it. Behind it, many experts claim, lies a scientific revolution on par with relativity, quantum theory, or the cracking of the genetic code. And as Chaos Theory techniques become more widespread, researchers here at the University of Minnesota use them to solve problems once thought insoluble. Yet many people still find themselves asking "What is Chaos Theory?"

Simplified, three of Chaos Theory's big tenets are: one: A system of any kind, with three or more variables, no matter how small, is never truly predictable except in a temporary and/or qualitative way. Two: Any orderly system has inherent instabilities, and always has the capability of breaking down into chaos from even minor disturbances. Three: In any open thermodynamic system—which means any system smaller than the entire universe—chaos has the ability to spontaneously generate order.

Described in its formal sense, Chaos Theory is the study of non-linear dynamics. Dynamics is itself the study of changing systems, and quite self-explanatory—until one realizes that almost all of the dynamics studied with physical science up until now are either linear, or linear approximations. Simply put, they are the equations with easy answers. Those of you familiar with calculus will understand how this idea works; when differentiating a curve, the idea is to envision the curve as an "imperfect" thing, an infinite collection of idealized, perfect straight lines. Discoveries like calculus made a host of these problems workable, and suddenly physics seemed to hold the promise of reducing everything to a machine-like description of causes and effects in a Newtonian clockwork universe. Quantum theory put unpredictability back into nature. But quantum events can be statistically averaged out, so statistically adjusted determinism still allowed no room for free will, and verbal and artistic communication still seemed only temporary necessities. They could be eliminated by logic and mathematics when humans possessed enough knowledge.

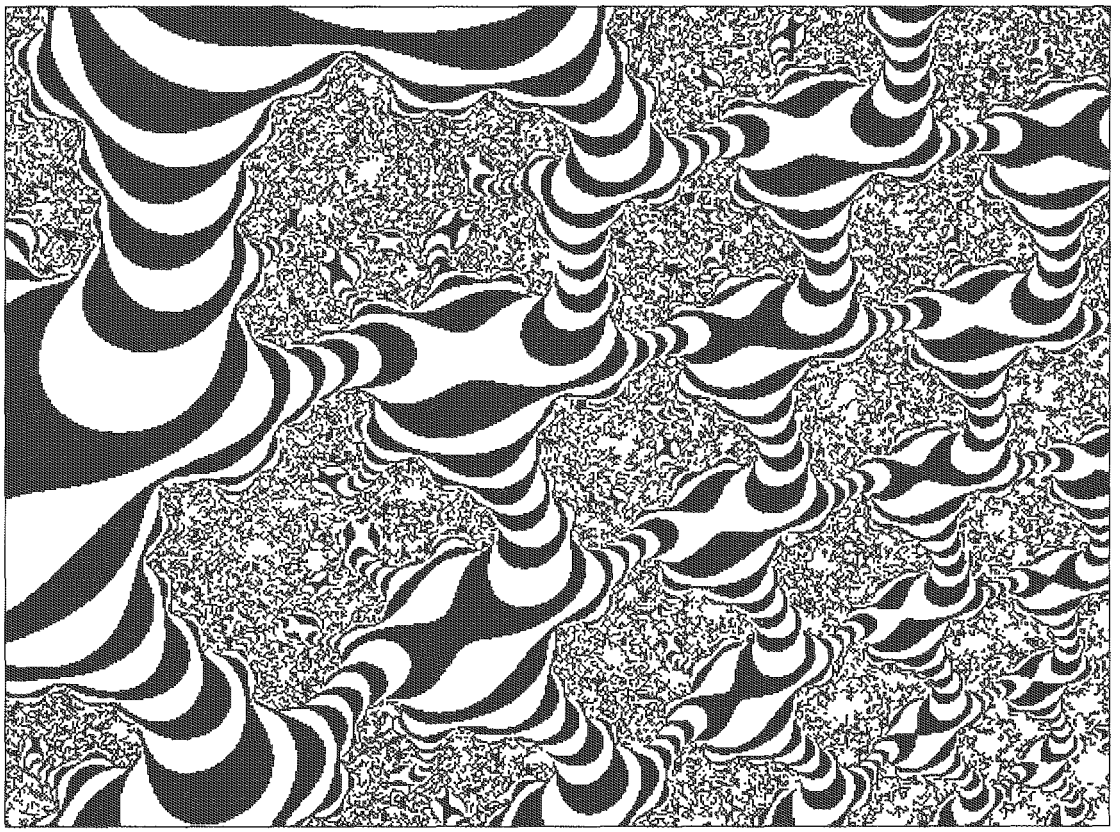
Everyone forgot that very little of natural phenomena had been successfully linearized. Despite developing a reputation for a search for ultimate truths, physics simply ignored problems it could not yet solve, and rested in the assumption that if and when a powerful enough computer existed it would be able to conquer these phenomena. Instead, with the advent of such supercomputers, a few pioneers decided to stop treating non-linear equations as imperfect copies. Evidence started to emerge that the world itself is non-linear. Humans' success with linearizing had made them forget they had only become lucky with a special case of nature.

Chaos was different. To picture it better, let's take a journey through phase-space.

To understand phase space, first contrast it with "regular" space, which graphs given points in space or space-time on separate axes. The actual variables of the system (momentum for example) that cause its behavior are not directly represented. To solve problems in regular space, one of two methods are used. We might graph an idealized equation or set of equations, and see if our experimental system follows the behavior we predict. Or we might plot the behavior of a system, hoping we have held constant all but one or a few variables, and then try to fit the plot to a curve. Both processes are linear methods. "Regular" space says nothing about the actual forces causing a system to act as it does. This is not a problem when the forces and variables involved "behave" and lend themselves to prediction and analysis. But in Chaos Theory one finds that "near-perfect" predictions are far from perfect and, conversely, systems that map as a hopeless jumble of points in such space might be chaotic-looking but are not necessarily random!

Phase space works by plotting all the variables directly against one another. Another way to think of it is that a point in phase space is a shorthand for the state of an entire system in space and time. A system with no real dynamics, and so at rest, is easy to picture as being "at" a single point. But what about something moving, like a pendulum? In the real world the

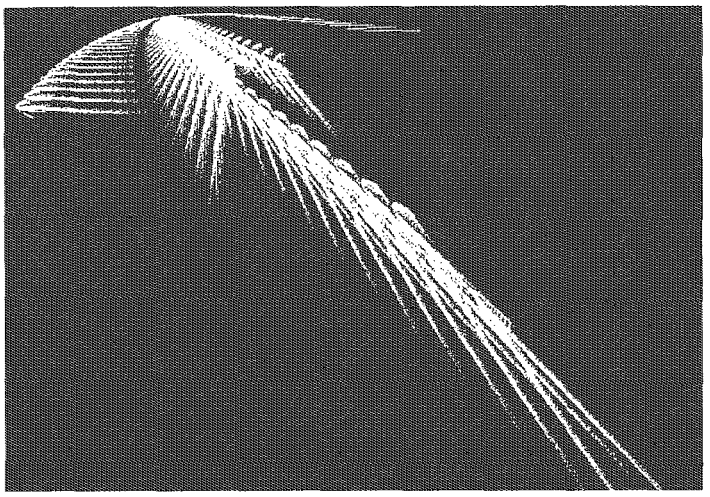
Four examples of images which Chaos Theory can generate



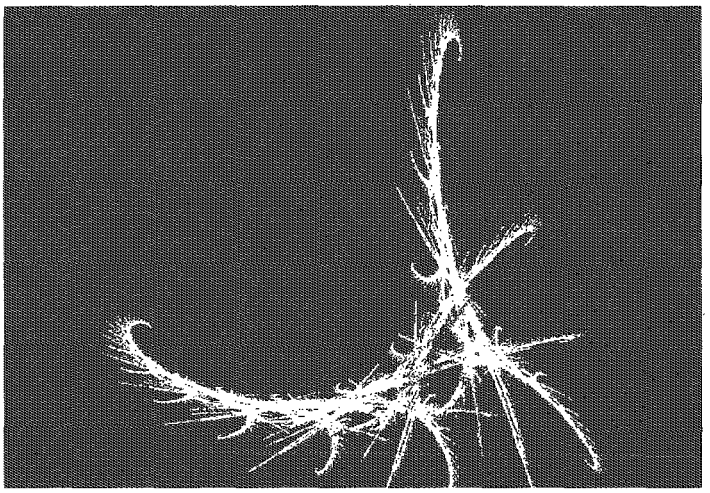
Robert Subiaga, Jr.

forces on a pendulum eventually bring it to rest. This means that its behavior in phase space, no matter how it starts out, will spiral into that single point we just described for a system at rest. Such a point is called an attractor.

Things start to become stranger as we realize that a system can have more than one attractor. One example is a typical predator-prey cycle in nature. The natural evolutionary forces on each population will drive it toward a maximum. But if one population is too successful (the predators, for instance) it will affect the other population in a way that brings it back down (killing too many prey animals reduces the food supply, predators starve, and their numbers come back down). Since each of the variables holds an upper hand against another, there is no way for the system to quickly settle into one rest state. Minus some major change in such a system (like introducing a new variable), it will continue to oscillate. Such a cycle is called a limit cycle, and it takes as many-dimensional a phase space to describe it as there are variables—and attractors. The cycle, however, can be perfectly predictable.



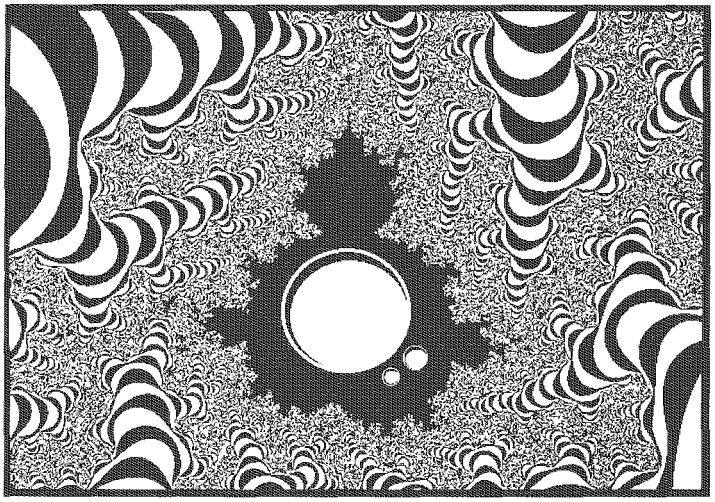
When two or more limit cycles become "fastened" to each other, however, the attractors in phase space take on an even more bizarre look. Now they cease to be points, but become a torus, a doughnut-shaped object. The system's variables cycle in such a way so that their values follow the surface of the torus. This is the only "rule," however—and there are infinitely many values to follow on this surface, without ever repeating the exact same path twice! To visualize one form of this in "regular" space, imagine drawing a figure-eight pattern on a piece of paper, but never actually retracing a previous path of the pen. This is called quasi-periodicity. The system tends to act in the same way in similar situations, but it never behaves exactly the same way twice. Like a living personality that is qualitatively predictable, the system nonetheless exhibits a "free will" on the small scale. While this is not Chaos quite yet, it is its close cousin.



Yet already this has immense implications for our whole conceptual framework of engineering, science and philosophy. Inanimate matter is not as predictable as we would like to assume; and by incorporating unpredictability in its own behavior, a living thing responds far more successfully to an unpredictable world than almost all present control-systems technologies. Rather than eliminating "mistakes," as most engineering solutions still do, the key seems to be "roll with the punches" and adapt by learning from mistakes. Nervous systems, in their dynamics, are in many ways just

souped-up versions of these same processes, with the capability to act and learn much faster than metabolic or genetic mechanisms. Contrast this with digital computers, which are designed to steadfastly resist glitches and display perfectly linear and predictable dynamics—but which "crash" so easily when errors do occur.

One might assume that since a three-dimensional torus in phase space describes coupled two-variable oscillators, all we have to do is keep increasing the dimensions of our phase space to include more dimensions. But something else happens. The torus itself becomes unstable, and starts to break apart, entering a space of—believe it or not—fractional dimension! It is the equations of fractional dimensional phase space that generate the beautiful, infintely complex images known as fractals, and the bizarre behavior encountered now makes Chaos Theorists refer to the breaking-up torus attractor as a strange attractor.



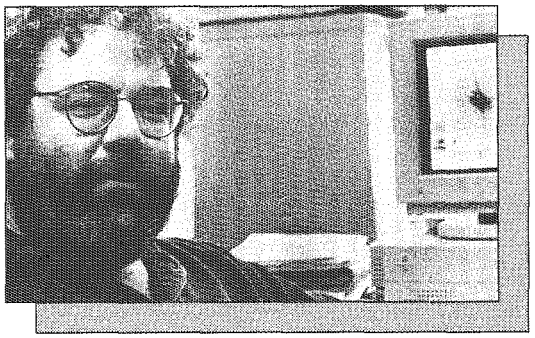
Describing the natural breakup of order into turbulence has long been very difficult. As few as three variables can elicit such a breakup. The third variable need not be large; instead, a little disturbance at just the right critical point can make all the difference. Picture a system that is very unstable: its attractor(s) are on the verge of "snapping," of changing their type or shape. Unlike quantum theory or relativity, the stakes of unpredictability in Chaos Theory impact our everyday lives. But Chaos Theory is not a picture of the world where nothing makes sense. Even horrendously complex systems can often easily be described qualitatively. Even when order breaks down to chaos, the seeds of new order are present. Where a quasi-periodic system displays global regularity and specific points of unpredictability, globally chaotic systems form intricate orders. Life, far from being an accident, is an imperative.

The thrust of Chaos Theory techniques, so highly mathematical yet so unwaveringly qualitative, seems paradoxical. But by giving up never-realized claims that it can find Ultimate Knowledge in principle, humanity holds the promise of finding incredible vistas of understanding, in practice. As Jeff Goldblum's character says in "Jurassic Park," "Life will find a way . . . Life always finds a way . . . " If physical science and technology are to advance, they will by learning the techniques of the beautiful and the organic, rather than explaining them away.

Robert Subiaga, Jr.

Budding chaositician **Robert Subiaga, Jr.** got his B.A. in Physiology in 1988 and subsequently did graduate study in Philosophy. He's now an extension student and Neurology Research Technician. When he's not creating computer graphics he provides illustrations for Technolog.

Profiles:



KEVIN DOOLEY
Mechanical Engineering
Industrial Engineering
Division
Ph.D, Industrial Engineering,
University of Illinois

Professor Dooley is curious about how people become systems thinkers. Dooley has a variety of interests which he actively integrates. "I like my music on the edge of chaos," he admits.

Dooley applies both engineering and management principles in his specialty of quality control. It is a field long driven by statistical methods. Dooley is"looking for deeper roots to 'chance' and statistics" and had taught himself quantum theory all over again in vain, when a graduate student introduced him to James Gleick's seminal book, Chaos. Dooley seeks to overhaul the statistical toolkit, which can prove weak when dealing with non-linear phenomena.

Statistics compares a system's "noise" with its linear model in making predictions. But what if background "noise" is really composed of subtle, pervasive non-linearities? The system may be sensitive to initial conditions, but very flexible to a wide range of real-world problems once it is qualitatively understood. (As Dooley says, "robustness and adaptability tend to be contrasting qualities.") Conversely, statistical methods cannot reveal lurking points instability in systems behaving linearly. This can leave a "theoretically perfect system" vulnerable to unexpected catastrophe, and those running it far too overconfident to respond effectively. (Anyone remember Three Mile Island?)

Dooley works with the Chaos Network, an organization of Chaos Theorists primarily concerned with applications to social systems and understanding organizational change "Many of my original questions remain unanswered," Dooley says, but one has the impression that in the process of shaking the Newtonian foundation he is discovering enough to keep him excited for a long time.

DAVID SCHUPE
Continuing Education
and Extension
Ph.D, Religion & Culture

"The element of Chaos in learning is inquiry," Schupe will tell you, emphasizing that the most intelligent, adaptive systems in the world self-organize. Such order emerges organically from the bottom up. But most education remains curriculum-based instead of inquiry-based, trying to force order from the top down. Most interpersonal, social, political, and spiritual systems also tend to mistake the process of causing order to emerge from chaos for a value-judgement that order is "good" and chaos "bad."

Given this, the importance of Chaos Theory's implications for the liberal arts and social sciences is immense. Yet, as far as applications of science to the humanities goes, Chaos Theory still lags behind the use of esoterica from quantum theory and relativity.

In the process of creating a 5xxx-level, three-quarter Extenson class series on interdisciplinary studies in Chaos Theory, Schupe needs a good cross-section of faculty to get university approval. He is having no trouble finding interest among science professors, but few are coming forward in the liberal arts. This is especially true in Career Education, which Schupe views as a field where the principles of non-linearity most need application. Schupe is, however, teaching an Extension course that focuses on chaos and order, through Cultural Studies and Comparative Literature.

TAYFUN TEZDUYAR
Aerospace Engineering
and Mechanics
Minnesota Supercomputer
Institute & Army High-
Performance Computing
Research Center Ph.D,
Mechanical Engineering, Cal-Tech

Originally from Turkey, Professor Tezduyar has become one of the most effective modellers of fluid mechanics in the United States. The new standards for supercomputing are Connection Machines (CMs) built by Thinking Machines Corp. They use computer processors arrayed in massive parallel banks to simultaneously address millions of equations. The Tezduyar Group was the first in the country to perform practical computations on the CM-5 outside of the company.

Parallel processing itself has innumerable conceptual connections to Chaos Theory, but it is the raw power of Connection Machines that make them necessary to Professor Tezduyar. To properly compute his models of fluid flow, he requires three iteration loops (feedback modelling) that dramatically increase the computational complexity. The systems he models appear simple—tanks of water being moved vertically or horizontally, cables buffeted by winds, wings moving through air, high-speed trains through tunnels, or submarines through water. But it is a truth about non-linearity that it can become overwhelming with as few as three variables, which are extremely simple systems! Archaic methods of analysis might once have solved half an equation for fluid flow around a symmetrical object and then assumed the other side is identical. But it would fail to show that under certain conditions wakes could break symmetry on one side and deadly turbulence erupt.

Tezduyar has not encountered resistence to non-linearity in his field. "Maybe in chemical engineering or something they can get away with linearizing flow equations," Tezduyar said, "but all flows with reasonable speed in practical ranges are non-linear and . . . cannot be simplified under assumptions of linearity." Thus, unlike quantum theory or relativity, Chaos Theory is a revolution as easily visible in everyday life as in its philosophical boundaries.

For Further Reading:

Briggs, John & Peat, F. David. Turbulent Mirror, Perennial Library, Harper and Row, 1989.
Briggs & Peat. The Looking-Glass Universe, Simon & Schuster, 1984.
Campbell, Jeremy. The Improbable Machine, Touchstone, Simon & Schuster, 1989.
Edelman, Gerald (Nobel Laureate), Bright Air, Brilliant Fire, Basic Books, 1989.
Fox, Ronald. Energy & the Evolution of Life, W.H. Freeman & Company, 1988.
Gleick, James. Chaos, Viking, 1987.
Jantsch, Erich. The Self-Organizing Universe, Pergamon, 1980.
Kosko, Bart. Fuzzy Thinking, Hyperion, 1993.
Penrose, Roger. The Emperor's New Mind, Penguin, 1989.
Prigogine, Ilya. (Nobel Laureate). Order Out of Chaos, Bantam New Age Books, 1984.
Prigogine, Ilya. From Being to Becoming, W.H. Freeman, 1980.
Ruelle, David. Chance & Chaos, Princeton University Press, 1991.
Schroeder, Manfred. Fractals, Chaos & Power Laws, W.H. Freeman & Company, 1991.

THE EVOLUTION OF POPULAR ENTERTAINMENT

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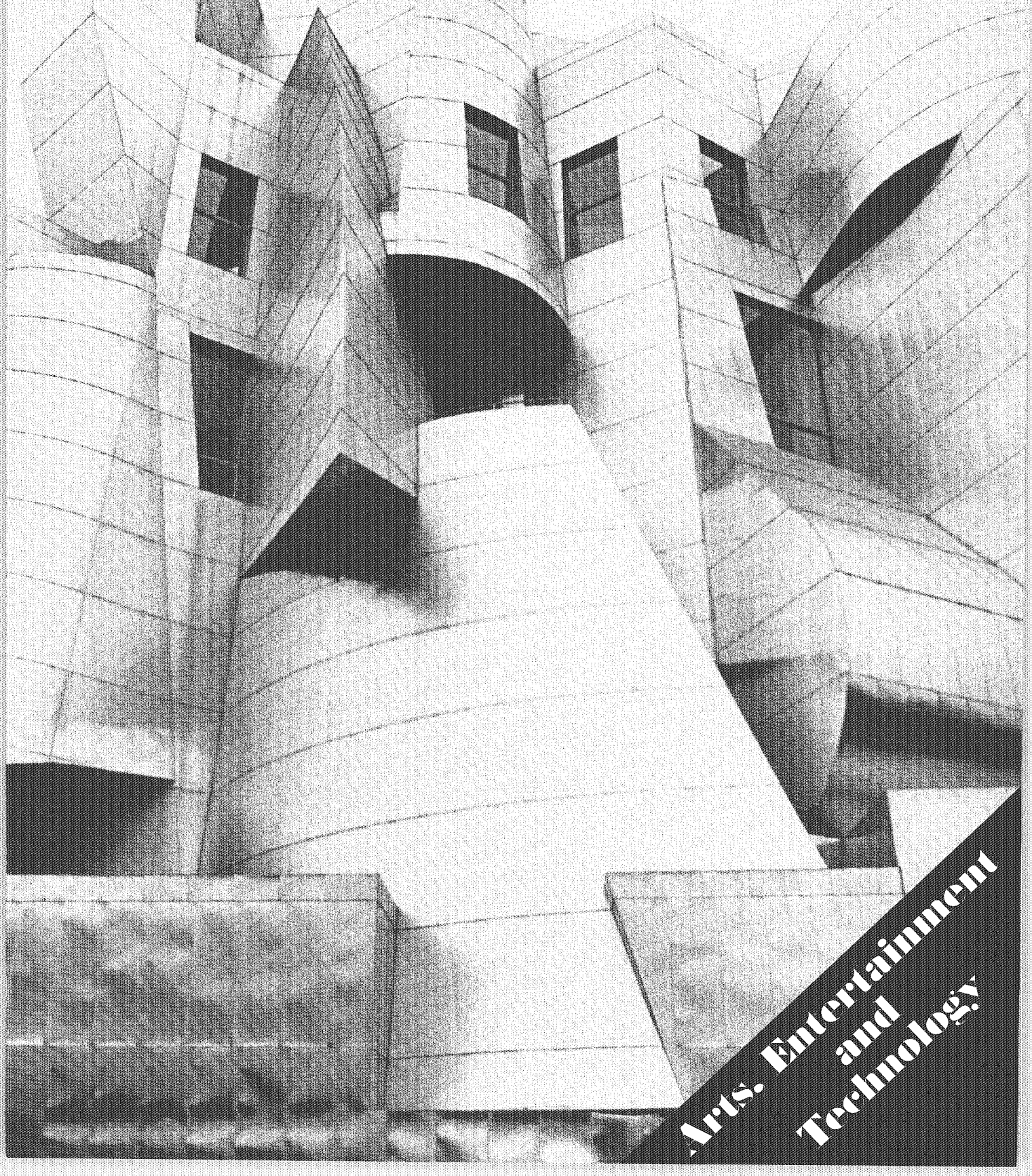

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Call now for details and an application *– Contact Rose L. Heintz, Program Director, National Invention Center, Akron, Ohio.*

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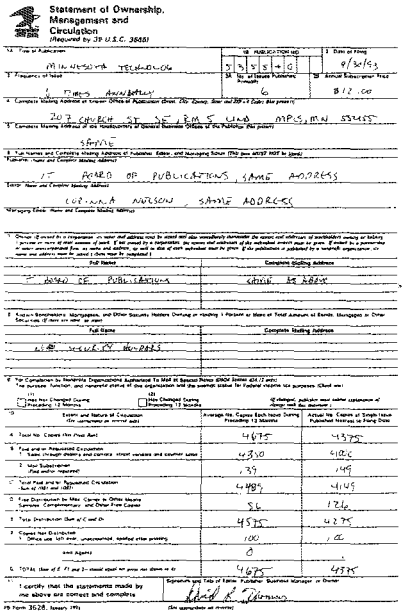

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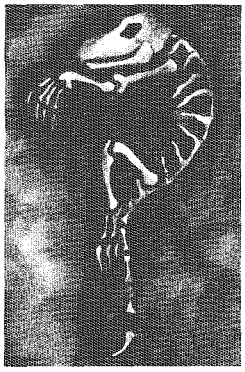

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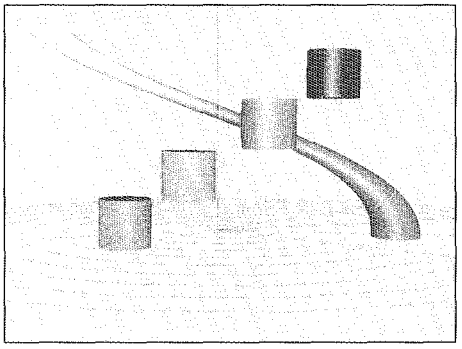

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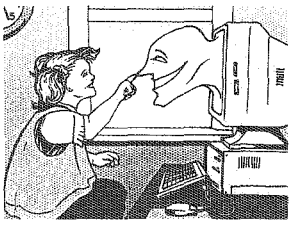

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About the cover . . .

Frank Gehry's controversial design for the Weisman Art Museum generated discussion all over campus. Photo by Charles Walbridge.

Departments

Correction

A photo in the fall one issue of Technolog was incorrectly credited. The page 24 photo of Dr. Wei-Shou Hu, Dr. Scott Nyberg and their fellow researchers was taken by Kari Shuda.

Information is Power... For the Few?

by **Corinna Nelson,** ***Editor in Chief***

In the time it takes a reader to scan this editorial, many more miles of fiber-optic cable will have been installed. Farther away, software mogul Bill Gates will be putting the finishing touches on his futuristic home, in between making business arrangements with entertainment and communications companies. These individual media/business events are harbingers of the huge consequences, good and bad, of emerging entertainment and communications media technology. IT technophiles may play a key role in determining who will have access to the incredible amount of power and information unleashed by these technologies.

The benefits of the "information superhighway," delivered either by cable or phone companies, seem obvious: How can a person have too much information? Feeling overwhelmed by data? Hire or hook up an "intelligent agent"—an electronic editor preprogrammed by the user—to sort through it all. Siblings driving you nuts? Hook 'em up to children's books on CD-ROM—they'll stay entertained.

Or will they just become more sophisticated sofa spuds?

The electronic stew of video, audio, TV, computer and phone lines makes information increasingly available to those who aren't hackers or cyberpunks. The volume and ease of access to mega-information has tremendous positive potential:

•Existing networks, such as Internet, will theoretically become available to more people. This may empower people who are now information-poor.

•International boundaries may become increasingly meaningless. Pen pals 12,000 miles away will be all but fleshed out when they can send video and audio along with their e-mail. And war victims may defuse hostilities by putting human faces on conflicts if they can plead, videomatically, for an end to the fighting.

> ENGINEERS AND SCIENTISTS ARE THE ARCHITECTS OF THE INFORMATION SUPERHIGHWAY.

•People with different learning styles—and with differing access to schools and work places—will benefit. Prison inmates, people with disabilities and adult learners are already benefiting from the privacy and endless patience of computerized lesson plans. And studies show that everyone learns better if their learning is reinforced visually, aurally and physically.

•Medical residents will have fewer surprises during early rotations if they've already done "surgery" on a computer screen which talks them through a 3-D procedure from multiple angles.

•The multiplicity of channels may mean filmmakers will have more venues for their work. It may also break the stranglehold that current production values have on the work produced. Hollywood has determined that movies with as little dialogue as possible--and an overemphasis on effects for their own sake--are most profitable, and neglect interests of whole segments of the American film-going community. New video technologies may help filmmakers create movies on a strict budget, giving individual writers more power and autonomy.

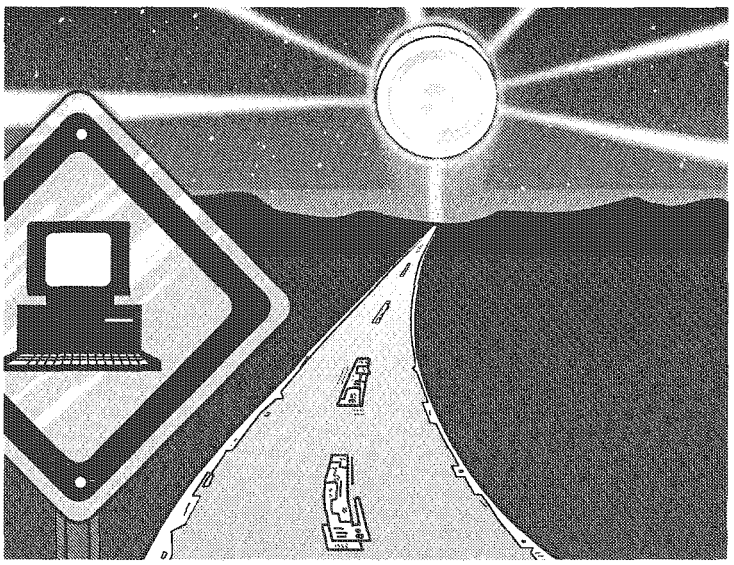
But then there's the potential down side. Let's say someone flicks on his or her Simple Electronic Filtering Tool to wade through all that pesky data and pre-programs it to separate and deliver only the stuff that's really important: a mix of shoe sale prices, badminton scores and dialogue from Bela Lugosi movies. Is this an informed citizen? Of course, for centuries some people have been ignoring the key events of their time. But fiber optics and Integrated Services Digital Network (ISDN) technology—which increases phone line bandwidth, allowing much more data to pass through phone lines—may overwhelm people. They might give up and let electronic gatekeepers filter out everything but the most easy-to-digest information.

Newspaper editors quiver at the prospect of electronic readers jumping ship and designing their own publications from stories stored electronically, abandoning paper. Although a paper-free future may cheer environmentalists, it does remove one source of potential community—the group of persons with access to similar information

contained in a given newspaper. Entirely self-designed information "edits" may so atomize people who are dependent on computers for their information that they will lack any basis for shared conversation with persons not in their particular electronic group.

Access is a loaded issue in the fiber-optic age. In the '90s, information is knowledge and therefore power. If the information stored electronically is based on a fee-for-use, the information gap between rich and poor may become too large to bridge.

In addition, the very technology which may enable independent producers to create films and videos may also concentrate power in the hands of companies which produce the technology.



Michael Kooiman

The blurring of distinctions between the computer, communication and entertainment industries may increase the promotional tie-ins we're now forced to sit through at the movies—and sometimes endure during the movies themselves, as illustrated in "Jurassic Park."

Engineers and scientists are the architects of the information superhighway and the managers of the computer technology which increasingly is being used to create films and art forms. As such, they need to make sure the highway has plenty of on and off ramps— that the information which rockets down it can be accessed by everyone. IT students can have fun with the new technology while doing their part to make sure people with less information can get on a more equal footing with those who have more by:

- working to create community "interactive technology" access similar to community cable;
- creating less-expensive clones so people with fewer resources can get in on the revolution;
- organizing electronic video and film distribution networks so independent producers can bypass media conglomerates and get their work directly to the people who want or need it;
- volunteering their time and expertise to teach those who are less technology-literate the basics of the new entertainment technologies;
- lobbying governments for continued wide access to these technologies.

People who have access to information and hoard it are not only acting unethically, they are losing the power gained through networking. Sharing information and increasing access to it enriches everyone. ❖

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IT Majors/Management Minors Develop a World of Skills

Imagine that your dream is to design and market an invention which would save lives, speed up information processing or simply satisfy your taste for entrepreneurship. Previously, IT majors with such dreams could rely on their own know-how to start companies after graduation, patch together coursework or even—perish the thought—go on for M.B.A.s. Now there is another option.

Business-minded IT majors can now minor in management through the Carlson School, in a program organized by the Center for Development of Technological Leadership.

Claudine Wullur, a Chemical Engineering and Materials Science senior, is using the minor to pursue her interest in medical technology. Wullur says that only the rich in her home country of Indonesia can afford high-tech operations such as open-heart surgeries. She hopes to combine understanding of the vagaries of markets, patents and her engineering field to create lower-cost technologies which will enable more Indonesians who need surgery to get it. Before returning home, she hopes to complete an M.B.A. Wuller is now working with a professor on a project involving blood oxygenators.

Since spring 1992, 186 IT students have been admitted to the minor. Mechanical Engineering is most frequently represented, but students in many other engineering and hard science majors have also entered. ❖

If you are interested in applying, the deadline for spring admission is Jan. 15. Contact Derek Maness at the Carlson School (624-3313) or Pauline Sargent at the CDTL (624-5747) for more information.

Desktop Video . . . The Future is NOW

by **Jeffrey Volk** *of Alpha Video*

In movie theaters all across the world this summer, Steven Spielberg's dinosaurs terrorized millions. This exciting project typifies a phenomena that is sweeping the video and film world.

From the blockbuster "Jurassic Park" to the current NBC series "seaQuest DSV," producers are turning to desktop video--the marriage of computer and video technology--to create special effects never before available.

In recent years, as competition heated up for viewer dollars, producers and directors turned to very expensive special effects to grab our attention and interest. Now, using advances made in 3-D animation computer technology, those same producers have turned to desktop video for more cost-effective special effects .

For example, the special effects used in the movie "The Return of the Jedi" cost tens of millions of dollars and required numerous model makers, artists, cameramen and other assorted technicians, not to mention the significant investment made in equipment. The finished result was visually appealing, but not very economical.

By contrast, the entire special effects budget for the recent television movie "Babylon 5" was only $250,000. The three-to-five-person effects team created 80 shots for the project using desktop Commodore Amiga computers, and the $2,500 Video Toaster. The result: a show with strong visual impact, produced in a cost-effective manner, which allowed the producers to come in under budget.

The broadcasting and film worlds are not the only industries benefiting from this new technology. Conservative estimates are that by 1995 there will be over 300,000 facilities incorporating desktop video in some manner.

The applications are unbounded. Schools, universities and corporations are doing their own internal television and media projects. To a large degree all of these applications used to be farmed out to production companies. Now people have found that they can purchase their own desktop video equipment. Professionals such as lawyers and architects use desktop video equipment for video depositions and simulated building walk-throughs. Teams like the Atlanta Braves use integrated desktop video systems to drive scoreboards and monitors at Atlanta-Fulton County Stadium. A similar system will be used at the University of Minnesota's new Mariucci Arena.

Perhaps the most intriguing market of all belongs to the independent producers and professional videographers. It is estimated that over 110,000 of these video professionals will offer their services after 1995.

For these producers, who edit everything from wedding tapes to rock videos, the real opportunities for this market are just around the corner when 500 channel cable systems and Direct Broadcast Satellite television systems turn from myth to reality.

This increase in available airtime could offer endless possibilities to independent producers. Specific interest shows, sports and entertainment programs can all be produced using these desktop video tools. And as with any technology, the price and performance barriers of all the products continue to fall. Already, equipment purchased five years ago which cost over $500,000 can now be effectively replaced for $50,000 or less. The lower cost of desktop video editing equipment, coupled with the fact that over 10 million Americans own a camcorder, make the potential for growth in the independent production arena even greater.

Despite these facts, not everyone is cut out to produce videos. Having the tools to make great videos is not enough. One must still possess a bit of creative ability and artistic flair to succeed, as well as some technical knowledge of video and business. However, those producers and editors who possess the necessary skills and desire will be needed by entertainment corporations in Hollywood and elsewhere and in non-entertainment-related markets as they continue to accept and realize what a powerful tool desktop video can be.

We live in a society obsessed with visual mediums, none more than film and video.

We live in a society obsessed with visual mediums, none more than film and video. The emergence of desktop video technology not only continues to improve those products, but also affords more and more companies, schools and individuals the opportunity to capitalize on these exciting new advances. From an editor at Universal Studios, to the audio/visual director of a corporate video department, to the independent producer who makes high school video yearbooks--desktop video products and technology have become indispensable tools....and the future looks even brighter. ❖

June 5, 1992 Commencement Speech

by **Marcella Diana-Forest Jones**

Editor's note: Technolog traditionally prints the commencement address for the preceding year. The 1992-93 Technolog did not print the 1992 address.

I thank my Lord and Savior Jesus Christ for allowing me to be here. I am honored at the opportunity to address you this evening.

I would like to offer my sincere congratulations to each of you. Our accomplishment, for which cause we have come to celebrate, is indeed a great and noteworthy one.

The attainment of this goal we celebrate today is a ticket of great privilege and tremendous responsibility. God holds each one of us responsible for the education we have been privileged to attain, and I would like to challenge you to live up to this responsibility.

I wish I could stand before you today and speak only of pleasantries and niceties, but the condition of our world prevents me from doing so. I would like to warn you of a perilous condition which may consume your very being if you are unaware of its deadly symptoms.

The emergence of a kind of "pseudo-poverty" in our society has been one of the primary causes of our nation's decline. Usually we define the state of poverty as a lack of the physical needs of life. There exists in our midst those who are impoverished by a self-imposed decision not to love. This kind of poverty requires a unique and peculiar solution. Money and material goods can solve the plight of those who lack material wealth, but they have no effect on the plight of the pseudo-poor.

We are well acquainted with the profile of the financially poor. Let us examine some of the traits of those who would be categorized as pseudo-poor.

This person has a selfish outlook on life. The only thing that matters to this impoverished soul is the promotion of self and self-interests. There is a lack of comprehension concerning the need to help someone else, unless of course there is some self-benefit to be received.

This person lacks integrity. There are no rules as this person seeks to gain whatever his heart desires. He won't do anything unless you pay him, and will do anything if you pay him. He will crush anything and anyone who steps in his path. Cheating and lying are his most dependable resources.

This unfortunate being is quick to hate and prejudge. Financial and educational status are the measurements that determine if someone else is important and worthy of attention. Those who are different in ethnicity, religious ideas or political views are considered worthless.

He is determined to waste none of his time or energy on those who are not obviously talented or gifted.

He has an insatiable craving for power.

His insensitivity will amaze you. The dilemma of someone else is no problem of his.

"As long as they don't bother me, I don't care," he says.

He blames those who are the victims of a cruel and vicious society. He prides himself on how he has made it on his own. He's quick to let you know he has pulled himself up by his own bootstraps.

His religion is a false one. He uses it to condemn and to support his hateful attitudes. You may find him in the place of worship regularly, yet God is far from him.

He believes he can do anything he desires and that having fun is the purpose of life. It would spoil his pleasure to face the fact that multitudes are suffering and need to be helped, and that he is one of the ones who can aid those in need.

His cold and cutting remarks are one of his most obvious traits. He's glad that he's so blunt and doesn't bite his tongue. He finds pleasure in cruelty and thoughtlessness.

He is obsessed with the physical. If it doesn't look good, don't show it to him, for he is not interested in anything that might be ugly or unsightly.

His head is buried in the sand. He ignores the plight of the poor. He has easy, simple answers for the difficult, perplexing tragedies of life.

The pseudo-poor have aided our nation's self-destruction. He permeates every facet of society. He lives in the most unsightly ghetto and in the most luxurious neighborhoods. He resembles your next door neighbor, your co-worker, your relative, and God forbid, may even look just like you.

There is no program that President Bush and his

administration cut to worsen this man's condition. He is pseudo-poor because it is a false poverty. He can escape his condition any time he desires. Those who are truly poor are held captive and do not possess the ability or power to self-liberate. The pseudo-poor weaves his own web of poverty and only he can tear the web down. He must choose to love, for love is an act of the will. He must decide that he will become concerned and interested in the poor. Only he can begin to disintegrate his selfishness, bigotry and close-mindedness by acknowledging the existence of such traits and developing understanding of those different from himself. He must discipline himself to exercise benevolence. Only he can decide to use his gifts and talents to make the world a better place and to better the plight of the unfortunate.

I urge you to take every precaution to guard against the destructive condition of pseudo-poverty. You are your own form of protection.

The wise author of the biblical book of Proverbs informs us that:

"He who gives to the poor will lack nothing, but he who closes his eyes to them receives many curses" (Proverbs 28:27).

Pseudo-poverty is a debilitating condition which robs its victims of their usefulness and destroys their ability to contribute to society. Beware, lest you become its next victim.❖

Marcella Diana-Forest Jones is now a math graduate student at the U of M. As an undergraduate, she was a member of numerous academic societies and helped form a Minnesota chapter of the National Society of Black Engineers. She received scholarships from the National Science Foundation, Cargill and others.

LIGHTS! CAMERA! ALGORITHM!

by **Brian DeVore**

Which came first, the art or the technology? In film history, the question became forever moot in 1877 when photographer Eadweard Muybridge lined up 24 wet-plate cameras side by side to settle a wager over whether all four feet of a galloping horse leave the ground. Muybridge modified his equipment to make it do unusual things. Similarly, mathematicians are using geometry to modify 20th century equipment—computers in this case—to create increasingly complex images.

Thirty high school mathematics teachers mixed geometry and entertainment last summer at the University of Minnesota Geometry Center's "Geometry and the Imagination: Computation, Visualization and Graphics." According to Tamara Munzner and Stuart Levy, senior technical staff members of the center, the class was intended to link basic high school geometry with film and television computer graphics.

Participant Nancy Guldberg said that goal was accomplished.

"As you study math and art together, you will see a lot of parallels," said Guldberg, who teaches in Eden Prairie. "It's really a pretty natural marriage."

It's not enough for a computer graphics technician to know what a certain creature or scene is supposed to look like. That person must also be familiar with refraction, reflection and algorithms.

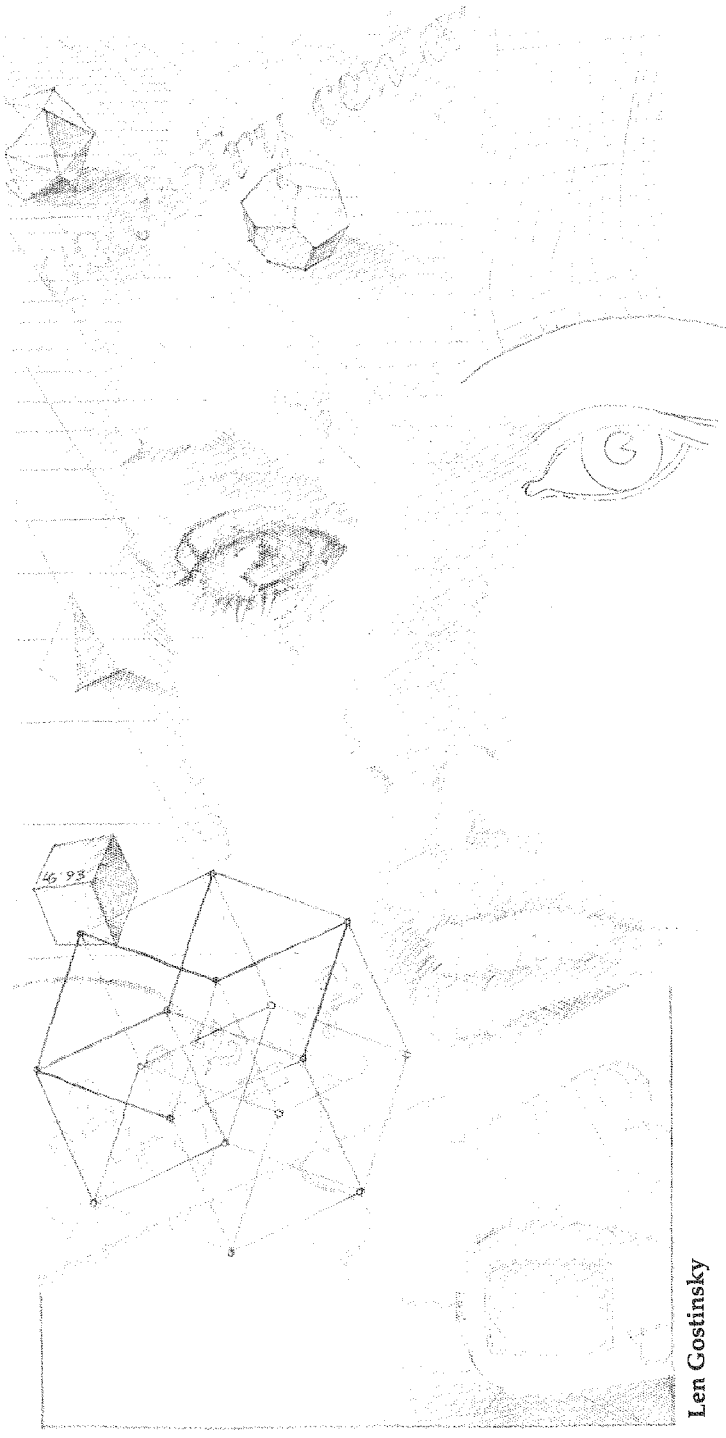
> **"As you study math and art together you will see a lot of parallels,"**
>
> **☆ Nancy Guldberg**

Guldberg said by the end of the two weeks she was able to take some pre-designed computer characters and speed up their walking, add a bird flying overhead or insert a sun rising and setting. She and the other participants also changed the shapes of spheres and cubes they designed on the computer.

This is the third year the center, which is funded by the National Science Foundation, the U.S. Department of Energy, Minnesota Technology, Inc. and the University, has offered summer courses to high school teachers on imaginative ways to present math. Center staff members regularly turn the abstract mathematical concepts of researchers into videotaped pictures using graphics work stations.

Pat Hanrahan, a course instructor and an associate professor of computer science at Princeton, said the faculty tried to show the high school teachers how today's special effects combine three fields — computer science, math and art — which students encounter in the classroom.

Hanrahan was formerly chief scientist at Pixar (formerly Lucasfilm, the creator of the "Star Wars" movies), and he won an Academy Award earlier this year for his development of the "Renderman" computer program. It's been used in, among other films, "Jurassic Park," "Terminator 2" and the animated "Beauty and the Beast," as well as in center videos illustrating never-before-seen geometric structures.



Len Gostinsky

"Renderman" allows a special effects technician to type in codes that will command the computer to create a realistic image. For example, to create a scene in "Jurassic Park" with a large group of dinosaurs running through a field, information was entered into the computer about the location of each "animal," the position of its legs while running, the color and texture of its skin, as well as the location of the lights and cameras.

"If you look at it (on the computer screen), it wouldn't look like a dinosaur; it would look like a bunch of text," said Hanrahan.

The computer acts on these commands and creates a photo-realistic image. Because computers are so precise, they allow real actors and sets to blend in with artificial images almost seamlessly, something that was difficult to do just 10 years ago.

Not only can filmmakers create imaginary creatures and backdrops, but they can also use computers to give the effect of a large crowd. Because moviemakers don't want to employ thousands of extras for crowd scenes, they have traditionally hired a few and painted in the rest in a process called "matting." Now computers can do all of that with much more precision and realism. This technique was recently used in "A Few Good Men" and "In the Line of Fire."

Computer programs such as "Renderman" have been so successful that they've not only gained wider acceptance among big name directors who want high-tech help in telling their stories, but in the case of "Terminator 2," they inspired the moviemaker to create a plot around the special effects, according to Hanrahan—perhaps further proof that art and technology take turns inspiring each other.

Local computer animation producer Larry Lamb reiterated this mutual inspiration.

"There are scientists that are all of a sudden aware of the values of aesthetics as well as artists that are more aware of the technical aspects of things," Lamb said.

These are all relatively recent developments. Lamb is president and creative director of Lamb & Company, a Minneapolis-based special effects business. He said new software and faster machines have made computer graphics viable for special effects work only within the past seven years. His company has used computer effects in commercials and the animated TV show, "The Incredible Crash-Test Dummies."

"Computers have revolutionized the art of picture-making," he said. "It's not dissimilar to what word processors have done for writing. We can cut and paste and try and experiment."

Special effects experts are now trying to perfect bodysuits which have sensors attached. While wearing such a suit, a person could send signals to a computer, which in turn would "tell" an animated character how to move like a human being.

High school teacher Guldberg took home software from the course, and although the PCs at her school have limited capacity, some simple animation can be done on them. She hopes to team-teach a class with an industrial arts teacher. By showing students the visual uses of

math, Guldberg said she wants to debunk some common stereotypes.

"Both in the performing arts and the visual arts, the kids don't see a need for math," she said. "People see mathematics as static and always the same, and art as very creative and changing. I always keep that in perspective when I look at the kid who is off the wall. Is he so creative he can't conform to basic math?"

In other words, that "off the wall" student may be the next Pat Hanrahan, looking for a different way to help tell an age-old story. ❖

Sources

Guldberg, Nancy. Phone interview, Aug. 16, 1993.

Hanrahan, Pat. Phone interview, Aug. 19, 1993.

Kasson, John. "Civilizing the Machine: Technology and Republican Values in America, 1776-1900." Penguin Books, Ltd., 1976.

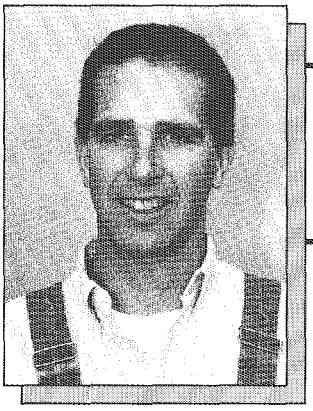
Lamb, Larry. Phone interview, Aug. 19, 1993.

Levy, Stuart. Personal interview, Aug. 10, 1993.

Marcus, Alan and Howard Segal. "Technology in America: A Brief History." Harcourt Brace Jovanovich, Inc., 1989.

Maxwell, Delle. "Animation Creation," Imagine That!, Spring 1993.

Munzner, Tamara. Personal interview, Aug. 10, 1993.



With a Peace Corps stint in Lesotho under his belt, new Technolog writer **Brian DeVore** has leaped into a graduate program in the History of Science and Technology. In another of his previous work lives he wrote about the environment.

On August 26, 10 U of M scientists and scholars participated in a forum at the Science Museum of Minnesota. "Who's Afraid of Jurassic Park?: A discussion for kids and adults about genetic engineering" was presented by The Center for Biomedical Ethics, The Minnesota Human Genetics League and the Science Museum. It was an opportunity for the public to separate fact from fiction in the film "Jurassic Park" and to learn what's happening in genetic research and engineering.

Science on the Big Screen: A Discussion of Jurasso-Ethics

by **Tamara Lubic,**
Technolog Associate Editor

A mosquito bites a dinosaur and then falls into resin. Sixty-five million years later, molecular biologists extract dino DNA from the insect and piece it back together to form brand-new dinosaurs with ancient appetites. Could it happen? *Should* it happen?

"Who's Afraid...?" panelist Perry Hackett, professor of Genetics and Cell Biology, said, "Jurassic Park has given people the idea we can do far and away more than is possible now. The wonderful thing is, it's raised the consciousness of the general public."

Robert McKinnell, professor of Genetics and Cell Biology at the U, said, "I believe the movie is a yarn but builds on bits and pieces of real science."

Of the 10 panelists, McKinnell's work in cloning most closely resembles the Jurassic Park concept of creating whole creatures from a few strands of DNA. He told the audience that rabbits, pigs, sheep and cows are now being cloned from embryonic cells. Perhaps more important, he noted that frog larvae have been cloned from red blood cells (the source of the dino DNA in Jurassic Park).

The distinction between the two types of cells is critical. Although the genetic blueprint for every organism is repeated in each of its cells, thus far all cloning that leads to an adult organism begins with the nucleus of an early-stage embryonic cell. After cell division is well-advanced, and each cell begins to identify itself as a particular kind of cell, i.e., liver, muscle, intestine, etc., a little-understood process makes it "forget" the rest of the blueprint and focus on its special function. McKinnell emphasizes that this process of differentiation is extremely stable and not easily manipulated.

But the manipulation *is* possible, a fact McKinnell says points out the unpredictability of science. In 1986, researcher Marie DiBeradino cloned frogs from red blood cells, although the larvae produced never matured into frogs. McKinnell

says, "We don't have the vaguest idea" why they didn't.

In "Jurassic Park," lab technicians dismiss the danger of uncontrolled (i.e., natural) reproduction in the genetically engineered dinosaurs, because all the embryos are female. Only mathematician Ian Malcolm questions how they can be certain that nature won't surprise them.

McKinnell knows that it *will*. He described his own experience with the unexpected. "We produced a cloned aggregate of frogs with a genetic tag [in them], and I said to my assistant, 'Of course, they'll all be the same sex,' and they weren't!" He called a colleague at the University of Iowa who told him, "All you have to do is change the temperature and the sex changes."

Researchers are working to reduce unpredictability. Hackett told the crowd that because not all genes are expressed in all cells at all times, identifying their on/off switches is just as important to researchers as identifying the genes themselves. Hackett said, "In some ways you can think of genes as the equivalent to floppy disks. Depending on the software and PC you're using, the information on the disk can be very useful, or it can be useless."

If we could make the leap from recreating a non-extinct species such as a frog, to creating dinosaurs, *should* we make that leap? Hackett asks, "If the technology existed, why not?" Hackett, whose research includes genetically programming larger, faster-growing fish, says, "Animals are going extinct every day. Through development we're encroaching on ecosystems." He adds that the world is now facing severe and growing population. "If it's a question of someone going hungry vs. the preservation of an exotic plant, the plant's going to go. Maybe through genetic engineering we could change the characteristics of a plant so that it could grow under different conditions."

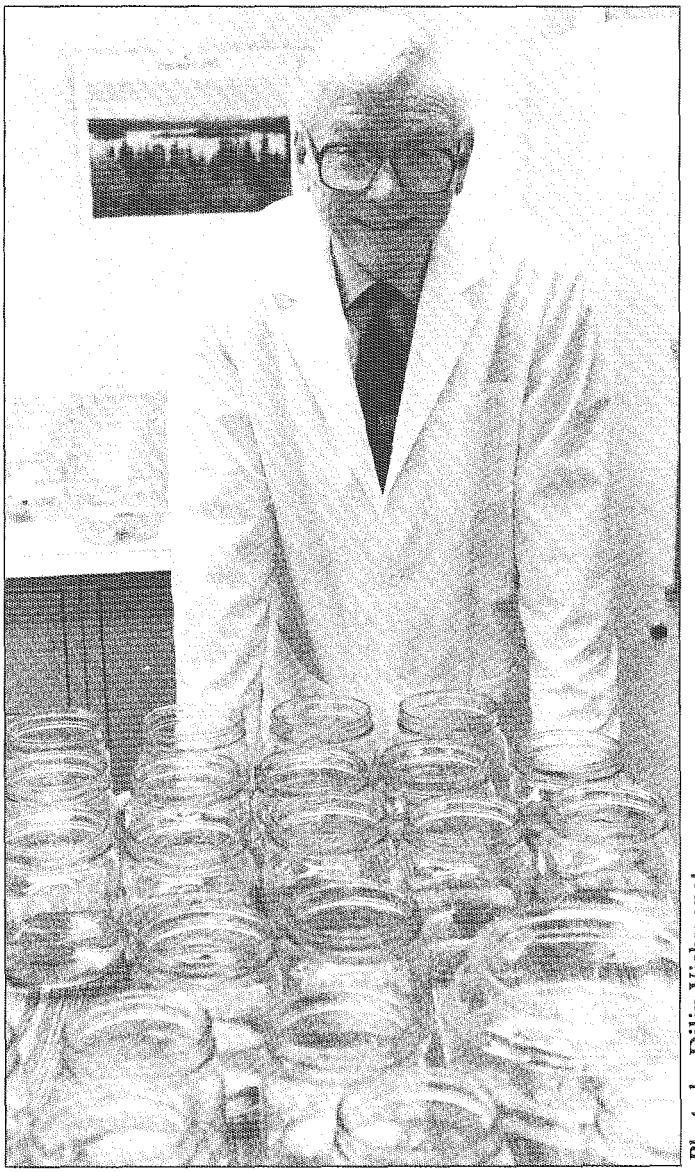
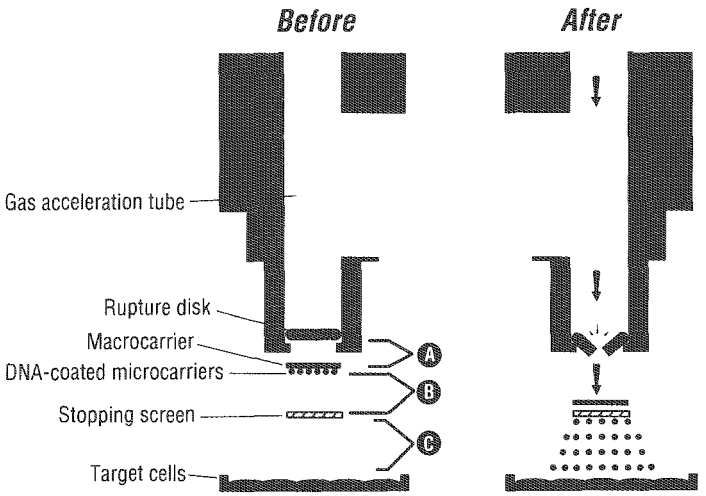


Photo by Dilip Vishwanat

Robert McKinnell, professor of Genetics and Cell Biology.



This system uses helium pressure to accelerate microparticles toward target cells.

Reprinted with the permission of Bio-Rad Laboratories, Inc.

Dave Somers, associate professor of Agronomy and Plant Genetics, says, "By selective breeding of animals and plants, we've been genetically engineering for a long time from the point of view of selected matings of particular males and females." The overall goal, he says, is to "enhance expression of, or to confer, some characteristic ... we think would be of value." But he noted a critical distinction between today's genetic engineering and traditional gene manipulation. "Now we can transfer genes from any organ to any other. We call them horizontal transfers."

The transfer takes place in a variety of ways, depending on the organism and the desired result. Vegetables, like most plants, have rigid cell walls. One method for penetrating them is use of the "gene gun." Using compressed helium as propellant, the gene gun blasts through the plant cell walls with micro projectiles made

of tungsten or gold and coated with the selected gene.

The panelists said that genetic alteration can be good for the economy and for the environment. Inserting genes into fruits and vegetables, for example, can immunize them against disease and make them unappealing to bugs, cutting down on pesticides. And using plants as small production facilities for biodegradable plastics could eventually prove both cheaper and more environmentally sound than petrochemical-based plastics.

Since discovering a bacteria that produces biodegradable plastic, researchers have set out to bestow the same characteristic on plants. But why relocate "production?" Somers said, "With bacteria you have to bring the nutrients to them, but plants use sunlight."

Improved efficiency and elimination of "mistakes," both natural and manmade, was a common thread running through the "Who's Afraid ...?" discussion. Hackett, using his genetically altered fish as an example, said that the large number of smaller fish in our lakes and streams compared to 200 years ago could be the result of human activity in the area during that period. He hypothesized that genetically producing bigger fish could help restore fish to their preindustrialization growth patterns.

And Sue Berry, a pediatrician and clinical geneticist, told the audience, "In your personal genome, you all carry genetic errors, changes and alterations. The idea of changing genes is a natural event."

Yet the basic premise of "Jurassic Park" is scientific error. Hackett acknowledges that mistakes will happen in genetic science, either individually or through some combination of genes. He also says, however, that scientists who work in the field of genetics are thinking about potential negative effects "constantly, because we get asked about them constantly."

He added that "People have a tendency to think that [today] is the way the world is, was and always will be."

He says he wishes that geneticists "had one percent of the power people think we have ... What we're trying to do is solve the problems caused by intense population pressure that's ever growing, and I believe the consequences of doing nothing are far greater than the consequences of trying to do something." ❖

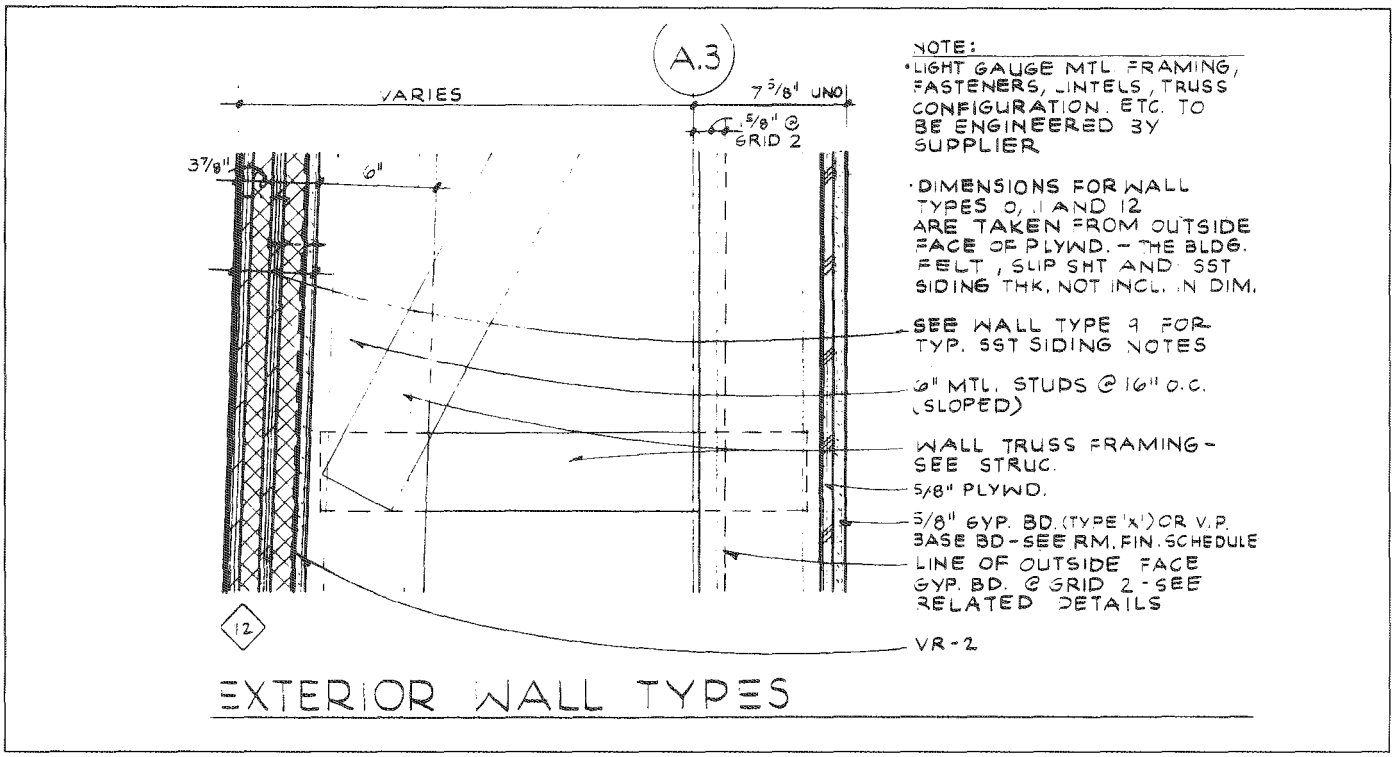
Jennifer Hughlett

Sources

Participants in: WHO'S AFRAID OF JURASSIC PARK? A discussion for kids and adults about genetic engineering. Aug. 26, 1993. Science Museum of Minnesota Paleontology Hall

- Arthur Caplan, Director, Center for Biomedical Ethics (Program Moderator)
- Eileen Flory, Director, SMM Paleontology Science Hall
- Robert McKinnell, Professor of Genetics and Cell Biology, University of MN
- Richard King, Director, Division of Genetics, Dept. of Medicine, University of MN
- Robert Silberman, Associate Professor, Art History, University of MN
- Perry Hackett, Professor of Genetics and Cell Biology
- Dave Somers, Associate Professor of Agronomy and Plant Genetics, University of MN
- Sue Berry, Associate Professor of Pediatrics, University of MN
- Scott McIvor, Associate Professor, Lab Medicine and Pathology, (also Institute for Human Genetics)
- Dianne Bartels, Associate Director, Center for Biomedical Ethics
- Bonnie LeRoy, Program Director, Institute of Human Genetics, UMHC

Tamara M. Luhic is extremely interested in how people decide what is right, wrong, or unavoidable. A journalism grad student with a minor in Biomedical Ethics, she sees a writing career as a way of getting answers.



The walls of the Weisman Art Museum as they appear on paper.
Architectural drawing courtesy of Meyer, Scherer & Rockcastle, Ltd.

The Technology Behind the Gleam

by **Drew Denker,** *Technolog Staff Writer*

Heard on the University of Minnesota campus:

- It's ugly! Why did they have to go and ruin our campus like that?
- I like the way it looks from across the river.
- When will it be finished? It already is??

During 1993, the construction and unconventional design of the Weisman Art Museum triggered campus-wide discussion, ranging from appreciative to skeptical—but never apathetic.

The museum's project architects made advances in building design and construction by developing specialized approaches to the structure's thermal barrier and lighting conditions.

The Architectural Team

Santa Monica, Calif. design architects Frank O. Gehry & Associates, and the Minneapolis-based project architects Meyer, Scherer & Rockcastle cooperated on the museum. Project architect John Cook explained, "It's always good to have a local association because the distance is too much ... to handle by themselves."

Gehry's firm developed the design for the building, drawing the various exterior façades and the interior's conceptual basis. That design provided the project architects with the basis to begin technical and construction design. Meyer, Scherer & Rockcastle did all of the construction drawings and supervised construction and structural, electrical and mechanical engineering work. Gehry's group stayed involved, also.

"There is not a clear-cut line where their responsibility ends and ours begins," said Cook.

The Conceptual Design

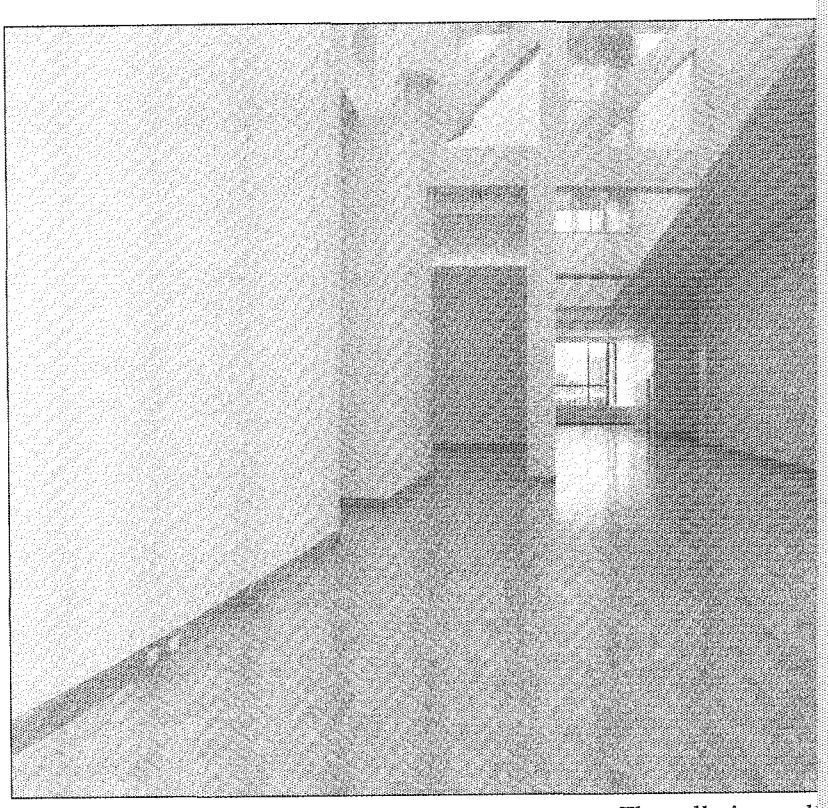
The east and south façades of the structure have brick faces, as do Coffman Memorial Union and Comstock Hall. The north and west façades of the museum are more distinctly Gehry designs. An asymmetrical, free-flowing stainless steel wall curves and dips in a continuous design, jutting out at irregular angles and shapes.

"Abitare," an architectural journal, says the museum "is best classified as being somewhere between post-cubism and science-fiction."

Considerations of the Project Design

The museum's project design focuses on protecting the art from fire and climatic changes and displaying the art to its best advantage. Cook explains the climatic considerations: "Because the building is an art museum, there are strict requirements for humidity and temperature control, and other than a sophisticated mechanical system, that either puts humidity into the system or takes it out. A critical thing for the architecture is to maintain a tight envelope with a good vapor barrier, basically like a balloon.

"The wall type is made up of several different products to achieve not only an architectural finish inside and out, but a temperature and humidity control," Cook added. "When you have a highly articulated façade like [the museum's west, stainless-steel-covered façade], it becomes quite a difficult task. You not only want to meet requirements of the design, the shape and all, but you have to meet the technical requirements as well."



The galleries are l

To meet both design and technical requirements, the building's walls are made of six or seven different materials-- depending on the façade-- layered together to form vapor barrier. The first layer, structural metal studs, is followed by an ice and water shield, made up of a polyethylene sheath laminated to a sticky bituminous product. A layer of rigid insulation lies just inside the ice and water shield, followed by a five-eighths-inch shell of treated plywood attached directly to the metal studs with stainless steel screws. This is followed by another layer of rigid insulation and an additional layer of the plywood, this time screwed directly to the inner layer of plywood with galvanized steel screws. "The reason for the multiple layers in the wall system is to prevent making the thermal bridge with the screws," Cook explained. "We split the screw so that one screw penetrates through the studs, [while] the other screw, the outside screw, the 'cold screw' as we call it, only gets halfway through the wall." The final layer of plywood is covered by 15 pound asphalt-saturated felt paper, and then on the north and west façades, a stainless steel skin completes the layers of the 'balloon.' On the south and east façades, the final layer is made up of brick. These final layers shield the building from almost all of the elements, rain or snow. As neither the brick nor the stainless steel form perfect seals, however, there is also a backup system to remove any water that gets beyond the outer layer.

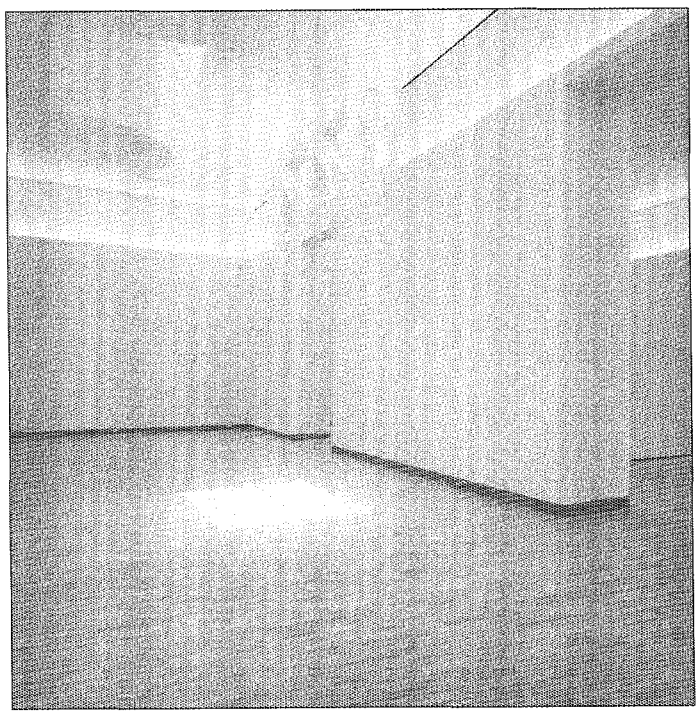


Photo by Chris Faust

A skylight in the Weisman Art Museum admits a controlled amount of light.

It is necessary to keep the relative humidity within the building's balloon at 50 percent all year round, maintaining a temperature range of 68 to 78 degrees Fahrenheit, the same for art museums everywhere. "They're

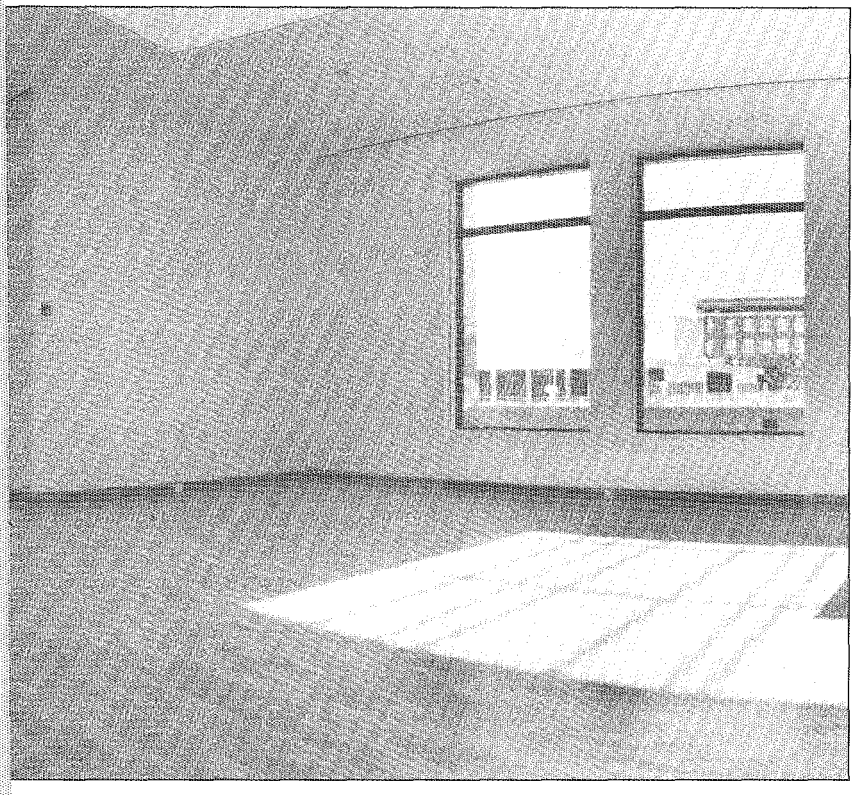


Photo by Chris Faust

ination of natural and articifial light, using skylights and reflective lighting.

standards without consideration of where the museum is, whether it's Minnesota or Florida," said Cook. "Here, in the winter, we have to put water into the system."

The Natural Light Debate

The argument about how much natural light a museum can admit centers on artwork conservation. The project architects designed the skylights, aided by a computer analysis from the University's Regional Daylighting Center. The analysis showed how much direct sun would hit the gallery at what times of the year. The executive architects determined exact dimensions for the skylights, including the depths of their wells.

Automatic blackout-shading devices, which museum staff can adjust, exist on all the skylights and vertical windows; the museum can reach total blackout. In addition, the window and skylight glass have an ultraviolet filter.

Despite all of the design precautions and considerations developed to allow natural light into the gallery, Cook says that some exhibit curators object. "Some museum curators will say, 'No natural light — I don't care if you have UV glass or not.' That's the trouble we're running into with the first show; there are some works on paper that the lenders are saying 'You will not have the skylights open, no matter what.' They don't buy the argument that we've effectively blocked out natural light."

The Challenge of Creative Design

Frank O. Gehry disagrees with those who call him an artist. "I want to say I'm an architect," Gehry said in an interview in Frank Gehry, Buildings and Projects. He explained that, given the influence of artists and their work on his designs, many people mistakenly classify him as an artist-- not an architect-- "in a way that's used like a dismissal."

Insisting that the museum must be classified as a design and building, rather than as a work of art, Gehry challenges architects, engineers and technicians with sometimes off-the-wall technical problems. Perhaps this is the price to be paid for a Frank O. Gehry design. ❖

Sources

"Architectural Design Citation: University of Minnesota Art Museum." Progressive Architecture, Jan. 1992: pp. 74-5.

Arnell, Peter and Bickford, Ted. Frank Gehry, Buildings and Projects. New York: Rizzoli, 1985.

"Art and Teaching Museum." "Abitare," April 1992 : p. 195

Cook, John. Personal Interview. Aug. 27, 1993.

"A Dream of Long Standing." University Art Museum Pamphlet.

When ME senior **Drew Denker** isn't grooving on his favorite tunes, he passes his time studying the theories of Ian Malcolm, allowing himself to become a part of the Jurassobandwagon. This is his second piece for 1993-94 Technolog.

Harnessing Music at the Computer

by Chris Kasic, *Technolog Staff Writer*

What's the difference between sound and music? Your parents thought they knew, when you cranked the Sex Pistols from your bedroom stereo. You, of course, knew it was much more than just sound. Nailing down just what is and what isn't music is about as easy as cleaning out tape spaghetti from a cassette deck.

Today, computers stealthily shift music from the realm of art to the realm of science. By breaking down music into its physical pieces—pitch, tone, loudness and timbre, for example -- and digitally tinkering with the finished product, computers can produce an astounding amount of musical variations in a fraction of the time it took Beethoven to write his symphonies.

To understand the link between computers and music in the '90s, one must understand traditional methods of representing sound. The earliest recorded attempt to do so used a series of dots and heights. This gradually evolved into standard notation. Centuries before Bach, composers and musicians had developed a complex set of graphics to represent pitches, scales and chords played over time--the same scale we use to represent and read music today.

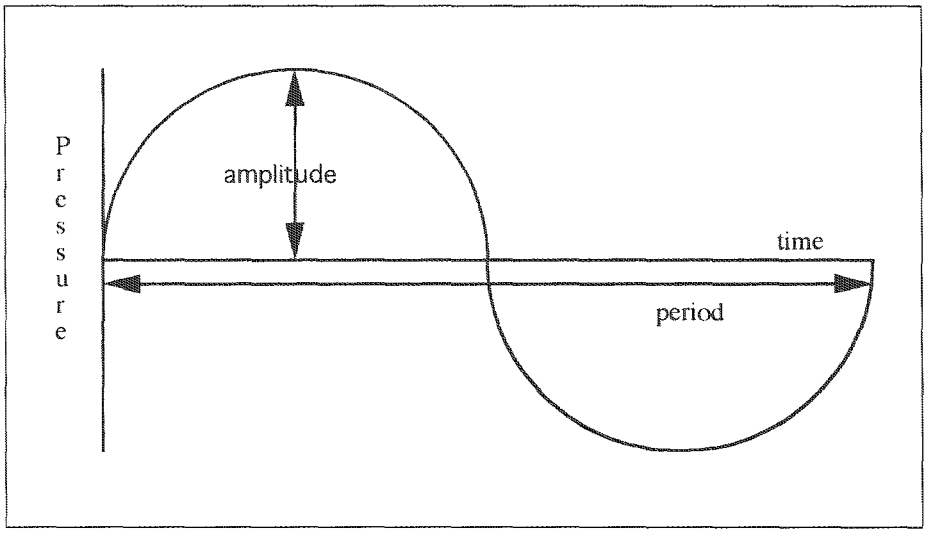
In the mid-19th century, player pianos represented scores by patterns of holes punched along rolls of paper. They couldn't duplicate the amplitude of a sound, but accurately represented the pitch duration by increasing the length of the punched hole. The punched-hole theory, which worked by shooting compressed air through the holes, would later work with light beams and punch cards in the computer age.

A third way to represent music is through its waveform. Loudness, represented in decibels, translates to amplitude. The number of vibrations per second translates to frequency (measured in Hertz), and when plotted for pressure and time, represents an analog sound.

Analog recording techniques use these waveforms to produce sound. The quality of the sound depends on the accuracy of the duplicated waveform. The smaller the portion of wave duplicated, or sampled, the more accurate and clear the reproduction.

Digital recording techniques use a different approach. A Digital-Analog Converter translates the signal from the waveforms into binary code. Digital encoding allows for a more accurate (and usually higher) sampling rate, and hence, a more precise sound. But the sound isn't anywhere near the real thing. Why not?

Analog sound represents a constant, barely detectable fluctuation. Analog synthesizers tend to create richer sounds through their variability. That's why most music is recorded, or at



Graphic representation of a sound wave.

least mixed, with analog techniques (ADD or AAD).

With the advent of the digital synthesizer, players and composers could transform music into bitstreams. Computers could then edit the sounds, provided they were of the same type. Timbre, the difference in sound between identical pitches played on different instruments, had to be dealt with separately. Early computers had no way to differentiate between identical frequencies produced on different instruments. In short, frequency was just not a good enough descriptor of sound. The Musical Instrument Digital Interface, developed in 1983, helped solve that problem. As a transmission protocol for sending digital sound, it allows multiple instruments to be connected through a single keyboard. It also sequences multiple sounds.

MIDI digitally codes information on pitch, loudness, duration and other components of sound. It channels musical information. By assigning an instrument to a discrete logical channel, MIDI enables many instruments to send signals at once. This data is sent to a computer or synthesizer in packets, usually made up of eight or 16 bits. Other information on pitch, loudness and tempo follows in bitstream.

MIDI still handles the majority of computer music protocols. It sufficiently handles large amounts of musical data efficiently, as long as your microprocessor and communications highway can handle the volume of data you send.

Each discrete sound sent over a MIDI channel can be split into four components—attack, decay, sustain and release. Attack represents the beginning of the sound, from zero to full amplitude; decay, the way the sound trails off to zero again; sustain, how long the sound is played; and release, how long the sound takes to disappear. In addition, each sound has a specific pitch (frequency), amplitude (loudness), duration, timbre and is followed by a particular space of time. Organizing many notes in time also requires that a beat be maintained throughout the piece of music. MIDI standardizes the way this information is reported. It allows translation from sound to computer code and vice versa. All this information is sent in a specific MIDI order to a processor, which then synchronizes notes and replays them.

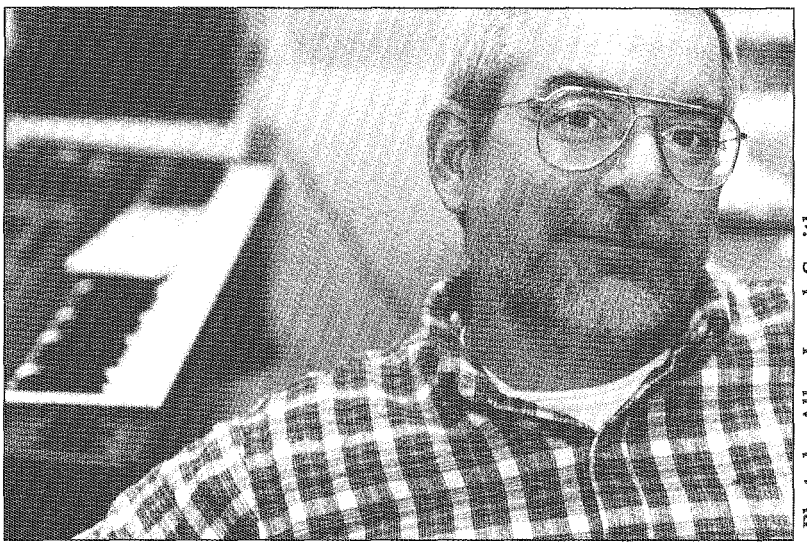


Photo by Allen Joseph Smith

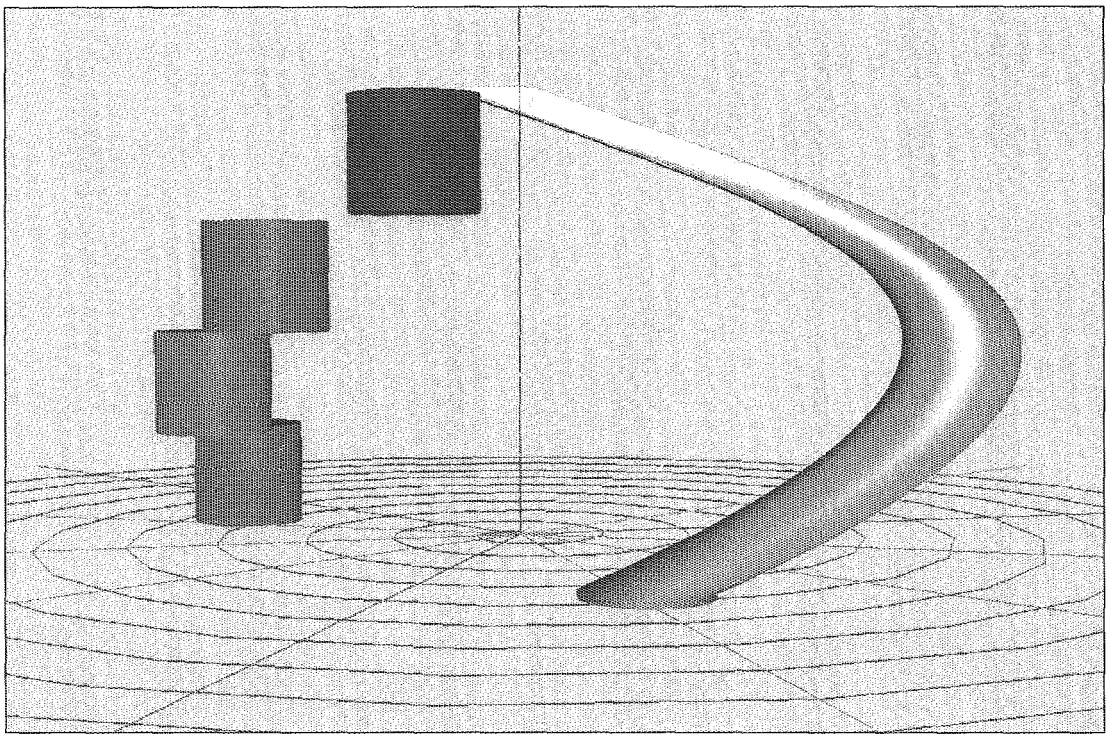
John Carlis, associate professor of Computer Science, sits next to one of the tools of his trade.

"I'd like to see the day when you can give a novice a dataglove and allow them the effect of physically manipulating notes and chords and watching the results of their change."

☆ Doug Perrin

Components of an orchestral piece represent a tremendous amount of information, and standard notation, for all its complexities, is an incomplete method of representing music.

A new method of representation should use modern technology to graphically enrich the language of musical notation. Doug Perrin, a junior Computer Science major at the University, wants to use the computer to represent music more completely. Perrin works with Computer Science Associate Professor John Carlis on the spiral representation of music. They began their research partnership through the Undergraduate Research Opportunities Program (UROP). Carlis has added a third dimension to the two-dimensional notation with notes,



Doug Perrin

These are computer representations of four notes in the same octave ascending chromatically,with a glissando going up a fourth simultaneously.

clefs and bars, turning the standard notation staff into a spiral moving around an axis representing time. "We are using the power of today's computer to functionally, rather than symbolically, represent music," said Carlis.

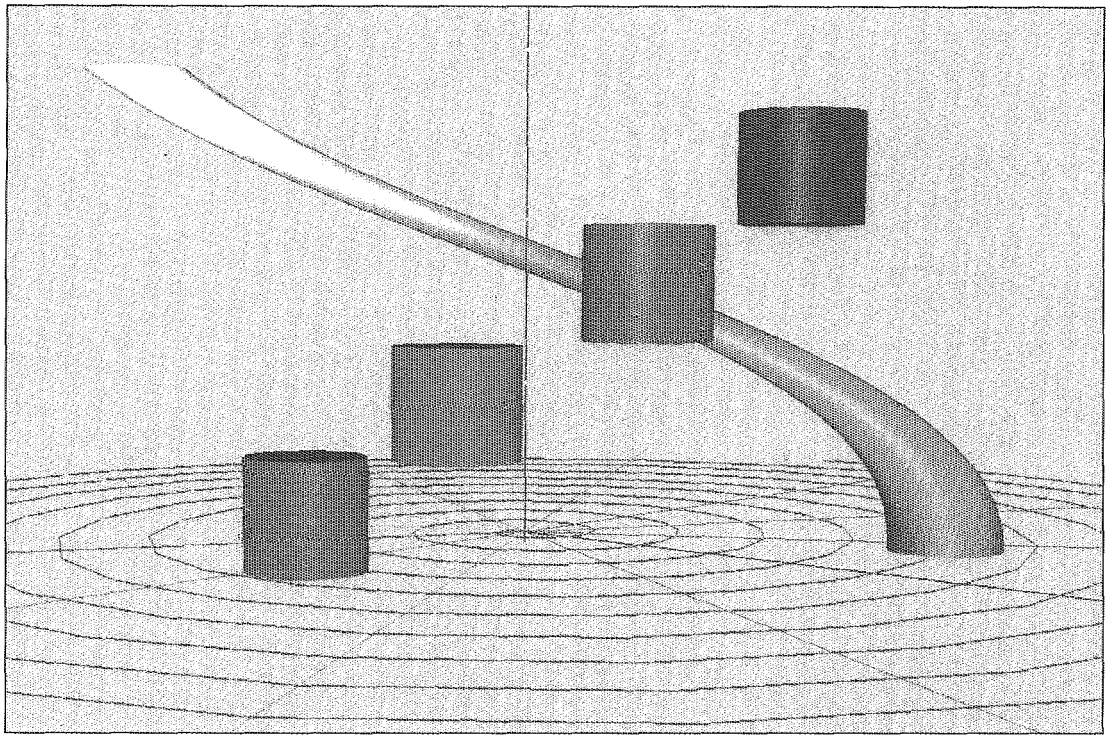
The two are exploring how pitch, duration and loudness might be represented graphically. A spiral represents pitch with the frequency of a point on the spiral proportional to the log of the distance from the origin to the point. One full octave (12 semitones) constitutes a complete spiral turn in Carlis' model. Each ray out from the origin has a color, but a ray is drawn only for the semitones, or every 30 degrees. Red, for example, might represent C, orange D, etc. A note in equal temperament tuning occurs where the spiral meets a ray. So if middle C is brick red, a three-octave raise to a high C will be a light red. Time is perpendicular to the spiral. In the simplest case a note is a cylinder centered over a ray-spiral intersection. The length of the cylinders, like the piano roll holes, increases as the pitch is played longer. Pitch-bends (where, for example, a slide trombone excels) distort the cylinders into strangely shaped worms whose colors change from end to end. An expanding helix-shaped cylinder would be a glissando, or pitch-slide from one end of the scale to the other. The momentary diameter of the note represents loudness. Several possible variations of a cylinder include a cone (which would be a decrescendo, or softening of a pitch) and a football shape (a crescendo, or amplification, followed by a decrescendo).

"We are using the power of today's computer to functionally, rather than symbolically, represent music."

☆ John Carlis

Much of Perrin's work involves translating concepts into C code. Perrin hopes his efforts will appeal especially to non-music students. He is unsure of whether composers will find the notation helpful, since they are already skilled in music's mechanics and nuances. But he envisions a future in which music is represented three-dimensionally. "I'd like to see the day when you can give a novice a dataglove and allow them the effect of physically manipulating notes and chords and watching the results of their change," he said.

Tim Rowley, also a junior computer science major working with Carlis via UROP, is developing a method of optically scanning musical scores in order to make publishing



Doug Perrin

more efficient.

"Music typesetting is much more an art than a science today," he said. Abbreviations vary among music publishers and are sometimes inconsistent within scores, which makes software development difficult. A note perhaps only lightly filled in on the original might be taken by the scanner as empty. That problem, however, can be remedied by having the software ensure that there are a correct number of beats per measure. Rowley claims that the scanning software will rarely be 100 percent accurate, unless music typesetters adopt a standard format.

In an effort to increase transmission accuracy, Rowley scanned overlapping segments of a score. By allowing the computer to compare scanner passes, the algorithm can better detect and eliminate anomalies like non-straight score lines, which might be mistaken for other notations. Rowley and Carlis envision music-scanning software which will allow individuals to digitize non-copyrighted scores.

"Music is repetition with variety," said Carlis.

Computer operators supply the variety by trying different arrangements and by manipulating the characteristics of the sound, all digitally. Since music is inherently mathematical, computers will continue to improve and offer more options to the musical novice.

We've just moved up a notch with the increasing functionality of the computer. Music is no longer a score solely printed for conductors and musicians, but can be manipulated by novices. ❖

Sources

Appleton, Jon. "Machine Songs III: Music in the Service of Science—Science in the Service of Music, "Computer Music Journal," 16(3), Fall 1992, 17-21.

Bigelow, Steven C. Making Music with Personal Computers. La Jolla, CA: Park Row Press, 1987.

Carlis, John. Personal Interview, 23 Aug 1993.

Cope, David. Computers and Musical Style. Madison, WI: A-R Editions, Inc., 1991.

Davis, Deta. Computer Applications in Music. Madison, WI: A-R Editions, Inc. 1992.

Perrin, Douglas. Personal Interview, 19 Aug, 1993.

Roads, Curtis, ed. Composers and the Computer. Los Altos, CA: William Kaufmann, Inc., 1985.

Rowley, Timothy. Telephone Interview, 22 Aug 1993.

Schaffer, John Wm., ed. Computers in Music Research. Madison, WI: The Wisconsin Center for Music Technology, Fall 1991.

Chris Kasic is studying online documentation issues in the Master's Program in Scientific and Technical Communication in the Department of Rhetoric. He recently moved to Minnesota from Ann Arbor, Michigan. He does technical writing for money, science writing for enjoyment and fiction writing for laughs.

The Toast — of the — Video Revolution

by **Robert Subiaga, Jr.,**
Technolog Staff Writer

With a touch of a button, the image on the television dissolves from a clown to a monster. Then, an athletic female tumbles across the screen, her silhouette wiping the last image away and replacing it with a surreal landscape. Finally, a title and credits scroll across the screen.

These images are samples of those available with video "Toaster" technology, which videographers use to create effects never before possible.

The Toaster uses video's flaws, such as lower resolution—which creates unrealistic contrasts—in order to create special effects. Low resolution allows for less gradations of color or light/dark between the edges of images on screen—for example, between those in the foreground and background—so the contrast between one object and another is greater, and the edge between them appears sharper. Since edge detection—together with binocular vision—is one of the chief ways with which people process visual information, this part of the image seems "too real." But everything else appears unrealistic. The Toaster also cleans up video images which go through multiple edits. Since video is not physically cut and spliced while it is edited— segments are copied from shoot tapes onto masters—a difficult editing process that copies original footage many times to add special effects can degrade image resolution, to the point at which the video becomes unusable.

The Evolution of the Toaster

A computerized environment solution was inevitable. But, the lack of a compatible video standard complicated and delayed the process. Both computer monitors and video produce images by horizontally scanning a cathode-ray tube, or CRT, across a phosphor-coated screen--but the way this is done can vary. The CRT might scan straight down and then go back to start at the top, as non-interlaced computer monitors do, which are renowned for flicker-free viewing. Television, on the other hand, skips every "odd" line on one trace and every "even" line on the next, combining these two images, or fields, into complete images—a frame. The number of lines scanned also varies, as does the shape of each pixel on the screen. Even in television there is variation. Most European countries use a TV standard called PAL, some countries use SECAM and the American standard is NTSC. Translating one video standard to another is technically difficult because of computational complexity. Taping the screen is ineffective; the different timing of the standards makes the taped image flicker.

Desktop video began in the 1970s and 1980s, when Amiga, a multimedia technology producer, chose the NTSC standard with the goal of allowing consumers to use their televisions as monitors. Programmers and hardware developers began to combine personal computer technology with video manipulation, and they created powerful and comparatively inexpensive means for amateur and newly established media artists. This evolved into the Toaster—technology which is primarily software with hardware add-ons—which grouped together four standard video tools.

The four components of Toaster technology are special-effects generation, color manipulation, character generation and rendering and animation. In video a special effects generator, or SEG, usually does the "cuts," or transitions, used in an edit. Using multiple video inputs

like most SEGs, the Toaster can dissolve from one image into another. But it also has some built-in effects—such as the "transporter," which deletes an object from a scene with its outline first shimmering and then disappearing, as seen in "Star Trek." In another type of cut, a "wipe," one image pushes the prior one off the screen in various ways. All such transitions must be done by an operator manually hitting a button; they therefore lack precise synchrony. The Toaster stores these effects, ensuring they are of identical length each time the operator recalls them. This makes the Toaster an improvement over typical SEGs, which only provide simple wipes and fades and do not correct for effect inconsistencies because of operator error when recreating them.

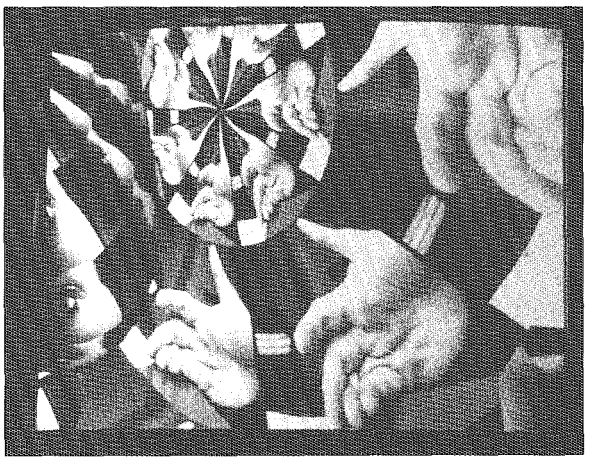
The Toaster also improves character appearance on-screen. Since image resolution on video can quickly degrade, the edges of on-screen lettering—particularly colored lettering—can become fuzzy. Toaster technology provides high-resolution lettering and allows the artist to scroll characters in many ways. Type layout and quality make a great psychological difference in static images, and the effect is much greater in video.

Toaster color manipulation is also superior to earlier SEGs. In color video, images are composites of primary light: red, green and blue. (This is actual light; pigment, which is reflected light, comes in primary colors of red, yellow and blue.) Furthermore, each color has two characteristics: hue, which is the "color" itself (i.e. where it falls in the spectrum), and saturation, which is the intensity of the color. Either of these can be manipulated independently on the Toaster, shifting the balance of the video image. For example, the Toaster can correct for poor lighting during taping. Video artists can manipulate color to affect mood. Colors which are composites of primaries can be altered, say, by converting only purples to whites. This makes the Toaster an essential tool for video artists who want to work in black and white, as monochromatic video cameras have not been manufactured for decades. Images that looked bad in color can be improved after a monochromatic conversion; in fact, monochromatic images are one of the few ways video can approximate the feel of film.

Many artists use a computerized-image generator that can create and animate what the artist renders frame by frame. The artist can designate a "camera path" that will move through the virtual landscape just as a real observer would, giving an illusion of three-dimensionality. Though this tool is labor-intensive—it takes 30 rendered frames to create each second of video—the comparative inexpensiveness of Toaster technology means entire batteries of artists can tackle a video project on a number of Toasters. More and more music video producers use such tactics. Space-fill rendering and animation programs are becoming popular for IBM-compatible and Apple machines as well, and conversion hardware that can take these video outputs and transfer them to videotape are now $300-$1,000. This only provides a small fraction of the video power of the actual Amiga Toaster, which costs $10,000-$20,000.

The University of Minnesota, through Intermedia Arts, teaches a Toaster seminar for those with rudimentary video-editing experience. Video artists can also acquire training for free through Metro area cable-access stations, if they provide non-commercial programming for community stations in return. Many of these cable-access organizations have Toasters for training and use.

Aesthetics and imagination are increasingly necessary for conducting good science. Now, science skills and technical aptitude are becoming necessary to produce multimedia art. ❖

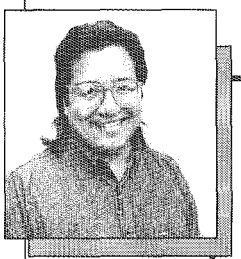


Natasha Frost

Program by Jerome Thelia

Sources:

Intermedia Arts courses Video 1,2 and 3; Video Editing; non-credit Toaster workshop.



Budding chaositician **Robert Subaga, Jr.** got his B.A. in Physiology in 1988 and subsequently did graduate study in Philosophy. He's now an extension student and Neurology Research Technician. When he's not creating computer graphics he provides illustrations for Technolog.

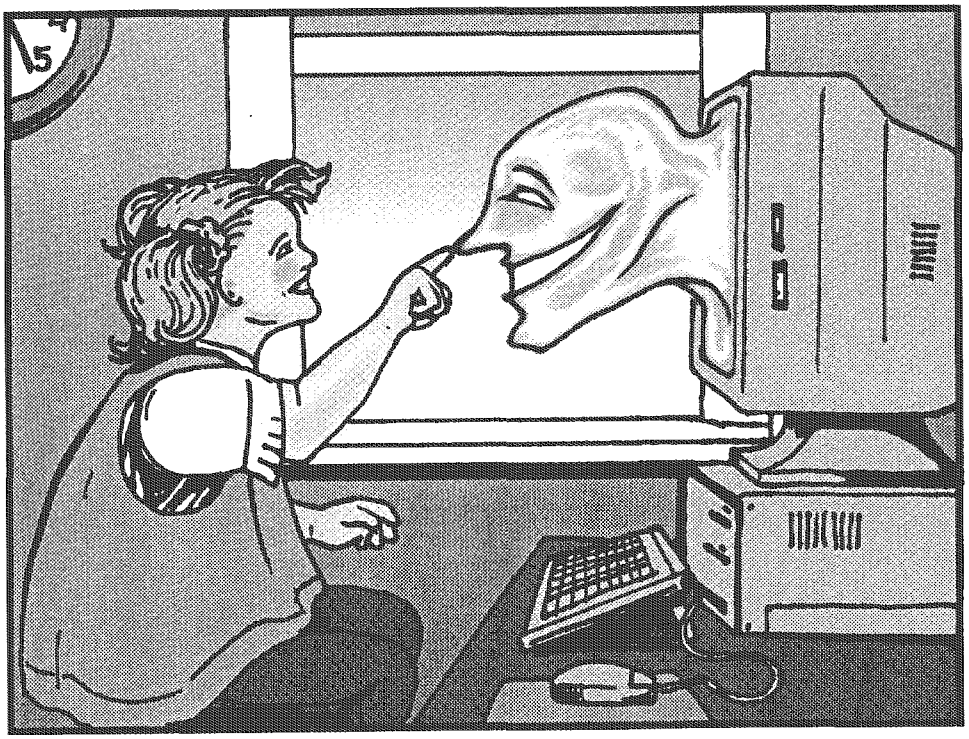
INTERACTIVE AGE: HOW FIBER OPTICS MAY CHANGE OUR LIVES

by **Matt McKinney**

What do AT&T, Vice President Al Gore and Italy have in common? A desire to use fiber optics to the greatest advantage of the people and interests they represent. According to communications producers, fiber-optics technology will enable viewers to direct television shows and music videos, shop from their homes, distance-learn from professors who answer questions on television and have in-home access to computer games, movies, books, magazines and newspapers.

Gore and others are interested in fiber optics' incredible powers of transmission: the capacity to deliver billions of bits of information in a fraction of a second to anywhere on the globe.

The light in fiber optics, however, grows weaker the longer it travels. For a communication system to spread across the world, the signal traveling in fiber optics must be periodically strengthened. Jim Leger, a University associate professor of electrical engineering, has worked with micro optics since he began researching a way to use lenses--much like microscopic versions of those in eyeglasses--to direct the light in fiber optics.



Michael Kooiman

These tiny pieces of glass direct and redirect the laser light. As that stream of information zings past a neighborhood, Leger's lenses would capture the light, split it up into hundreds of signals to homes in the area, then send it on to the next neighborhood.

Technology now exists which can produce the same result as

Leger's lenses; he aims to make the lenses smaller and more efficient.

Becoming interactive

Another problem with fiber optics is that the light in them weakens as it gets divided.

Some systems today rely on a kind of battery pack placed along the fiber-optic cable that recharges the signal every 50 kilometers. Used in submarine cables which connect countries, these "pumping" units use electrons to provide fresh energy to the fiber-optic signals. But to split the signal to many subscribers, Leger says, many repeaters may be needed. A system like that of the submarine cables would be too weak.

Leger's work borrows from recent discoveries in fiber optics such as that of researchers at AT&T who re-examined an experiment using fibers made from silica glass and a rare-earth element: erbium. The first such experiment dated back to the 1960s, when researchers at the American Optical Company first made fibers with neodymium, another rare-earth element, and found that the fibers could amplify light.

But, neodymium did not work well with silica glass, and the research was abandoned. Not until the mid '80s did another team of researchers attempt to use a rare-earth element to make a fiber that could amplify light. At the University of Southampton, Wales, scientists tried erbium. As noted in Emmanuel Desurvire's January 1992 "Scientific American" article, the erbium fibers could amplify light to 25 decibels--enough to attract the attention of scientists elsewhere.

At AT&T, researchers tried pumping the same fibers with a different frequency and found an even greater gain. Predictions are that the erbium fibers will carry 2,000 to 3,000 billion bits of information in one second when the technology is perfected.

Fiber-optics systems already use a "repeater" to carry messages over long distances. It interrupts the laser, converts the photons into electrons, amplifies the electrons and then converts them back into photons. The repeater is used in fiber-optic systems around the world. But Leger's lenses would be used for a different sort of battery pack.

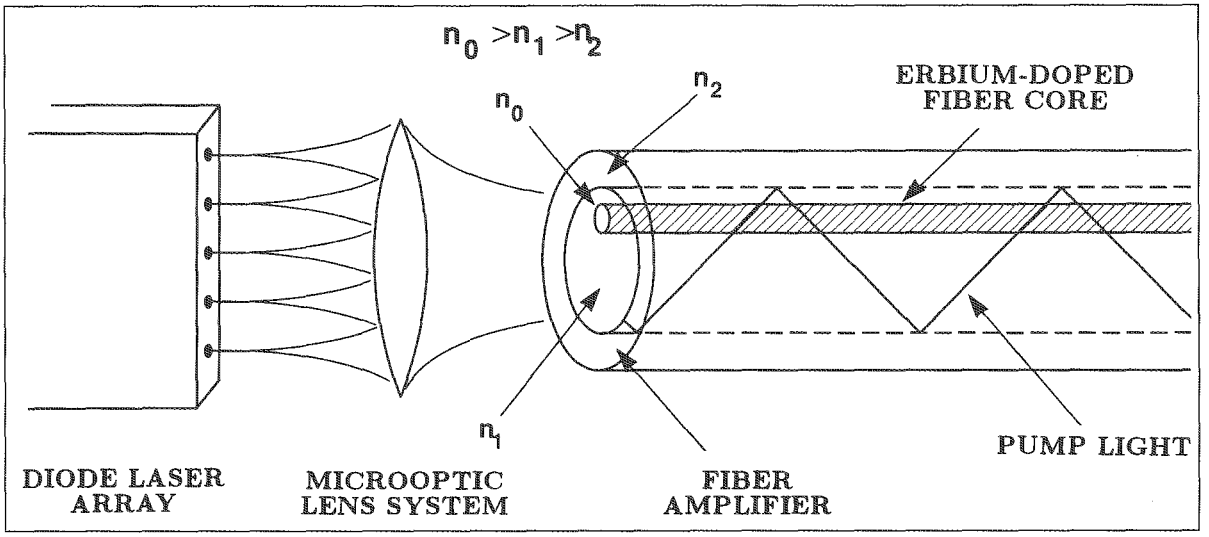
A single lens takes several days of meticulous construction, and Leger needs thousands of them.

When the information-laden light in fiber optics reached a neighborhood, Leger's lens system would concentrate 1,000 lasers into a "pumping" laser, which would strengthen the signal for division into hundreds of signals for neighborhood homes. A stronger laser could do the same trick as the thousands of single lasers, but no one has developed a laser that comes close to the combination of lasers Leger's system proposes.

Working in tandem, the lasers would excite the erbium in the fibers. The erbium would absorb a sufficient amount of pump light and recharge the signal.

A single lens takes several days of meticulous construction, and Leger needs thousands of them.

Leger first puts a tiny piece of "photo-resist" on a



Pumping of a double-clad fiber amplifier. *Courtesy of J. Leger.*

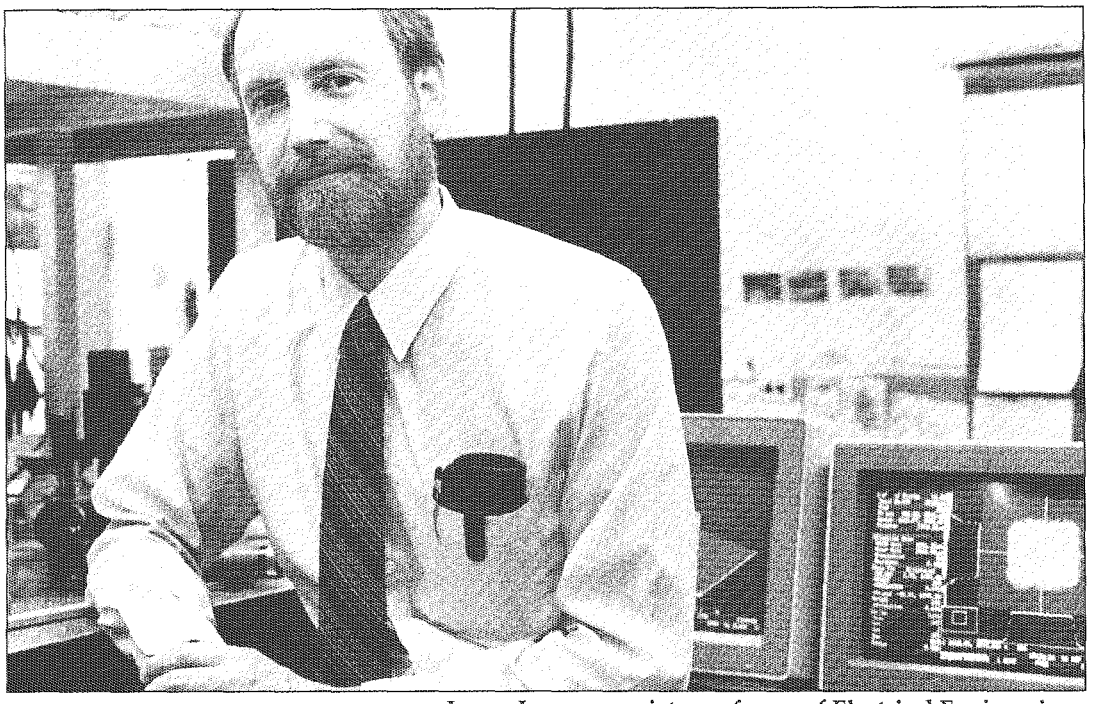


Photo by Dilip Vishwanat

James Leger, associate professor of Electrical Engineering.

substrate. Photo-resist can be exposed like a piece of film, but is not affected by ion etching. When Leger turns on an ion-etching machine, the exposed substrata is carved away, while the portion covered by photo-resist is left untouched.

Leger repeats the process, removing more of the substrate each time. He eventually constructs a tiny series of steps which rise up from the substrate and then drop back down — all in a space equal to the width of a human hair.

Then, using a specially designed oven, Leger bakes the piece of carved-up substrate at 1200C. This rounds off the edges of the steps while Leger carefully monitors the oven's temperature and atmosphere. Leger hopes to create the dome-shaped lenses by the end of this school year.

The research is just underway. Steve Campbell, an electrical engineering colleague of Leger's, is collaborating with the design of the furnace that will be used in making the lenses.

Even if the lenses are not suitable for fiber amplifiers, Leger believes the micro lenses could be used for coupling light into and out of fiber optics. ❖

Sources

Jim Leger, Personal Interview, August 1993

Dickson, Martin. "Forced from a cozy cocoon: America's Baby Bell Telecommunications Groups Face Radical Changes." Financial Times, April 20, 1993.

Desurvire, Emmanuel. "Lightwave Communications, the fifth generation." Scientific American, January, 1992. Vol. 266, No.1

Bruder, Isabelle. "A Guide to Distance Learning." Electronic Learning, November, 1991. Vol. 11, No. 3

Extel Financial Limited, July 14, 1992.

When Journalism grad student **Matt McKinney** isn't piloting a boat through Alaskan waters or rooting out corruption, he can be found squinting in front of a Technolog computer in his quest to become an even more evolved writer.

OPEN MOUTH

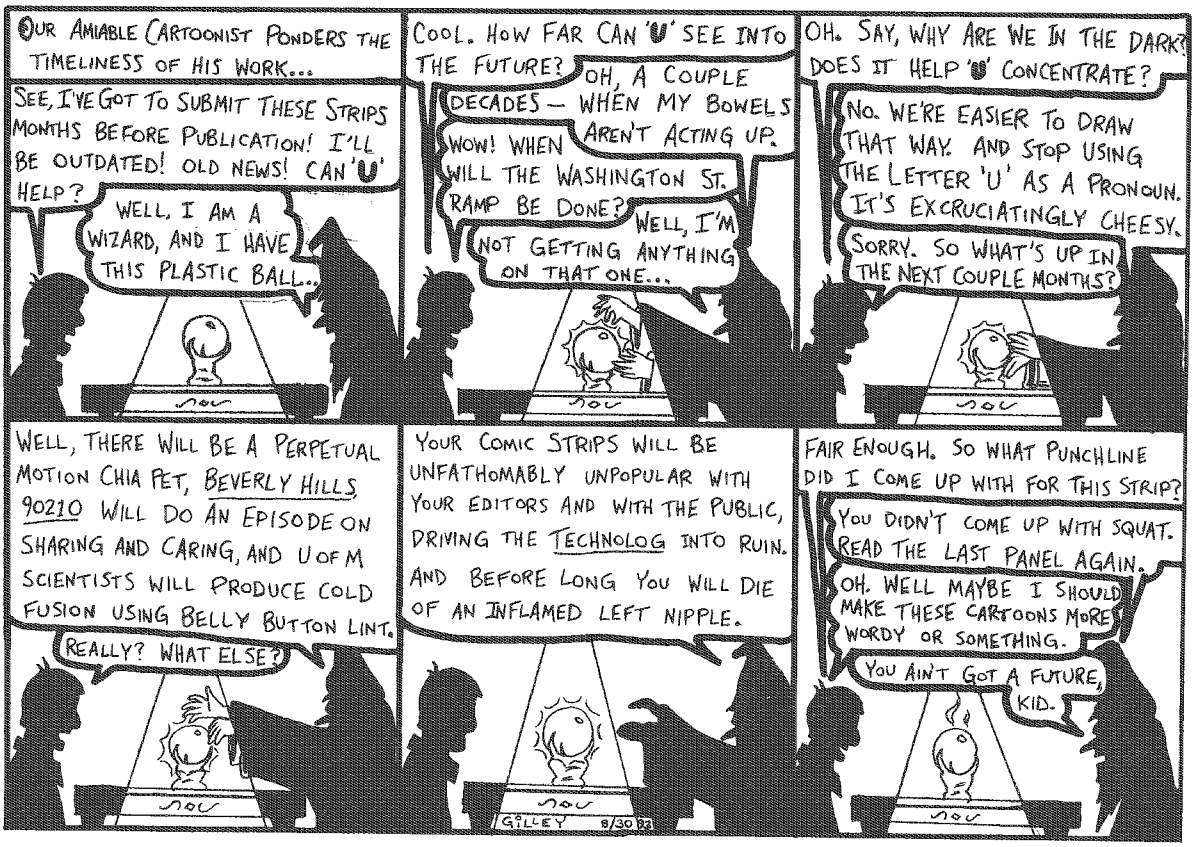
INSERT FOOT DEPARTMENT

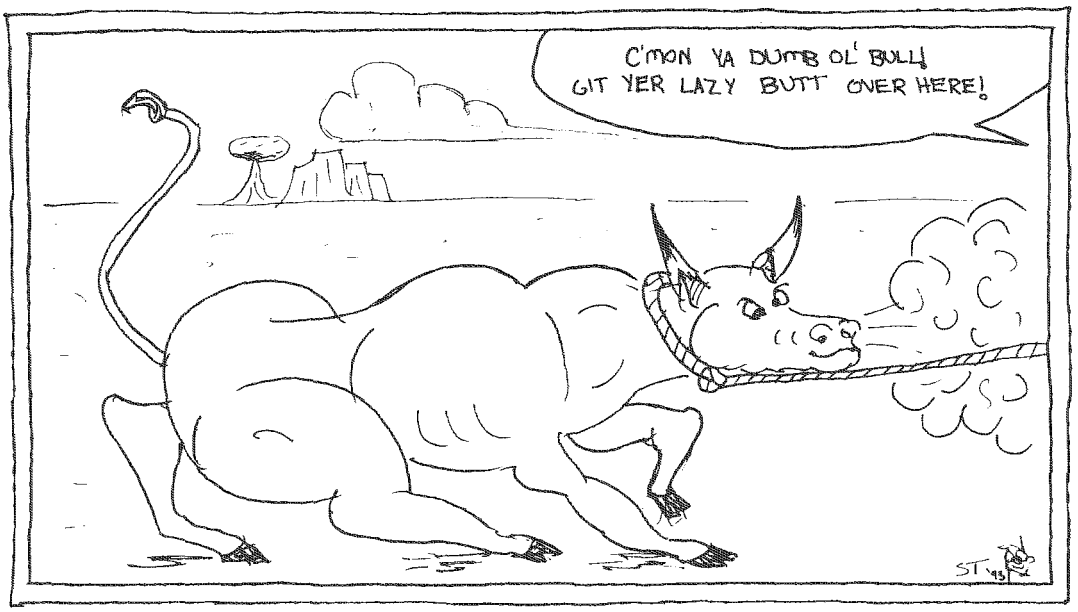
Not so famous predictions:

"Airplanes are interesting toys, but they have no military value."
Ferdinand Foch, French Marshal
1911

"Stocks have reached what looks like a permanently high plateau."
Irving Fisher, Economist
October 16th, 1929

"With over 50 foreign cars already on sale here, the Japanese auto industry isn't likely to carve out a big slice of the U.S. market."
Business Week, 1958





AS COWBOY BOB IS ABOUT TO LEARN, A ROPE IS A PULLER — NOT A PUSHER.

Rhyme and Reason

The riddle has a venerable tradition. The ancient Egyptians believed the Riddle of the Sphinx held great power over mankind. Who could forget that fateful exchange between Bilbo Baggins and Gollum in the bowels of Middle Earth? Here are a few you can use to test your mettle.

1

I am the king's most loyal supporter,
bones of wood, I need no mortar.
The commoner too may use my strong back.
I have several legs, it's feet that I lack.

2

This lady wears a cloak of white,
She sleeps the day, awake at night.
Her countenance doth constantly change
In her full beauty, strong men go derange

3

**Small, insignificant, I hold mighty powers.
I guard treasures, prisons, and great towers.
Teeth of iron, I'll eat no meal.
With me as your ally, great riches reveal.
Here's hoping you're seeing where all this is leading,
the key to this riddle is diligent reading.**

4

**My twenty-one eyes grace sextuplet faces,
Some people use me instead of horseraces.**

5

I am in your mind now
Staunch there 'till I am named.
I am a vicious torturer,
yet I'll never leave a mark.
I answer myself.
What am I?

Answers: 1. a chair 2. the moon 3. a key 4. a die (singular of dice) 5. a riddle

1994

TECHNOLOG SCIENCE FICTION CONTEST

Jennifer Hughlett

An outside panel of judges will select the top three entries. These will be printed in the April issue of Technolog. Winning authors will receive prize money accordingly:

First:	$125
Second:	$100
Third:	$75

CONTEST RULES:

The contest is open to all registered U of MN students, except Technolog and ITBP members. Entries must be typed and double-spaced, previously unpublished and no longer than 3000 words. Attach a cover page entitled science fiction contest entry, and don't forget to include your name, address, and phone number. Do not include your name on the manuscript! Entries may be turned into Lind Hall 5.

DEADLINE: **Monday, February 7, 1994**

MINNESOTA
TECHNOLOG
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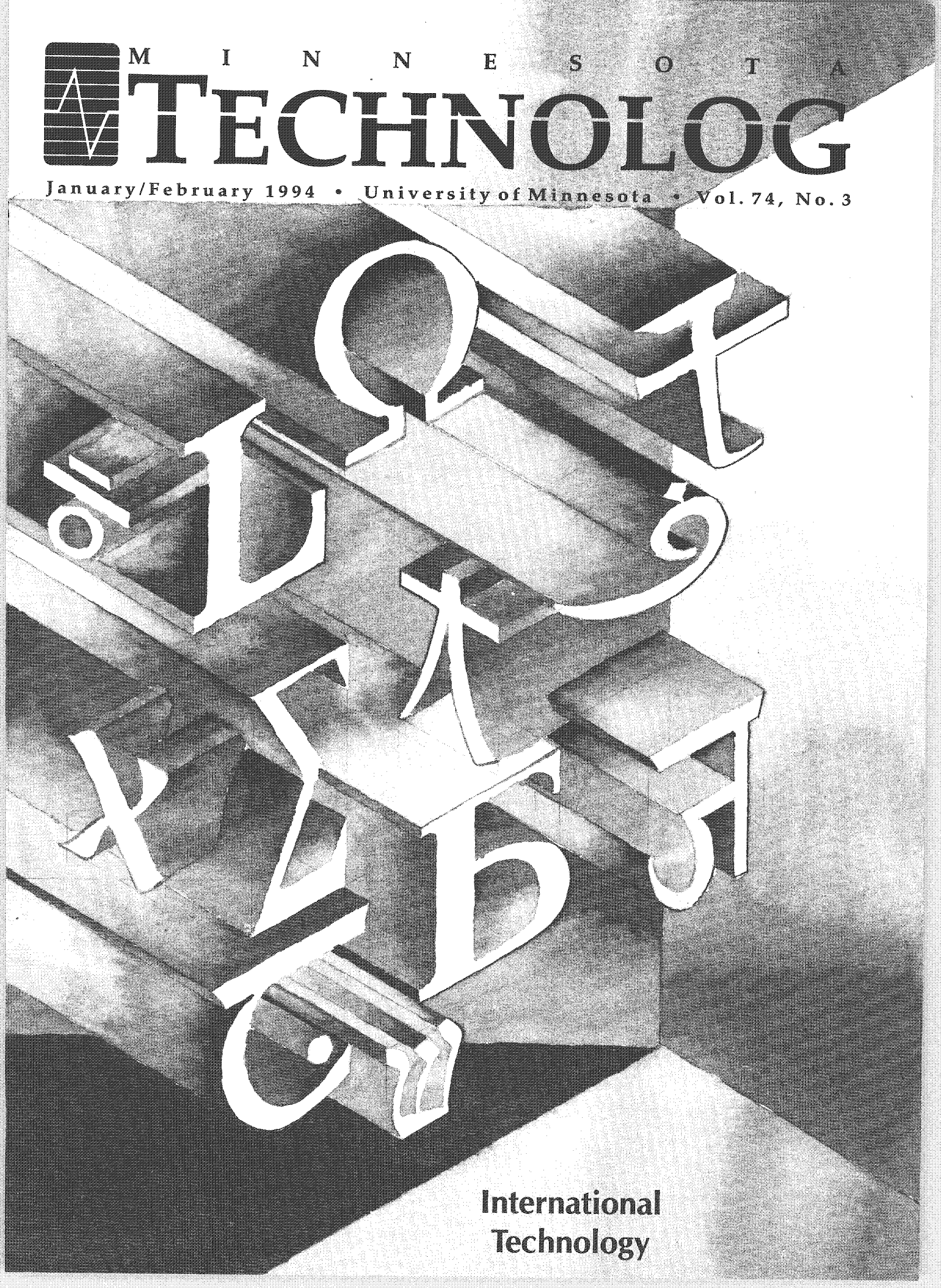
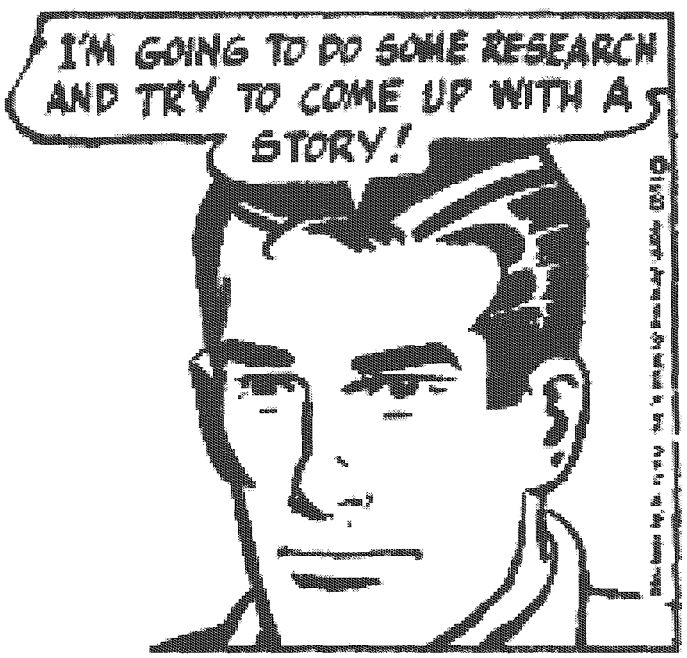


International Technology

1994-95 Student Positions Available

Going to be on campus for a few extra hours per week next year? How about getting involved with the award-winning Minnesota Technolog, or the soon-to-be-famous I.T. Connection? Interested I.T. students are encouraged to apply by **February 11, 1994** for the following positions:

- **I.T. Connection Editor: Stipend $110 per issue, 5 issues per quarter. Edit the student newsletter of the Institute of Technology.**
- **I.T. Connection Distribution Manager: $15 per issue, 5 issues per quarter. If you enjoy walking about I.T., and would like to get paid to carry things every two weeks, this position is for you.**
- **Minnesota Technolog Editor-in-Chief: $500 per issue, 2 issues per quarter. If you're serious about communicating about science and technology, this is the position for you.**
- **Minnesota Technolog Advertising Manager: $30 per issue, 2 issues per quarter plus 10% commission.**
- **Minnesota Technolog Circulation Manager: $50 per issue, 2 issues per quarter. If you don't like to walk around I.T. enough to apply for the I.T. Connection Distribution Manager position.**
- **IT Board of Publications Business Manager: $250 per quarter.**



Deliver: 1) short resume, 2) statement of goal(s), 3) writing samples for editor positions to: Room 5 Lind Hall. The application deadline is February 11, 1994. Training for all positions provided during spring quarter.

• • • • • • • • • • • • • • • • •

Call Jeff Conrad or Tiffany Chung at 624-7086 for more information.

EQUAL OPPORTUNITY EMPLOYER

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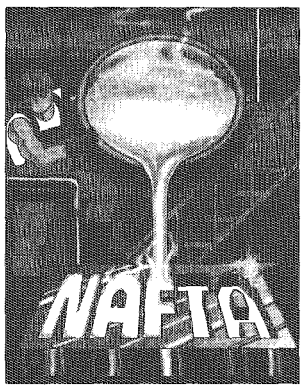

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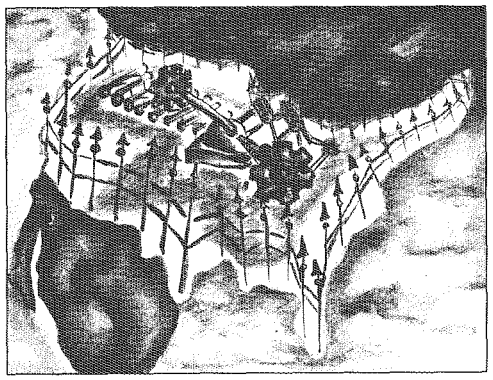

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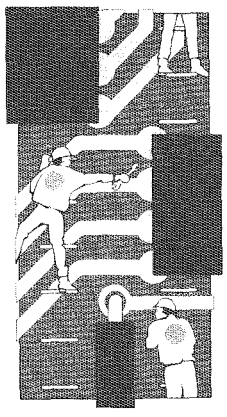


4

Departments

About the cover . . .

Len Gostinsky's interpretation of our international present.

NAFTA: North Americans Fearful of Trading Abroad?

by **Corinna Nelson,** ***Editor in Chief***

If a document could scream, this one would be deafening. The American Engineering Association's Legislative Alert on the North American Free Trade Agreement said in no uncertain terms that passage of NAFTA would:

- export manufacturing jobs to Mexico;
- export manufacturing in general away from the U.S.—making it a "third world country,"
- import lower-paid engineers and other technical employees into the U.S., displacing American engineers.

With the passage of the Agreement, the AEA can now only wait and see what will happen to American jobs and manufacturing.

What will NAFTA actually do? It's like the Equal Rights Amendment—lots of people have strong opinions about it but few have actually read the thing.

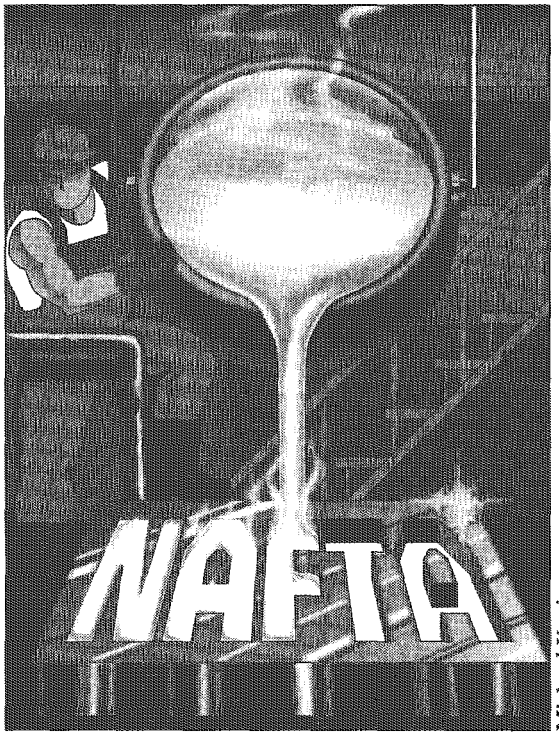
And how could they read it? It's five volumes total, weighing six pounds or so--a masterpiece of governmental wordiness. And so, readers, I took it upon myself to take a peek at the pounds of paper which might drastically affect our future.

My conclusions about the ramifications of NAFTA are as clear as the mud in the Rio Grande and Rainy Rivers. I'll quote from the Agreement, throw out a few possible scenarios and let you—future engineers and scientists with possible jobs from Monterey to Montreal in your future—decide on the ramifications for yourselves.

The objectives of NAFTA are listed below; the "Parties" are the U.S., Mexico and Canada:

- "Eliminate barriers to trade in, and facilitate the cross-border movement of, goods and services between the territories of the Parties;
- promote conditions of fair competition in the free trade area;
- increase substantially investment opportunities in the territories of the Parties;
- provide adequate and effective protection and enforcement of intellectual property rights in each Party's territory;
- create effective procedures for the implementation and application of this Agreement, for its joint administration and for the resolution of disputes;
- establish a framework for further trilateral, regional and multilateral cooperation to expand and enhance the benefits of this Agreement."

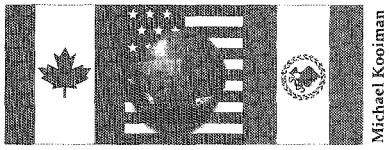
Nice words. But what do they mean? Let's look at employment of engineers and other technical professionals first. The AEA believes the objectives are government-ese for "unemployed engineers." They're especially fearful of the section in one of the appendices to NAFTA which concerns professional employees. NAFTA says the U.S. may approve as many as 5,500 "initial petitions of business persons of Mexico seeking temporary entry...to engage in a business activity at a professional level..." (NAFTA, Appendix 1603.D.4 United States).



Michael Kooiman

NAFTA lifts citizenship requirements for professional licensing. It also sets basic criteria for required professional training. Engineers must have a baccalaureate, a licenciatura degree or a state/provincial license. They are not required to have any professional experience. But interestingly, computer systems analysts must have three years' experience in addition to professional training.

Here's the first scenario. According to its legislative alert, AEA "Believes foreign professionals will be admitted in unlimited numbers through



Michael Kooiman

NAFTA even though they are not citizens of Mexico or Canada so long as they are paid by a Canadian or Mexican company." AEA believes "a Mexican company, for example, may shop worldwide for the lowest salaries and then import them to the United States." AEA does not provide its reasons for these arguments. But engineers and computer professionals are by virtue of the difficulty of their training already an elite class of workers. AEA speaks about them as if they are passive and helpless, unable to use their bargaining power to shop internationally for the best wages.

Cream rises. The best engineers will have even more opportunities—here and across our northern and southern borders—to shine.

Where does that leave your competent, but average, engineer or computer jockey?

Competent and average types (most of us) often get jobs in manufacturing facilities. Here's where the second scenario--the specter of shipping our manufacturing base abroad--comes into play. AEA thinks manufacturing plants—where value is added to raw materials—will be shipped south wholesale. AEA believes the U.S. cannot maintain a high wage economy simply by generating ideas and having others produce the actual products.

No single industry has had as much attention focused on it during the NAFTA debate as the car industry. Opponents of NAFTA might point to the example of car manufacturing in Japan to bolster this point of AEA's argument. Japan began its foray into automaking by building upon techniques originated in the U.S. Now it's a dominant force in both the creation and execution of new car designs.

Proponents of NAFTA point out the cultural differences between Japan and the three countries of the North American Free Trade Agreement. A design and manufacturing strategy which works for a small, nearly homogeneous island probably won't translate directly into the multilingual, multicultural stew of the three NAFTA countries--which reach from the Arctic Ocean to Guatemala.

Proponents of NAFTA also point to the tariffs issue. Currently, American car makers have an incentive to build manufacturing plants in Mexico because of high tariffs on U.S.-made vehicles sold in Mexico. Eliminate those tariffs, as well as the requirement that cars sold in Mexico be produced there—as NAFTA does over a 10-year period—and the need to produce cars in Mexico will decrease greatly.

Opponents say: low Mexican wages will then provide the incentives for companies to continue producing cars there.

Proponents say: cars will always be made in the U.S. because of higher worker productivity here and because of the costs of transportation.

The mud in the Rio Grande and Rainy Rivers is still thick and the conclusions about NAFTA's impact unclear.

The one thing that is clear is that we won't get a true idea of NAFTA's full impact for 10 years or more.

What does that mean for I.T. students? Don't give up on careers in manufacturing just yet. But be sure to brush up on your French or Spanish.

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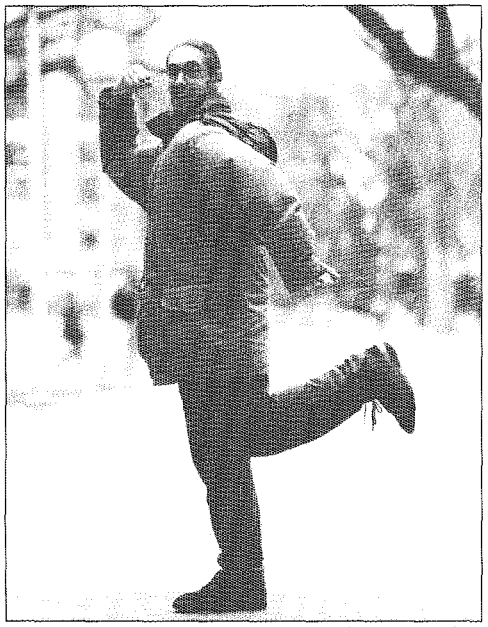
Profile: Vincent Voelz



Mitch Hanley

Vincent Voelz

Vince Voelz's idea of a good science fair project has a lot of heart. But only if it's complete chaos. His senior project in high school was entitled "Examining Bifurcation in a System of Van der Pol Oscillators: A Nonlinear Model of the Heart." It won him a second place award from the American Physiology Society and a Third Place Grand Award at the International Science and Engineering Fair in Gulfport, Mississippi this past June. He's been working his way around the country at prestigious science fairs since his freshman year in high school, and earning national awards in the process.

Voelz has brought his interest in chaos and biology to I.T. this term as an Honors student. His high school interests in the human heart and dynamic systems were in fact spurred by Mathematics Professor Richard Moeckel, whom he met while taking high school Honors classes here at the U.

A 1993 graduate of Anoka High School, Voelz was most recently the State of Minnesota's representative at the American Academy of Achievement's Salute to Excellence.

In addition to attending science fairs, Voelz has also spent some quality time hopping around major research institutions in the United States presenting at science fairs. His studies and projects have taken him to the National Energy Research Supercomputing Center in Berkeley to nose around NERSC's latest research projects in advanced computing. Locally, Voelz also spends some time at Cray Research, Inc. utilizing the latest silicon on large computations which often accompany the nonlinear equations of chaos theory.

> "I LIKE TO SEE THE PRACTICAL APPLICATIONS AND NOT JUST MACHINE-INTENSIVE WORK."
>
> VINCENT VOELZ

Here at the University, Voelz plans to major in mathematics and perhaps biology. He wants to continue researching chaos in biology through the University Assistant Scholars Program and hopes to shoehorn some electives in jazz music and anthropology into his already busy schedule. Whatever subject he researches, says Voelz, "it will involve people—I like to see practical applications and not just machine-intensive work."

Voelz is also a member of the Men's Choir—and a conflicting lab this term was all that stood between him and a jazz piano class.

"I'm having fun right now," says Voelz. He admits he was offered an opportunity to attend Stanford University, but chose to remain in Minnesota with many friends who are also attending the U. "I've always been an independent person, and the opportunities and diversity of the University are great." **--by Chris Kasic**

International Joint Ventures in R&D

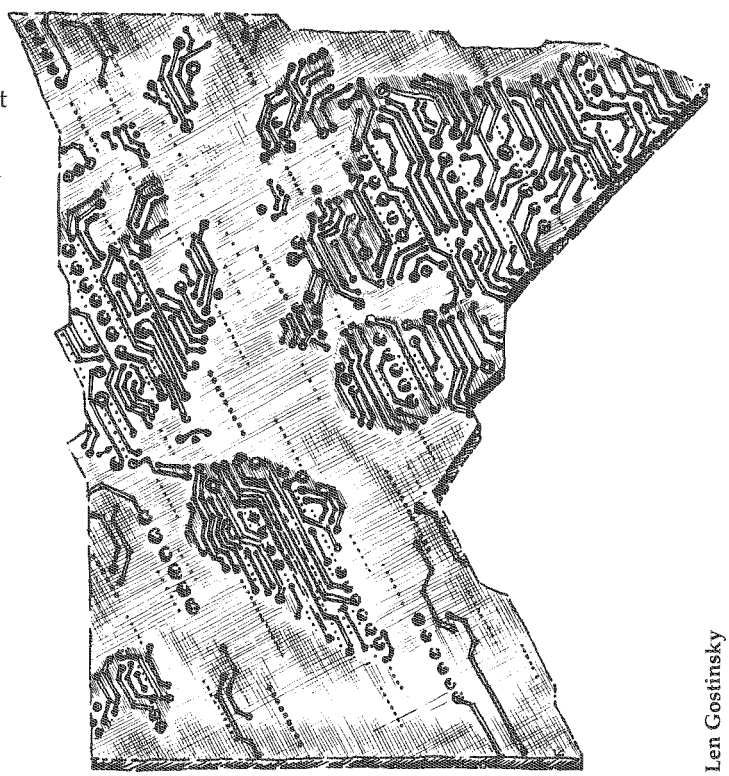
by **Dan Shendar**

When Stratus Computer, Inc., a publicly held $450-million U.S. company, contemplated the development of a new software system in 1990, it first considered recruiting its own team of software experts. The software was to run on Stratus computers and provide banks with a single communication gateway to networks such as telex, EDI and SWIFT. After realizing the time and expense it would take to gather a high-quality group and bring them up to speed with Stratus' technology (not to mention the financial risk of such a new endeavor), the management at Stratus decided to approach it from a different angle.

Instead of starting from scratch, Stratus teamed with an existing organization that had a record of expertise in developing such systems. This organization would be responsible for developing the software based on product specifications and strict marketing guidance provided by Stratus. After a short search for the ideal partner, Stratus found the Israeli-based Manof Systems , Ltd., thereby starting an international joint venture in research and development.

Generally speaking, an international joint venture in R&D is composed of two companies with a common goal. Defining the responsibilities of each company is rarely an issue, because the work is divided according to each partner's expertise. In the Stratus-Manof venture, the Israeli company took the job of software development, while the American company provided the technical specifications, performed testing, and developed training and documentation. During the commercialization phase, Stratus was to provide the sales, distribution and customer service in the United States, while Manof was to do the same in Europe.

The benefits to Stratus were obvious. First, they saved a great deal of development time — more than a year according to management's estimate. Second, they were able to obtain state of the art, proven technology from their foreign partner. Third, they gained immediate access to Europe and other world regions via the existing distribution network of Manof Systems, Ltd. Last, the two partners were the fortunate recipients of a generous grant provided by their respective governments, which funded half of each partner's product development costs.



Len Gostinsky

Such public funding of international joint ventures in R&D is not new to Minnesota. The Minnesota Legislature, recognizing the importance and benefits of international cooperation in new product development, passed the International Partnership Program Bill (Statute Section 116j.974) in May 1991, for the purpose of stimulating joint ventures

in research and development between Minnesota-based and foreign companies. The Legislature also authorized the Minnesota Trade Office, a division of the Minnesota Department of Trade and Economic Development, to act in promoting and funding such joint international ventures.

As a result, the Minnesota Trade Office assists Minnesota firms by providing "matching" services to local companies that seek a foreign partner suitable for joint R&D work. Once a foreign match is found, it is the responsibility of the two firms to set up the R&D program and negotiate the arrangement between them. The arrangement usually covers the responsibilities and budgets of each partner within the R&D phase as well as the ownership of the know-how and the details of the phases that follow development work, including manufacturing, sales, service and technical support. When the Minnesota company and the foreign company are in agreement on a joint program, the local company, and in some cases the two partners, may apply for funding of their product development work.

THE MINNESOTA TRADE OFFICE ASSISTS MINNESOTA FIRMS BY PROVIDING "MATCHING" SERVICES TO LOCAL COMPANIES THAT SEEK A FOREIGN PARTNER SUITABLE FOR JOINT R&D WORK.

The Minnesota Trade Office promotes several international programs as well as a "home-made" one. One of these programs, established by the governments of the United States and Israel for the purpose of stimulating technology-based joint ventures, gives financial support to R&D projects conducted by an Israeli-U.S. pair of companies. The program is known as the BIRD Foundation and uses a $110 million endowment to fund 50% of the total R&D costs for projects costing up to $2.5 million. The money is provided as a conditional grant and is paid back to the foundation on a royalty basis only if the fruit of the R&D is successfully commercialized. The BIRD Foundation was established in 1977 and has already funded nearly 350 projects. These projects have generated business, primarily for the U.S. companies, estimated to be in excess of $3 billion. A similar, but smaller program, named PACT, was established six years ago with the government of India.

The local "home-made" program is named after The International Partnership Program mentioned earlier, and it provides local manufacturers with not only the matching services, but also with the funding to help stimulate such joint R&D ventures. Currently, small, privately-held companies can apply to the Minnesota Trade Office for funding, which is generally up to $250,000 and is available through the Equity Fund of Minnesota Technology, Inc. An expansion of the program to include larger companies is being considered by the administration.

Minnesota is an excellent place for the creation of R&D joint ventures. Not only is there a large and growing community of technology-intensive companies, but the state legislature and administration, having recognized the significant economic impact that international cooperation in research and development could create, has made it easier for local companies to form such international joint ventures and, in many cases, receive state and/or federal funding to support such efforts.

Dan Shendar is a local consultant on international high-technology joint ventures and is the coordinator of the International Partnership Program in the Minnesota Trade Office.

Important Telephone Numbers:
(612) 297-4222 The Minnesota Trade Office
(612) 297-4283 The Int'l Partnership Program

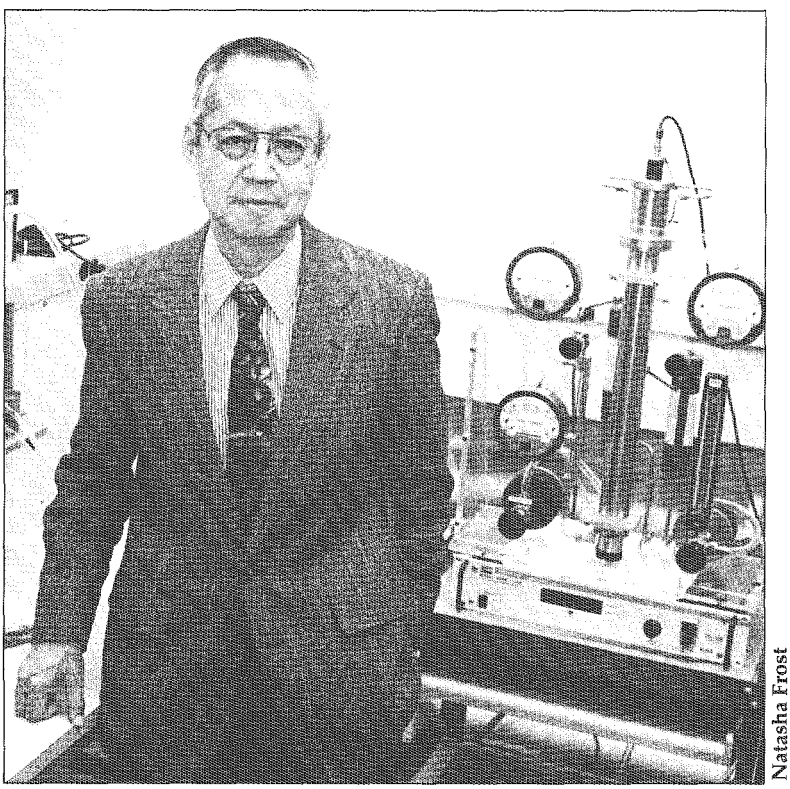
Giving Nature a Helping Hand

by **Brian DeVore,** *Technolog Staff Writer*

University of Minnesota Mechanical Engineering professor Benjamin Liu can barely hide his excitement as he explains a new patented method for removing toxins from incinerator waste. The method, developed at the University's Particle Technology Laboratory, didn't involve the latest science and isn't even particularly high-tech. In fact, it basically consists of injecting steam into tiny particles of toxins to make them big enough to be broken down through traditional wastewater treatment methods.

"It's simple," says Liu, director of the Particle Technology Laboratory. "There's nothing new about steam."

And if it works, steam injection could simplify waste treatment budgets. The method is being tested at the Minneapolis Wastewater Treatment Plant where tons of solid waste is produced every day. Officials incinerate these solids, but still end up with toxic heavy metals such as zinc, lead and cadmium which are too small to be picked up by smokestack scrubbers. A device called an electrostatic precipitator can remove these toxins, but would cost as much as $10 million to install.



Natasha Frost

Professor Benjamin Liu in a lab that he oversees.

Steam injection is currently being tested at the wastewater plant and Liu estimates making it a permanent part of the facility would cost approximately $1 million.

"Environmental technology shouldn't cost an arm and a leg," says Liu.

Countries looking to prevent or clean up pollution using technology are hoping people like Liu are correct in their assessment of the final bill. The reality of today's world is that often the most polluted nations are also the least able to afford environmental technology. In hopes of increasing their cash flow and easing monstrous debt loads, "underdeveloped" countries have pursued industrial progress with fervor, usually with a mix of 19th century "anything goes" industrial growth and 20th century technology. In some cases the results have been devastating.

Consider the Mexican border towns where American tennis shoes, among other items, are

manufactured at a fraction of what it costs to make them here. Toxic chemicals and other manufacturing waste are dumped into ancient sewer systems, or worse, straight into rivers and streams. Unusually high clusters of deformed children are being born in this "maquiladora" sector of Mexico, and activists on both sides of the border are pointing fingers at the American-owned factories.

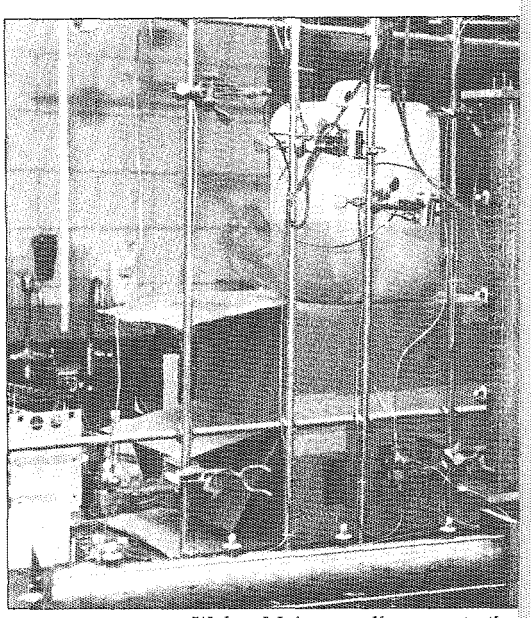
Regions like this are prime markets for technology that can prevent and clean up ecological contamination, say environmental technology experts. In fact, Mexican officials report having increased spending on environmental technologies and services from $1.7 billion in 1990 to a projected $2.2 billion this year and $2.5 in 1995, according to the Seattle Times. America leads the world in environmental technology, from water purifying processes to smokestack emissions abatement to toxic waste clean-up methods. It is currently a $270 billion a year global market and may expand to $400 billion by the end of the decade, according to the Times.

The U.S. Commerce Department has promised to boost United States imports of environmental technology any way it can. The Overseas Private Investment Corporation plans to establish an environmental investment fund, combining federal and private capital, to provide equity for U.S. environmental projects abroad. And environmental technology was one of the topics discussed at the International Symposium on Trade and the Environment held at the University in November.

Promotion of environmental technology is of particular interest in Minnesota, which is recognized as a leader in the development and manufacture of pollution control devices and processes, according to Ronald Kramer, director of the United States Commerce Department's Minneapolis office. According to the Minnesota Trade Office, the state has more than 300 companies involved in developing environmental technologies for export. They range from highly technical energy controls for increased fossil fuel efficiency, manufactured by Honeywell, to relatively simple water treatment processes developed by the Twin Cities' Lemna Corporation.

Much of the research on environmental technology is coming out of the University's laboratories in the form of devices that can measure emission levels, prevent pollution from being produced in the first place, or treat the problem at the end of the smokestack or wastewater pipe.

Whatever the technology, it will have to be cost effective if it is to make inroads into some of the world's most polluted nations. Eastern Europe, Asia and Latin America offer the biggest markets for environmental technology but are not likely to be in the market soon, says Karin Nelson, international trade and environmental industry adviser for the state trade office.



Walter Maier standing next to the

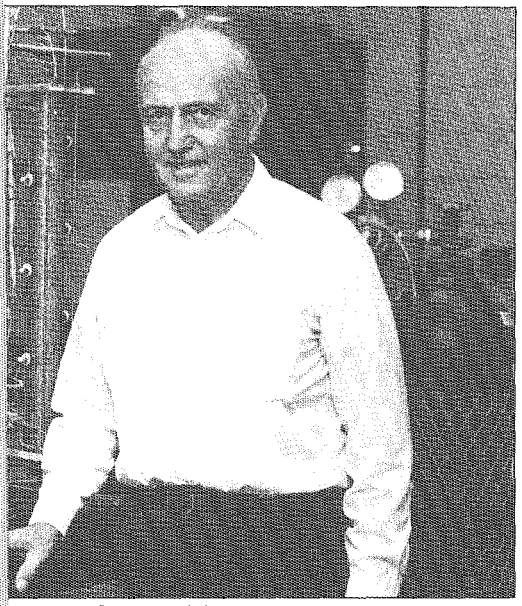
"For example, Eastern Europe is huge ... but what the actual possibilities are in getting paid for environmental technology sent there is a whole different story," she says.

Liu agrees, but says that often "new" environmental problems can be solved using relatively inexpensive "old" technology simply by looking at the problem in a new light.

"It's intellectual application of an old process," he says.

For example, there's nothing new about using oxygen and bacteria to purify water. In nature, water utilizes bacteria to rid itself of contaminants. But bacteria need oxygen to thrive and often oxygen levels can't be maintained when massive amounts of artificial contaminants enter the system. That's why University Civil and Mineral Engineering professors Walter Maier and Michael Semmens are looking for ways to get as much oxygen as

LIU SAYS THAT OFTEN "NEW" ENVIRONMENTAL PROBLEMS CAN BE SOLVED USING RELATIVELY INEXPENSIVE "OLD" TECHNOLOGY SIMPLY BY LOOKING AT THE PROBLEM IN A NEW LIGHT.



Natasha Frost

Insert Column which tests undisturbed soil samples.

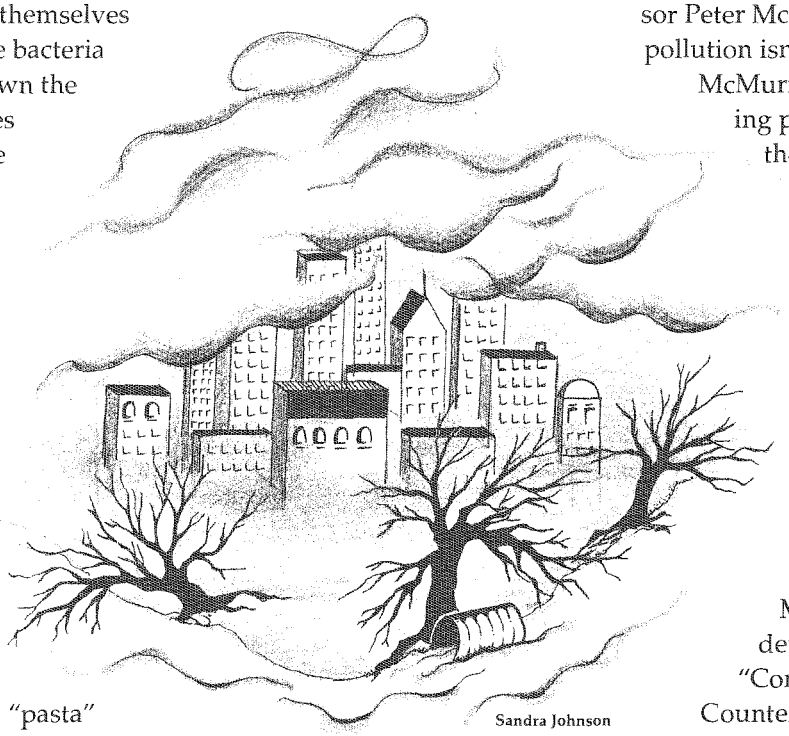
possible to the bacteria.

Traditionally, that oxygen can be supplied by pumping large volumes of it directly into the water. It's effective, but high volume pumping creates bubbles. Toxins such as heavy metals often attach themselves to these bubbles before the bacteria have a chance to break down the contaminants. The bubbles rise and evaporate into the air, creating airborne pollutant problems.

"Once you transfer that air into the atmosphere, you've transferred a water pollution problem into an air pollution problem," says Maier.

It's a tough problem, but Semmens has helped develop a device that may help solve it. It looks like a bunch of uncooked spaghetti, but this "pasta" is made from polypropylene and polyethylene, and it waves back and forth when shaken. These tiny hollow fibers, a version of which is already known to chemists who do gas transfer experiments, are very effective at transferring oxygen into water. So effective, in fact, that during a 12-month test conducted at St. Paul's Wastewater Treatment Plant, no bubbles were formed during the process.

Bubbleless oxygen transfer is more efficient, dissolving 100 pounds of oxygen for $21, as opposed to roughly $30 for other oxygen pumping methods, according to Charles Gantzer, who with Semmens owns and operates a Minneapolis environmental technology company called Membran Corporation. The membranes have proven effective at breaking down creosote waste in Montana and the next big test will be this winter in St. Louis Park, Minnesota. There, Membran and the Minnesota Pollution Control Agency will attempt to stimulate bacterial growth in an aquifer that contains creosote contamination from an industrial site.



Sandra Johnson

Stimulating bacterial growth around landfills and other polluted areas could also help protect groundwater, says Maier. Later this year the researcher will test a "bio-barrier" system near Bemidji, Minn., where groundwater contamination is a big problem. By injecting oxygen and perhaps nutrients into these gravel barriers, he hopes to create the kind of bacteria that will break down toxic chemicals such as benzene and vinyl chlorine. In addition, the barriers can help stop the migration of methane from landfills where it is produced through anaerobic digestion. Capturing methane would be an added bonus; while breaking down, the gas creates enzymes that biodegrade other chemicals, according to Maier.

"The technology is really an extension of the natural purification process of water, " says Maier. "We've built on that to get more rapid cleanup."

Hollow membranes, bio-barriers and even steam injection represent ways of cleaning up air and water in a relatively small area. But University mechanical engineering professor Peter McMurry knows that pollution isn't always local.

McMurry specializes in measuring particulates in the air—those pollutants that can dim the awesomeness of the Grand Canyon and influence global warming.

Pollution control experts looking for ways to reduce particulate emissions have to know where they come from and what they are made up of. McMurry helped develop a device called the "Condensation Nucleus Counter" to answer those questions. The device, about the size of a dormitory refrigerator, can measure particles down to the 3-12 nanometer range—electron microscope territory.

"There was no way to measure particulates this size before this

device was developed," says McMurry.

As particles enter a chamber, they are saturated with butyl alcohol vapor, which is cooled so it becomes supersaturated. This causes condensation to occur, enlarging the particles one thousand times. That's large enough for the naked eye to see. By studying these particles, McMurry and his colleagues hope to understand the processes that determine the rate at which the particles are produced. Such data will provide a view of the global impacts of particulate emissions.

"We are moving to the step where we can bridge the gap between molecules and particles," he says.

The device was commercialized two years ago and McMurry has used it to measure particulates in several spots on the globe, including the Arctic, Hawaii and the Colorado Rockies. Because air pollution knows no boundaries, the researcher says such measurements will become even more important as countries look for ways to cooperate on environmental protection.

"I think these are questions that will receive increasing international attention."

Sources

Liu, Benjamin. Personal interview, Nov. 2, 1993.

Kramer, Ronald. Phone interview, Nov. 2, 1993.

Nelson, Karin. Phone interview, Nov. 15, 1993.

Maier, Walter. Personal interview, Nov. 4, 1993.

Gantzer, Charles. Phone interview, Nov. 12, 1993.

McMurry, Peter. Personal interview, Nov. 11, 1993.

Semmens, Michael. Personal interview, Nov. 9, 1993.

Semmens, Michael. "Bubbleless Aeration," Water/Engineering & Management, April 1991, pp. 18-19.

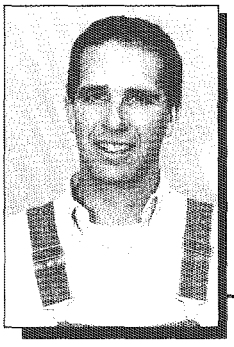
Semmens, Michael and Charles Gantzer, "Gas Transfer Using Hollow Fiber Membranes," Water Environment Federation 66th Annual Conference & Exposition, Oct. 3-7, 1993.

Semmens, Michael, S.R. Wickramasinghe and E.L. Cussler, "Hollow fiber modules made with hollow fiber fabric," Journal of Membrane Science, Vol. 84 (1993), pp. 1-13.

Runge, C. Ford. "The North American Free Trade Agreement (NAFTA): Issues and Impacts for Minnesota." Center for International Food and Agricultural Policy, May 20, 1993.

Williams, Marla. "Lowry: NAFTA Good for State — Area High-Tech Firms Would Benefit, He says of Proposed Trade Pact," Seattle Times, Sept. 10, 1993, p. B1.

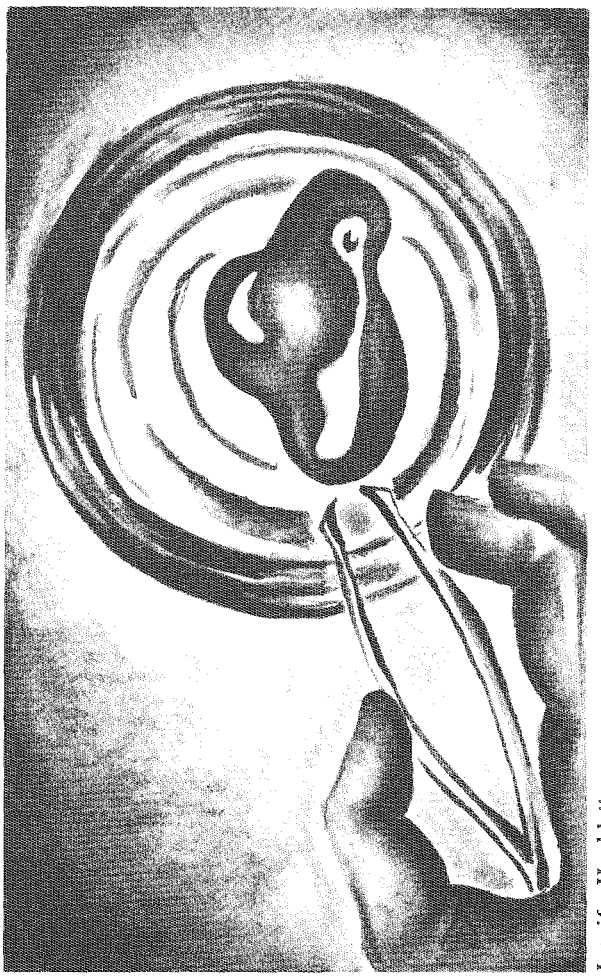
Mitchell, Cynthia. "Business Report: On International Business," Atlanta Constitution, Aug. 10, 1993, p. F2.



He's worked in places ranging from Iowa to Lesotho, and now **Brian DeVore** is working in the most challenging venue of them all: Technolog. Brian is in the Master's program in the History of Science and Technology.

Capital Ideas:
Patents – and – Technology Transfer

by **Tamara Lubic,**
Technolog Associate Editor



Jennifer Hughlett

Good ideas can travel a long way, but sometimes it's better to keep them at home. In the international marketplace, deciding when to share ideas, products, or technologies, with whom, and at what price requires a complex formula.

One way to spread good ideas around is technology transfer, the process of transferring ownership of intellectual property (a patent or copyright for example), from one source to another, usually via licensing.

Michael Moore, communications director for the University's Office of Research and Technology Transfer Administration describes a license as a legal contract or agreement that gives the buyer rights to commercialization in exchange for remuneration to the seller. There are many types of licensing agreements, with remuneration ranging from direct financial return such as royalities or a lump-sum fee to a research development agreement, in which the buyer helps fund specific types of research in exchange for the rights to commercial use of any products or technologies arising from that research.

At research universities like Minnesota, which was ranked 9th among U.S. universities in 1992 with 32 patents granted, technology transfer usually refers to collaborations between the university and private industry.

The Bayh-Dole Act of 1980 gave universities the right to negotiate exclusive licenses with companies for inventions developed out of federally-sponsored research. According to Moore, universities must, however, consider all interested companies in negotiations, including smaller ones, and companies that license a product to be sold in the U.S. must manufacture the product in the U.S.

In non-university markets, technology transfer may mean licensing a patent from one company to another, or, at the international level, from one country to another.

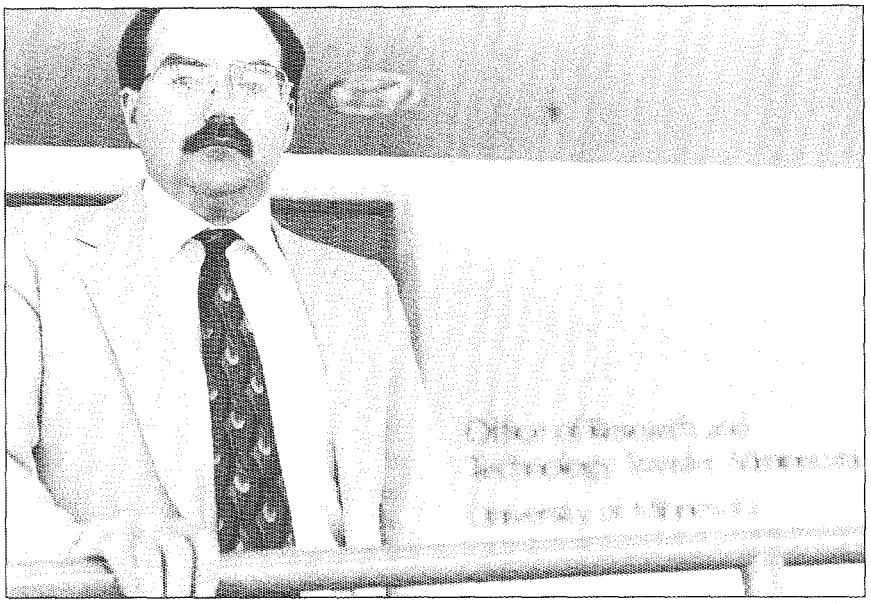
In his book Technological Collaboration in Industry, Mark Dodgson writes, "The internationalization of private-sector technology and its significance on a world scale has led to 'techno-globalism,'" with an accompanying increase in research and development collaboration and multinational marketing strategies.

However, Moore says the decision to transfer technology across nation/state borders is complex because it affects national economies and market competitiveness.

He says a good local example of the technology transfer decision-making process is Taxi 2000, the personal rail transit (PRT) system developed by former Mechanical Engineering Professor J. Edward Anderson.

In June the Illinois Regional Transportation Authority (RTA) voted to award an $18 million contract to a team comprised of the Taxi 2000 Corporation and Raytheon Company, which agreed to invest $20 million of its own money to build a Taxi 2000 prototype.

The July issue of ORTTA's newsletter, Research Review, reported that "Raytheon had determined that PRT was one of very few technologies that could occupy its Missile Systems Division if defense contracts de-



Dilip Vishwanat

Michael Moore, of the Office of Research and Technology Transfer.

creased significantly. The company estimated the potential worldwide PRT market at $100 billion."

Moore says that Japan, the Philippines and the Netherlands expressed interest in licensing the Taxi 2000 technology, but both Anderson and the University, after lengthy consideration, felt that it should stay in the U.S.

He notes that at some point, Raytheon may opt to sublicense Taxi 2000 internationally. Like licensing, sublicensing agreements can vary but often refer to selling marketing rights to a product or technology and dividing the profits.

Grady Frenchick, adjunct associate professor in the University of Minnesota Law School, and an attorney with the Madison, Wis. law firm Stroud, Stroud, Willink, Thompson, and Howard, says that with increased globalization, "national boundaries are essentially disappearing."

However, William Brustein, director of the Center for European Studies and associate professor of Sociology, says the visibility of borders and boundaries depends largely on the state of national economies.

He says, "In times of economic problems, there is a tendency towards protectionism. As economic problems continue, we're going to see a slowdown in terms of our willingness to transfer technology."

Research and development takes time and money; organizations, institutions, and nations with significant R & D investments need to continually weigh the advantages and drawbacks of technology transfer.

Another complication is inconsistency in the patenting process throughout the world. The Minnesota State Bar Association defines a patent as "a government grant to an inventor which gives him the right to take legal action, if necessary, against others who, without the consent of the owner, make, use or sell the invention covered by the patent during the time the patent is in force. This right may be sold or licensed to others."

Governments encourage organizations and individuals to protect and license their intellectual property for profit, publicity, and the public good.

But in the U.S., patent law is based on the person who is first to invent. If two people apply for a patent on the same invention, the legal system allows the Patent and Trademark office to determine who was first by examining laboratory and/or research records. In the rest of the world, with the exception of a handful of countries, "first" means first to file for a patent. And the rest of the world, under the auspices of the World Intellectual Property Organization (WIPO), is asking the U.S. to change its system so that it "harmonizes" with that of other countries.

Some opponents of harmonization view the issue as one of big business versus the individual (or small company), because large organizations tend to file for patents on virtually any development that has potential for commercialization, and they have the staff and money to stay on top of the paper-pushing process.

In an editorial in the July 19, 1993 issue of Barron's, Thomas Donlan describes the first-to-invent principle as "protecting people who are not well-versed in the patent filing system and who may have trouble coming up with thousands of dollars in fees for every bright idea."

> "...OUR OWN TECHNOLOGY GIVES US AN ABILITY TO MAINTAIN AN ECONOMIC ADVANTAGE IN THE WORLD."
>
> WILLIAM BRUSTEIN

Controlling intellectual property rights internationally is difficult, and the stakes are high. In 1993 the U.S. Chamber of Commerce published a report titled "Europe 1992: A Practical Guide for American Business." It summarizes the progress and direction of the European Community single market program and its implications for U.S.-EC trade.

One of the controversies involves private ownership vs. public access. Summarizing developments in intellectual property law, the report states that "in March 1993, the European Telecommunications Standards Institute (ETSI), the European standards setting body responsible for developing European telecommunications standards, adopted a policy which favors public access to technology over intellectual property rights. This policy threatens U.S. industry's control of its intellectual property."

The report adds that "U.S. companies such as IBM, Digital Equipment and Motorola that spend billions of dollars on research and technology face expropriation of their R & D investments."

Within the computer world, the report states that "The Business Software Alliance estimates that illegal copying of software in Europe cost U.S. companies $4.5 billion in business in 1992."

But if national revenue is one consideration in trade and transfer, expenditures are also noteworthy. The March 1993 issue of "USA Today" reported that the International Monetary Fund disbursed approximately $5,000,000 throughout Eastern Europe in 1991, and the U.S. alone provided almost two billion dollars in aid to East European governments in 1990 and 1991. Promotion of free markets in new democracies is a goal that U.S. government and trade officials generally espouse.

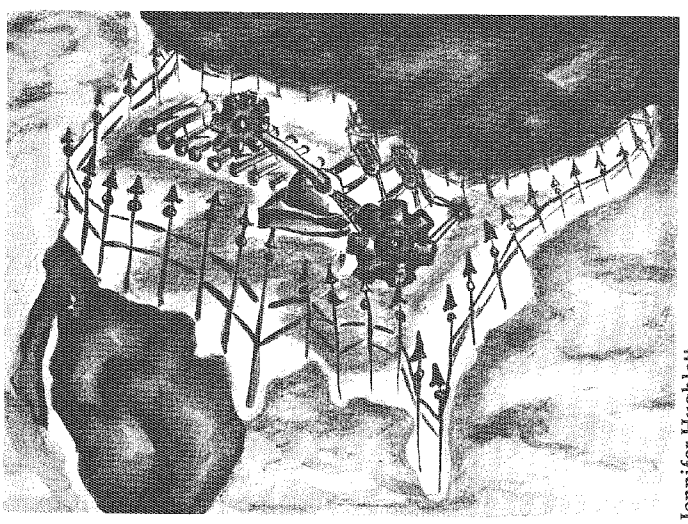
But the willingness to assist generally stops short of transferring technology. In his book, Dodgson notes that given today's communication technologies and movements towards regionalized economies (like the EC), globalization of technology is not happening as fast as some might expect. In fact, he cites a study released in 1991, of the technological activities of 686 of the world's largest manufacturing companies; it found more than 80 percent of those activities were domestic.

Dodgson writes, "In every industrialized nation the economic standard of living and the social quality of life depends crucially upon the way industry uses technology to enhance competitiveness."

CES Director Brustein agrees. He says, "With the Cold War over, one would think ideological differences are reduced, and we'd be willing to give China or whomever our technology. But our own technology gives us an ability to maintain an economic advantage in the world."

He adds, however, that economic impact can be measured more than one way. Regarding the globally explosive issue of immigration policy, he says, "If you really want to stop the flood of immigrants from LDCs [less developed countries], you've got to help develop economies. Technology transfer may help achieve this."

NOTE: Information about the University of Minnesota Office of Patents and Licensing and its procedures, the patent process, related policies, and the rights and obligations of Unversity inventors may be obtained by calling 624-0550.



Jennifer Hughlett

Sources:

Moore, Mike. Interviews, Oct. 12, Oct. 23 and Nov. 30, 1993.
Frenchick, Grady. Interview Nov. 3, 1993.
Brustein, William. Interview Nov. 3, 1993.

Research Review, Office of Research and Technology Transfer Administration, University of Minnesota, June 1993.

Research Review, Office of Research and Technology Transfer Administration, University of Minnesota, July 1993.

Research Review, Office of Research and Technology Transfer Administration, University of Minnesota, August 1993.

Invention Disclosure Form, Office of Patents and Licensing, University of Minnesota.

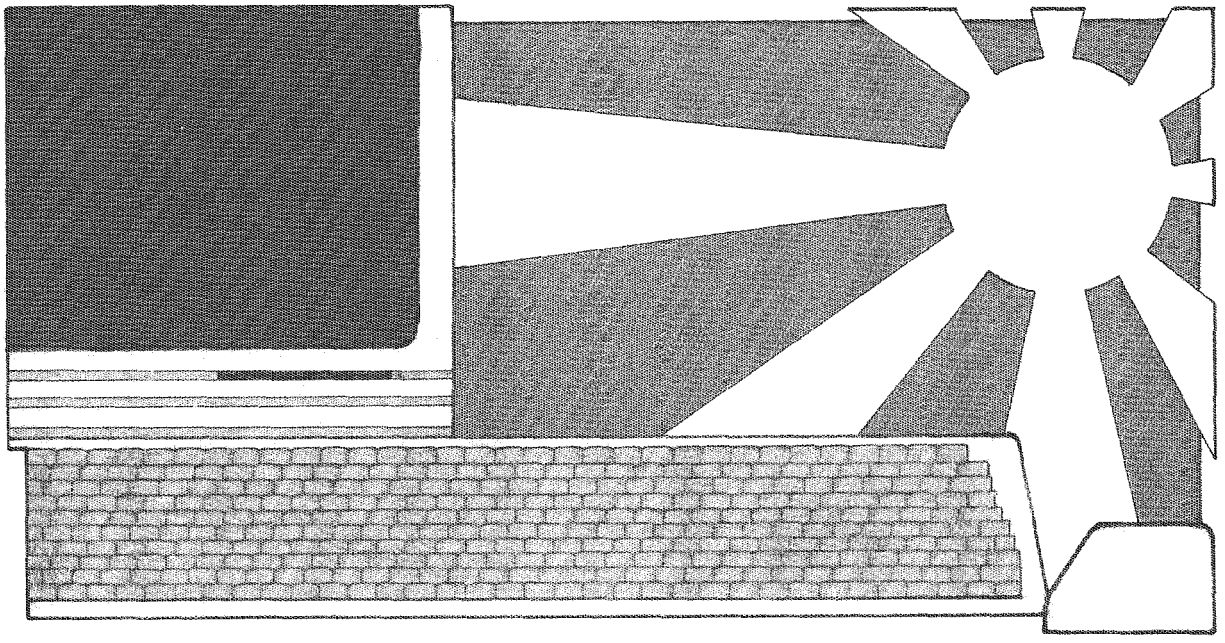
Thomas G. Donlan, "Don't Kill the Umpire: Nurturing Invention Requires an Adversarial Patent System," (Editorial Commentary), "Barron's," July, 1993.

James Bovard, "Washington's Iron Curtain Against East European Exports," "USA Today," March 1993.

European 1992: A Practical Guide for American Business, The International Division, U.S. Chamber of Commerce, 1993.

"Patents, Trademarks, and Copyrights," (brochure), Minnesota State Bar Association, 1976.

Tamara M. Lubic is extremely interested in how people decide what is right, wrong, or unavoidable. A journalism graduate student with a minor in Biomedical Ethics, she sees a writing career as a way of getting answers.



Bryan Newman

Talking About My Generation

by **Peter Kauffner**

In the early 1980s, Japan's Fifth Generation Computer Systems project was the focus of an avalanche of publicity and was a symbol of America's anxiety over Japan's growing economic and scientific prowess. Both America and Europe were so worried that they initiated similar research projects of their own. But when Japan's 10-year, $500-million project came to an end in 1992, there was the widespread feeling that the Fifth Generation was computing's "lost generation."

The Fifth Generation project gained wide publicity as the result of a book by Stanford professor Edward Feigenbaum and writer Pamela McCorduck called The Fifth Generation. The book warned that the Japanese intend to build computers with which "users will be able to speak in everyday conversational language, or show pictures to, or transmit messages by keyboard or handwriting." Moreover, "the intelligence will be greatly improved to approach that of a human being."

Four major research projects were initiated in response to Japan's efforts, including Britain's Alvey project and the European Community's ESPRIT project. The U.S response consisted of the Strategic Computing Program funded by the Defense Advanced Research Projects Agency (DARPA), and Microelectronic and Computer Center, a consortium of private U.S. companies headquartered in Austin, Texas. Ironically, each of these projects spent more on computer research than did the Institute for New Generation Computer Technology (ICOT), the group which organized Japan's Fifth Generation project.

Prior to the Fifth Generation project, historians of technology had divided the history of electronic computers into three generations. First generation computers built in the 1940s and 1950s contained thousands of vacuum tubes which were used as logical switches. The 1960s was the heyday of second generation computers in which the vacuum tubes were replaced by solid state transistors. Third generation computers first came on line in 1965 and used integrated chips. Such chips contain numerous transistors and other circuit elements on a tiny silicon wafer.

According to ICOT, the use of very large-scale integration (VLSI) chips made the 1980s the era of fourth generation computers. A VLSI chip has several million circuit elements. A hypothetical fifth generation machine would use parallel processing architecture, logic programming, and artificial intelligence applications.

Mainstream computers today have a central processing unit (CPU) which performs computations one operation at a time. Parallel processing involves the use of many processors performing calculations at the same time. The Fifth Generation project designed an operating system

for parallel processing computers called PIMOS which works on a 64-processor machine. A machine with 256 processors was also built. Ambitious plans for a 1000-processor machine were not achieved by the 1992 deadline.

Logic Programming

The decision to use logic programming was perhaps the most controversial one of the project. In LP languages like Prolog, the programmer supplies a series of relationships among objects and the program then determines whether a given statement is true or false under the given conditions. This contrasts with imperative languages like C where the programmer directs the computer to perform a series of operations in a particular sequence.

Supporters claim that LP is easier to learn and use, but critics charge that it produces inefficient algorithms unless the programmer is highly skilled. LP suffers from its image as a language form with application only to artificial intelligence. Worse yet, ICOT used a highly specialized form of LP called concurrent LP. So even companies with expertise in LP may find that the software solutions developed at ICOT are remote from their experience.

> ICOT "ACHIEVED THEIR TECHNICAL GOALS, BUT THEY NEVER GOT THE INDUSTRY INTERESTED IN LOGICAL PROGRAMMING."
> EDWARD FEIGENBAUM

As C gains ground as the international programming standard, the attraction of LP may decline even if it can be demonstrated that LP is technically superior. The standard "qwerty" keyboard and VHS videotape are examples of how industry may adopt a standard that is demonstrably inferior.

A company can develop software in C secure in the knowledge that its future programmers will be able to read and maintain the software without specialized training. Developing software in C also allows a programmer to plug into the largest pre-written library of software available. LP needs to integrate smoothly with C or it will lose ground commercially. Quintus, the developer of Prolog, has attempted to meet this need by developing a C-like macrolanguage that compiles into Prolog.

Certainly programmers of the future will want more of a natural language interface than C can supply, but change is more likely to come as a result of incremental improvements in established languages rather than as a shift to an entirely new and unfamiliar standard. As Feigenbaum himself admits, ICOT "achieved their technical goals, but they never got the industry interested in logical programming. It's like they threw a party and nobody came."

Artificial Intelligence

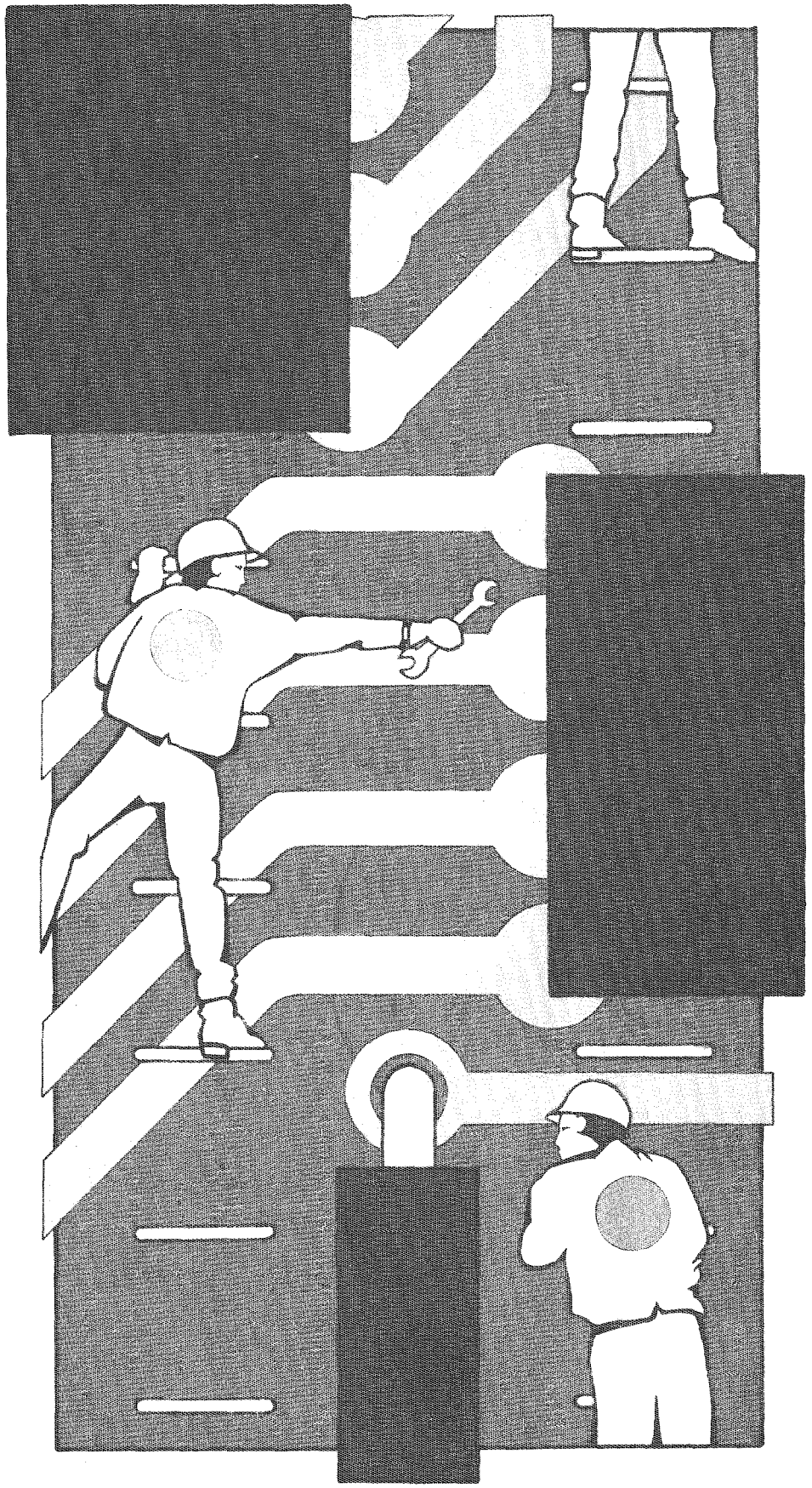
Artificial intelligence is the use of computers to simulate functions of the human mind. Of course, you can't necessarily tell whether a programmer intended to simulate the mind by simply looking at the finished program. But the semantic problem need not concern us here. The Fifth Generation project focused on a branch of AI called "expert systems." Not coincidentally, expert systems were pioneered by Fifth Generation booster Feigenbaum.

An expert system is a database with a search or interface procedure that attempts to simulate the thought processes of a human expert. The Fifth Generation project produced a legal expert system called HELIC-II. This program has two search procedures or "inference engines," one to find relevant statutes and the other to look up case precedents.

In the early 1980s, expert systems were all the rage, especially after research indicated that some expert medical systems could give more accurate answers than specialists in the field. Of course, you can get an even more accurate answer by looking it up in the appropriate reference book. In recent years, computer scientists have become increasingly skeptical that an expert system can really do much that can't be done just as as well by a plain old database.

Only a few years after the Fifth Generation project began, expert systems and parallel computing fell out of favor with Western experts, who became convinced that neural networks and massively parallel machines were more promising research areas. ICOT stuck to its original priorities, however.

Of course, HELIC-II has some extra bells and whistles not found on other legal databases. For example, it can look up cases according to the legal reasoning used. "These engines draw all possible conclusions and output them in the form of inference trees. Users can then use the trees to construct arguments in a legal suit," according to Katsumi Nitta, a member of the design team.



Bryan N ewman

Japanese Script

The complexity of Japanese script helps to explain Japan's interest in artificial intelligence. Japanese children spend significantly more time learning to read and write than do the children of other nations, yet the level of reading skills in Japan is lower than in other industrialized nations. "Even in England, where the most time is spent on this, a child masters reading and writing in five years. But in Japan, even after six years in elementary school and three years in middle school, a student still cannot read a newspaper satisfactorily," as the noted linguist Kindaichi Haruhiko observed in 1957. There is more per capita publishing in Japan than in any other society in the world, but what the typical Japanese person reads is "manga," books that contain mainly graphics and very little text.

Japanese students must learn three separate scripts, native alphabetic scripts called "hiragana and katakana" and a set of Chinese characters, called "kanji," which represent words. There are over 6,000 kanji characters in the Japanese Industrial Standard, and nearly 3,000 of them are classified as "high frequency." Putting such a large character set on either a typewriter or a computer keyboard is scarcely practical. As recently as 1984, it was reported that 90 percent of documents in Japan were handwritten. Even journalists turned in handwritten stories.

In theory, all Japanese words can be written using hiragana and katakana. Kanji is used to convey differences in meaning between certain homonyms. But script reform efforts to promote the use of alphabetical script and limit the use of kanji have had only limited success due to the widespread belief that kanji gives an additional meaning that is lost when alphabetical script is used.

In the last several years, the use of personal computers has grown dramatically due to improvements in Japanese word processing software. But this software is still quite awkward to use. What Japan's technocrats really want is a voice processing computer that can produce the standard mixed hiragana-katakana/kanji output. The factors that determine when it is appropriate to use which characters are so complex that this task is well beyond the capabilities of current computers. This is why Japanese leaders are so keen for a technological breakthrough in this area.

The computer industry has matured to the point where the radical "generational" improvements that occurred in the 1960s are no longer a useful model for further development. Witness the fact that the fourth,VLSI, generation of computers is the result of gradual improvement of the LSI technology used in the 1970s. Today the watchword is incremental improvement. Parallel processing, LP, and artificial intelligence are all useful avenues for future research. But a radically new machine would mean junking standards in which a great deal has already been invested.

Sources:

Cross, Michael, "Farewell to computing's fifth generation," New Scientist, June 13, 1992: p. 12.

Feigenbaum, Edward A. & Pamela McCorduck, The Fifth Generation: Artificial Intelligence and Japan's Computer Challange to the World. Reading, Massachusetts: Addison-Wesley Publishing Company, 1983.

Kowalski, Robert, "Communications of the ACM," March, 1993: p. 54.

Unger, J. Marshall, The Fifth Generation Fallacy: Why Japan is Betting its Future on Artificial Intelligence, New York: Oxford University Press, 1987.

Computer Science senior **Peter Kauffner** is currently interning at the National Journalism Center in Washington, D.C. After he graduates in June, he aims to become a Technical Writer.

"I think that probably most of the manufacturers have such a car in their drawer." To Prof. Bill Cunningham, biology teacher and environmentalist at the University of Minnesota, the Volvo LCP has lost its surprise.

The LCP stands for Light Car Project, an experimental car designed in the late '70s after the oil crisis. With falling gas prices, the project was abandoned. But now, fuel efficiency is big news again.

"We Encourage Energy Waste"

by **Josef Zens,** *for Technolog*

Cunningham has been showing a video starring the LCP quite often to different classes. Using composite materials and a special German engine, the Volvo LCP averages 60 miles per gallon. Its three-cylinder "Elsbet engine" runs on diesel fuel but the video causes a lot of "Wows" when the Swedish engineer who developed the car, pours salad oil in the tank. The "Elsbet engine" can run on a variety of fuels.

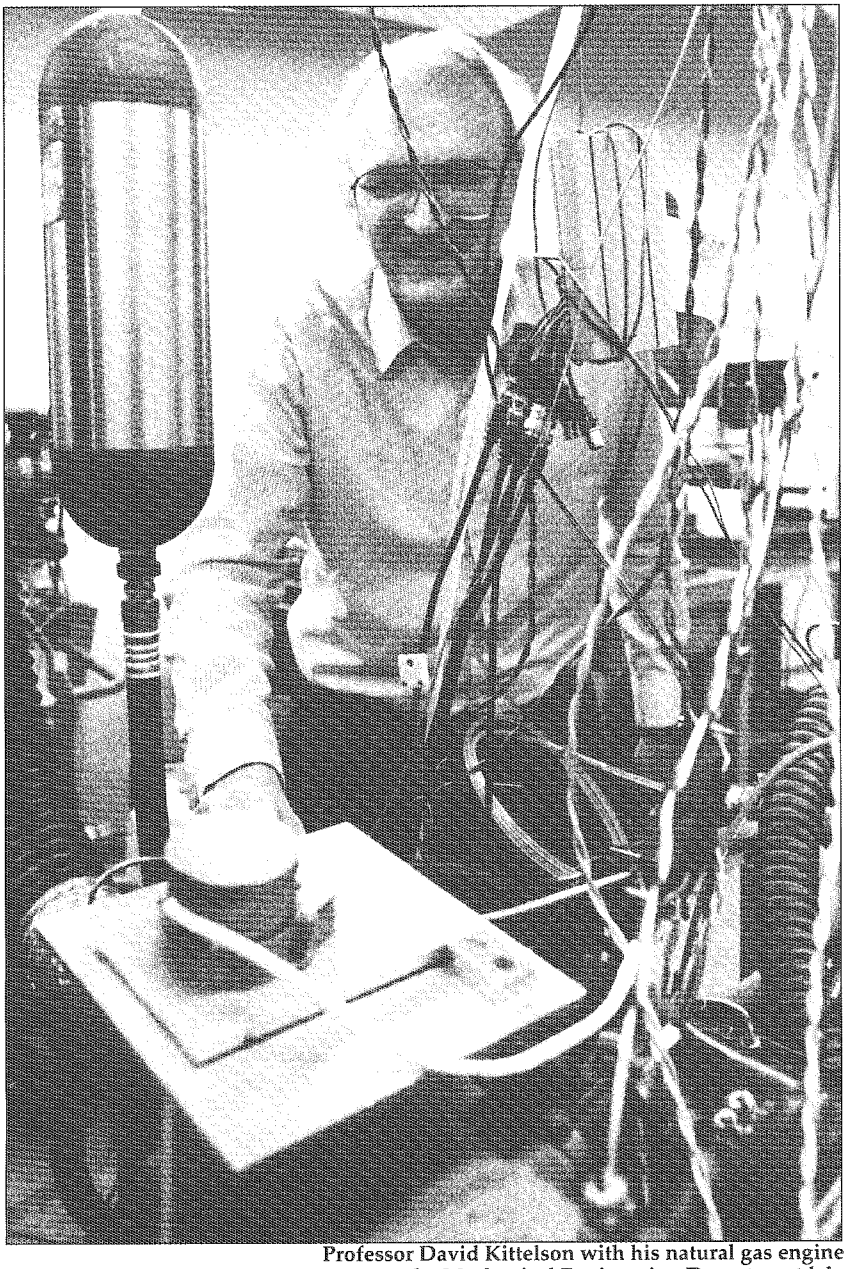
Only four of these cars were built by Volvo. There was simply no market for fuel efficient vehicles. Neither in Europe nor in the U.S..

"The fuel economy of new light-duty vehicles (automobiles, pick-ups and vans) now appears to be stagnating and even declining, after rising from about 14 miles per gallon in 1973 to 28.7 mpg in 1988," reports Steven Plotkin in the April 1993 issue of "Environment."

Yet many scientists think it would be possible to build the 80 mpg car that President Clinton proposed recently.

"It's just an extrapolation of current technology," says Prof. David Kittelson of the Mechanical Engineering Department at the University of Minnesota. He has been working on fuel economy and alternative fuels for about 20 years. The apparent lack of incentives to save gas makes Kittelson very angry: "I think our (fuel) prices are absurd. We encourage energy waste, and we encourage pollution. We need much higher prices. And it is sheer nonsense to say that the standard of living will decrease when we raise energy prices. Look at the European economies."

The price of gas in Germany is about four times higher than in the U.S. Still, the Germans have so many cars that all the country's population would fit into their front seats alone. German government officials have talked about raising gas



Silvana Correa de Faria

Professor David Kittelson with his natural gas engine at the Mechanical Engineering Department lab.

taxes even higher—which made the chairman of Opel, David Herman, complain to the German weekly Der Spiegel: "The government is telling the people 'please, don't buy cars.'"

Will this policy stimulate the automobile industry to look for more efficient cars? At the International Automobile Exhibit (IAA) in Frankfurt the industry was not able to meet the goal of Greenpeace in Germany, that is, to deliver a 94.3 mpg car. This odd number results from measuring fuel consumption in terms of liters per 100 kilometers instead of miles per gallon. A telling change of denominators.

Americans are interested in the distance they can travel not the amount of gas it takes. On the contrary, Germans want to know how much gas they need for a given distance and measure thus in terms of liter per 100 kilometers - a matter of values. In general, U.S. buyers don't go for fuel efficiency. According to U.S. automakers, quoted in an Oct. 18, 1993 Star Tribune article, the ten most fuel-efficient models in the EPA ratings, which range from 43 to 58 mpg, "represent less than two percent of all passenger cars sold" in America.

Still, there is little difference between the German cars sold in the U.S. and the American fleet. Gas consumption does not differ that much, as the EPA fuel economy ratings for 1994 show. In fact, in the largest category--subcompact cars--the German cars sold in the U.S. rate worse (20.8 mpg) than U.S.-made vehicles (26.8 mpg). However, one must take into account that in Germany many cars are sold with more efficient engines. They are not as fast as their big brothers.

Compared to foreign cars, the American fleet is thirsty for gas. In most of the EPA ratings the foreign cars were the most fuel-efficient. And when U.S. cars came in first, foreign cars - mostly Japanese - always came in second.

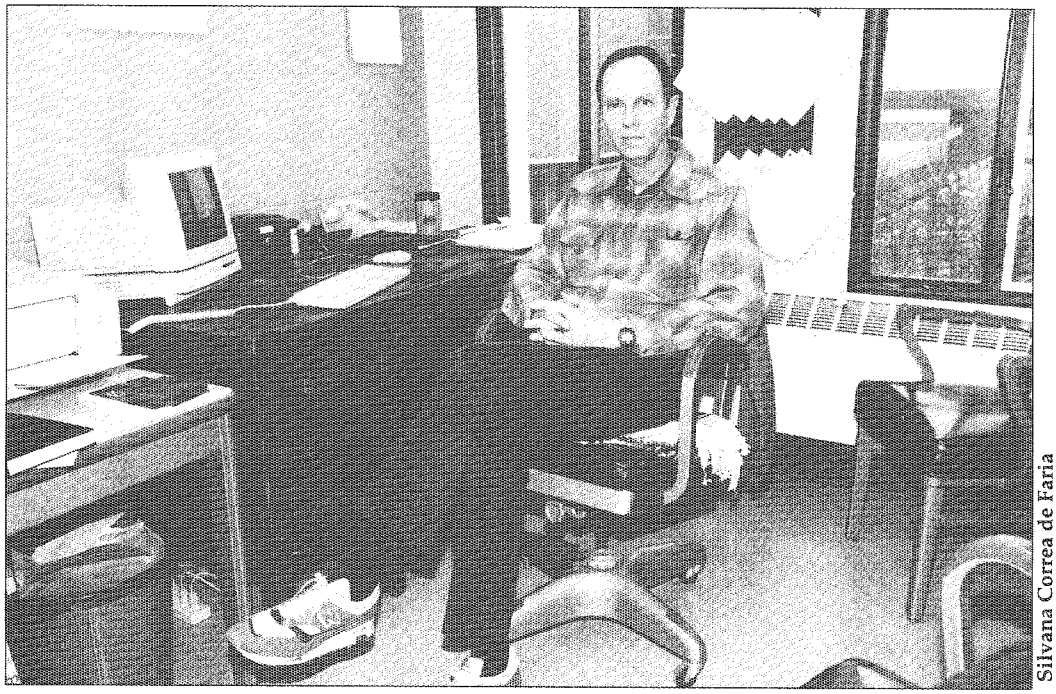
Efficiency Versus Safety

The car industry weighs efficiency against safety. A campaign in the U.S. indicated that "green (small and thus energy saving) cars will cost lives," as the New Scientist reported in late 1991.

At this year's Automobile Exhibit in Frankfurt, the largest German automobile club, ADAC, brought wrecked small cars to the exhibition halls. The ADAC had carried out crash tests similar to America's car industry. "Of course, it's safer to drive in a tank than in a Volkswagen Beetle," says Kittelson, "but energy is much too precious to be wasted that way."

Automobiles, pickups and vans account for about 40 percent of U.S. oil consumption and 16 percent of total energy consumption. According to Bill Cunningham's book Environmental Science, energy use per capita in the U.S. amounts to the equivalent of more than seven tons of oil a year. A two-car family averages 1,010 gallons of gas annually, says the Automobile Club of Minneapolis. This family relies mostly on the safety of big cars, a decision supported by the car industry.

Kittelson points out that a tiny vehicle sandwiched between big cars is more at risk, but if the whole fleet



Silvana Correa de Faria

Professor Bill Cunningham, from the Genetics and Cell Biology Department, in Blegen Hall.

downsized and appropriate crash cells - a sort of solid cage around the passengers - were installed, a high level of safety could be maintained.

There are composite materials and new structures, too, to enhance safety and decrease weight. Aluminum, for instance, can be used in engines. But since it is much softer than steel, it is reinforced with ceramic particles. This composite material is lighter and dissipates heat better than steel. In a video serial "Race to Save The Planet," an engineer lifted a wheel of the LCP made of the composite material with his little finger.

Even with conventional materials, smaller cars are not necessarily more dangerous. The New Scientist wrote in 1991 that between the '70s and '80s, the number of people who died in car crashes fell by 25 percent even though more people were driving small cars. By 1992, traffic deaths reached a 30-year low, according to the National Highway Traffic Safety Administration.

The need for alternative fuel

Can these numbers convince the public? "I'm pessimistic," sighs Prof. Bill Cunningham. He thinks that people will continue to look for big, high performance cars. That's why I favor hydrogen as an alternative fuel," he adds. It would be easily available and deliver good results. He was on a State committee for energy saving in the 70s.

Cunningham is also concerned about the impact on the environment: pollution, carcinogens and the greenhouse effect. Hydrogen engines could reduce many of the hazardous wastes; the exhaust consists of a combination of hydrogen and oxygen, also known as H_2O or water.

Kittelson is fond of hydrogen, too, but in a different way: "It will make a wonderful fuel for airplanes, not in cars." He points out that hydrogen needs to be stored in cryogenic tanks.

But he knows of many alternatives to petroleum-based fuel: plant oil, methanol, ethanol, electricity.

Dave Hofeldt, a colleague of Kittelson and a specialist in combustion, has done some research on alternative fuels in heavy-duty vehicles—trucks and buses. He published a ranking on criteria such as emission standards, cost, safety, influence on the greenhouse effect and performance. His findings were surprising. Hofeldt simply says: "Diesel wins."

> "Of course, it's safer to drive in a tank than in a Volkswagen Beetle, but energy is much too precious to be wasted that way."
>
> David Kittelson

However, he qualifies that at once: "It was an extremely complicated thing [to weigh the criteria]. I could change the ranking and could make the answer anything you want to." Still, a lot of evidence shows that diesel is better than the possible alternatives, Hofeldt says.

Alternative Engines

This may be the reason why you don't see many alternatives on the road. Hofeldt's research on combustion and high temperature flows also shows that engines

run most efficiently at maximum load. Thus, smaller engines running constantly at maximum load could power a rather big car. But that would make acceleration nearly impossible unless you combine such a small engine with a special energy storage device like a battery (electric accumulator). This combination is called a hybrid engine.

> "We must not see an alternative fuel monolithically," David Kittelson

Another means to save energy in engines is via fly-wheels. In Switzerland the government experiments with fly- wheels in buses to store energy. There are stations where the fly wheels are set into high speed rotation. By going downhill they can be accelerated and thus be recharged. That energy is then used to help the engine go up the next slope.

As Andrew Beevers reported in the May 2, 1985 issue of "The Engineer," the British vehicle manufacturing company Leyland experimented with flywheel hybrid engines. Their flywheels were made of composite material: fiber reinforced plastics. The 160 kg (nearly 353 pounds) flywheels run at 16,000 rpm. By slowing down, the 460 mm diameter flywheel produced energy at a rate of 160 kw - "equivalent to the output of a 210 hp diesel engine," Beevers wrote.

He described another Leyland device, the continuously variable transmission (CVT). This "sort of 'gear box' with an infinite number of gears transmits energy from the flywheel to the wheels of the bus and vice versa." When the bus brakes, energy is added to the flywheel by accelerating it.

Kittelson worked with his students on another kind of regenerative braking and hybrid engine, the hydraulic one. Instead of heating up and wearing down—that is, adding energy to—brake discs, a high pressure liquid is pumped into a container and compresses a gas behind a flexible membrane. This "hydraulic accumulator" stores the braking energy via a transmission attached to each wheel. This transmission delivers the energy of the wheel to a "hydraulic motor-dash-pump," explains Kittelson. This "motor/pump" can be run either as an engine or a pump, thus either helping to accelerate or brake.

Most parts of the system already exist. Hydraulic engines are used in power steering, and not just in cars; the pilot of a 747 jet needs strong power steering to move the flaps. This is achieved by hydraulic engines and hydraulic accumulators, explains Kittelson.

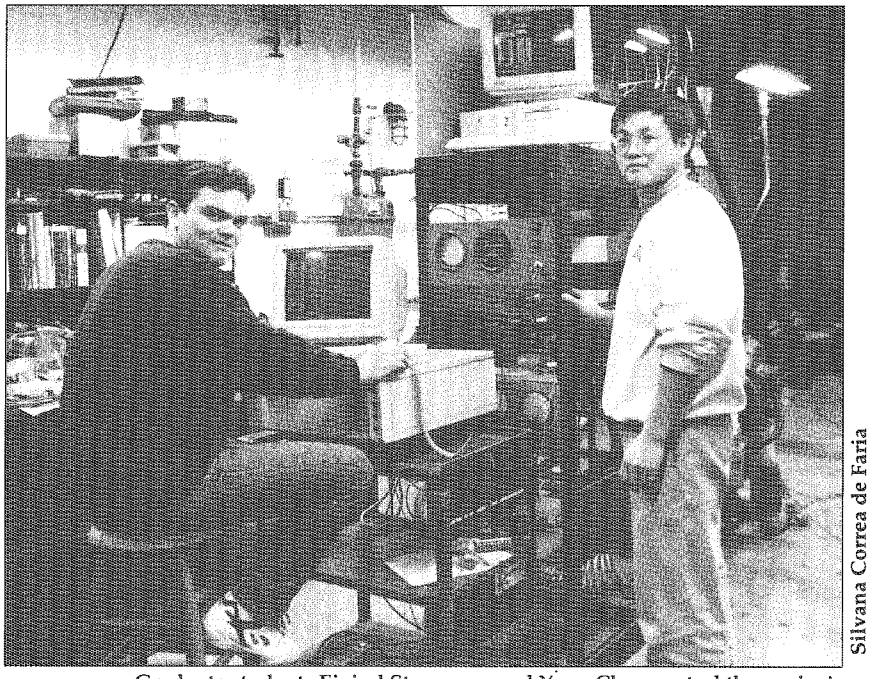
Transmissions based on liquids are known as hydrostatic transmissions. Their main advantage is infinitely variable speed.

Electric motors are infinitely variable, too. Big diesel trains in the U.S. are driven by electric motors which are powered by generators. The diesel engines drive the generators, says Kittelson. Here, energy set free by braking could be stored, too.

Regenerative braking devices work best fit for stop-and-go urban driving. But with an accumulator full of energy, a small engine could also handle highways. Both Kittelson and Hofeldt stress that big engines often run below their optimum.

But all of this would require a major change in society, "a fundamental restructuring of our economy," says Kittelson.

"We must not see an alternative fuel monolithically," he stresses. There would be a whole patchwork of different systems according to factors such as purpose, availability or climate. In the midwest, with its rich soils, the fuel used could be methanol or plant-based ethanol.



Silvana Correa de Faria

Graduate students Eivind Stenersen and Yong Chen control the engine's condition to measure its performance and emission exhaust.

The Minnesota government acquired 30 alternative fuel vehicles (AFV) for the state motorpool, says Michael K. Roelofs from the Department of Public Service. But this department runs a fleet of more than 1300 vehicles. Roelofs does not believe in major changes. Instead, he thinks that by creating incentives the government might be able to encourage fuel efficiency or alternative fuels; lower sales taxes for methanol for example. He doesn't even believe in higher gas taxes - "too unpopular."

So thinks Cunningham. He adds that people don't want to believe in the greenhouse effect. Maybe if the gas price were fourfold, but not if the government said so. "We need a great statesman to convince people," sighs Cunningham. Clinton? He smiles: "Unfortunately not. We'd need a Franklin Delano Roosevelt - or a crisis."

He grew up in Bavaria, but new Technolog writer and Adult Special student in Geography **Josef Zens** has lived in Berlin the last two years. Herr Zens has driven cab in Berlin and has traveled the famed autobahn, driving at reasonable speeds at all times. Really.

Sources

Beevers, Andrew. "Plastics flywheel starts buses." The Engineer, v. 260, May 2, 1985, p. 36.

Plotkin, Steven E. "Automobile Fuel Economy: How Far Should We Go?" Environment, Volume 35, Number 3, 1993, p. 25-29.

"Fette Enten" ("Fat Ducks"), Der Spiegel (German weekly) #37,1993,p. 230-233.

"Traffic Deaths Reach 30-Year Low," Traffic Safety, May/June 1993, p. 20-21.

Cunningham, William and B. Saigo, Environmental Science, Wm. C. Brown Publishers, 1993.

Charles, Dan. "Green cars will cost lives, says US industry," New Scientist, Nov. 9, 1991, p. 15.

The following articles are from the Star Tribune:

"Fuel-economy progress is slight, but GEO mpg best," Sept. 29, 1993.

"Clinton reveals alliance with Big Three to build 80 mile-per-gallon passenger car," Sept. 30, 1993.

"John Gilbert: On the road" ("Picking the best of the litter from 1993"), Oct. 2, 1993.

"Super-car plan is vague but needed," Oct. 8, 1993.

"John Gilbert: On the road" ("Ready for the all-new '94s? Some of them aren't yet ready for you"), Oct. 9, 1993.

"Gasoline prices in Minnesota rise by more than 4.3 cents of new federal tax," Oct. 9, 1993.

"EPA fuel economy ratings for 1994," Oct. 9, 1993.

"U.S. oil situation has gone from bad to worse," Oct. 18, 1993.

Kittelson, David. Prof., Mechanical Engineering. Interview.

Cunningham, Bill. Prof.,Biology. Interview

Roelofs,Michael K. Minnesota Department of Public Service. Interview

Hofeldt, Dave. Prof., Mechanical Engineering. Interview.

And you thought Michelangelo was bad news...

Computer Viruses '94

TED TURNER VIRUS: Colorizes your monochrome monitor.

PAUL REVERE VIRUS: This revolutionary virus does not horse around. It warns you of impending hard disk attack—once if by LAN, twice if by C:.

Robert Subiaga, Jr.

ARNOLD SCHWARZENEGGER VIRUS: Terminates and stays resident. It'll be back.

POLITICALLY CORRECT VIRUS: Never calls itself a "virus," but instead refers to itself as an "electronic microorganism."

RIGHT TO LIFE VIRUS: Won't allow you to delete a file, regardless of how old it is. If you attempt to erase a file, it requires you to first see a counselor about possible alternatives.

ROSS PEROT VIRUS: Activates every component in your system, just before the whole thing quits.

MARIO CUOMO VIRUS: It would be a great virus, but it refuses to run.

OPRAH WINFREY VIRUS: Your 200MB hard drive suddenly shrinks to 80MB, and then slowly expands back to 200MB.

AT&T VIRUS: Every three minutes it tells you what great service you are getting.

THE MCI VIRUS: Every three minutes it reminds you that you're paying too much for the AT&T virus.

GOVERNMENT ECONOMIST VIRUS: Nothing works, but all your diagnostic software says everything is fine.

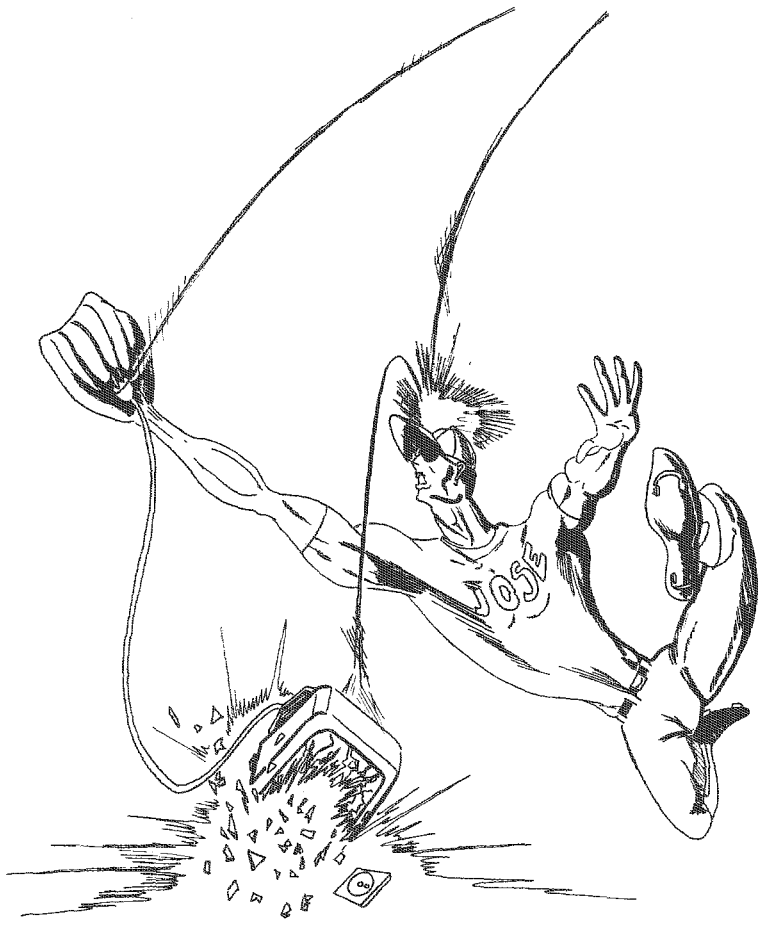
NEW WORLD ORDER VIRUS: Probably harmless, but it makes a lot of people really mad just thinking about it.

FEDERAL BUREAUCRAT VIRUS: Divides your hard disk into hundreds of little units, each of which does practically nothing, but all of which claim to be the most important part of the computer.

GALLUP VIRUS: Sixty percent of the PCs infected will lose 38 percent of their data 14 percent of the time (plus or minus a 3.5 percent margin of error).

LAPD VIRUS: It claims it feels threatened by the other files on your PC and erases them in "self-defense."

Robert Subiaga, Jr.



Robert Subiaga, Jr.

CLEVELAND INDIANS VIRUS: Makes your 486/50 machine perform like a 286/AT.

TERRY RANDLE VIRUS: Prints "Oh no you don't" whenever you choose "Abort" from the "Abort, Retry, Fail" message.

TEXAS VIRUS: Makes sure that it's bigger than any other file.

ADAM AND EVE VIRUS: Takes a couple of bytes out of your Apple.

MICHAEL JACKSON VIRUS: Hard to identifiy because it is constantly altering its appearance. This virus won't harm your PC, but it will trash your car.

CONGRESSIONAL VIRUS: The computer locks up, screen splits eratically with a message appearing on each half blaming the other side for the problem.

AIRLINE VIRUS: You're in Dallas, but your data is in Singapore.

FREUDIAN VIRUS: Your computer becomes obsessed with marrying its own motherboard.

PBS VIRUS: Your PC stops every few minutes to ask for money.

ELVIS VIRUS: Your computer gets fat, slow, and lazy and then self destructs, only to resurface at shopping malls and service stations across rural America.

OLLIE NORTH VIRUS: Turns your printer into a document shredder.

NIKE VIRUS: Just Does It!

SEARS VIRUS: Your data won't appear unless you buy new cables, power supply, and a set of shocks.

JIMMY HOFFA VIRUS: Nobody can find it.

CONGRESSIONAL VIRUS too: Runs every program on the hard drive simultaneously, but doesn't allow the user to accomplish anything.

KEVORKIAN VIRUS: Helps your computer shut down whenever it wants to.

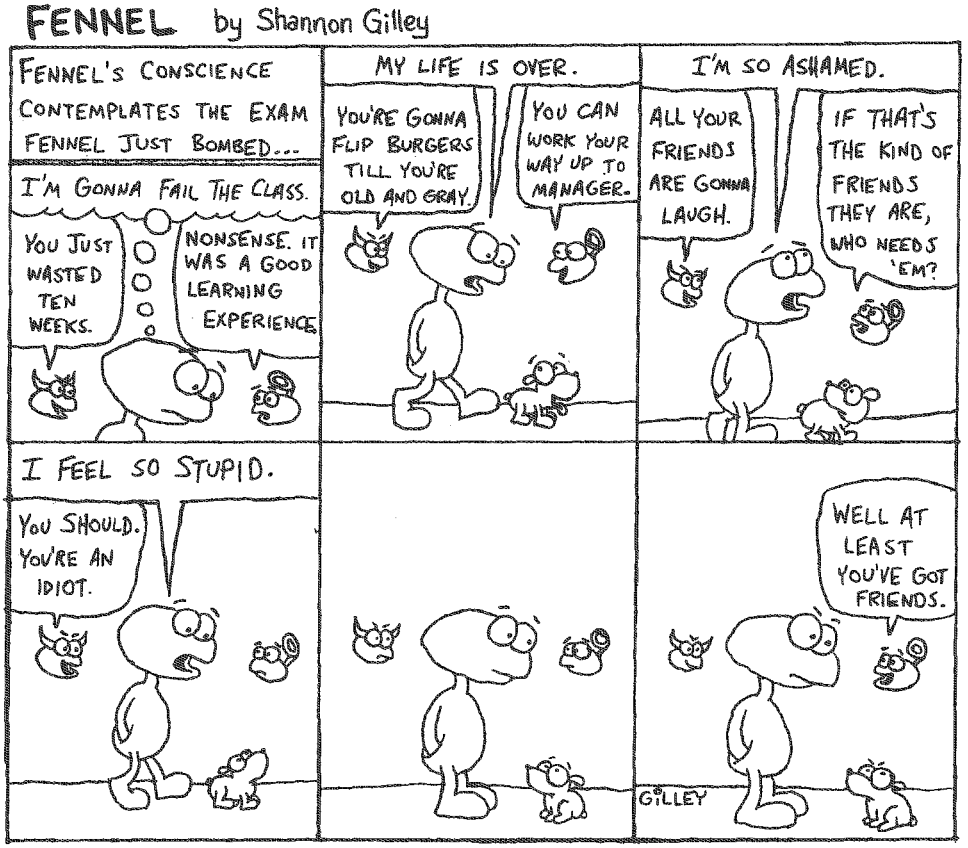
IMELDA MARCOS VIRUS: Sings you a song (slightly off key) on boot up then subtracts money from your Quicken account and spends it all on expensive shoes it purchases through Prodigy.

STAR TREK VIRUS: Invades your system in places where no virus has gone before.

HEALTH CARE VIRUS: Test your system for a day, finds nothing wrong, and sends you a bill for $4,500.

CHICAGO CUBS VIRUS: Your PC makes frequent mistakes and comes in last in the reviews, but you still love it.

These viruses were provided compliments of Computer Science Professor Youcef Saad.



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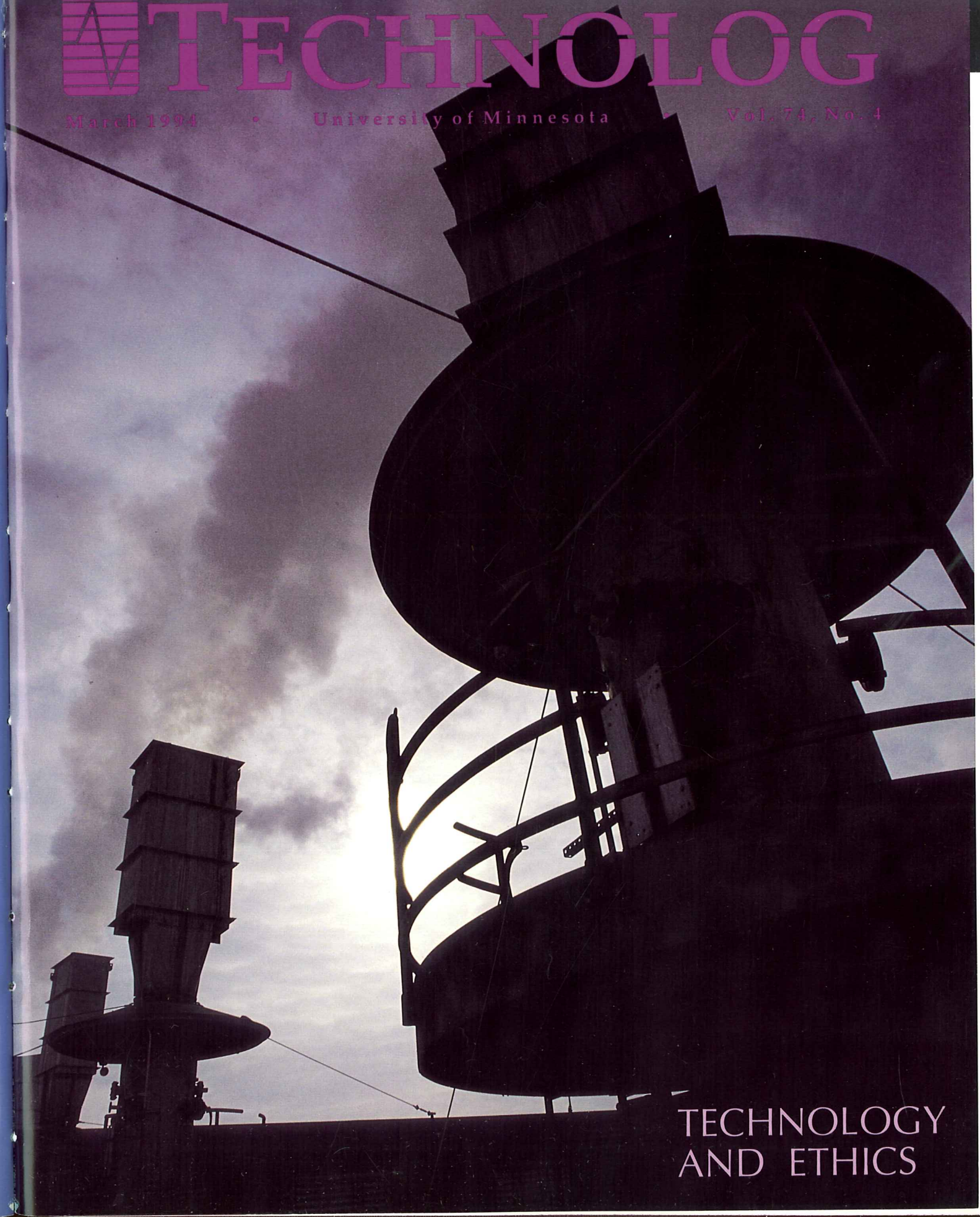

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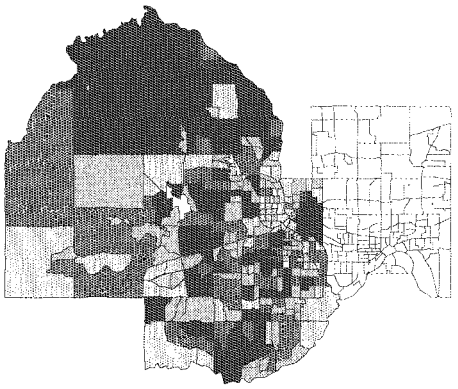

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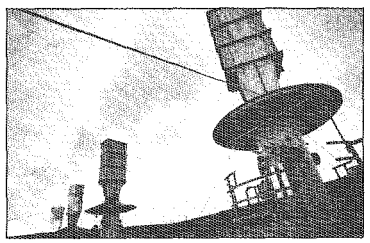
9 GIS at Your Doorstep: You may Never be Lost Again

Hate asking for directions? Then go create your own maps using Geographic Information Systems databases available to U of M students. Tap into information from the Census and many other sources to create visuals of the kind used increasingly in fields as diverse as banking and emergency planning...or for just getting around town.

13 All Steamed Down

The Mississippi may be cleaner in 1994 than in 1993 if the new emissions-capturing system put in place by the Metropolitan Wastewater Treatment plant works. Read how a little artificial fog might help clean up the United States' biggest river.



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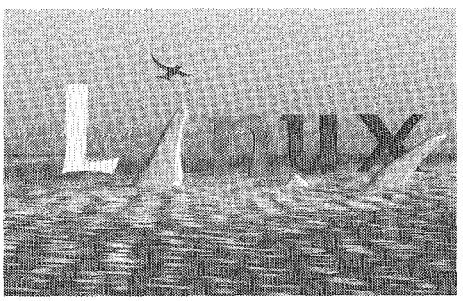
17 LINUX: the Free UNIX Clone for IBM PCs

When a 22-year-old Finnish computer science student started developing a new operating system he may not have known how big it would get. "LINUX" is growing weekly and you can contribute to its development.



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Departments

About the cover . . .

Emissions from the Metropolitan Wastewater Treatment plant on a 1994 winter day may be cleaner than those emitted in 1993.
Photo by Michael Branscom.

Pushing the Netiquette Envelope

At 11 o'clock one winter night, after toiling over another issue of Technolog, I called the U escort service for a walk over to the Transitway lot. The escort and I got to talking. He was all excited because he was going to meet his girlfriend. In person. For the first time.

Well, color me curious.

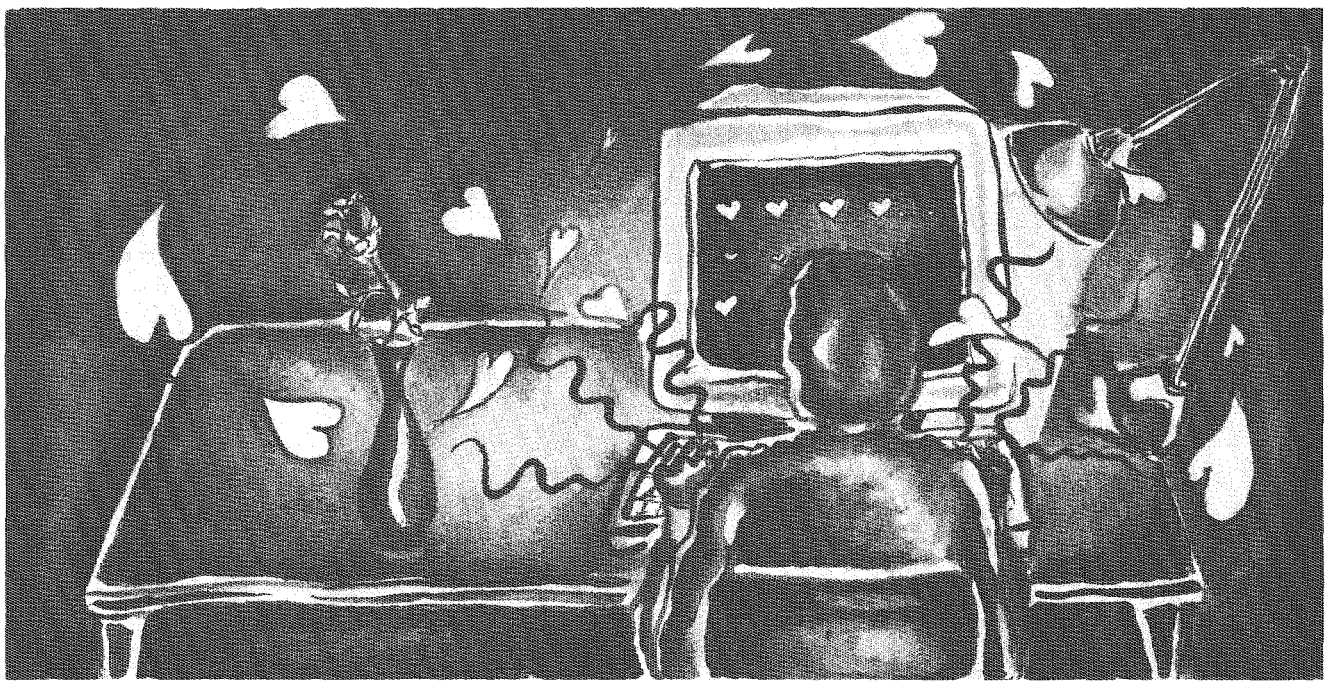
He told me the history of their relationship. They'd "met"—cybernetically— on a computer bulletin board, were so intrigued by each other they "went voice" (spoke on the telephone) a couple months later. Now they were meeting each other physically. Marriage might be in the offing.

Buoyed up, if somewhat thrown off kilter, by this tale of young love in the nineties, I revved up my aged, non-computerized subcompact for the drive home. I flipped on the radio.

The male voice that greeted me was somewhat nasal, and friendly. Yes, he said, the woman was kind of annoyed when she found out he was a man, but she got over it and now they were back to being good friends.

Huh?

Turns out he, too, was cruising the Net—as a female. He developed nice friendships with other (ostensibly) women, and was hit on periodically by (ostensibly) men. Women, having discovered a new bosom buddy, as it were, bared their souls to him. And he could girltalk with the best of

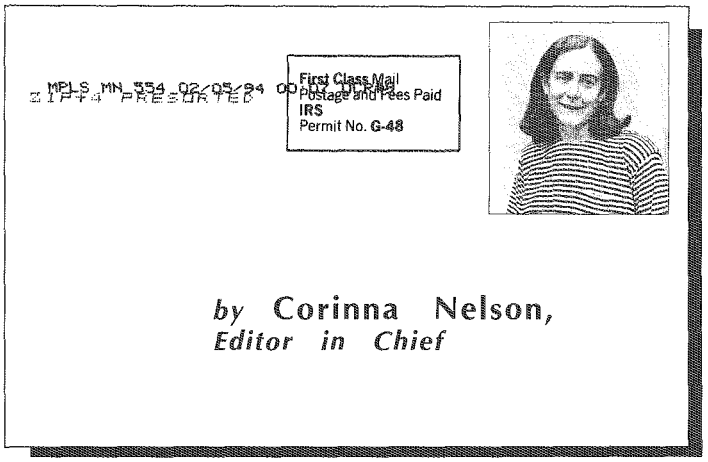


Jennifer Hughlett

them. Had them fooled. Really—who's to know, these days, just what you are when you're filtering your personality through a keyboard. Get the lingo down, don't mention certain relationships in your life, and you can remake yourself.

But then he 'fessed up by going voice with her at her insistence.

I got up the next morning, thinking what I'd heard the night before was just an aberration—how common can it be for people to actually trust relation-



ships they develop through the Net? Only for computer jockeys, right?

So I pick up the funnies the next morning, turning to my favorite strip—Doonesbury. If any strip in the paper tracks and reflects trends, this is the one.

And there it is. Michael Doonesbury, tapping away at his keyboard, is chatting with his dear new Net friend. Actually, Michael's perilously close to being cybernetically unfaithful to his long-suffering cab-driving wife.

Things are going swimmingly for Michael until he mentions the deadly word "we" to his Net friend—making he/she realize he might be married or otherwise coupled. Bink! The Net friend logs off. Michael's lost her. Him? Turns out Michael was carrying on unwittingly with a long-term gay male college friend via the Net.

How many Net cruisers have no clue who they're speaking to?

I'm intrigued by this concept of being able to remake myself on the Net. I can be whatever sex, race, age, nationality or gender I want. I can have multiple identities. I can be a stockbroker one day and a phys ed instructor the next.

The problems? How do you develop trust with someone you just type to? How do you develop trust with someone you've befriended under pretense? Minds can meet but eventually voices and bodies need to as well to develop full relationships and friendships.

Or maybe not. It's the nineties, relationships can come in different varieties. Free your mind and your body will follow? Nah. Free your keyboard and sit right where you are. ✻

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"I don't care what product you suggest. They'll tell you they can make it better by putting a nuclear reactor inside it."
– Marylia Kelley, in Livermore, California, commenting on the problems of "dual use" technologies.

The False Promise of Dual Use Technology

by **Janet Groat**

"Dual use" technology. It's the trendy new topic of the post-Cold War era. In case you haven't noticed, nuclear weapons are out. Dual use products are in.

But are they? And are we any safer for it?

With the election of Bill Clinton, dual use technologies have become a smash hit with Washington insiders. Eager to fend off a raid on the Pentagon's $261 billion budget, military contractors and their friends in Congress have embraced the dual use theory — that is, that government should finance technologies that have both military and civilian purposes.

On the surface, this sounds good. It would seem to fit in with the president's stated goal of converting our economy "from a defense to a domestic economic giant."

But when you stop to examine the facts behind the administration's dual use/conversion program, it promises much more change than it delivers.

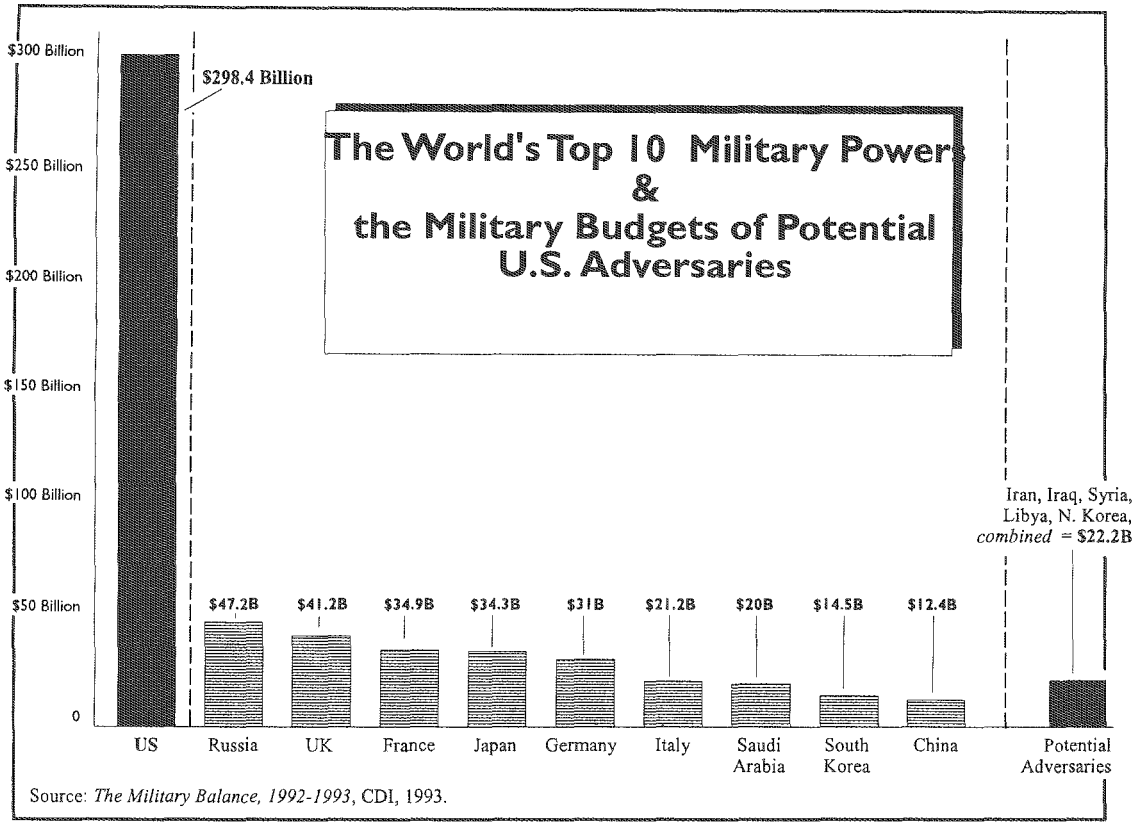
Just consider the case of a California defense contractor who wants to design alternative fuel buses.

Southern California needs the buses; there's a state mandate to cut down on fuel emissions. But unless the contractor can come up with a way to demonstrate that the work has military applications, the project can't be funded through the new Technology Reinvestment Program (TRP).

Why? Because the TRP emphasizes "dual use" technologies at the exclusion or neglect of those that have purely civilian value. That's significant, because the TRP is the flagship of President Clinton's new "defense conversion" initiative.

The president has pledged to spend $20 billion over five years on conversion. Congress appropriated $1.7 billion in 1993, and a similar amount is expected for 1994.

The bulk of the money is for grants to private industry, industry consortia and educational institutions to research, develop and deploy dual use technologies.



Clinton's initiative represents a significant step forward from past administrations, which avoided any mention of economic conversion. Clinton deserves credit for bringing the issue to center stage.

But the emphasis on dual use technologies is misguided, at best. There is no acceptable rationale for tying our nation's research and development priorities so closely to the military.

Today, four years after the fall of the Berlin Wall, the U.S. government still spends 60 percent of its Research and Development budget on the military—more than any other industrialized country.

The new emphasis on "dual use" severely limits the type of civilian technology projects the government will undertake and keeps the existing military industrial complex intact.

The program does little to convert our military industrial capacity from swords to ploughshares. It simply says to industry: "We'd like you to make both swords and ploughshares now."

Consider the situation at Lawrence Livermore Laboratory in California.

There, nuclear weapons scientists are seeking to demonstrate the use of enriched uranium for fuel in nuclear power plants. This is a classic dual use project, because the laser-based method being developed to separate isotopes may also be used to enrich uranium for bombs.

The project is opposed by Tri-Valley CARES, a watchdog group in Livermore.

"It will create enriched uranium, which we don't need," said Marylia Kelley, an organizer with Tri-Valley CARES. "And it will create nuclear waste, which we certainly don't need."

Many of the "dual use" projects promoted by Livermore lab pose environmental risks and nuclear proliferation risks, she said.

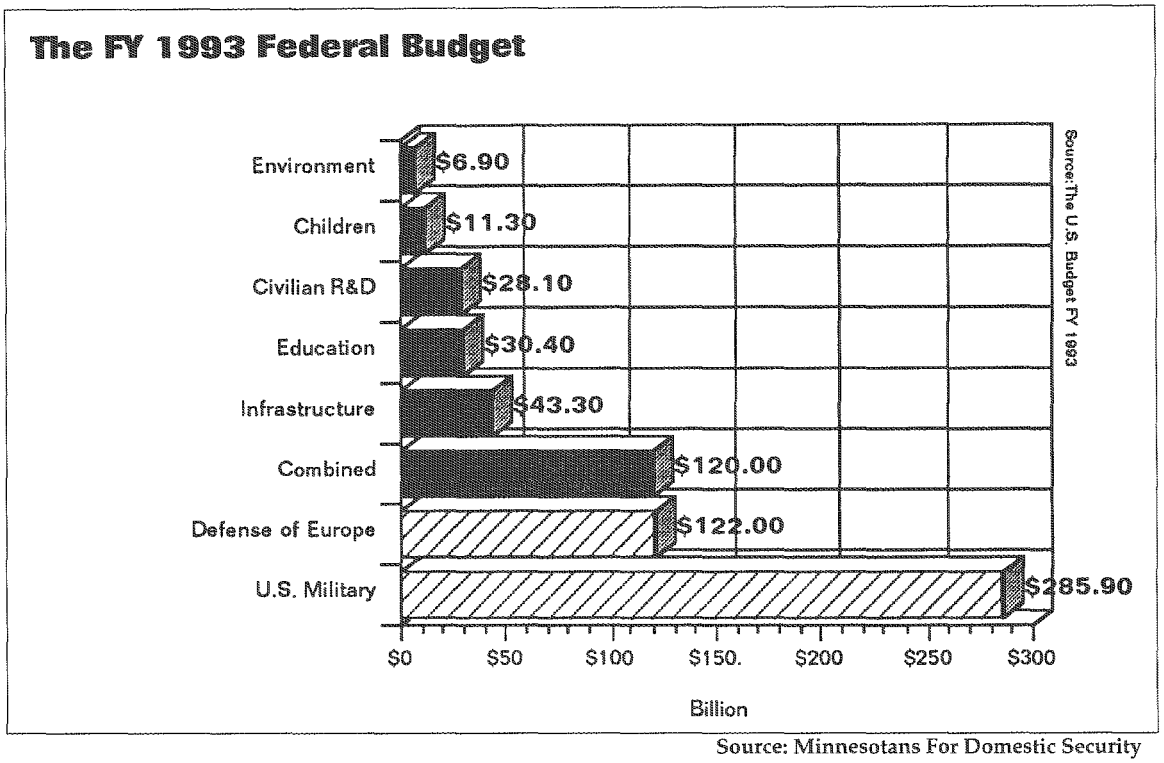
The laser isotope separation project, for instance, would make it easier for Third World countries to develop nuclear weapons by reducing the amount of electricity needed to make bombs, Kelley explained. This would limit the possibility of detection, and could be an incentive to small nations to develop nuclear weapons.

To Kelley, the government's support for "dual use" projects means new funding sources to keep weapons-related research alive.

"The Department of Energy funds this as a nuclear weapons activity... It suddenly becomes touted as `dual use' in an attempt to monopolize civilian energy funding," she said.

"Our group wants to see some of the civilian energy funding go to research on nonpolluting energy sources — solar, wind, that sort of thing."

Tri-Valley CARES advocates a conversion of the laboratory and its scientists away from military work to research that meets society's needs in the post-Cold War era.



Source: Minnesotans For Domestic Security

Direct government investments in civilian technologies are more likely to meet society's needs for environmental protection, housing and health care than dual use investments, which underwrite military projects and assume some "spinoff" benefit will occur.

However, there is a limit to how much civilian "spinoff" is possible from military research.

In years past, military research spawned the development of such civilian products as nuclear power, jet airplanes and lasers, to name a few. But as Ann Markusen and Joel Yudken conclude in their book, Dismantling the Cold War Economy, the payoffs from U.S. military-sponsored research have shrunk in recent decades, and have become more confined to military projects.

A more aggressive and sensible response to the conversion challenge is to explore what technologies are needed in the 21st Century — and what the market is unlikely to provide on its own — and to offer government support for the development of those technologies and products.

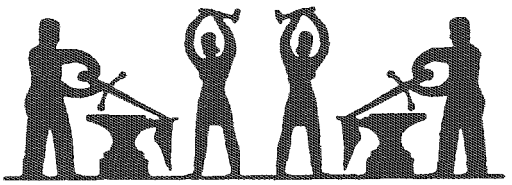
This is the path advocated by such citizens' organizations as Minnesota Jobs with Peace.

This would force military contractors and laboratories to do things in entirely new ways. It would end the cozy relationship between military contractors and the Pentagon.

It would curb private industry's appetite for foreign arms sales by providing better incentives for technologies we need at home.

The challenge would be difficult. But that's what turning swords to ploughshares is all about. ✻

Minnesota Jobs with Peace is a nonprofit, membership-based organization doing research, education and advocacy to promote economic conversion in Minnesota. For further information, call (612) 338-7955.



"THE EDUCATION OF MR. SPOCK"

by **Robert Subiaga, Jr.**

Science. It deals primarily with the acquisition of knowledge: an endeavor that can bring great insight, but can also exploit nature when pursued indiscriminately.

Technology. It involves the implementation of previously acquired knowledge, but in the hands of someone hungry to gain or consolidate power, it can oppress or destroy.

Ethics. It deals with the degree of right and wrong of human actions. When bearing on science and technology, ethics asks what actions in the acquisition and use of knowledge are to be allowed, what actions condoned and what actions condemned.

When asking what the relationship should be between science, technology and ethics, the response usually falls into one of two camps. One insists that science is a craft, whose limits should be determined first by traditional ethics. Scientists, doctors and engineers do not have enough exposure to this, and forcing more training in this area is the solution. The other camp, usually composed of old-school scientists itself, say this is fluff; questions about philosophy and ethics are nothing but an excuse to "take it easy" rather than concentrate on tough technical training. Whatever science can do, it should do, even must do; complaints about ethical implications come from an ignorant lay public that is frightened and envious of their betters.

Robert Subiaga, Jr.

It is imperative that scientists combine both logic and ethics, and realize that their methods can have an impact on ways of thinking about ethics.

Characters from the old and new versions of "Star Trek" help illustrate this.

Everyone remembers the character formula of that show's original crew: McCoy, the oh-so-humanly passionate physician, the vocal curmudgeon. Mr. Spock, the Vulcan science officer obsessed with eradicating emotion in favor of logic. And Captain Kirk, who relied upon both McCoy and Spock, and went outside their debate by integrating instinct and rationality. I now see the subtle warnings woven into those characterizations. Unlike Commander Data's rationality in the newer series, Spock's was not an innocent matter. Even if he had been full Vulcan the issue was not one of being without emotions but of repressing them. In fact, the desire to be free of emotion and the arrogant pride that apparent lack of emotion could bring to a Vulcan were themselves emotions of great power. The blindness of Vulcan culture to this simple folly was quite laughable, as was their inability to recognize the possibility that emotions have a "logic" or at least a sensibility, of their own.

Scientists have the chance to see when their methods and inventions illustrate the

folly of such rigidity.

A case in point might be just under your nose: a vacuum cleaner perhaps, or an SLR camera or video camcorder, or maybe even the new thermostat on your wall—if such a device uses a control system employing what is called "fuzzy logic."

Fuzzy logic is a type of programming that was originally developed in the United States, but left unutilized until a host of Japanese companies started realizing its potential to make extremely fine alterations in function.

To understand fuzzy logic, let's look at how it would work in a thermostat. Imagine a thermostat that controls both an air conditioner and heater, and the thermostat is set to 70 degrees. Now imagine the room you are in is at 72 degrees. The air conditioner will kick in, right? But all the control system knows is: "It's hot." It doesn't vary the air conditioner setting any differently because you're close to the desired setting; for all it knows, you're at 100 degrees. And so, as the room cools, the air conditioner shuts off when you hit 70 degrees. Unfortunately, with the air conditioner running full bore until this point, the temperature itself doesn't stop dropping until you've overshot the mark a little—say to 68 degrees. What happens then is that the heater kicks in—at full setting. It also stops when the rising temperature hits 70, but overshoots the mark as well. The air conditioner starts back up, and a terribly wasteful, oscillating cycle keeps going ...and going ... and going ...
What is the problem here? Simply put, the thermostat is dumb. It understands two values: "hot" and "cold." It doesn't understand "warm" or "cool," let alone fine gradations of each. It doesn't, but a human being would. That is, unless the human being were using traditional notions of logic.

In standard logic, there are simply two values for a statement: "true" and "false." Traditional computers are built around this design: a circuit is either "on" or "off." This doesn't mean that there can't be a complicated series of operations for a system, but it does mean that, at some fundamental level, the component of a system is either yes or no.

To put it in lay terms, it's a situation in which things are black or white, but have no shades of gray. Control systems which employ fuzzy logic outperform the old control systems. Making machines that "think" more like the analog reasoning of a human being makes those machines work better—just as Mr. Spock learned from Kirk and McCoy how effective it could be to bluff, guess, estimate, rage, intuit, or even reason his way out of the idolatory of rigid logic he had been raised to value.

Fuzzy logic, like many other profound and apparently mundane modern developments in science, is not well-addressed, nor well understood, nor seen as relevant in modern academic philosophy.

No one belongs in science, medicine, or engineering who does not question or wonder. Where do I come from? Where does It All come from? Why are things the way they are? How should I conduct my life? How should I interact with others? A person's involvement with science is an expression of such questions already. And if a host of revolutionary ways of looking at the world come out of scientific discovery, then we have a responsibility to ruminate on them, discuss them at length with each other and discuss them in lay terms with the public. Students of science should begin such discussions now—not when they have a host of awards on their wall, not when they have been "properly" schooled by philosophical "experts" and not as quiet coffee-shop discussions they are afraid to make public. Right here. Right now.

It is not a question of rights. It is a question of responsibilities. ✻

Extension student **Robert Subiaga, Jr.** is a Neurology Research Technician. He writes science fiction in addition to writing and doing illustrations for Technolog. His first science fiction novel to see print, Eyes, will be released this spring.

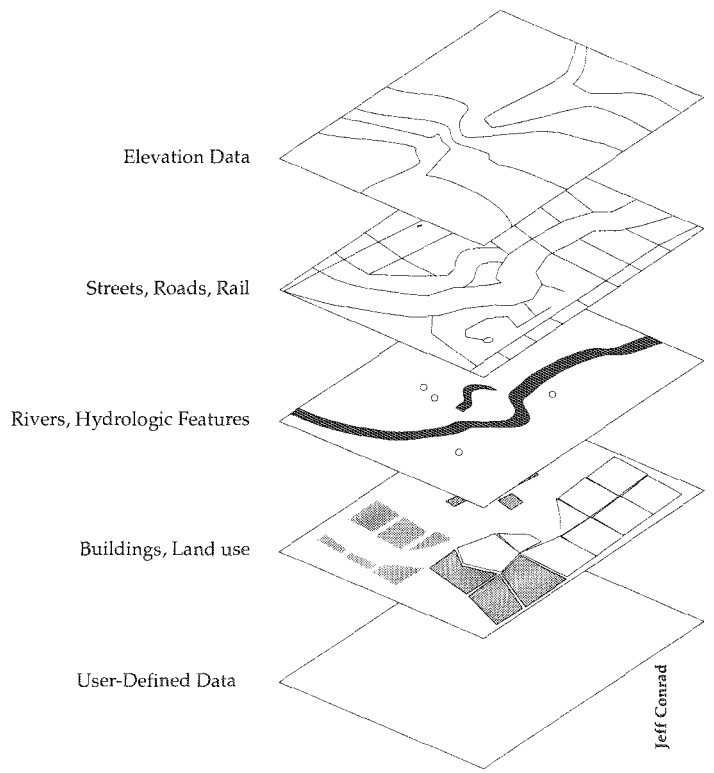
GIS AT YOUR DOORSTEP: YOU MAY NEVER BE LOST AGAIN

by **Jeff D. Conrad**

Imagine that you need to locate a buried gas line. You will need to know the depth, orientation, and access points of the line. Or imagine that you need to make a map of heap-leaching piles for a mining company. You will need an efficient way to specify the boundaries of your piles, and put them into a digital format for superimposition onto a property map. Imagine that a large number of people need directions to your religious institution. They will want to know the street names and landmark references needed to find their destination.

These are all scenarios that require access to spatial data. They include different categories of data organized in an x-y coordinate system. In the paper age, if you needed a digital representation of geographic data, you digitized every point yourself with a digitizing table. But now hundreds of companies have realized that the market exists for this information in a standard digital format. Thus U.S. Geological Survey topographic maps, U.S. Census Bureau TIGER files, satellite images, and foreign maps are now available on CD-ROM. Today, the data you seek might already be compiled.

Consulting and design companies rely on this kind of data for their "what-if" scenarios and construction projects. But Geographic Information Systems (GIS) are useful to fields other than engineering. The digital age has allowed the compilation of vast databases of all kinds of spatial information useful to sociology, history, public planning and legal fields.



YOU HAVE ACCESS TO GIS

GIS databases are now available to you. Thanks to the kind folks at the Boerchert Map Library (in the basement of Wilson Library), University of Minnesota students now have access to a variety of GIS data-

bases including: ArcInfo, MapExpert, Global Explorer, AUTOMAP, PCUSA, PCGlobe, ArcView, AtlasGIS, MapInfo, DATANET, and a plethora of other databases and programs. The center also has a color scanner and a digitizer for overlaying your own data directly into programs.

Using this service is easy. After you have signed up for an information session, you can sign up to use any of the four PC-compatible or two Macintosh computers. The information session summarizes the basic application possibilities of the various programs at the center.

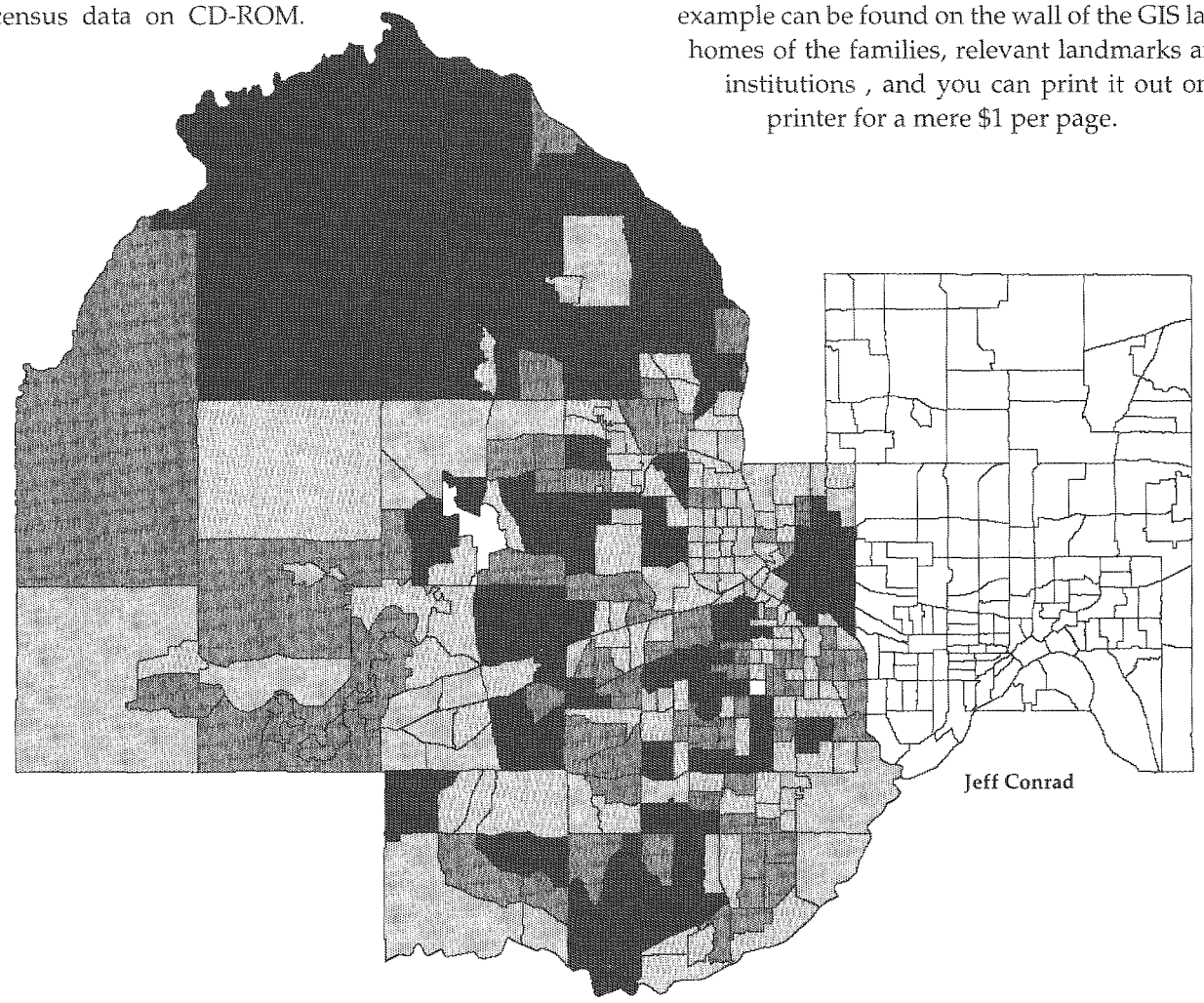
Brent Allison, head librarian, says that the amount of lab use fluctuates throughout the quarter. The cartographic center was funded under a two-year Department of Education grant, and began in October 1992 to establish a digital mapping center at the University.

Some GIS databases correspond to political boundary maps, upon which you can specify values in spreadsheet format for different counties, or load previously published census data on CD-ROM.

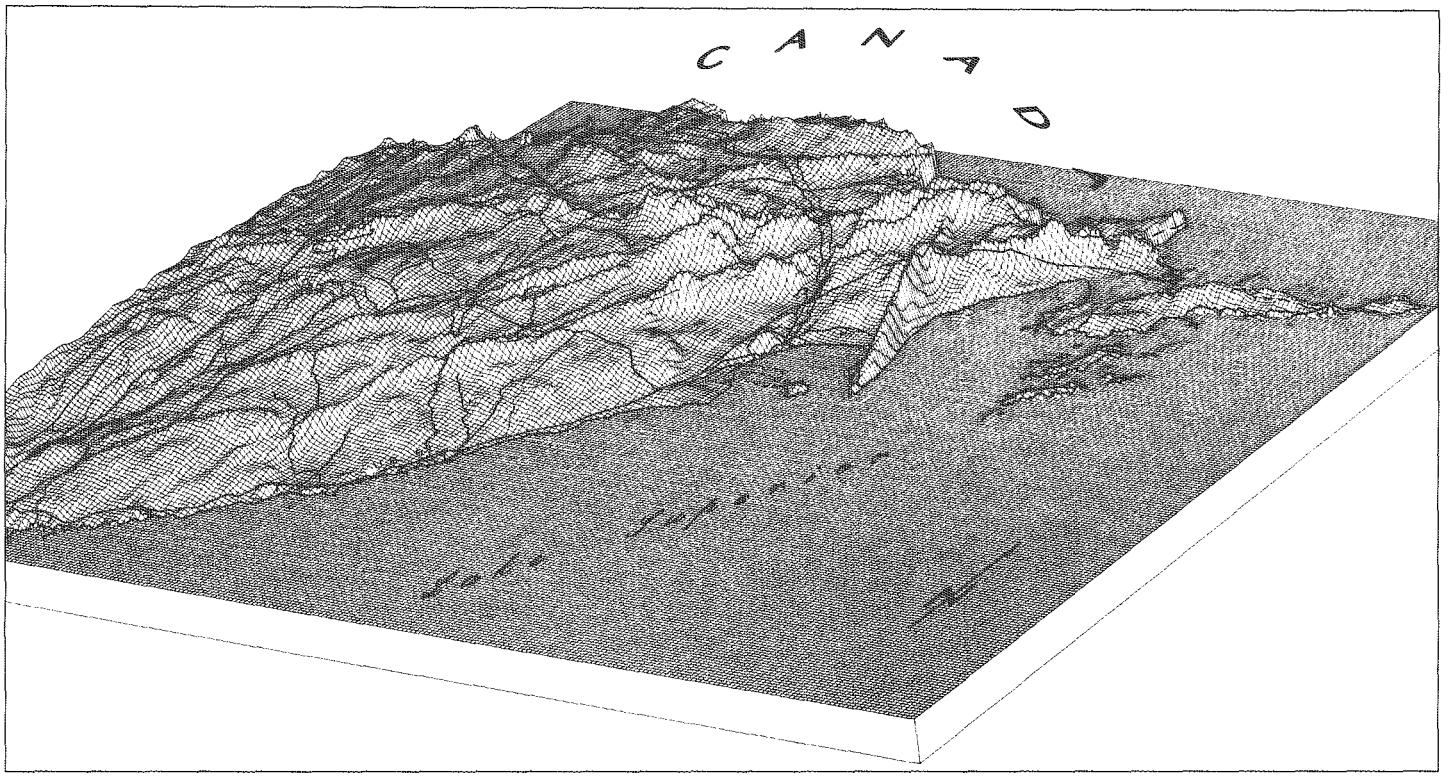
> Graphic information can be layered – that means on your map of important mill property, you can include land elevation, rivers, the mill and related buildings and the connecting railroads.

The outputs are color gradients corresponding to the various intensities of the data received. There are a significant number of databases already constructed; you can also input your own categories. Other databases allow superimposition of road networks, streets, wires, land use, census demographics, well locations, hydrologic features, resources, and soil types.

Back to the beginning example—if you're trying to tell people how to get to your religious institution for your wedding, you can design a map including all the major roads, in a real scale, and in full 24-bit color. Such an example can be found on the wall of the GIS lab, including homes of the families, relevant landmarks and religious institutions , and you can print it out on their color printer for a mere $1 per page.



Jeff Conrad



Grand Portage Indian Reservation Three-Dimensional View. Digital Elevation Models constructed by the U.S. Geological Survey along with other data sets are used with Arc/Info software for long-range planning, daily operations and cartographic production. Used with permission of Carl Hardzinski, Minneapolis Area Office, Bureau of Indian Affairs.

Applying GIS

Graphic information can be layered; for example, on your map of important mill property, you can include land elevation, rivers, the mill and related buildings, and the connecting railroads. For a contaminant transport study, you could superimpose wells (private/municipal), hydrologic features such as rivers and lakes, and locations of nearby industries.

Using GIS for studies and simulations is convenient, because instead of opening up approximately eight maps and datafiles simultaneously, you can superimpose several files onto one "seamless" map, cropped to the right coordinates and scaled to the right zoom factor. A single integrated database may consist of the data for an entire state; one such database exists for Colorado, consisting of 90 layers of information such as census data, transportation links, soils, environmental hazard areas, contours, rivers, lakes, land use, federal and state land ownership, and political boundaries. Such a dataset takes about two years to make and includes over seven megabytes of data.

The applications of GIS in engineering and planning are growing. In transportation, for instance, the GIS market is expected to exceed the average industry growth rate from $56 million in 1992 to $136 million in 1997, as federal, state, county and city transportation departments convert their land and street information into digital format.

In planning, more controllable GIS systems are used with other software to try out several scenarios and quickly modify sets of information. This is the goal of a new standard for OpenGIS. The goal of such software is an object-oriented framework for accessing geographic data. OpenGIS creates objects out of interrelated data, processes and database servers. The goal is to develop a more flexible standard, resulting in easier data transformation between programs.

GIS is used increasingly in banking, real estate, emergency planning and response, property management, pollution control and hazard analysis. In our example, GIS could be used to send monitoring crews to the precise location of a monitoring port along the pipeline.

Using GPS with GIS

Global Positioning Systems (GPS) utilize the NAVSTAR satellite network and portable computer technologies to compute the latitude, longitude and elevation of any point in the United States. The technology uses several satellites, each of which broadcasts a time marker. The time it takes for the time mark to reach the unit is used to compute the distance from the GPS unit to the satellite. Triangulating several signals gives a three-dimensional coordinate in space-time.

GPS hand-held units have the ability to record, coordinate and identify information, making them useful for single-person surveys. Recently, portable note-taking

devices such as Newton have been enhanced to incorporate GPS modules. Back at the office, GPS data can be easily integrated into GIS datasets. GPS is also useful for locating positions in environments with poor accessibility, or for finding surveying reference markers, such as in dense foliage or on barren land.

GEOSPAN, a company based in Bloomington, Minn., plans to use GPS technology to digitize street maps and capture images of every city in the United States with populations of 25,000 or more. Eight hundred thousand miles are scheduled to be completed by 1996. The project has a total price tag of $50 million, with the returns expected to come from the Census bureau and other customers. To get the data, workers will drive special GPS-equipped vans up and down the city streets until they have obtained precise measurements of roadways.

Like other developing information technologies, there is a controversy over the freedom of use of GPS systems. The military currently scrambles the signals from the satellites, so that real-time positioning is only accurate from 1-100m, depending on the system used. This scrambling necessitates correcting information later for more precise measurements, or using base stations, which are corrective GPS at nearby known coordinates that broadcast correct time information. The scrambling is for internal security reasons. Some military proponents suggest that technologies be in place to disable public accessibility to GPS in the event of conflict, for the security of U.S. service personnel.

There is also a debate over the availability of public GIS information. Should GIS information compiled by the government be sold to taxpayers to recover collection costs?

The cost of upcoming generations of GPS technologies should be reduced enough for mass consumer use in general aviation, automobiles, and perhaps someday, wrist units. The prospects are bright: You may never be lost again. ✻

Sources

Allison, Brent. Interview. January 10, 1994.

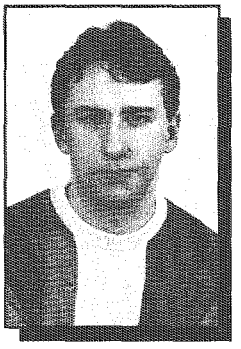
Forrest, David. "'Visual Geographic Information' Development Under Way." GIS World. January 1994, p. 58.

GIS World. "Transportation GIS Market Expanding." November 1993, p. 10.

Hansen, Paul. GIS Information Session. November, 1993.

Strand, Eric J. "OpenGIS Unlocks Private Spatial Databases." GIS World. November 1993, pp. 24-5.

Jeff Conrad created the illustrations on pages 9 and 10 using GIS.



Jeff Conrad, a Civil Engineering/Russian Studies senior, emerges from cybermapspace periodically to perform his duties as President of the I.T. Board of Publications.

ALL STEAMED DOWN

by **Brian DeVore**

In the 10 years he has worked as an engineer for the Metropolitan Wastewater Treatment Council, Steve Greenwood has developed a simple strategy for dealing with the sewage produced by citizens of the Twin Cities.

"All this stuff has to end up somewhere," says Greenwood of the toxins extracted from 209 dry tons of sewage sludge treated at the St. Paul facility every day. "We'd rather it end up where we can control it."

That's why Greenwood and his colleagues were distressed when they learned that, in fact, they weren't controlling all the waste being handled at the plant, which each day treats 226 million gallons of Minneapolis-St. Paul metropolitan area waste before releasing it into the Mississippi River. The year was 1987 and tests showed that the incinerator smokestacks at the sewage treatment plant were producing heavy metals such as cadmium, zinc and lead. The problem is that smokestack scrubbers are only effective on particulates that are at least a micron in diameter (one micron is about the size of a bacterium and 70 microns are the size of a human hair). The heavy metal particulates are more on the order of 0.2 microns, difficult to see even with an electron microscope. This concerned treatment plant officials. For the past 10 years, the plant has produced 0.9 pounds of particulates per dry ton of incinerated sewage sludge. The federal limit is 1.3 pounds. Greenwood says although the plant is under the standard, there are concerns that tighter limits in the future will put the plant over.

"We're still below the limit, but we'd like to be significantly lower," he says.

Several "common sense" approaches to stopping those tiny pollutants from reaching the atmosphere—such as increasing the water flow to the scrubbers—proved unsuccessful. Then Greenwood, who has bachelor's and master's degrees in engineering from the University of Minnesota, went back to school and took Mechanical Engineering Professor Benjamin Liu's class in particle control technology. It would be nice to say that Greenwood learned enough in that class to solve his problem. But in fact, the opposite occurred.

"We realized then that we really didn't understand the nature of particulate emissions from the smokestacks," the engineer recalls. "There's not very much detailed scientific work done in this area."

So Greenwood asked Liu, who is director of the University's Particle Technology Laboratory, to do a full-scale research project on the particulate problem at the plant. As a result, University researchers turned the sewage treatment plant into a giant laboratory in an attempt to find out more about the submicron particulates produced by incinerators.

They not only learned the nature of these tiny pollutants, but struck upon an effective, efficient and relatively inexpensive way of reducing their release by at least half. It's based on a patented technology Liu, a nationally recognized pioneer in aerosol science technology, helped develop. Researchers hope it will have applications anywhere incinerators are producing submicron pollutants.

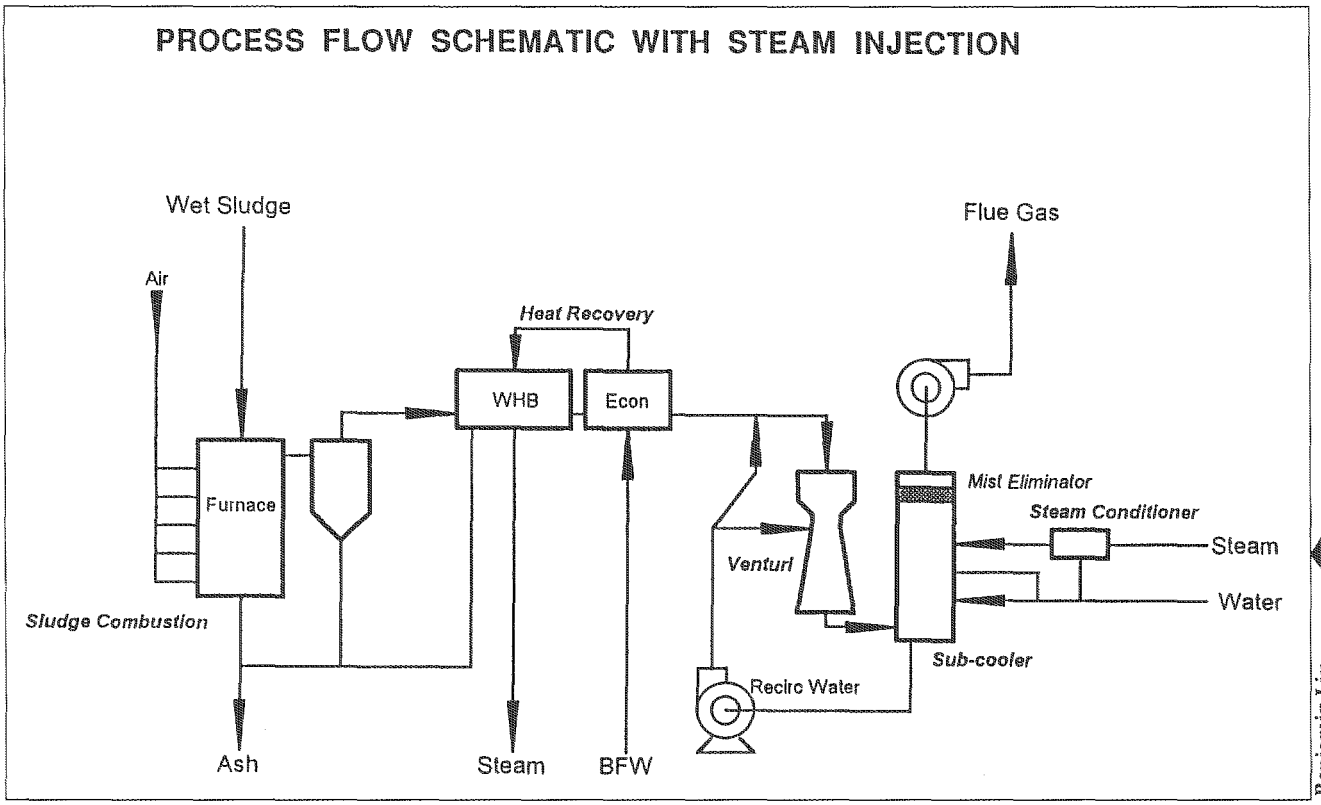
The technology is called "steam injection," and according to David Thimsen, a research fellow at the Particle Lab, it is almost as simple as the name implies. Under the guidance of Liu and Mechanical Engineering Professor Peter McMurry, Jinjun Sun, a postdoctorate research fellow in the department, studied Greenwood's problem and found that yes, indeed, the particulates were too small to be picked up by smokestack scrubbers. But instead of modifying the scrubbers in an attempt to pick up these micro-pollutants — something considered nearly impossible anyway — researchers decided to "grow" the particulates to a cleanable size.

This wasn't totally untrod territory. Environmental scientists hoping to get more accurate measures of particulate pollutants — the kind that actually make the atmosphere look hazy — have "grown" them via butyl alcohol injection for several years. As early as the 1890s a British scientist developed an airborne particle counter to study pollution in London. But Liu says this is the first time condensation technology has been used to control submicron air pollution.

In this case, treatment plant technicians are using the excess steam produced by the incinerator as the growing medium. The technique is deceptively simple. Sewage sludge is the material left over after the waste Twin Citians flush down drains and toilets is treated. It is a mass of mostly sand and grit that contains such organic materials as fats, proteins and sugars. Spicing up this stew are concentrated toxins which must be broken down through incineration. The problem with incineration is that it can change a solid waste problem into an air pollution problem. Environmental scientists have found that traditional air pollution control methods only go so far in making incinerator emissions benign.

> "If we completely foul this up, they can get it back in service in a day,"
> –jokes Thimsen

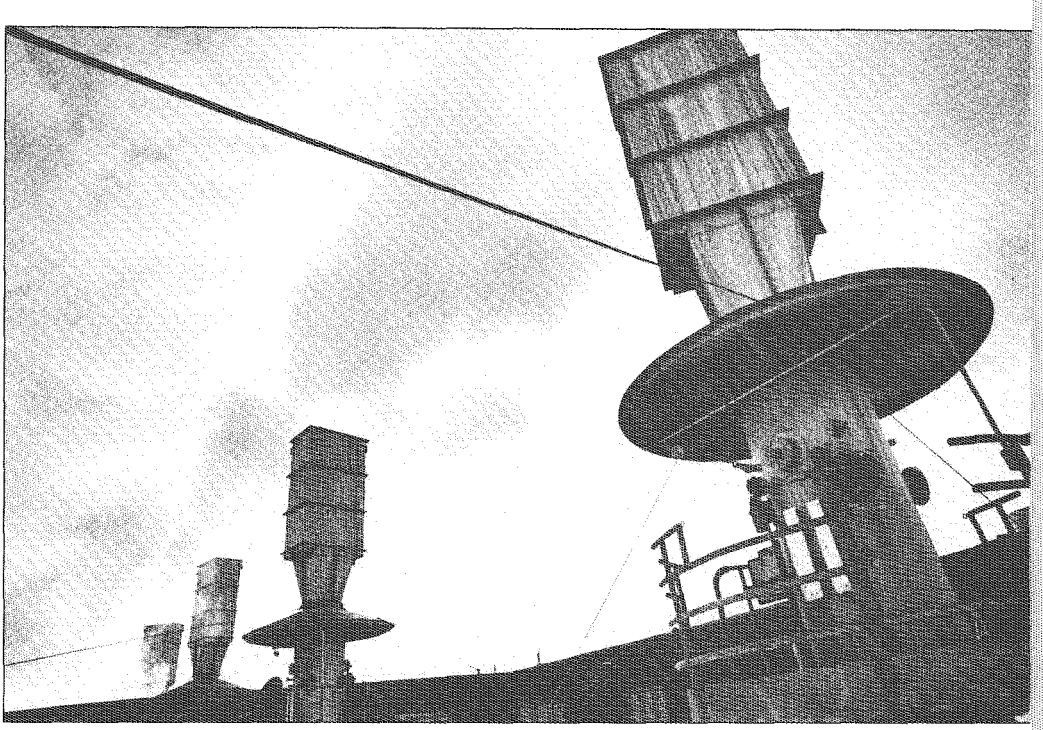
After the sludge is incinerated at 1,600-1,700 degrees F, the flue gas is directed to a containment area where it mixes with water. The water in this "subcooler," as it is called, cools the gas down to 70 degrees F, or below the dew point. The scrubbers remove all particulates larger than one micron, but that is only 10 percent of the total; the rest escapes into the atmosphere. As ways of control-



ling coarse pollutants become increasingly successful, pollution control experts have turned their attention to these escaping submicron particulates.

The most severe air pollution problems are due to fine particles, says Liu, adding that they often pose the greatest risk to human health.

That's because many of those submicron particulates are heavy metals, which can be toxic to people. Plant officials are particularly worried about the amount of cadmium that slips through the wet clutches of the scrubbers. This heavy metal can cause neurological damage in humans when inhaled in large amounts, and the Environmental Protection Agency has attempted to severely curtail production of it by incinerators. Greenwood says it's only a matter of time before those restrictions become a reality.



Michael Branscom

Smokestacks emitting flue gas (steam) on top of metropolitan area waste management plant in St. Paul.

What University researchers have done is to install steam injectors in an exit hole on one of the subcoolers. Now when the cooled flue gas leaves the subcooler, the particulates in it are also being supersaturated with steam. Just as dust particles form the core of raindrops in nature, the incinerator particulates become the center around which the droplets form. The droplets grow until they are a thousand times heavier that the original particulates.

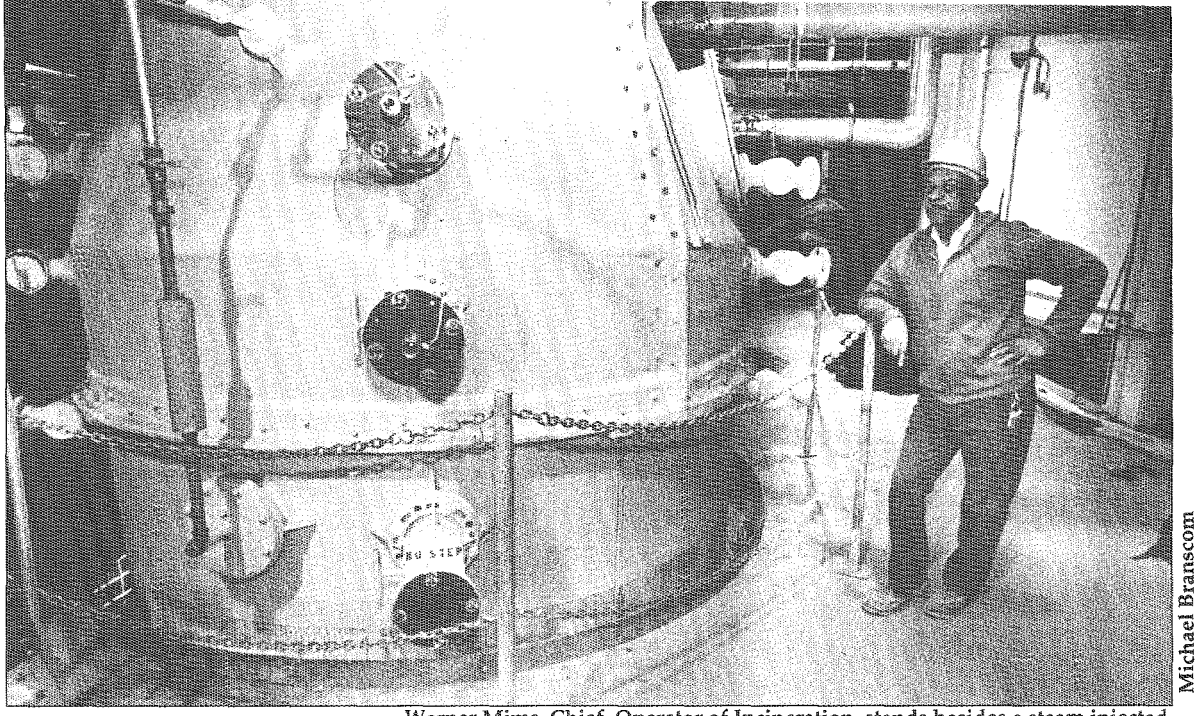
"So it's essentially all water," says Thimsen.

And what do water droplets do when they become large? They become a dense fog. The fog droplets are too fat to pass through a filter, which is referred to as a mist eliminator. As a result, this mass of polypropylene (fishing line) causes water droplets to form when the fog hits it. The droplets are collected along with the particulates contained in the droplets and eventually are drained to the bottom of the subcooler, where they are sent back to the head of the plant for treatment. Eventually, the treatment produces an ash that can be mixed with asphalt to make a harmless road surface or other kinds of building material. So, in the end, steam injection doesn't eliminate toxic pollutants; it just gives technicians control of where they eventually end up. And that's the way Greenwood and his colleagues like it.

A steam injector system has been in operation on one of the St. Paul plant's incinerators since December. Testing has shown that it reduces submicron particulate emissions by 50 to 70 percent. Greenwood says once some wrinkles in the system are ironed out, it has the potential to remove up to 90 percent of the particulates produced by incineration. He and his colleagues will spend the next year fine-tuning the system and working out such engineering problems as making the mist eliminators more efficient. Mist eliminators are crucial to the success of the system and researchers are looking for ways to reduce the amount of particulate-laced fog that's leaking around these filters. The technicians are also interested in figuring out the best way to extend the period of time the particulates and steam spend mixing with each other. The more they mix, the more efficient the condensation. However, because the steam injector was installed on an incinerator system that was already in place, the researchers had limited space in which to create a mixing area. It's been a challenge to make the best use of the space available, says Greenwood.

Greenwood and Thimsen concede they took a bit of a risk installing the untested technology directly onto a working incinerator. However, Greenwood says three independent calculations done by Particle Lab scientists convinced him the theoretical idea would work in practice. In addition, there are certain factors, such as running an incinerator at full bore and producing certain kinds of particulates, that can't be replicated even in the best laboratory experiment.

"Something like this you really have to go full scale," says Greenwood, adding that even if an effective lab test could have been conducted, "you'd still have the same question about how it's going to perform full scale."



Michael Branscom

Warner Mims, Chief Operator of Incineration, stands besides a steam injected subcooler. An employee at the Metro Plant for 17 years, Mims monitors subcoolers for temperature and water flow on a computer screen.

The flexibility of the treatment plant's incineration system also made it easier to test the steam injector in a real-life situation. There are six incinerators/subcoolers in all, making it possible to manipulate one for testing purposes without impacting significantly the overall capacity of the plant. But best of all, modifying the one subcooler was relatively simple.

"If we completely foul this up, they can get it back in service in a day," jokes Thimsen.

All technicians did was add some piping to redirect the steam, a mist eliminator and steam nozzles for injection. The steam injector's simplicity makes it an amazing bargain in today's world of multimillion dollar pollution control devices. It would cost roughly $600,000 to retrofit all six units with the system, estimates Greenwood. The system is relatively cheap to run because the steam it relies on is often produced in excess by the treatment plant. The other viable alternative to reducing particulate emissions is to install a device called an electrostatic precipitator, a device that uses electric fields to collect particulates. It is 80 to 90 percent efficient, but the price tag is a whopping $10 million.

Liu says steam injection technology could be useful in any situation in which high temperatures are being used in waste treatment. In fact, even the fine particles produced by coal-fired power plants could theoretically be gleaned from the air by steam injection, he says.

One day recently, Greenwood and Thimsen led the way through the huge labyrinth of pipes and ducts that make up the treatment plant's sludge incineration operation. They stopped by a large, yellow potbellied subcooler, and Greenwood shined a penlight into one of its glass portholes. The beam reflected off a pea-soup fog that was laced with toxic heavy metals. Somewhere in there were innumerable heavy metal particles that had been tricked into forming the nuclei of water droplets.

The two men climbed the stairs to the roof and opened the door onto a scene right out of an environmentalist's worst nightmare. The cold weather made the water vapors billowing from the six, ice-encrusted incinerator stacks look more ominous than they were. But summer or winter, invisible toxins do escape from these stacks. On this day, the emissions were all a uniform white, but because of a miniature rain cloud formation being passed through some fishing line somewhere below the roof, one of those smokestacks was sending fewer heavy metals out over the nearby Mississippi River. ✻

Sources

Greenwood, Steve. Personal interview, Jan. 4.

Thimsen, David. Personal interview, Jan. 4

Liu, Benjamin. Telephone interview, Jan. 11

Ye, Yan, Benjamin Y.H. Liu and David Y.H. Pui. "Condensation-Induced Particle Formation during Vacuum Pump Down," Journal of the Electrochemical Society, Vol. 140, No. 5 (1993), pp. 1463-1468.

Zhao, Jun, Benjamin Y.H. Liu and Thomas Kuehn. "The Formation of Water Aerosols During Pump-Down of Vacuum Process Tools," Solid State Technology, Vol. 33, No. 9 (1990), pp. 85-89.

He just can't get too far from the Mississippi. Iowan **Brian Devore** has shifted his sights north to Technolog while completing a masters in the History of Science and Technology.

the Free UNIX Clone for IBM PCs

by **Ed Chi**

There's a new computer operating system being developed worldwide which may give DOS and Microsoft runs for their money. It's called "LINUX," it's free and it has multiple applications.

LINUX is a UNIX operating system clone for IBM-compatible machines with 386/486 or Pentium chips. UNIX is an operating system designed at the Bell Laboratories of AT&T back in the 1970s.

UNIX was a landmark in operating system design and implementation. The C language was originally designed for the UNIX operating system, so there is a strong synergy between C and UNIX. After UNIX was rewritten in C in 1973, it could be ported to new hardware in months, and changes became easier. Many companies took the source code and modified it to create their own versions of UNIX. The development progressed at AT&T for many years, and now its version of UNIX is called "System V." The Computer System Research Group of the University of California at Berkeley has its own flavor of UNIX called the BSD, or the Berkeley System Distribution.

System V and BSD are the two main versions of UNIX. UNIX now comes in an incredible variety of flavors that are being shipped by various computer vendors. Unfortunately, most Unices (versions of UNIX) are derived more or less directly from AT&T's proprietary code. Because of this, a royalty fee must be paid for each copy of the operating system sold. Luckily, there are also UNIX clones: UNIX-compatible systems with no AT&T code.

Since different Unices are incompatible, the Institute for Electrical and Electronic Engineers (IEEE) has begun standardizing UNIX's features in the specification called POSIX.

Enter LINUX

LINUX is an independent implementation of POSIX and contains no proprietary AT&T code. It works only on IBM PC compatibles with an ISA or EISA bus and an Intel 386 or higher processor. Most of the programs running under LINUX are generic UNIX freeware that can be obtained from many places around the world. LINUX is freely distributable under public license, which means it is copyrighted, but can be obtained free of charge. All source code is available for free, including the whole kernel and all drivers, the software and all user programs.

> The number of LINUX users could be well over 40,000.

Because LINUX is free and runs on one of the most popular platforms— the IBM PC compatibles—it has became one of the best-known Unices available for the Intel 386/486 machines.

LINUX was started and mostly developed by a 22-year-old computer science student, Linus Torvalds, at the University of Helsinki in Finland.

The history of LINUX

Linus took a course on UNIX and C in the fall of 1990. When he had scrounged up enough money, he bought an 386 compatible machine to run the commercial MINIX, which is another 386 UNIX operating system. Getting MINIX was not altogether a pleasant experience, because it lacked various features, such as job control, floating point co-processor support or memory management.

At first, Linus experimented with the protected mode of the 386 chip, and he wrote a protected mode program that printed "Hello world." The protected mode is what allowed the implementation of the advanced UNIX features. Slowly, the pieces started to come together. In about half a year, a virtual memory system was in place and version 0.12 was announced. By that time, LINUX was a valid alternative to MINIX.

The name "LINUX" stands for "Linus' MINIX."

What can LINUX do?

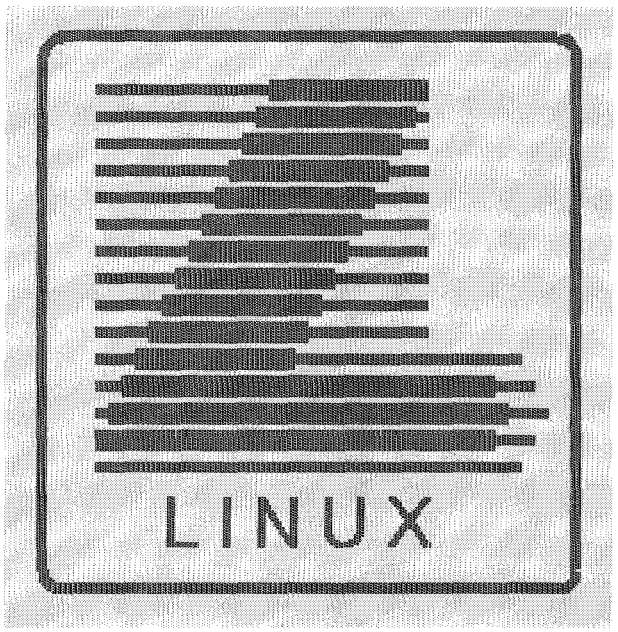
LINUX programs include, free of charge, all of the basic UNIX commands, GNU C and C++ compilers and GDB debugger, GNU emacs, most UNIX command shells, news and mail programs, TeX typesetting processing system, X Window environment and games. There is even an MS-DOS emulator currently in testing that will allow you to run DOS programs.

Additional LINUX features include:

* Multiprograming: several programs running at once

Stefan Haas. Used with permission.

* Multiuser: several users on the same machine at once
* Memory protection between processes, so that one program can't bring the whole system down
* Demand loads executables: LINUX only reads from disk those parts of a program that are actually used
* Multiprocess: several processes can use the same memory to run. When one tries to write to that memory, that page is copied somewhere else. This feature increases speed and decreases memory use
* CD-ROM support: can read all standard formats of CD-ROM filesystems.



Who can use LINUX?

Anyone with an Intel 386SX/16 with more than two megabytes of RAM can run LINUX with about 60 megabytes of hard disk storage space. Since no one is required to register their copies with any central authority, it is difficult to know how many people use LINUX.

The LINUX user base is large. Several businesses exist now that solely depend on selling and supporting LINUX, such as SoftLanding Software, InfoMagic, Trans-Ameritech and Clark Internet Services. LINUX news groups are some of the most heavily read and posted on the Internet.

Harald T. Alvestrand tried to get an idea of the size of the Internet LINUX user base. According to his registration program, as of Jan. 4, 1994, there were 4,495 Internet users in his counting program. Seventy-four percent use LINUX at home and 25 percent at work. There are LINUX users from Iceland to South Africa. Since many of the users get their copy of LINUX through bulletin board systems, the number of LINUX users could be well over 40,000. The number is growing fast. The Australian Surveying and Land Information Group in Canberra uses LINUX-based systems. Andrew Tridgell, the designer of these LINUX systems, talked about his Antarctica project which uses LINUX in a recent discussion in the comp.os.LINUX.misc Internet news group:

"There are now three LINUX boxes in a cargo container on their way to Antarctica with 14 more on the way for other sites in and around Australia. The application is for data gathering. The LINUX boxes are attached via serial ports to a 'TurboRogue' satellite receiver system which monitors the 32-satellite Global Positioning System. Data is downloaded from the satellites and stored in a four megabyte flashcard in the back of the TurboRogue, and from there it is downloaded to the PCs. The PCs store the data and forward it to a base system in Canberra."

> Anyone with C programming expertise can join the project.

Where and how is LINUX available?

Many bulletin board systems carry LINUX distributions. A list of them is occasionally posted to Internet news group comp.os.LINUX.announce. A Minneapolis bulletin board system that carries LINUX is Part-Time BBS at (612) 544-5552. A list of these BBSes is contained in the LINUX distribution HOWTO, which is available by anonymous Internet ftp as sunsite.unc.edu: /pub/LINUX/docs/HOWTO/distribution-HOWTO, and it is also posted regularly to the comp.os.LINUX.announce news group.

You can ask friends and user groups for a copy of LINUX, or order one of the commercial distributions. For Internet users, there are several distributions available at sunsite.unc.edu:/pub/LINUX/distributions/.

There is a 150-page guide on getting, installing and setting up LINUX, which is available at tsx-11.mit.edu:/pub/LINUX/docs/LDP/install-guide-1.ps.gz. In addition, the LINUX Documentation Project has put out several other books in various states of completion, and these are available at sunsite.unc.edu:/pub/LINUX/docs/LDP/. Over 600 pages of documentation in book form have been released by the LDP alone, plus a large group of manual pages.

The future of LINUX

A LINUX documentation project is in process and an MS-Windows binary emulator called WINE is being developed. Once it is completed, the user will be able to

run MS-Window programs directly under LINUX and X Windows.

Work is underway on LINUX version 1.0, a refinement of earlier versions. Once the networking code has been stabilized, version 1.0 will be released.

All of this development work was done in two years. So watch out, DOS and Microsoft: LINUX could become the preferred operating system on the PC platform and become the wave of the future!

Want to help develop LINUX?

LINUX is now being developed jointly by a group of people, with Linus as the main kernel developer. Anyone with C programming expertise can join the project. This group of people and the LINUX users communicate through the USENET newsgroups on the Internet. The five news groups include:

— comp.os.LINUX.announce is a moderated news group for announcements about LINUX (new programs, bug fixes, etc)

— comp.os.LINUX.admin is an unmoderated news group for discussion of administration of LINUX systems

— comp.os.LINUX.development is an unmoderated newsgroup specifically for discussion of LINUX kernel development. The only application development questions that should be discussed here are those that are intimately associated with the kernel

— comp.os.LINUX.help is an unmoderated newsgroup for any general questions a LINUX user might have

— comp.os.LINUX.misc is meant for any discussion that doesn't belong elsewhere.

The current development version is always public (with a delay of up to a week or two) so that anybody can use it. The result is that whenever a version with new functions is released, it almost always contains bugs. It also results in very rapid development, because the bugs are generally discovered within hours of a kernel release. Bugs are corrected quickly, especially those which might endanger a user's data, so it is easy for an end-user to avoid them. ✻

Sources

Most of these sources are from Internet newsgroup postings which are often not archived. A good source for general information about LINUX is newsgroup comp.os.LINUX.misc.

Aburto, Al (aburto@marlin.nosc.mil), "The Dhrystone 2.1 and 1.1 MIPS Results," Oct. 1993.

Alvestrand, Harald T., "Results of the LINUX Counter" (Posting to comp.os.LINUX.misc), Jan. 4th, 1993.

Binns, Roger and Winstead, Jim Jr., "A standard for LINUX packages and version numbering," Aug. 1993.

Drinovsky, Steven (stevend2@cs.utexas.edu), "Benchmarks of LINUX with 486," Jul. 1993.

GNU General Public License, Free Software Foundation, Inc., 1991.

Kappe, Dietrich, comp.os.LINUX.misc news article, Nov. 15, 1993.

Johnson, Michael K., LINUX Meta-FAQ, 1993.

Johnson, Michael K., LINUX Information Sheet, 1993.

Linksvayer, Mike, "The Choice of a GNU Generation," Meta Magazine, Volume 1, Number 1, Nov. 1993.

Timar, Ted M.A. (tmatimar@empress.com), UNIX - Frequently Asked Questions Digest, Dec. 27, 1993.

Torvalds, Linus (torvalds@klaava.Helsinki.FI), LINUX's Birthday, July 31, 1992.

Torvalds, Linus (torvalds@klaava.Helsinki.FI), LINUX CPU Scheduling, June 1993.

Tridgell, Andrew (tridge@nimbus.anu.edu.au), LINUX in Antarctica, Nov. 1993.

Wirzenius, Lars, LINUX News, issues 1-8, Oct 5, 10, 18 and 26, 1992; Nov. 6, 16, 22 and 28, 1992.

Tree, Denise, LINUX News, issues 9-14, Dec. 18, 1992; Jan. 1, 10 and 25, 1992; Feb. 16, 1993; Jun. 13, 1993.

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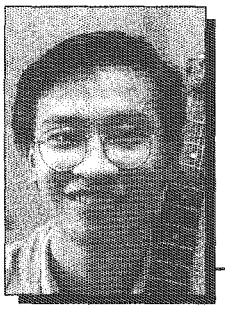


Computer Science senior **Ed Chi** can be found strolling the halls of Lind when he's not cruising the Internet. This is his first article for Technolog.

THE HACKER TEST - Version 1.1

(greatly abbreviated and somewhat revised)

Conceived and written by Felix Lee, John Hayes and Angela Thomas at the end of the spring semester, 1989.

Scoring:

Count 1 for each item that you have done, or each question that you can answer correctly.

If your score is between:	you are:
0x000 and 0x010:	a Computer Illiterate
0x011 and 0x040:	a User
0x041 and 0x080:	an Operator
0x081 and 0x090:	a Nerd
0x091 and 0x100:	a Hacker
0x101 and 0x180:	a Guru
0x181 and 0x200:	a Wizard

And now for the questions...

0x007 Have you ever missed a class while programming?
0x008 ... Missed an examination?
0x009 ... Missed a wedding?
0x00A ... Missed your own wedding?

0x00B Have you ever programmed while intoxicated?
0x00C ... Did it make sense the next day?

0x013 Have you named a computer?

0x016 Do you know how many days old you are?

0x017 Have you ever wanted to download pizza?

0x02B Can you read a punched card, looking at the holes?
0x02C ... feeling the holes?

0x030 Have you met any IBM vice-president?
0x031 Do you know Dennis, Bill, or Ken?

0x038 Does your terminal/computer talk to you?

0x039 Have you ever talked into an acoustic modem?
0x03A ... Did it answer?

0x03B Can you whistle 300 baud?
0x03C ... 1200 baud?

0x03D Can you whistle a telephone number?
0x041 ... Do you know what it is?

0x042 Can you play music on your line printer?
0x043 ... Your disk drive?
0x044 ... Your tape drive?

0x072 Have you ever received a case of beer with your computer?

0x081 Ever thrown a computer from more than two stories high?

0x093 Can you convert hex to octal in your head?

0x0B7 Do you have the Anarchist's Cookbook?
0x0B8 ... Ever make anything from it?

0x0EF Have you ever downgraded your job to upgrade your processing power?

0x0A1 Do you know who wrote Rogue?
0x0A2 ... Rogomatic?

0x195 Do you know any people?
0x196 ... more than one?
0x197 ... more than two?

0x198 Are your shoelaces untied?

0x199 Do you interface well with strangers?

0x19A Are you able to recite phone numbers for half-a-dozen computer systems but unable to recite your own?

0x19B Do you log in before breakfast?

0x1A1 Do you dream in any programming languages?

0x1A2 Do you have difficulty focusing on three-dimensional objects?

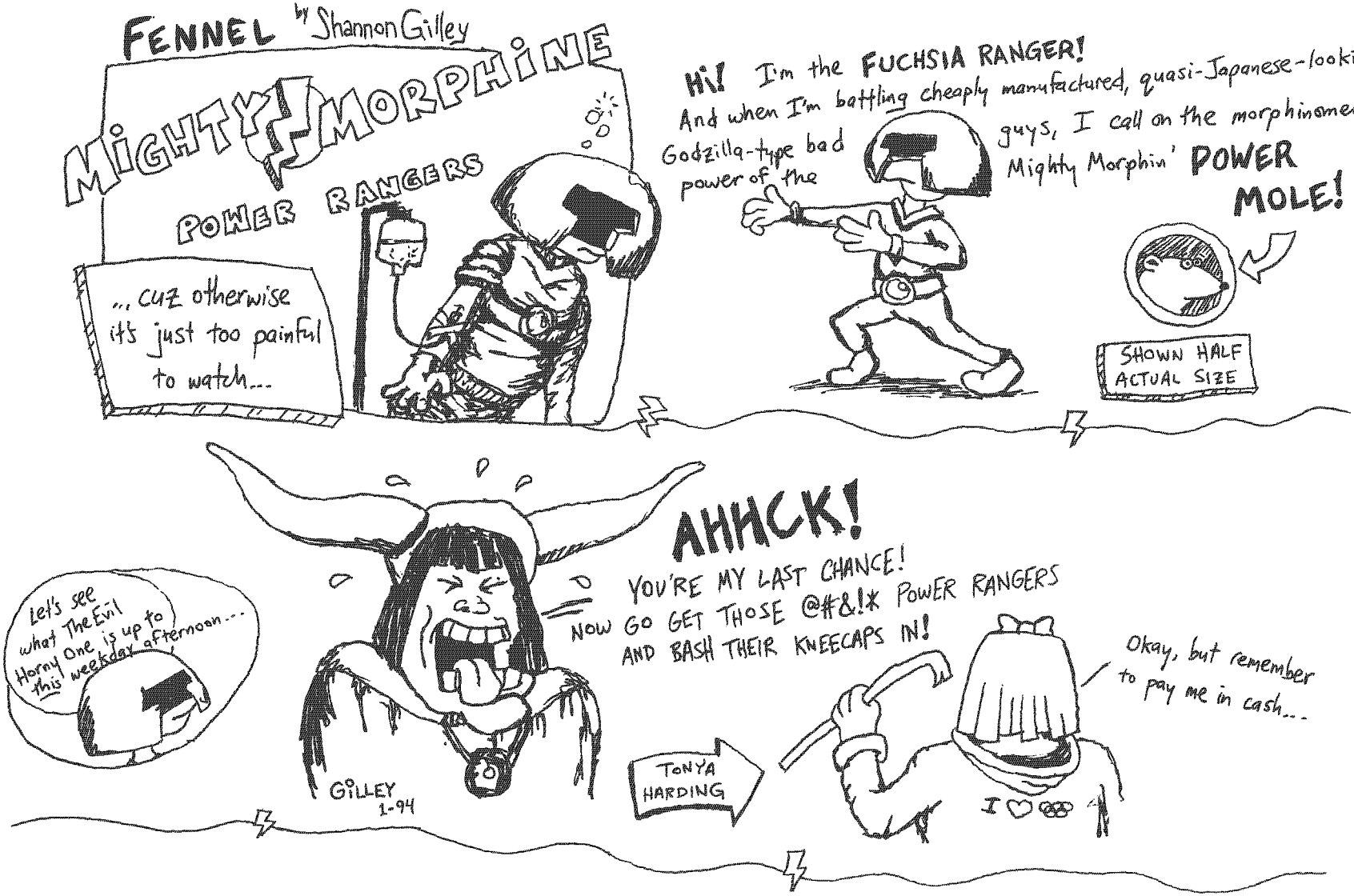
0x1A9 Have you ever seen the dawn?
0x1AA ... Twice in a row?

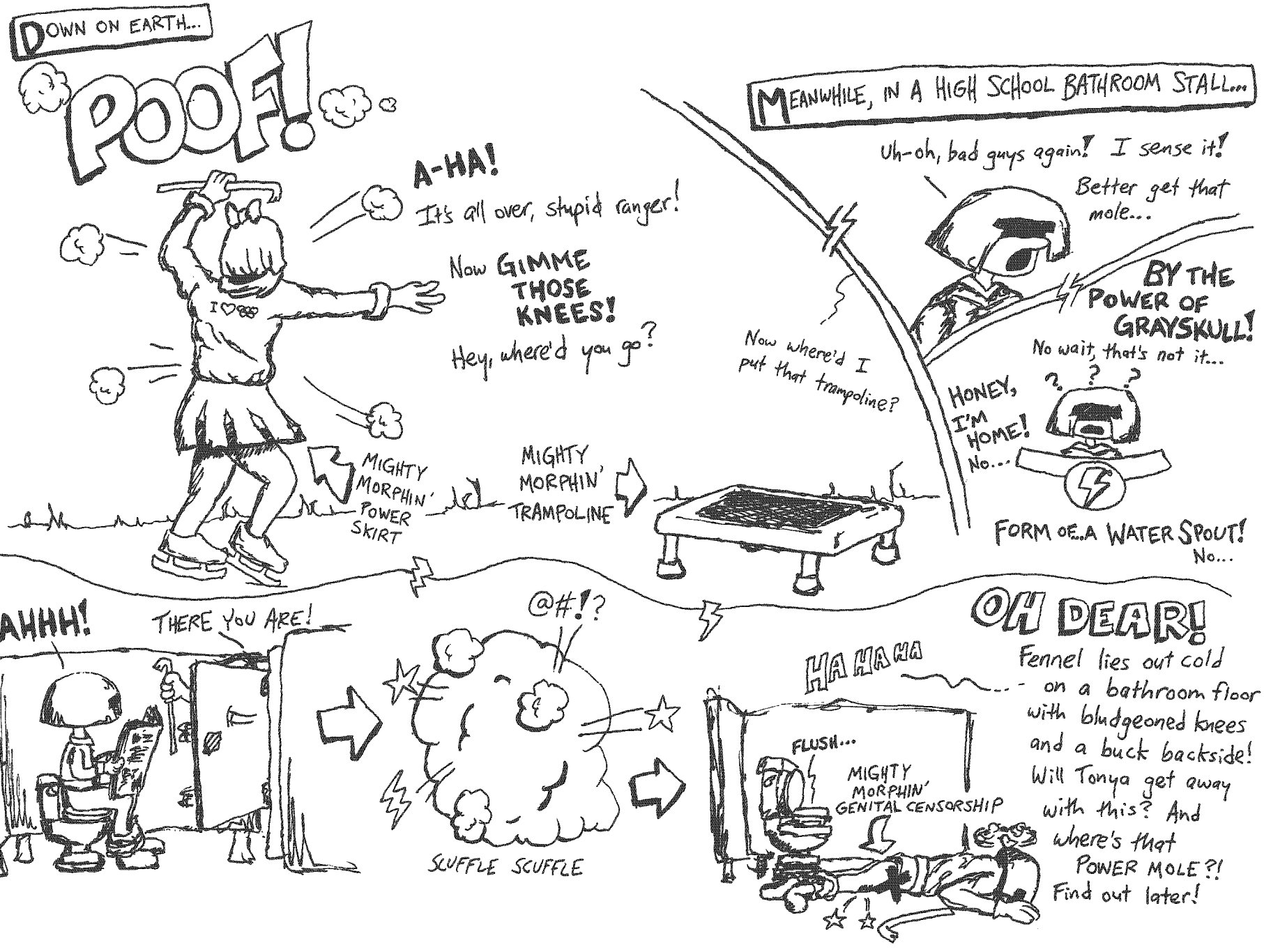
0x1B0 Do you think garbage collection means memory management?

0x1B6 Have you ever set up a blind date over the computer?

0x1EF Do you use smiley faces regularly?

0x200 Did the breakup of Ma Bell create more opportunities for you?


FENNEL by Shannon Gilley
MIGHTY MORPHINE POWER RANGERS
..cuz otherwise it's just too painful to watch...
HI! I'm the FUCHSIA RANGER!
And when I'm battling cheaply manufactured, quasi-Japanese-looking Godzilla-type bad guys, I call on the morphinomena! power of the Mighty Morphin' POWER MOLE!
SHOWN HALF ACTUAL SIZE
Let's see what The Evil Horny One is up to this weekday afternoon...
AHHCK!
YOU'RE MY LAST CHANCE! NOW GO GET THOSE @#&!* POWER RANGERS AND BASH THEIR KNEECAPS IN!
TONYA HARDING
Okay, but remember to pay me in cash...
I ♡ $$$
GILLEY 1-94


DOWN ON EARTH...
POOF!
A-HA!
It's all over, stupid ranger!
Now GIMME THOSE KNEES!
Hey, where'd you go?
MIGHTY MORPHIN' POWER SKIRT
MIGHTY MORPHIN' TRAMPOLINE
MEANWHILE, IN A HIGH SCHOOL BATHROOM STALL...
Uh-oh, bad guys again! I sense it!
Better get that mole...
BY THE POWER OF GRAYSKULL!
No wait, that's not it...
Now where'd I put that trampoline?
HONEY, I'M HOME!
No...
FORM OF A WATER SPOUT!
No...
AHHH!
THERE YOU ARE!
@#!?
SCUFFLE SCUFFLE
HA HA HA
FLUSH...
MIGHTY MORPHIN' GENITAL CENSORSHIP
OH DEAR!
Fennel lies out cold on a bathroom floor with bludgeoned knees and a buck backside! Will Tonya get away with this? And where's that POWER MOLE?! Find out later!

Precious Life

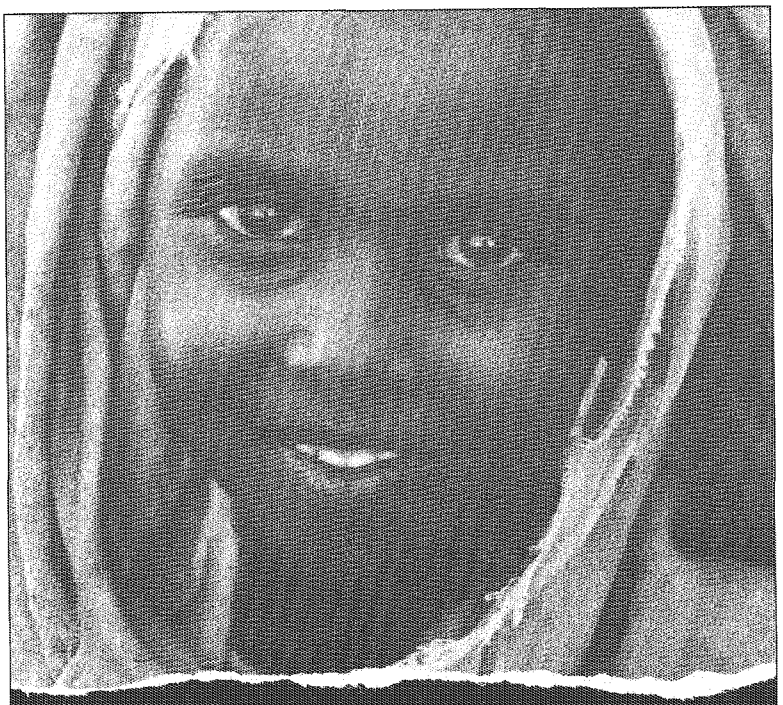
Not too many years ago, this nurse was a patient at St. Jude Children's Research Hospital. She fought a tough battle with childhood cancer. And won.

Now married and with a child of her own, she has returned to St. Jude Hospital to care for cancer-stricken children.

Until *every* child can be saved, our scientists and doctors must continue their research in a race against time.

To find out more, write St. Jude Hospital, P.O. Box 3704, Memphis, TN 38103, or call **1-800-877-5833.**

ST. JUDE CHILDREN'S RESEARCH HOSPITAL
Danny Thomas, Founder



She didn't ask to be hungry.

War, drought and famine engulfed her country, until the support of Americans like you helped us save her. But there are still many more who desperately need your help. Please care. **1-800-521-CARE** CARE

AIM HIGH

IF YOU'RE THINKING SCIENCE OR ENGINEERING, THINK AIR FORCE ROTC.

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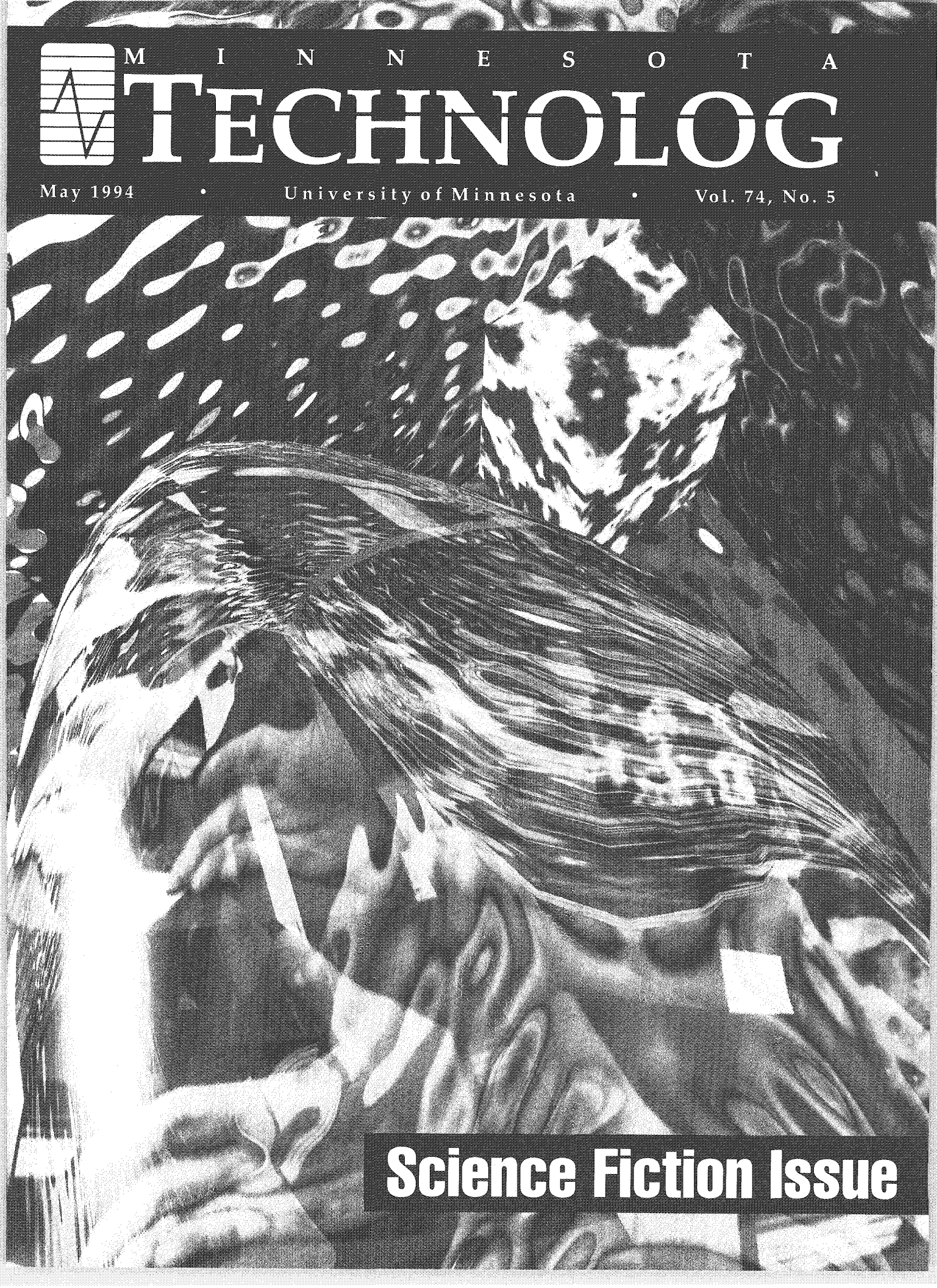

Science Fiction Issue

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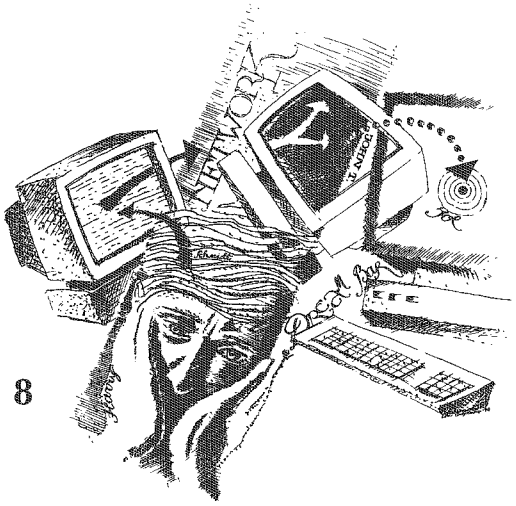

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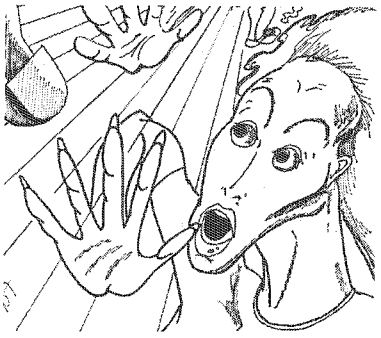

12

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First Place

Second Place

Third Place

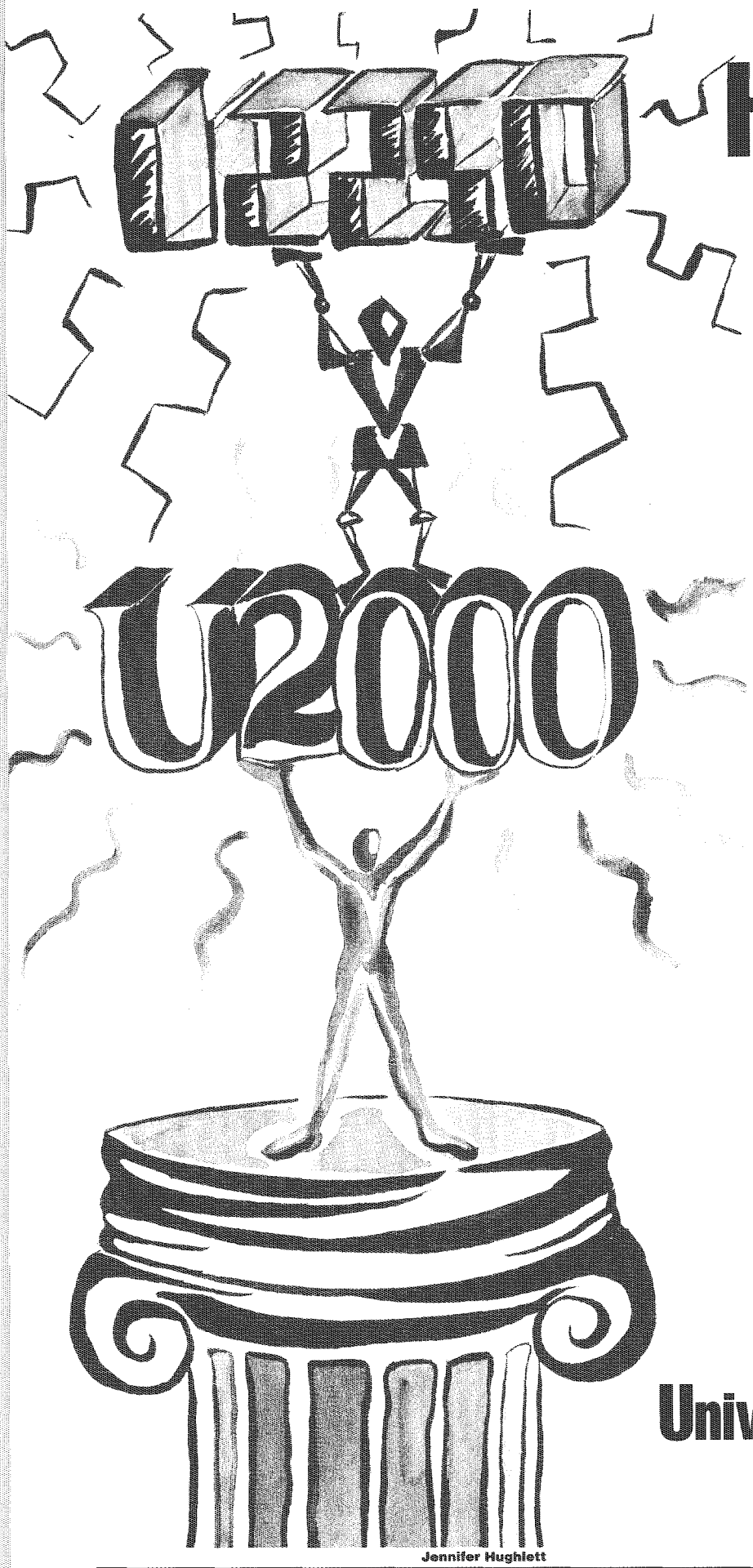
Honorable Mention

Honorable Mention

About the cover . . .

Jerome Thelia interprets the future with an image straight from the Toaster.

Departments



Jennifer Hughlett

University 2250: To Boldly Go...

How do you go about writing an editorial in a Science Fiction issue? How do you do Heinlein, Asimov and Crichton one better?

Answer: rewrite University policy.

I picked up a copy of University 2000, our school's proposal to straighten up and fly right, and thought: why stop at 2000? Why be trapped by time? Why not go further, higher, stronger and get creative? Why not write UNIVERSITY 2250?

First, let's set the scenario for University 2250. Imagine an IT of the future: on-line registration. Heck, online classes and labs. You won't even need to swing by the U except for your biweekly, mutually-respectful one-on-ones with the full professors who will be teaching all your classes.

And computer access? Don't worry about buying your own. In the 2250's, computers are basic—like chairs. The U will provide all students with one. Or more, if needed.

Those pesky core requirements? Not to worry. Electronics went from palmtop to braintop so long ago you've been implanted with a processor since first grade. No more calculators—you do the problems in your head.

Quirky history buffs write about what would have happened if Bill Gates had gotten the people skills application implant. Microsoft might not have lost out to IBM back in the 2000s.

But your Mom and Dad are so retro, though, they're still stuck in the 2230s. Mom just had her first electronic implant installed a couple months ago—she wanted to be able to converse easily with your in-utero baby sister. There was just no way around it. Dad's still resisting though. Railing on about foreign bodies.

Herewith, my proposal. I'll compare U 2000 with U 2250. You be the judge of which is better.

U 2000 proposes five strategic areas to

consider: "research, graduate and professional education, undergraduate education, outreach and access to University programs and finally a user-friendly University community." Yes, user-friendly was the exact term.

Research

U 2000: "Recruit, retain and reward world-class researchers."

U 2250: "Contact, conserve and converse with the solar-system-wide news groups hooked up to this and every other school."

Graduate and Professional programs

U2000: "A hallmark of graduate and professional education at the University of Minnesota is that it emanates from research, scholarship, and artistic activity. . . excellence in graduate and professional education is based on participation in the creation of knowledge." (Unless, of course, it's film-related knowledge, or they wouldn't have axed Intermedia Arts.)

U 2250: "Knowledge is not created, it is discovered and shared with anyone who wants it, for free."

Undergraduate Education

U 2000: "The University must provide a high quality undergraduate education in a nurturing environment. . . and must provide congenial (Congenial. Isn't that a great word?-ed.) support systems that help students move through their academic programs from admission, to orientation, to registration, to advising, to graduation, to placement."

U2250: "Since all students are equally valued, regardless of year in school, faculty are available to all. Although research will continue as in the past, teaching will be valued even more so. Faculty will mentor students throughout their job placement."

Outreach and Access to University Programs

U 2000: "The University, as a land-grant institution with its largest campus located in a major urban area. . . has a special responsibility to meet the needs of a growing and increasingly diverse population."

U 2250: "The University, as a baud-grant institution, has nearly completed its mission to provide access keyboards to each resident of Minnesota. Since the concept of 'diversity' is drastically altered in a cybernetic environment, the University will continue its mission to build community electronically."

A User-Friendly University Community

U 2000: "Educational excellence depends on the creation and maintenance of a humane and physically appropriate environment in which all members of the academic community can thrive and work to their fullest potential."

U 2250: "Although everyone with keyboard access is a member of the academic community, professors as full-time participants in this community are responsible for academic "house calls"—electronically or in person— to ensure an equitable learning environment for all the residents of Minnesota."

U 2250: Now *that's* science fiction.

CORINNA NELSON

TECHNOLOG

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Off the Shelf: Science Fiction 1994

Tamara Lubic

Uncle Hugo's Science Fiction Bookstore in Minneapolis is "the oldest science fiction bookstore in the United States," according to Manager Scott Imes. (The store celebrated its 20th birthday March 2.) Imes is also editor of the science fiction and fantasy genres for What Do I Read Next? A Reader's Guide to Genre Literature, an annual reference work published by Gale Research. Part of his job is "reading" (he says scanning is sometimes sufficient—even preferable) 400-500 books per year, with a team of readers who help out. In 1993, he annotated 200 science fiction and 200 fantasy works for the guide. Below, Imes shares some thoughts on the sci-fi world.

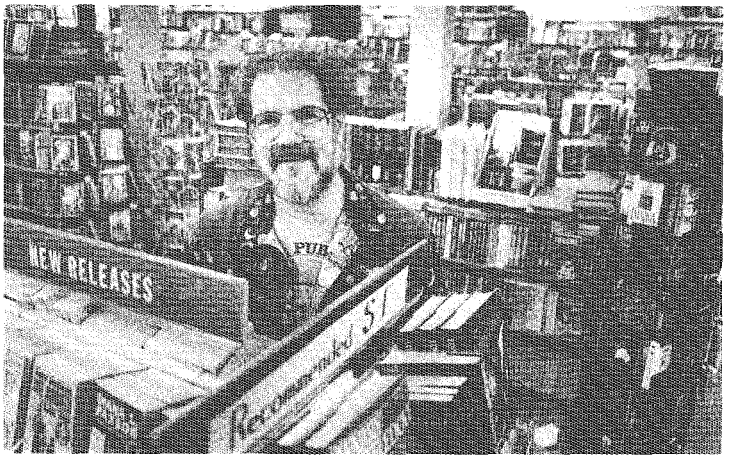
Q: You read and edit both fantasy and science fiction. How would you define fantasy?
A: We sometimes say that science fiction is "rockets, rayguns, robots and beings with extra body parts," and that fantasy is "elves, dwarves, epic quests, legends, mythology and magic." But that's a wet-finger-in-the-wind description.

Q: What trends do you see in sci-fi?
A: This last year, there were more than 250 new, meaning never-before-published, science fiction novels, up from the previous year. The number of titles is up, even though the number of publishing houses is down because of increasing corporate takeovers. There's an awful lot of fantasy being published—slightly more than science fiction. In general, the quantity of fantasy is higher; the quality of science fiction is higher.

The new material is oriented more toward hard science. Technology, computer science, artificial intelligence and biology are extremely strong, and in the last couple years, science fiction frequently incorporates humor. There's also been a tendency toward longer fiction, what we call "door-stop fiction," and a tendency toward long series. Editors hate the words, "The End."

Q: What's a good read?
A: I highly recommend "Snow Crash" by Neal Stephenson. It's about a computer virus that goes after hackers and a simultaneous neural-linguistic virus around since the fall of Babel—ancient Sumerian religion and virtual reality come together. [Imes describes the book as a satire that "can pull science fiction's leg pretty hard."] It's very visual. Several of our customers have bought two or three copies at a time for friends, to explain what virtual reality is.

Another book strongly oriented toward computer science that I'd recommend is the



Michael Branscom

Scott Imes has worked at Uncle Hugo's Science Fiction Bookstore on 28th and Franklin since the late '70s. The store is known for its wide new and used selection -- from a StarTrek section to up-and-coming titles about computer viruses invading everyday life.

1993 Hugo Award winner by Vernor Vinge, "A Fire Upon The Deep." You could call this "space opera." It's about what happens when a human archeological expedition unintentionally reassembles a malevolent artificial intelligence thought wiped out for thousands of years. It wakes up hungry and decides to eat the universe. This one features a millions-of-years-old computer network called by users, "the net of a million lies."

Q: What percentage of your customers are women?
A: I'd say it's approaching halfish. This is distinctly different from 30 years ago, probably in part, I'd guess, from "Star Trek." In the '70s, about the time that "Star Trek" conventions began, [science fiction] started to integrate the sexes more. Most of my favorite sci-fi writers at the moment are women. They seem to be producing the best work.

Q: Are there misconceptions or stereotypes about science fiction that you would change if you could?
A: I would change English teachers' prejudices. I would award them open minds with which to determine which science fiction is good (about 10 percent according to Sturgeon's Law) and which is bad. English teachers seem to think that 100 percent of it is bad. But science fiction offers some leading-edge writing. There is a tendency toward darkness and a lot of sloppy writing, but the best writers try really hard to craft their writing in such a way as to find solutions, even if they're not always pleasant ones.

Q: What are some positive things science fiction offers?
A: It allows safe exploration of dangerous ideas. It allows a person to view technology which will soon be available, since writers and technicians read the same scientific journals, and the lead time on writing is much shorter than the lead time on technological developments. That's why Willey Ley, co-founder of the German Rocket Society, said that science fiction is so often predictive. Science fiction is accessible to all ages; older people don't have a leg up on understanding it. If it's good writing, the ideas are fresh and new, and it keeps a person young in mind, young in spirit. And it's fun.

Q: What do you anticipate seeing in the next several years?
A: I assume we'll see more biology as we begin to undergo the biological revolution that physics underwent earlier in this century and that chemistry underwent in the last century.

Q: How do you account for the lukewarm success in bringing science fiction (with "Star Trek" a possible exception) to television, for example, "Max Headroom" and "Wild Palms"?
A: I say, "Burn your television." Science fiction is best when read. Television is too small in scope and mind to encompass science fiction. Its stage is too small. "Max Headroom," in its first season, was just about as aggressively science fiction as you can get and still keep the audience. It was marvelous. The second season they dumbed it down.

I think the problem with putting science fiction on television is that it doesn't smell right, doesn't feel right. When you read science fiction, you get lost in your senses. Television draws you in, but it gives you everything. It literally doesn't allow your mind to generate the images. Marshall McLuhan called television a hot medium, and it is, but I think a cool medium is better for involvement. It's a matter of involvement and commitment. With a book, people do get involved and committed. Not that it won't be possible to do this with virtual reality; maybe it will. Maybe we will fool ourselves and become more involved as technology gets better.

Note: Imes tells Technolog that getting to Uncle Hugo's from campus is easy: Take a #2 bus down Franklin and a #5 down Chicago. It's at 2864 Chicago. Or call 824-6347.

Imagined Futures: Prediction in Science Fiction

Tracy Bauman

Want to see the future? Forget about calling your psychic, looking into the nearest crystal ball or reading today's horoscope. Instead, grab some science fiction and dive right in. SF readers knew about space travel and moon-walking years before Apollo 11 landed and Neil Armstrong took one giant step for mankind.

Back in the late 1800s Jules Verne speculated about moon travel when he wrote "From the Earth to the Moon" and "Around the Moon." In these stories, three men, Barbicane, Michel Ardan and Nicholl, were propelled toward the moon in a projectile named Columbiad, "the vehicle which was destined to carry the three hardy adventurers into space." The men in Verne's story left from "Tampa Town, Florida." A newspaper account of the trip might have read like Verne's prose: "An immense spout of fire shot up from the bowels of the earth as from a crater. The earth heaved up, and, with great difficulty, some few spectators obtained a momentary glimpse of the projectile victoriously cleaving the air in the midst of the fiery vapors!"

July 16, 1969, saw another launching of three men into space with the moon as their target, this time for real. Astronauts Armstrong and Aldrin landed the lunar module Eagle on the moon while astronaut Collins orbited the moon in Columbia. Both crews of space explorers departed from Florida and splashed down in the Pacific. Verne's characters, however, were engrossed in a game of dominoes when they were found.

Need more information about moon travel? Don't pick up the newspaper. Author Arthur C. Clarke's plan for getting news in the future was not far off base. He envisioned modern news technology as far back as 1964, when he wrote "2001: A Space Odyssey": "[H]e would plug his fools-cap-sized Newspad into the ship's information circuit and scan the latest reports from Earth. One by one he would conjure up the world's major electronic papers."

Although Clarke could be describing today's news databases, his character was speeding away from earth "at thousands of miles an hour." Obviously his predictions didn't all come true. But Clarke did note the importance of change, a significant factor in science fiction: "Floyd sometimes wondered if the Newspad, and the fantastic technology behind it, was the last word in man's quest for the perfect communications....It was hard to imagine how the system could be improved or made more convenient. But sooner or later, Floyd guessed, it would pass away, to be replaced by something as unimaginable as the Newspad itself would have been to Caxton or Gutenberg."

But wait, SF writers may not agree with being called fortune-tellers, and SF readers would probably point out that few of the many predictions made in science fiction stories actually come true. "To people who don't read science fiction, the most amazing thing about the field is its apparent ability to predict the future," wrote Isaac Asimov in an introduction to his essay "How Easy to See The Future." He described science fiction as "that branch of literature which deals with the reaction of human beings to change in science and technology."

For Asimov and other writers in the genre, extrapolation is key. Author Lester del Rey wrote that "[m]ost of the predictions of science fiction were made by taking some idea from science and speculation on how it could be developed into engineering reality."

How many times while stargazing have you focused on the perfect star, only to find it moving across the sky out of your vision? When Clarke wrote about satellites in the 1950s, the "stars" didn't move. "Yes," his character noted, "a lot has happened in the last 40 years, and sometimes I'm afraid that you people down on Earth take the space stations for granted, forgetting the skill and science and courage that went to make them. How often do you stop to think that all your long-distance phone calls, and most of your TV programs, are routed through one or the other of the satellites?" In "The Other Side of the Sky," Clarke looks back at 1957 from 40 years into the future. Again, after reading the next part of the story, SF enthusiasts would hasten to note that Clarke was too optimistic: "And how often do you give any credit to the meteorologists up here for the fact that weather forecasts are no longer the joke they were to our grandfathers, but dead accurate 99 per cent of the time?"

Early SF writers didn't confine their ideas to technology. In the process of moving their characters through space and time, authors sometimes imagined such everyday objects as waterbeds, shopping malls or credit cards.

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Consider Robert A. Heinlein's story "Waldo." The main character, Waldo, has to travel from his free-orbiting space house to earth without endangering his already precarious health. Voilà! The first waterbed: "The tank was not a standard deceleration type, but a modification built for this one trip. The tank was roughly the shape of an oversized coffin and was swung in gimbals to keep it always normal to the axis of absolute acceleration. Waldo floated in water—the specific gravity of his fat hulk was low—from which he was separated by the usual flexible, gasketed tarpaulin."

The next time you drop by the Mall of America, try to picture your surroundings as this visitor from 1888 did. "There was nothing in the exterior aspect of the edifice to suggest a store to a representative of the 19th century." When the main character in Edward Bellamy's "Looking Backward 2000-1887" awakes from a 113-year sleep, he is introduced to life in the year 2000. At one point, his hosts introduce him to the new way to shop. "I was in a vast hall full of light, received not alone from the windows on tall sides, but from the dome, the point of which was 100 feet above. Beneath it, in the centre [sic] of the hall, a magnificent fountain played, cooling the atmosphere to a delicious freshness with its spray....Around the fountain was a space occupied with chairs and sofas, on which many persons were seated conversing. Legends on the walls all about the hall indicated to what classes of commodities the counters below were devoted."

You can further imagine his surprise when his host handed him a credit card, "a piece of pasteboard," and explained its use by telling him: "the value of what I procure on this card is checked off by the clerk, who picks out of these tiers of squares the price of what I order."

So what if your chance of discovering the one accurate prediction in a sea of SF postulations is less likely than finding the lost city of Atlantis? There is still a remote chance that the next SF book you read may hold a blueprint for tomorrow. If you still don't believe, consider how crazy walking on the moon would sound if you had just left your four-legged transportation in the stable.

Sources

Asimov, Isaac. Asimov on Science Fiction. Garden City: Doubleday, 1981.

Bellamy, Edward. Looking Backward 2000-1887. Belknap Press of the Harvard University Press, 1967. (first published in 1888).

Clarke, Arthur C. "The Other Side of the Sky" in A Treasury of Great Science Fiction, Vol. 2 . Anthony Boucher, ed. (orig. copyright 1957 by Royal Publications).

2001: A Space Odyssey Penguin, 1968 (based on screenplay by Clarke and Stanley Kubrick).

Del Rey, Lester. The World of Science Fiction, 1926-1976. New York: Garland Publishing, 1980.

Heinlein, Robert A. "Waldo" in A Treasury of Great Science Fiction, Vol. 1 Anthony Boucher, ed. (original copyright 1942).

Verne, Jules. From the Earth to the Moon and Around the Moon.

The Adventure

He tossed another crumpled sheet of toweling on the pile nea the trash can, shoved the restroom door open, and then let it slam behind him. They scattered into alternate hallways as he marched down the hall. The "they" always seemed the same; every year brought in names and faces just like the year before. Jeremy C. replaced Mister Dobbs as the class clown, or Julie Something-or-other replaced that Cynthia girl as the tough girl. They always seemed the same.

Of course, each year got worse. Used to just be smokin' and *maybe a little bit of drugs*, but now the stakes were so much higher.

Damn! Damn! Damn! Shouldn't have had that cup of coffee.

He noticed they had peeled various letters of his last name o the classroom door. Mr. Harry Schmidt was no longer teaching there; some species of human waste was. He felt like that abo then.

The class bustled more than he had hoped. Well more than half the students hadn't even hooked up to their terminals yet, which actually lightened his mood rather than disturbing him.

"Julie," he called—with no response—to the leader of a group of gossiping girls. "Julie!"

"My name ain't Julie," the girl retorted without turning to him "It's Jasmine, Harold."

"Jasmine, please hook into your terminal and begin today's assignment. I leave the room for two minutes and you girls set the U.N. council." He added, "Now get to work," with as much authority as he felt like working up.

His mind was not on whether Jasmine or anyone else was chattering away; he truly could not have cared less. Not that I was a bad teacher or without concern for his students but precisely the opposite.

He glanced quickly over the rest of the class with just the occasional nod or finger to direct the wandering minds. He noted those consumed at their terminals, making snap judgments based on past experience and individual actions.

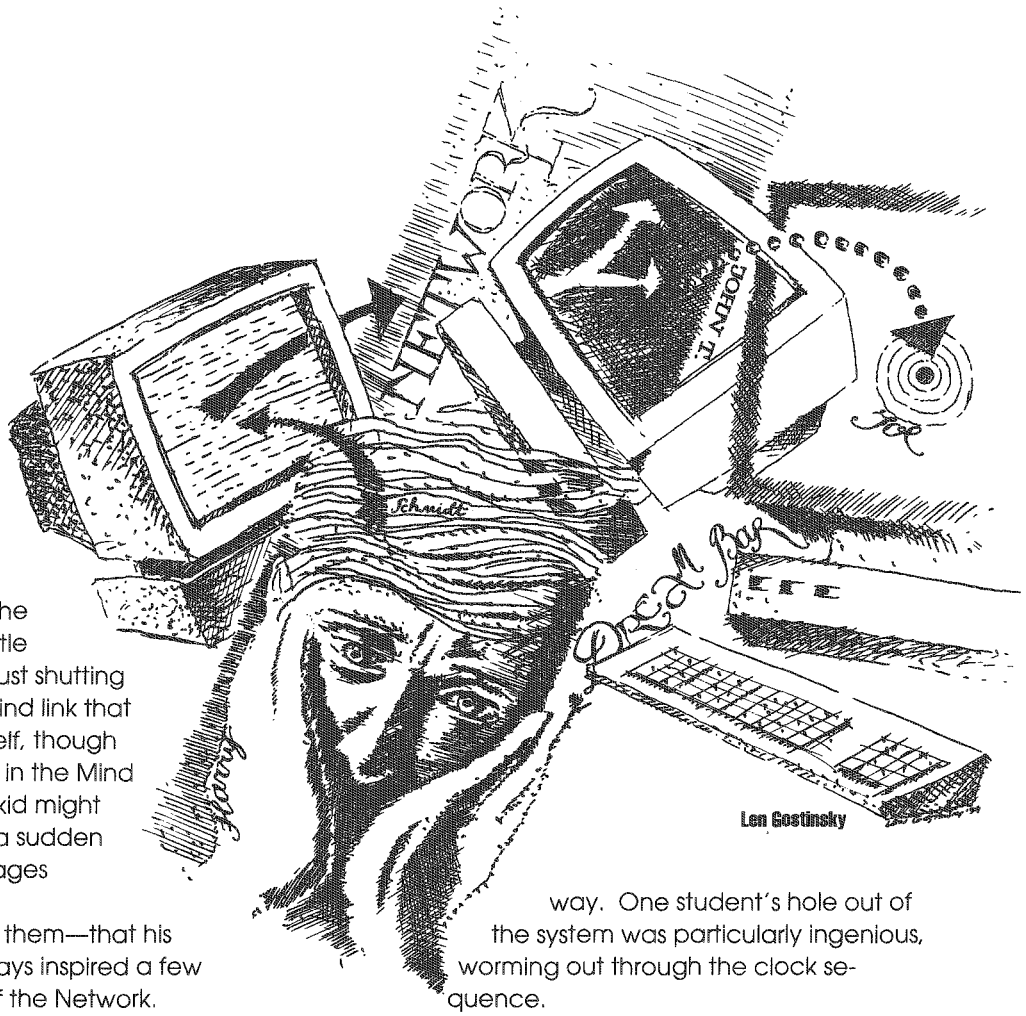
Carl, John B. and Denise are consistently at work, no worries there. James and that new girl, Donna I think, both seem too dumb to get out of the system, but John T. has always had a group of them off somewhere in the Network, finding trouble o making it. John, well, at least he looks occupied. . . Still wish I could reach him. But that's not the immediate threat. I gotta get John T. and Co.

He slipped into his leather desk chair with some confidence The desk was black, glossy, impeccably organized—with the exception of his poetry manuscripts that always somehow resisted any filing—and the terminal sat, humming quietly in th corner.

Damn! Shouldn't have had that last cup of coffee.

f John T.

Robert Holton



Heck, might as well use the visor: teacher's privilege.

The students were limited to a 'Rap-round' monitor box, open at the top so he could observe everyone to some extent, but John B. always slipped down into the corner and became nearly invisible. The headsets attached to each box were linked to the main console, but that really offered little control. If the kid was in the Network, just shutting down the sound wouldn't break the mind link that formed. Shutting down the monitor itself, though possible in extreme circumstances—as in the Mind Plague of '08–was not advisable. The kid might suffer permanent brain damage from a sudden cessation of activity in the neural passages linked into the computer.

Schmidt knew he had to go in after them—that his leaving the room, however briefly, always inspired a few kids to sneak out of the system and surf the Network.

These school computers should be locked off from the rest of the Network. They should put some kind of safety net on a bunch of teenagers on an electronic high wire.

'Shoulds' never get anything done; he knew that and began rapidly tapping the sequences to enter the system. Once inside, the visor and the advanced teacher's program created a perfectly-defined computer image within the computer classroom.

God, I love the ties this program gives me!

He saw five or six of the students working diligently in the system, mere blue clouds that absorbed information. He stepped between two other sets of clouds that were exchanging more with one another than with the system, and knew he appeared in stern expression in their boxes.

His fingers tapped again across the keyboard, not only because he hated using the voice module, but because if the students heard his key to exit the system, he'd have his present problems multiplied tenfold. The visual representation of the information structure slid apart ever so slightly, and he stepped through. For a moment the projection program had to disentangle itself from the system to allow him to maintain his present visual form, which he felt was invaluable in terms of creating respect as he corralled the vagrant students.

He quickly found the exit points and recorded them instinctively, knowing full well they would always find a way. One student's hole out of the system was particularly ingenious, worming out through the clock sequence.

Quick thinkers when they don't need to be.

He followed the trail of information they had left, and he thanked God they were not more adept at Network travel. He entered the main building menu, which was packed with novice users. The more advanced user quickly learned to avoid the main menu, which—as all things created to ease confusion and tension do—had created both in abundance. The concept of a single program to funnel every Network user was noble, but really very impractical. Still, children didn't know this, or at least he was trusting in that. The clock hole still left him slightly uneasy.

He maintained anonymity as he passed through, making cursory checks of the log-in lists at the most typical hangouts. The Dream Bar listed three codes he had tracked from the system, which no doubt belonged to the pseudo-retro-hippie-type guys that sat furtively in the corner of the classroom. Naturally logging in under his common code, he was slightly embarrassed by the program offering him "the usual," and in fact, he'd had a difficult time convincing the hard-sell software that he wasn't there for a "meditation trip," as they called it.

The boys stuck out like kids in a laboratory, which wasn't too far from the truth. He collared them quickly, and without much surprise to either party. He stuck a recall and lock program on them and let them slip

innocently back to the system.

He found John T. and Co. next door, so to speak, in the Network, still within the feely program district. John T. was a good kid, just knew a little too much to handle. He was laid out on a beach visualization program, and had obviously convinced four of the girls who came along to participate in his little fantasy. Of course, they probably didn't put up much of a fight against being visualized in the Network as famous models. A faint ticking beat in John T.'s chest, a humorous reference to his escape route.

You cocky son of a buck! If I didn't have to teach you, I'd have to join you.

One major limitation to John T.'s little computer fantasy: It was a sampler program, an interactive brochure. While it provided kicks for the kid, it was easily traceable. The teacher walked up to his image and kicked a little sand in his visual face. When the static cleared, he stood up smiling.

"Hey, teach." He definitely hadn't kept his slightly shaky voice here.

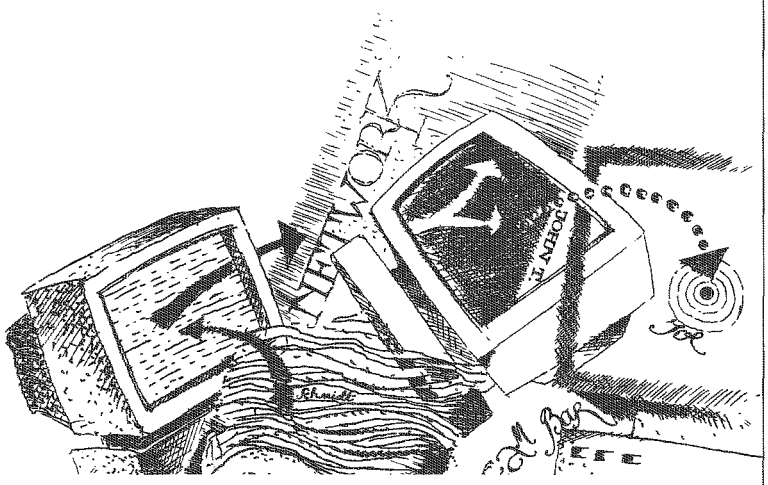
"Sending you back, John,"

"Gotta catch me first!" and his image dissolved.

The teacher was shaken; his hands tapped nervously on his impeccably clean black desk. His image turned to the four girls, and he slapped on the recall and lock programs. He pulled out of the vacation program. His fingers tapped louder. The students who had sat around idly gossiping looked up to him fidgeting in his desk chair and then returned to their discussion on the new shoe style.

Where'd he go? The kid isn't that good. Just disappear from a visual program without any trace. I couldn't do it that quickly.

He pulled back even further, to the main menu. After a second check of the logs, only John T. remained in the Network.



Have to start over at the clock. Take it easy; you got time. That little bastard! Is he playing with my mind? He must know I have to get him out of here before class ends. Did he choose the clock route on purpose?

John T. was a con man—con boy might be more appropriate—clever, witty, with a few very promising completed assignments. But he lacked the expertise and the flair for the dramatic that this escape had taken. The teacher knew that. His fingers tapped more quickly on the desk.

He dialed his home number and retrieved a program that his ex-ex-girlfriend had used to track him down.

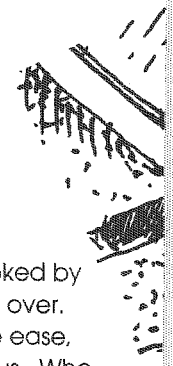
"Knew that whole mess would yield something decent," he thought.

The search program picked up the old trail, which now began to get more erratic and to climb deeper into the Network.

He kicked in the search program and limited the parameter with hesitation; if he set it too wide the search would waste time, but he feared underestimating his prey. While he was mentally compromising the limits, John T. appeared.

"Hey, teach, bet you didn't expect th...." he disappeared in mid-sentence.

The teacher quickly surmised the reason and set the search program to follow John T.'s trail. John T. wasn't the brains behind this one. Whoever had the smarts to cut off his pompous little taunt knew the search would be on. Some dealer, hanging around the edges, pushing kids where they had no right going.



Well, this guy's mine. I'm going for charges on this one. Run me all over the Network, set my students up on nude beaches, taunt me, then hide from me, when I'm already having a highly sub-par day. Yeah, charges on this one, buddy.

The search program stopped suddenly, choked by a virus that simply repeated the time, over and over. The teacher cleaned the program with relative ease, but was still left puzzled by the nature of the virus. Whoever was behind this joy riding wasn't the typical hack. The virus and the clock hole both ignored all adherence to programming logic, which made them even more difficult to crack. Once the error was spotted, he easily disabled the program, but the tension was knotting his stomach. His hands gripped the side of his impeccably clean black desk until his knuckles were white.

The search program picked up the old trail, which now began to get more erratic and to climb deeper into the Network. A couple of double backs and into a major

corporate mail room, then up the corporation system, from memos to documents to files to secret files. Here the prey stopped for a moment and then split.

John T. appeared once more.

"Teach, you got to get him. He's going crazy, I think," spoken in the cool monotone of his computer character.

"Who?"

"John B., man. It's John B."

The teacher slid the recall and lock into John T.'s program and reset the search program, held up at the split. The program followed John's trail.

"John B.? I didn't even think he hooked into the system, much less knew how to get out. 'Mentally deficient' was the stamp on the bio. God, if he's this good, he probably searched the bios. This is not good. Where the hell is this kid gonna go?"

John B.'s trail kept digging deeper into secret files, and the program blindly followed. Had John B. known the slightest thing about closing the holes he'd opened, had he ever been chased before, the teacher would have had no chance. The red glow of the visual around him flooded all the documents as soon as the entry was detected. The security program depended on the files being rendered unreadable, and the intruder would soon depart. But John B. didn't come to read; he came to hide. Like a chameleon, his trail began to resemble the static that surrounded the invaded files. The program followed various leads, each of which the teacher could judge was not the real one. The program still had an unmistakable uniqueness to it; it would never blend in completely.

The program marched through the files methodically once inside. Constant acknowledgment programs collided with his, demanding identification, but he ignored the constant flashing requests. Finally, inexorably, the search collapsed to one bank of files. John B. no longer fled: he sat, blending slightly with the surroundings, but unmistakable to the end. The teacher slid the recall and locked the program in. It was rejected.

Son of a b-.

He attempted again and was rejected. Stalemate. He backed the search program off slightly. John B. followed. He would not be forced back to the system, but he would come. The teacher shut the search program down.

Don't run, baby—don't you dare.

John B. followed straight behind, followed the teacher right up to the door to the system, and then darted off.

Damn! Not again. I'm not paid enough to take this sh-.

The teacher, still looking in upon the system, contemplated returning without John B. But he had to find him. As he turned to begin the search, he caught a glimpse inside. John B. stood just inside the door, waited a moment, and then returned to his desk through the clock hole.

As if by some power of thought in that confluence of electronic data, the buzzer indicated the end of the period.

He shut down his projection program and exited the system. The visor was damp as he removed it, and the stack of poetry papers had fallen to the floor. The class was quiet, but a much different quiet from this morning. He welcomed it. He smiled at the students as they left, but not proudly, or very happily, for that matter. John T. searched his face, obviously shaken. The teacher smiled, hoping the effect was reassuring. John B. left last, without a word, without a look. He seemed helpless, the same John B. who walked in and out every day, never quite blending in.

Inevitable

Gregory Hawkins

Bill wouldn't stop. With every backward glance, he thought about the oval-shaped thing that just appeared from nowhere and he willed himself to run faster. The ragged breathing and pain gnawing at his side were ignored, but his feet couldn't maintain his mind's pace. They faltered, and Bill crashed to the sidewalk. His nose crumpled, and his forehead was cut by a discarded bottle cap. He tried to get up, but his vision faded to black.

Near Bill's body, a portal of gray smoke took shape and lost its translucence.

"I should've known," William said. As he looked from his laboratory, through the time gateway, and down on the young man he had been 25 years earlier, his finger traced his crooked nose. "I'm going through." William passed through the portal, rippling like a pond disturbed by the first drop of rain. He staggered out the other side, feeling a wave of nausea rush over him, and almost stepped on Bill's unmoving body. Sharon followed William into the past, time shifting with considerably more grace.

"Unbelievable. Time travel *is* possible...," said William. "This place is *just* like I remember. The grocery store, the old theater...," Lost in memories, he wondered down the street.

Sharon was speechless. Her eyes danced around the world of her youth, then settled on the young man unconscious at her feet. His face seemed oddly familiar and seeing him sent a chill down Sharon's back. "Billy," she whispered and the memories flooded back. When Sharon was 30 years younger, she and Bill had been high school sweethearts. It probably could have led to marriage, but she accepted an engineering scholarship at MIT and Bill decided to attend the local business school. Their worlds were too different and they drifted apart, but Bill never lost his place in Sharon's heart. They lost contact for 20 years, but then two years ago, he called her and wanted to meet. Bill, now calling himself William, showed Sharon to one of the best nights of her life. She fell in love all over again. She didn't discover his true intentions until later.

William ran back up the street. "It's almost dawn. We'd better bring him back to our own time before anyone sees us." They dragged Bill's body toward the portal, but the gateway had drifted slightly and was now about a meter off the ground. "Damn! Sharon, I'll boost you through and you can fix this thing."

Sharon kicked off one shoe, raised her foot, and William cupped his hands beneath it. He heaved her up and through. From his vantage point, perpendicular to the edge of the two-dimensional gateway, it appeared that Sharon sailed into the air then rippled into nothingness.

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Although the portal remained stationary in the laboratory, Sharon was having difficulty forcing it closer to the ground in the past. Following the

Robert Sublaga, Jr.

blueprints and programming notes William had given her, she successfully built a prototype shifter, but neither of them really knew how it worked. She tried adjusting the fine coordinate control, but nothing seemed to happen so she turned the coarse control.

William turned his face from Sharon's *pleading* eyes and noticed the damaged shifter for the first time.

• • •

In the past, the gateway leaped into motion, and flew silently down the street. Although William couldn't see the portal back to his own time, he knew it was there. The street light on the corner suddenly lost a three meter section of its post. Sparks flew as the disembodied light winked out and crashed to the ground.

Before William could decide what to do, the portal hurled back toward him. Only seconds from cutting him off at the waist, it stopped and sank to the sidewalk. He lifted Bill off the sidewalk and prepared to take him into the future, when the gateway sunk further until only a waist-high arch was visible above ground. He set Bill back down and pushed him through the portal.

• • •

The lamppost could've killed Sharon. It flew through the time gateway and into the laboratory with tremendous velocity and smashed into the time shifter, scant centimeters from where she was standing. Most of the controls were destroyed, and she was barely able to stop the portal before it hit William. Now, she couldn't control the gateway at all.

Sharon turned away from the damaged time shifter and saw Bill's still unconscious body ripple through the top of the gate and tumble almost two meters to the floor. All thoughts of the damaged time shifter and her near-death experience were gone.

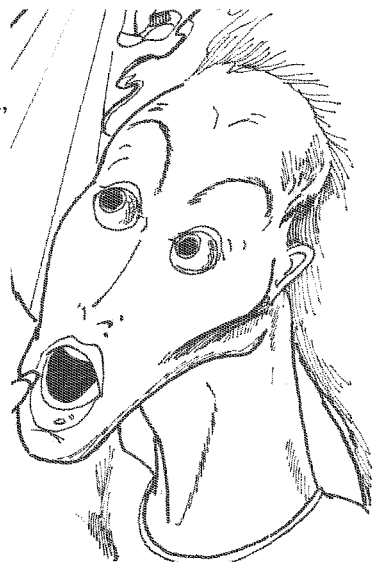
William followed Bill through the gate and landed heavily on the laboratory floor. "Sharon, what in the hell happened?" William asked as he slowly got to his feet.

"Oh my God, do you think Bill's okay?" Sharon asked as she approached him.

"Relax. He can't be hurt too badly, I'm still okay aren't I?"

"What does that prove?" Sharon asked as she went to Bill's side and wiped his face with a cloth. "William, I've been thinking. Maybe we should just put Bill back in his own time and forget this whole thing. It's just not right. You don't know any more about time shifting than I do. Maybe what happens to Bill while he's here in our time won't happen to you. How do you know? I'm really starting to worry about this. It isn't right." Sharon tried to collect her thoughts.

William turned his face from Sharon's pleading eyes and noticed the damaged shifter for the first time. "My time shifter..." He ran over to the pile of twisted metal and plastic which used to control the portal and tried to survey the extent of the damage.



Robert Subiaga, Jr.

"William, I'm serious. I think Bill's really hurt. This was a bad idea and I should never have agreed to build that machine for you," Sharon said as she left to get the mediconsole from another room.

William went over to Bill's still unmoving body. He looked down at the youthful man then glanced across the room and saw the reflection of his own aging face. *What happened to me?* William thought. *Back when I was him, I had the world at my feet. I was going to do it all.* "But guess what Billy-boy," William said. "Unless I help you, you won't do it all. I sure didn't. The life of an accountant is very uninteresting. It's downright dull, boy. I worked for Triton Industries for the last 10 years. Sitting in a half-wall office filling out hundreds of forms day after day just does something to a man. When I heard about the time shifter they were building, I guess I just cracked." William checked to be sure that Bill was still unconscious then continued, "I stole the plans, Bill. But, just think of how good it will be. If you take the blueprints back and build the machine first, we'll have a great life. We'll be rich, we could probably even marry Sharon while she's still young. She'll never need to know what we did. I can't wait..." William was interrupted as

Sharon re-entered the lab.

"William, let's stop this now," Sharon said. "We could put Bill back and return the plans. We haven't done any real damage yet. Let's just forget the whole thing. Please..."

"Sharon, don't start in on this again. We're sticking to the plan," William said. A flush of anger touched his face.

Sharon switched on the mediconsole, and allowed its blue-energy plasma to flow into Bill's injuries. In a few moments, his breathing eased and scabs formed over the wounds on his face and arm. "I'm serious William. Look at how much good we've done Bill so far. He broke his nose trying to get away from us and now we've kidnapped him. This isn't right."

"I can't change what I've already done. I'm doing this with or without you," William said, his voice rising in volume.

"It'll have to be without me," said Sharon, her voice suddenly shaking. "I've given this a lot of thought... I wasn't sure before, but now I am. You have to make a choice. If you continue with your plan, I'm leaving. You'll never see me again." Sharon looked deep into his eyes, but when he said nothing, she turned and started to leave.

Rage and sorrow exploded in William's mind. "Fine! Go," he yelled and pushed her toward the door.

Sharon lost her balance and hit her head on the edge of the broken time shifter.

"Sharon," William screamed as he ran over to her. "I'm so sorry. I never meant to..." He touched her face, but she was unresponsive. "You don't understand. This *is* right. For both of us. You'll see," he whispered in her ear. He lifted her limp body off the floor and gently set her in the hall. "You'll see." He stepped back into the lab and locked the door behind him.

After a short while, Bill began to regain consciousness. His outward wounds had completely healed, but his nose would never again be straight. William noticed he was awake, stopped fiddling with the time shifter, and said, "Good, good, I didn't know how long you would be out. You had a pretty nasty fall."

"Who... Who are you?" Bill asked.

"To put it bluntly, *I* am *you*," said William.

"What, what are you talking about?" Bill's head was still swimming. He struggled to a sitting position.

"This might be hard to accept," said William. "But, I am who you will be in 25 years. Look at me closely. A few pounds heavier, more wrinkles, and less hair, but I'm you. I've brought you into your future."

Bill looked around the room and found most of the electronic gadgetry unrecognizable, but the laboratory itself seemed normal. "You're lying."

"It's true and I can prove it." said William. "Think back to elementary school. Remember when our sister, Julie, took the love note we wrote for her friend Kim? We knew a 12-year-old would never be interested in a fourth grader, but we dreamed anyway. Remember how Julie showed it to all her friends, and how they laughed? Even Kim? The next day at dinner Julie got sick, really sick. Mom and dad had to take her to the hospital. They didn't know what was wrong, but we did. We made her sick, and it only cost us a quarter."

Bill saw the portal for the second time. This time he didn't run away in *fear*, but he wanted to.

Bill shook himself from the memory. Mushrooms, Julie was allergic to mushrooms. In his anger and shame, he bought some mushrooms. Just one in with her dinner did the trick. He *never* told anyone about the incident and didn't think anyone could possibly know. "Let's suppose I believe you. What do you want with me?"

"I'll tell you, but we have to move fast. The time machine I used to get you here is damaged and I'm not sure how long we can keep the portal between our two times open," said William gesturing to the gateway behind his predecessor.

Bill saw the portal for the second time. This time he didn't run away in fear, but he wanted to. At first glance, it looked like a large oval window with smoked glass, but it had no real substance and wasn't on any wall. In fact, it didn't touch anything. Through the gateway, he could see about five feet of dirt and rocks, a foot of concrete, and a three foot section of the world he remembered, albeit a below ground-level view he didn't often see. "Tell me."

"Well, about 18 years in your future, you, really *we*, will become an inventor. You'll develop the theory of time shifting and invent a machine, like that one, that can actually do it. But before you patent your invention, some thieves will steal your prototype, all the research logs, and notes. Somehow, Triton Incorporated will get the plans, and receive patents on the time shifter before you can reconstruct your work. You won't be able to prove that you originally devel-

oped the theories and your years of research will be for nothing, such as mine were." William paused in the delivery of his well-rehearsed lies.

"What do you want me to do?" A chill snaked its way up Bill's spine. He didn't like someone talking about his future as if it had already happened.

"Take these plans back to your own time, and build a time shifter several years earlier than we did the first time." William handed Bill a large envelope filled with documents.

"This doesn't seem right..." Bill was having difficulty analyzing the situation. He couldn't believe what he was seeing and hearing. Never being much interested in science, he thought the road from accountant to inventor seemed long and improbable.

"Look, you don't want all my efforts, all *our* efforts, to count for nothing, do you? Just take the file and go. Like I said, we don't have much time." As if to add weight to William's argument, the portal blinked and Bill's world momentarily disappeared from view. When it reappeared, William pulled a ladder from a supply closet and leaned it against the gateway. The top of the ladder protruded into the past. "Please hurry," William pleaded. "It's really for the best."

"I can't do this. It isn't right." Bill retreated to the far end of the room.

"Quit being such a damn idealist! You're just like Sharon," William said as he approached Bill menacingly. "Your attitude will change when Triton Industries announces plans to build a time shifter. All you ever get to do is count the money, never spend it. Give me those papers, I'll go back myself!" William lunged at Bill, who easily side-stepped the aging man. Neither of them noticed the pebble that flew through the portal and landed on the floor.

William picked up a chair and started swinging it back and forth. "Give me that envelope. Don't make me hurt you. So much for trying to improve my past. I'll leave you here and improve *my* present and future," said William as he advanced on Bill.

Bill's danger indicator went up several notches. *This can't be real,* he thought. *I've got to get out of here.*

William smashed the chair down on Bill's back. Bill fell to the floor and dropped the envelope.

There was a loud pounding on the laboratory door. "Police, open up!" When William turned toward the sound, Bill dashed for the ladder. The door splintered inward, and two police officers rushed into the room. They were followed by Sharon. "Don't move," one of the policemen shouted.

William momentarily stopped his pursuit of Bill, who was already halfway up the ladder and ready to cross through the portal into his own time. At this same instant, a shoe flew in from the past, through the gateway, and grazed Bill's head. It hit the time shifter causing the portal to blink out. Bill and the ladder, no longer supported by anything, started to fall to the floor.

• • •

Meanwhile, in the past, daylight had broken and a growing number of people noticed the funny archway on the sidewalk. Some of those who saw the strange aberration felt compelled to stay and study it. One person circled the archway time and time again to convince himself that it could only be seen from one side. A few daring individuals even approached the arch with the intent of getting a really good look inside or touching the ladder that was hanging out, but they couldn't bring themselves to cross the spots of dried blood that were in front of the gateway.

A hush fell over the crowd as one *enterprising* young man, Pete, prepared to throw his shoe through the archway.

A hush fell over the crowd as one enterprising young man, Pete, prepared to throw his shoe through the archway. He swung it wildly over his head, trying to draw everyone's attention. He had already tried this trick with a small stone, but using his shoe was soliciting a much bigger response. "One for the money," Pete shouted. He wanted to drag this out as long as he could. He had heard that everyone gets 15 minutes of fame and he didn't want to be rooked out of one second. "Two for the show...Three to get ready...and..." Pete considered starting over at one again so he could keep the group's attention, but when he saw the anticipation on their faces, he couldn't disappoint them. "Four to go!" Just then Pete saw a face pop up on the other side of the archway, but it was too late. He let the shoe fly.

Before anyone registered what had happened, the archway disappeared. The top section of the ladder, being severed at a strange angle, lost its balance and clattered to the sidewalk. The circle of onlookers gasped collectively and began to walk toward the center of the circle. Suddenly, the archway reap-

peared, and the gawkers scrambled to back away from it.

• • •

In the future, the police stood transfixed by the existence, then the disappearance and reappearance of the gateway. William took the opportunity to grab the packet of time shifter plans and throw them through the time doorway to get rid of the evidence of his crime.

The reappearing portal caught the amputated ladder in mid-fall, but Bill was now a few feet down from the edge of the sidewalk. He quickly gathered his strength and thrust himself up at the opening. His head swam and his stomach turned as he rippled halfway through the gateway.

William, not wanting Bill to escape, reached up, grabbed one of Bill's legs, and pulled.

• • •

As soon as the portal rematerialized in the past, something flew out of it. A woman screamed as the projectile hit her in the chest, then landed on the sidewalk. She kicked at it with her shoe, and discovered that it was nothing more than some papers in a large manila envelope. Her eyes strayed back to the archway, and she screamed again. Half a man was sticking out of the portal, and he was flailing his arms madly. After a while, she stopped screaming. Under the circumstances she would probably flail her arms too.

The crowd *waited* for the gateway to reappear, but *nothing* happened.

"Somebody please help me," screamed Bill. "Don't let me be pulled back through." At first, no one offered to help. Finally, Pete, who wasn't really sure he wanted the rest of his fame that day, extended a shaky hand.

• • •

The two police officers rushed to keep the suspect from leaving the laboratory. One of them grabbed William and tried to pull him off Bill's leg. The other grabbed Bill's free leg and tried to pull him back to the future. It suddenly occurred to Bill what would happen if the portal blinked while he was only halfway through and he kicked his legs with a new burst of strength, causing both the police officer and William to lose their hold on him. Bill scrambled completely into the past. While one officer handcuffed William, the other jumped on the ladder and prepared to go through the time doorway to recapture Bill.

Meanwhile, Sharon approached the time shifter. "This must end now. This situation just wasn't meant to be. It's over." With that, she threw a chair at the remains of the time shifter. Sparks flew and the gateway closed for the last time.

• • •

After Bill took the young boy's hand, Pete pulled mightily to free him. Suddenly, Bill rippled the rest of the way into the past. Everyone watched the archway with anticipation. It looked like more excitement was in store when the police officer prepared to come through, but then it was over. The archway disappeared.

The crowd waited for the gateway to reappear, but nothing happened. Then somewhere in the back of the group someone started clapping. Before long the entire crowd burst into thunderous applause.

Despite the numerous questions being demanded of him, Bill just sat on the sidewalk, exhausted. Eventually, he tried to answer a few of the questions, but many of the specific details of his adventure had already faded blissfully from memory.

"Mister, Mister," Pete pushed his way back through the crowd. "I think this is yours." He held out the envelope that had hit the lady in the chest.

"It's okay, I don't want it. You keep it, as a souvenir. I want to thank you for helping me get back where I belong."

"Thanks mister! But it wasn't nothin'." Pete's face blushed red, and he began fiddling with the envelope.

"Yes it was, and I plan to repay you. I'm Bill Dahlman, and you are?"

"Pete Triton. Thanks again." Pete ran off, anxious to see what top-secret treasures his envelope held.

"Triton? Pete! Wait! Wait!" Bill staggered to his feet, but Pete was gone.

IN THE EVENT OF AN EMERGENCY...

Laura Sachi

Images of robots clad in breastplates and codpieces flashed on the screen. The robots wrestled each other amid a barrage of laser beams. Just as a giant, laughing white robot leveled his gun at the downed leader of the foe, the television switched to a multicolored test pattern followed by the usual ear-splitting whine.

Tommy got up in a huff from his sitting position just a few feet from the TV. He hated when these tests came on. Not only did they always seem to come on when something good was about to happen, but that awful noise hurt his ears.

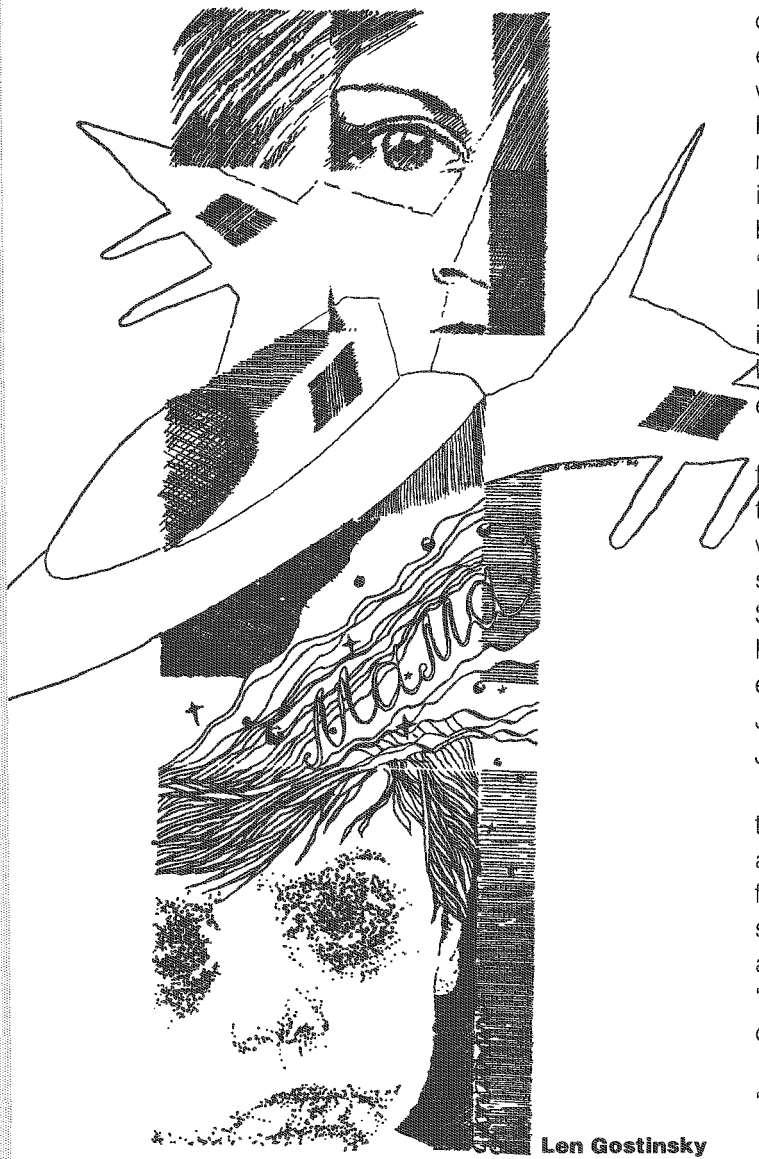
Tommy was not the only one irritated by this interruption. He could hear his parents in the dining room complaining about the loud whine and the increased frequency of the emergency broadcasting tests. The disturbances had been appearing every week for the past few months. If so many people didn't like these tests, why were they on so often? What were they for, anyway? Tommy pondered these thoughts for a few seconds before going to his room to play with his toys.

Across the street, someone knew the answer to Tommy's questions. Jonathan had been casually watching early morning cartoons while drawing a picture of his house with his new box of crayons when he heard a familiar noise issue from the TV. He put down the blue crayon he had been using to color in the lawn and stared fixedly at the bars of vivid colors encompassing the screen. He enjoyed looking at the vertical bands because they reminded him of the brilliant flags he saw the soldiers carry as they marched through the streets after a victory. He yearned for the day when he could be one of those soldiers, standing proudly in the sight of everyone, waving his green, blue and red striped flag. But what good was a soldier who didn't understand the symbol he was holding? If anyone ever asked him, Jonathan knew how to respond: "Green, blue, red — we give thanks to the sea, land and sun, for it has given us the victories in battles we've won."

He remembered the first day his mother had told him those words. It was a golden harvest morning and she took him out for his first time to watch the soldiers march

through the streets. Jonathan's eyes were as round and bright as moons when he saw the sea of flags pass by. When they had gone from sight and the cheering had died down to a few sporadic shouts, mom explained to him the life of the soldier and the meaning of the flag each one carried. From that day forth, he set his eyes on becoming a soldier. But it required training and hard work. He was too small and young to physically prepare himself, but he prepared himself mentally by reciting the motto of the flag each day. Soon, he knew he would be able to stand next to his mother as they walked down the street in unison, their flags nipping at each other in the light, swirling breezes. He could imagine dad towering above the spectators, grinning broadly as pride beamed from his eyes.

The sound from the TV increased in pitch and startled Jonathan from his reverie. As he became aware of the noise, it seemed to get even louder. He then began his usual routine of listening intently to the noise that accompanied the test pattern, hoping he could hear the exchange of words muffled by the whine. He imagined his father nervously watching the three-minute timer as he spoke rapidly to the person on the other end. He could almost hear his father's hushed, hurried conversations with someone else deciding what to do during the few minutes they had before the test was over. He only wished he could really hear what they were saying, especially now, when the tests were on TV so often. He inched his face closer to the screen, concentrating even harder. Jonathan thought he could hear something faint, but looking only made his eyes sore and caused his head to hurt.



Len Gostinsky

Jonathan's eagerness was tearing him apart. He didn't know if he could sit for the minute or two left of the test. If only he hadn't asked his father what would happen "in the event of an emergency." He wouldn't be sitting here, waiting for the earth to be annihilated — his dad never told him what that meant — or waiting for something much more important. So far, each week he had waited eagerly in front of the screen only to have his hopes dashed as a blank screen appeared while an announcer declared, "This was a test of the emergency broadcasting network. In the event of an emergency..." Nothing happened when it was only a test. Oh, how he wanted an emergency. Please, just this once, he begged to the sky, let it be an emergency.

Silence regained control as the TV went blank. A familiar voice issued from the set, claiming, "This was a test..." Jonathan's heart sank as he heard those words. He was so sure something was going to happen this time. He slumped from his erect posture as elation turned to sorrow. Suddenly, a large, gentle hand lifted up his downcast head. A face stared knowingly into Jonathan's querulous eyes. His father picked him up and whispered into Jonathan's ear the answer to his silent question: "Soon, John, soon."

Jonathan's father brought him over to a giant mural on the wall. Three vast triangular steel-gray spacecraft swept across a star-speckled void. Formidable turrets protruded from the nose and wing-like extensions on either side of the ships' hulls. Jonathan's father pointed to the leading ship, a green, blue and red band circumscribing its front end. "She said she'll be here soon, and she said she'll be coming in this ship."

Jonathan's eyes brightened at his father's words. "Mama."

One Puddle Short

Travis Lemke

Jennifer Hughlett

Amidst his yawn, the truck driver tried to remember when they constructed the reservoir at the base of the mountain. Environmentalists and industrialists cheered at the prodigious work of man that would solve the valley's water problem forever. Adjacent to the natural edifice and the reservoir was a domed city. In the early morning light the truck driver had stopped at a scenic overlook on the only road into the community. As his truck sat idling near the sheer cliff, he watched an eagle soar above the substantial system of electric wires overhead. In his state of intoxication he almost felt irresponsible as he urinated over the cliff and into the water. He took another sip of his warm beer and climbed into the cab. He soon forgot his actions as he fell asleep to the sounds of a new audiocube taken from the semitrailer.

*

Avoiding the numerous puddles and being careful not to step on any cracks in the sidewalk, the Boy traversed the distance to his bus stop. He had the hype audiocube, "Heavy Water," pumping from his earphones. Above the drone of the empty tram overhead, a passerby could feel the bass and catch a few lyrics...

"Society believes nothing is wrong
But that idea won't last too long
We gonna need to change our way—
Present, pronto, I mean today."

Covering the tram and the city, the round, pink, translucent dome glistened. The morning cleaning of air in the city had transpired

and the puddles were all that remained of the artificial shower. Even though the cleansed air only lasted until mid-morning, when the air was tainted by the busy city, its Lysol-sponsored pine-fresh smell refreshed his lungs making him feel glad to be alive. Almost.

A gust of air suddenly made him grimace. The scent reminded him of the time he had to clean the gym locker room at school, but worse. The vibration of heavy breathing on his earlobes interfered with his hip hop. Consequently, he removed his glance from the sidewalk in fear of being trampled. He thought that the origin of the breathing was a massive panting dog. He immediately wished he hadn't looked up. A round, portly woman was walking her Pitbull. The Boy returned his glance to the pavement and hoped he wouldn't get squished.

We are treating our children like toys.
Not looking out for our girls and boys.
We are treating our world like glass
about to drop it and fall on our ass..."

He leaned against a Max's Extraordinarily Wild Army Outlet Store window and thought she might rumble by, leaving him untouched, and more importantly, his Bandwagon brand shoes glaring white. The Boy glanced in the window and noticed five goldfish in a very small glass of water. He turned his attention to a motionless fish at the surface. He thought it was strange that Max did not take better care of the fish, but the thought soon floated away as the epicentrum millimetered closer. He realized it wasn't a dog that was wheezing, it was her. The Woman stopped and listened...

While we're sitting homeless,
the man is rollin' in dough.
While we're sitting naked,
the chief is sniffin' snow.
While we can't find work,
the mayor is gettin' a..."

"Child, what are you listening to? What was that I heard? Was it foul language? Don't you know that this uncultured music is destroying your mind? I bet it already has. Are you listening to that gang music? You probably worship Satan, don't you? Boy, can't you hear me?" asked the Woman who was now sweating profusely.

A drop fell from her forehead into an immense puddle, which was drowning the curb. The Boy had hoped someone would throw her back into the water, but she remained beached.

"Ashes to ashes, dust to dust, Trying to dis me? You must be nuts," smartly responded the Boy as the bus pulled to the curb.

She turned around just in time to catch the brown liquid sent in her direction by the slowing school bus wheels.

"You juvenile jack..." started the soaked Woman. She composed herself and continued scolding the Boy more gently, "Do not step on that bus, Boy."

The Boy stopped his Cubeman as the steaming Woman explained the situation to the bus driver. The Boy overheard the driver say that he was glad someone was going to do something about "these kids," who are nothing like he was during his own model childhood. The Boy hopelessly stared into the immense puddle, which looked back at him with his own eyes. He could not clearly distinguish what he saw. Unfortunately, he was interrupted from his vision by a sharp pain running through his arm that jarred his Cubeman from his hand.

In between deep breaths the woman snapped "Come with me young man. I'm going to teach you a lesson," as she dug her fingernails into the childish freckled skin of his arm.

"I'll teach them a lesson," she thought.

The cube popped out of the player and was submerged in the brown liquid. The puddle slowly began to bubble.

**

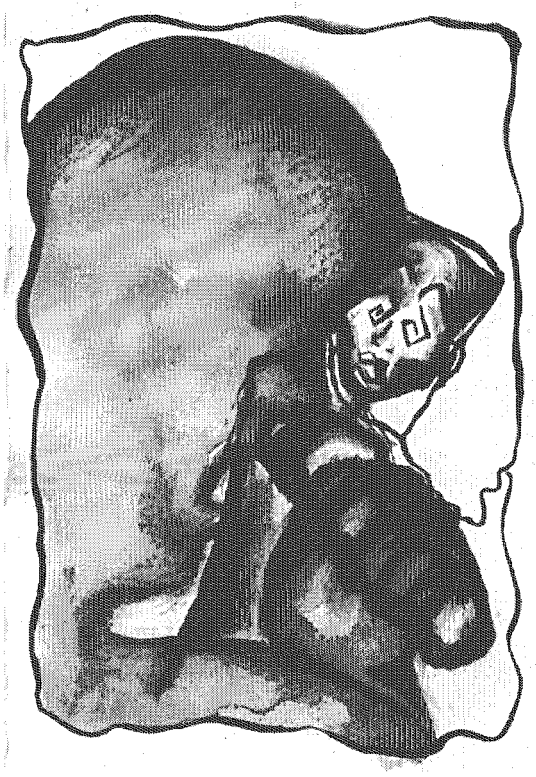
In a doctor's office, situated between Max's Really Wild Army Outlet Store and the Paramount Court Building, the Woman sought out help....

"Young man, would you please keep an eye on this boy while I see the doctor," patronized the Woman.

"O.K.," rejoined the receptionist whose enthusiasm could only be rivaled by an old car's starter on a winter's morning.

He chewed on a plastic straw from his water packet.

The receptionist mumbled, "Young man, indeed! When will they start treating me with respect?"



Jennifer Hughlett

He disgustedly tossed the almost-full packet of water in the waste receptacle.

The Boy sat in the silence of the waiting room. In the silence he found his thoughts. He could not understand adults and their vexations with youth. Didn't they have anything else to worry about?

"Doctor, you're telling me that I am in poor health?" asked the dumbfounded Woman.

"Yes, I am afraid your cholesterol level has been and still is significantly excessive. Neither John Penn, the Quaker Oats company, nor a plumbing service could unclog your arteries."

"John who?"

"You have what we call in the profession, a case of ignoranus projectium."

"Doctor, is that serious?" stuttered the Woman.

"Yes, I am afraid so..." and after she glanced at the cold tile floor she continued, "You may want to change your ways soon...or..."

"Or what, Doctor?"

"Let's just say that if you continue to ignore your problems, you may have to consider entering an inanimate state until medicine discovers a cure for your condition."

He could not understand adults and their vexations with youth. Didn't they have anything else to worry about?

"What can I do? I'll do anything. Please doctor, help me."

The doctor sighed as if she knew her efforts were in vain and stated, "First of all you must change your diet and stop ignoring the condition of your body. Secondly, you must reduce stress and stop worrying about others and concentrate on your own well-being. You were in perfect health before you started your personal crusades. Your health has deteriorated to the point where you have to do something immediately. It is essential that you concentrate on your job and break all outside time commitments."

"Out of the question," retorted the Woman who left the office with the Boy, her Pitbull, and the strengthened determination to prove the doctor and the world wrong.

***

The congested streets did not help control the Woman's anger as she hailed a taxi.

"I commissioned the building of a mass transit system and no one uses it," exclaimed the Woman as the taxi completed the five-hundred-foot journey to the courthouse.

From the bouncing double chin of the Woman who now held him by his ear, the Boy's concentration shifted to the enormous entryway to the courthouse. The automatic sprinklers near the Ultra Supreme Court Building were watering the dandelions. The dandelions nodded appreciably under the pulse of water, which came dangerously close to hitting the Woman's Pitbull. The Pitbull stopped and glopped some run-off water from the sprinklers. As the Woman and her shoes appreciated the momentary rest, the Boy watched the steady stream of people flowing through the doors. They cursed the liquid spraying from the sprinklers, which dampened their salon-fresh hair--a consequence they thought they should be able to avoid, since the climate and air control program worked fine. At least that is what they were told. The domed community was the first of its kind and was used as a model for similar projects. The early-hour dispersal of the reservoir-drawn artificial rain ceremoniously followed its schedule, but the antiquated sprinkler systems still ran amuck.

The Woman in the pink dress who now tightened her corset-like grip on the Boy, also seemed to mutter something under her breath as they entered the building.

A security guard bravely stepped in the path of the Woman, "Excuse me, but no pets are allowed in the building."

The large Woman seemed undaunted, "Don't you know who I am? And besides, anywhere not good enough for my dog is not..."

The Woman continued arguing with the guard as the Boy turned his attention to another conversation. A man in a cream-colored dress shirt, which boasted a light blue pocket protector full of mechanical pencils, argued with a man in a black suit.

"I must be able to talk with the Mayor," pleaded the man with the multitude of writing utensils, who noticed the Mayor arguing with the security guard.

He fished a pencil from his pocket and promptly started chewing on the graphite-tarnished eraser and simultaneously resumed his argument. "We must start on phase two of the construction of the infrastructure of this city. The condition of the city is deteriorating at an alarming rate. I have tried to reason with the council members, but they chose to ignore the real problems of this community. I can't function in my position without the support of the Mayor. I do not see your justification of cutting my budget when it..."

The man in the black suit also noticed the Mayor and saw a chance for brownnosing.

"Mayor," snapped the man in the black suit, who quickly asssumed the role of white knight, "I am deeply sorry for any misunderstanding. What may we do for you?"

"I have charges to press against this young hooligan for disturbing the peace, loitering, harassing an adult and listening to obscenities," replied the Mayor.

As he was dragged into the courtroom by his freckled ear, the Boy wondered how anyone whose body odor was worse than a wet dog could be elected Mayor.

In the courtroom, the Mayor spoke about the youth of today and how she would help change the world if she could teach the young people of this community a lesson. Her speech dragged on for a length comparable to the food lines found after the breakup of the

Jennifer Hughlett

European Economic Community. She finally closed, "...and as head of the CEPC, Commission for an Extra Perfect Community, I believe that music not authorized by our entertainment subcommittee should be banned from our community. I am to assume that all those here today know that music degrades the minds of our children. I am also predicting that if we ban this so-called music of our youth, incidents such as the one that transpired today, will disappear."

The judge presiding over the court session awakened from a daydream of a chocolate sundae sighed and stated, "Thank you, Mayor. This case seems to represent what is wrong with the community today."

The Mayor gave a reaffirming grunt.

The judge continued, "The youth of today show little respect for their elders. Their minds are being corrupted by the messages bombarding them in their music. Therefore, I side with the Mayor on this account."

The Pitbull drooled appreciably.

"But, I feel that banning all controversial music would be unconstitutional, and does not follow the plan of the Really Perfect Community Charter of 2016. Although I am forced to punish this child, the punishment will be lenient. I will model this child's punishment on the Mayor's entertainment subcommittee's highly successful parental warning stickers on musical products. This boy will be forced to wear clothes imprinted with warning holograms. These identifications will allow unsuspecting citizens to avoid these delinquents. Moreover, the warning program will make the community a safer place and raise the standard of living for the inhabitants of this community."

The Mayor's grin disappeared as did her hopes to prove to the world that she was right.

"Your Honor, the punishment is exceedingly light," responded the Mayor.

"I also object," offered her attorney.

"Oh, sit down and shut up," muttered the Mayor.

The judge adjourned to a malt shop after he had saved the city from imminent destruction again.

The courtroom emptied as the Boy entered the juvenile detention department where he awaited processing. The Mayor lumbered blindly into her office located in the adjoining building. She was a determined woman of action. She had a cause. A purpose.

The Mayor did not even kiss her Pitbull good night. She called an emergency meeting with the entertainment subcommittee of the Commission for an Extra Perfect Community. If the law would not help her cause, she would help herself. They did not know what was good for them. She could handle her life; she didn't need anyone telling her what she could do. It was time all those vintage terrorist movies she watched paid off.

****

At her home, the contented Mayor believed she had been right. She looked at her watch. She knew that the charges she had set under the audiocube shipment were about to go off.

The truckdriver awoke with a terrible hangover. His trailer was blown from his truck. The explosion snapped a nearby electrical wire support that followed the trailer off the vertical drop and into the reservoir below. The dangling wires and the silent water came into contact. The trailer, with its contents spilling into the reservoir, hit the surface of the water. The water level gradually dropped as the surface bubbled turbulently.

The Mayor's grin disappeared as did her hopes to prove to the world that she was right.

On the ensuing day, the Boy was waiting at his bus stop with his new cube and player. He wandered over to a store window where he saw that the goldfish were now all floating at the top of their confined environment. The store was closed. He also noticed that both the puddle and his cubeman from the previous day were gone. The hollow plastic remains of the cube sat near the curb. Dry. The air also lacked its familiar Christmas tree air freshener smell.

The Boy did not hear that the tram was not running. Neither did he hear the absence of activity nor the silence of the streets. He did not hear anything but his music. Although he listened, he did not understand. Apparently neither did anyone else.

The Edge

Bruce Dunsmore

"Welcome! everyone!" said the Ring Announcer, "to the main event here in downtown Minneapolis, headquarters of the North American Robot Fight Association! In the corner to my left, at a massive 297 kg, from Purdue, Indiana . . .With a full head of steam, The Boiler!!! To my right, the reigning champion and homestate favorite! From Hinckley, Minnesota at 232 kg, TractorPartz!!!!"

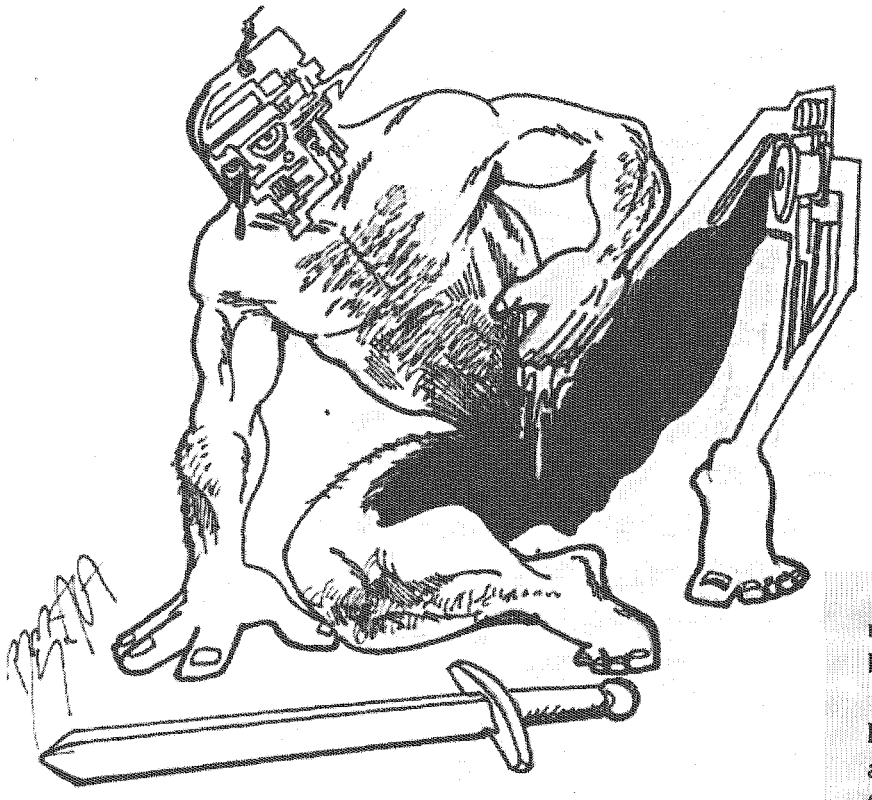
After the bell rang it seemed more like a cock fight. Both bots dancing around feeling each other out, taking a jab every now and then to test the other's response. And then a quick jab and scrape at the cowling over Boiler's pneumatic lines at the hips. The cowling flew into the crowd as Boiler jabbed like lightning at the optical sensor on Tractor. "AOohohAOAOAOohA!!!!!"

Tractor screamed! This wasn't the sound of the damaged optical sensor, it was generated by Tractor in response. It seemed odd to me that someone would program such a bone-chilling scream into a bot. The scream would mean nothing to the feelingless opponent, but the crowd gasped as if a friend were just wounded. Then in a frenzy, the crowd screamed words of support to Tractor! Even Boiler fans were shocked into silence.

For half a dozen swipes, Boiler moved much faster than I thought possible but could not connect with Tractor. Obviously Tractor couldn't see very well with one optical damaged. That made the next offensive strike so much more exciting to see. Tractor hit Boiler's body 10 times—one looked as if it would disable the left hip for the duration of the fight. The bell rang; my heart raced.

In the second round Boiler was hobbling around swinging and jabbing. The few glancing blows dished out by Boiler were returned in quick succession by Tractor. In a few minutes Tractor would wear his opponent down. At least I thought so.

"ACHchAaakkkK—ohOA!!!!" A very lucky blow to Tractor's "neck" proved beyond doubt that Newton's Second Law was still in effect! Tractor was screaming that chalkboards-scratching sound as the crowd watched slackjawed, unbreathing.



Robert Subiaga, Jr.

Boiler was about to come down on Tractor and finish the job when the convulsing mass grabbed at Boiler's hip. Rolling out of the way and ripping the pneumatic line out, Tractor stuck the free end of the pneumatic line into his external input. Boiler's valves must not have shut off fast enough because Tractor sucked the steam right out of Boiler! Three blows directed at Boiler's "head" powered partly from Boiler's own air and the match was over!

Obviously Tractor still had too much air pressure in his tanks because the next sound was that of passing wind. I thought this appropriate because of where Tractor's emergency vent was located on his anatomy. The crowd collectively laughed at that sound as some wiped tears away. I wasn't the only one affected by those eerie screams.

The screams: I wonder if they could be used to dishearten enemy troops? Another research project for the people at DARPA.

"Mr. Olson, Mr.Ferril Olson? My name is Ecurb Eromsnud from the Defense Advanced Research Projects Agency. The U.S. Army is very interested in using bots in an infantry support role. Your bot has a long record of--,"

"You're barking up the wrong tree. I can't help you. There is no way a bot can replace a human in a fight. People will always have the edge," Olson said.

"Don't you see, Mr. Olson, the benefit in having cold ruthless fighting machines with no feelings used in a military operation. They would be unstoppable. All we want is some insight into any programming or engineering you've put into Tractor. You would be doing your country a great service," Eromsnud continued.

"I've told you everything you need to know. Do your country a great service, listen to what I am saying, and go," Olson said.

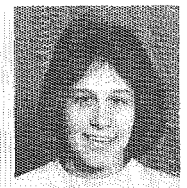
"Tractor is programmed to survive but what makes him win so often? And why the programmed scream – no other bot screams?"

In a deep voice so soft that no one could overhear, Olson said this to me: "Every higher level bot is programmed to survive. Only Tractor was built and programmed to know why. We didn't program Tractor to scream. In fact we were just as surprised as anyone when it first happened. It's a side effect of his ability to feel pain. He has a rudimentary feeling of pain."

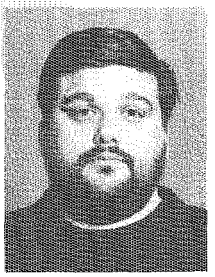
About the Authors...

A fifth-year senior in CLA, English Literature Major **Robert J. Holton** is graduating in Spring. He started in the Aerospace Engineering Honors program, until he decided computers were not his friends. His primary influence is William Gibson, who may just be the next great American Novelist. He intends to teach high school after graduation, and also to continue to write both poetry and science fiction.

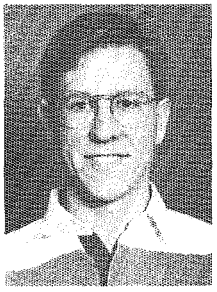
IT freshman **Laura Sachi** has just started writing science fiction.



Sometimes being frustrated with the pace of his scientific advance as a theoretical physical chemistry graduate student, **Greg Hawkins** occasionally turns to writing science fiction. Unlike research, unclear results in short stories don't require months of additional work, only an eraser or delete key.



Chemical engineering senior **Travis Lemke** graduates this spring and will be job hunting. "One Puddle Short" is Travis's second science fiction story. He would become a full-time writer if his chemical engineering "hobby" did not take up all his time. He feels science fiction allows him to vent his creative ideas. It also provides a medium for expression of ideas that do not have to be proven or justified.



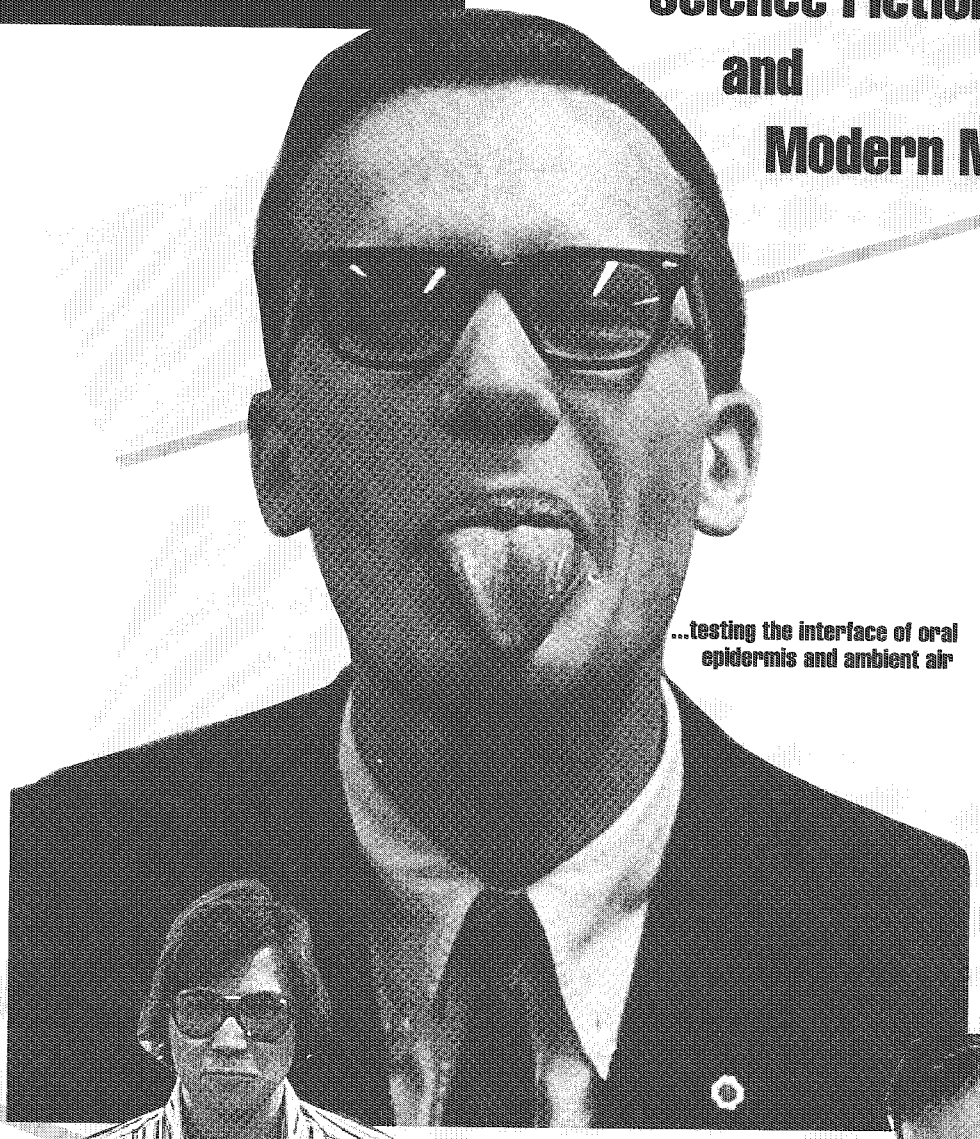
Bruce Dunsmore has a degree in Industrial Engineering from UMD and has begun work at the U on a second degree- in Physics. This is the first science fiction story he's written. A budding entrepreneur, Bruce is interested in making money before he gets out of school. He wants to move back up north.

Judges' bios

Steve Deyo is a former Technolog editor and currently is editor in chief of the Computer User newspaper group. He reads SF avidly and speaks frequently on various topics in technology, writing and ethics.

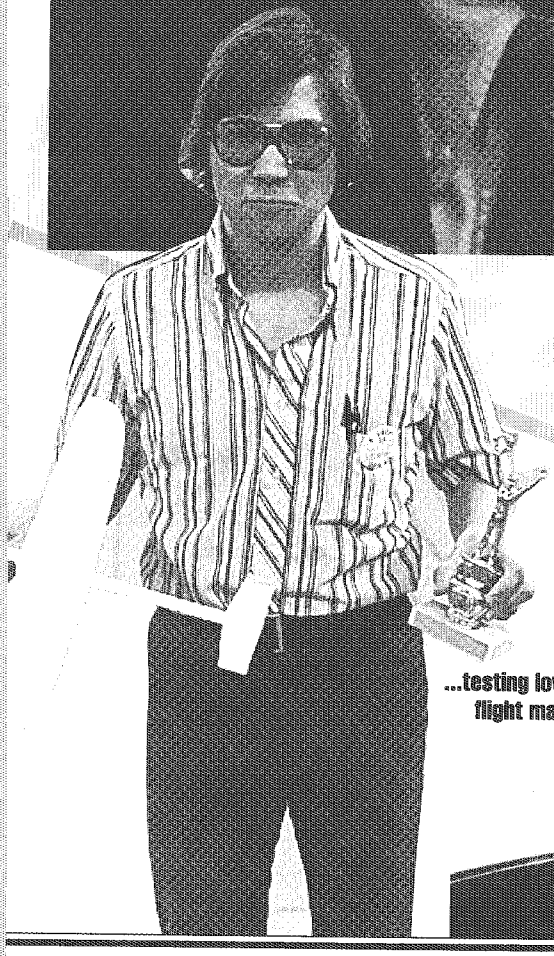
Robert Subiaga, Jr. has been reading, writing and illustrating one form of speculative fiction or another since . . .well . . . he has been old enough to read. A tremendous fan of the original Star Trek series and classic pulp authors and their literary descendants, his interests in fiction are also expansive enough to include everything from Harlan Ellison to John Gardner, Margaret Atwood, Hemingway and Shakespeare. A former graduate student in the philosophy of science, Bob also devours non-fiction books about science's cutting edge. His own writing includes screenplays, plays, poetry and fiction. Bob's novel "Eyes" has just been released by a local small press, XAOS BOOKS. For further information on XAOS, write Chaos Warrior Productions, P.O. Box 14407, University Station, Mpls., MN 55414-0407.

Science Fiction and Modern Man



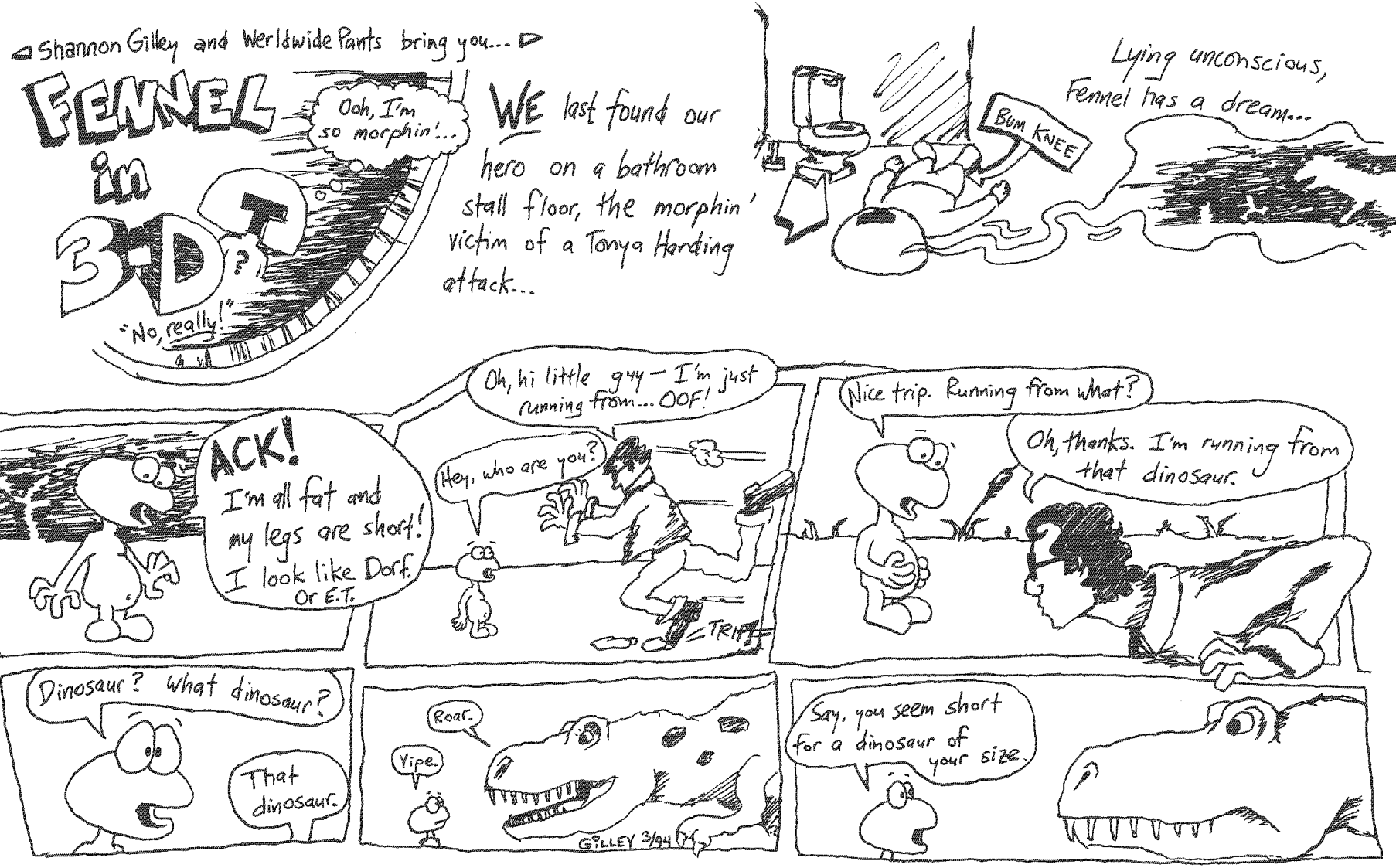
...testing the interface of oral epidermis and ambient air

...testing velocity of diminutive human transportation



...testing low-friction flight materials

...testing geo-digit interaction


Shannon Gilley and Werldwide Pants bring you...
FENNEL in 3-D?
Ooh, I'm so morphin'...
"No, really!"
WE last found our hero on a bathroom stall floor, the morphin' victim of a Tonya Harding attack...
BUM KNEE
Lying unconscious, Fennel has a dream...
ACK! I'm all fat and my legs are short! I look like Dorf. Or E.T.
Oh, hi little guy — I'm just running from... OOF!
Hey, who are you?
TRIP!
Nice trip. Running from what?
Oh, thanks. I'm running from that dinosaur.
Dinosaur? What dinosaur?
That dinosaur.
Roar.
Yipe.
GILLEY 3/94
Say, you seem short for a dinosaur of your size.


Well you see, I'm quite fat and shortlegged today.
Hey me too.
THIS PANEL OBSCURED BY DINOSAUR TAIL
WE APOLOGIZE FOR THE INCONVENIENCE
Thanks! The Mgmt.
Hey get off my leg.
KNOCK KNOCK
Huh?
Hey mister, are you gonna be in there all day? I gotta whiz!
=Aeeaeeaeeaee=
Oye, Herschel what a headache
Look, this isn't going anywhere! Where's the plot! Get up and do something so I can use the toilet!
Look, mister, I'll sing you a song if you let me use the bathroom.
Really?! What's it called?
"Mmm Mmm Mmm Mmm"
That's the name of the song?
Mm-hmm.
Isn't that a silly name?
Hm-mmm.
Mmm. I see.
So if I come out you'll sing that song?
No, I just thought it would lure you out.
Do you even need to go to the bathroom?
No, actually I want your autograph.
Crash Test Dummies
Gosh, if you really want my autograph.
Yeah, really. Wanna have lunch?
Sure.
Wow, a real mighty morphine autograph.
Ah, it's no big whoop.
Say is that really the name of that song?
Mm-hmm.
Crash Test Dummies
THE INSIGNIFICANT END

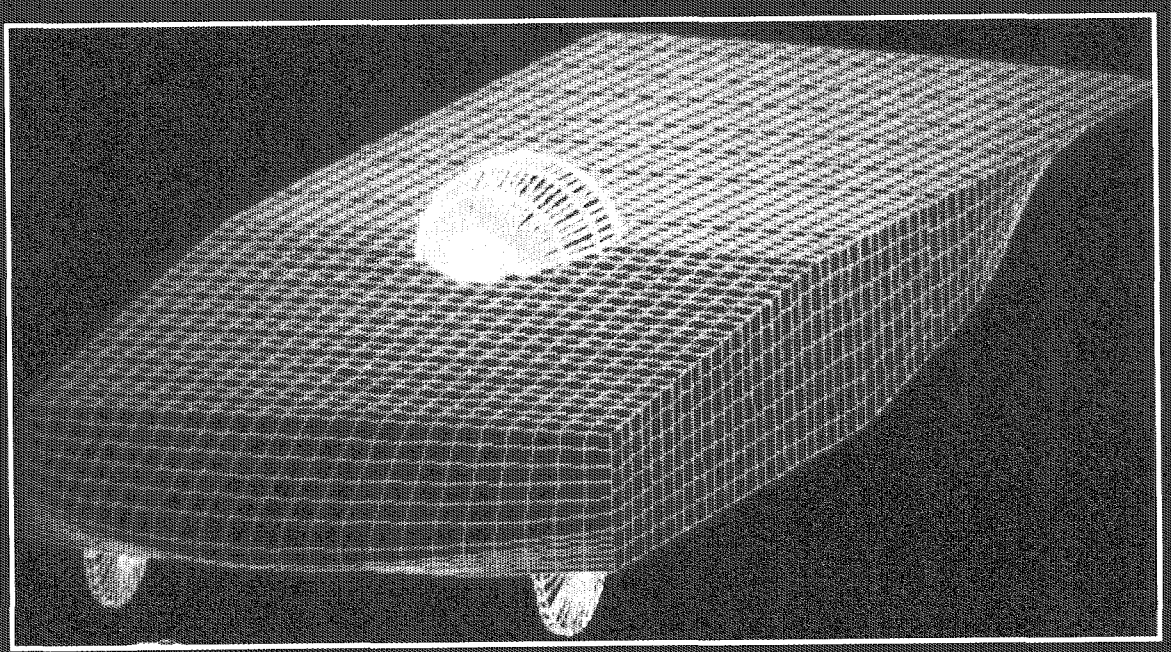
IF LIFE'S A BEACH, MAKE SURE YOU'RE ON IT.

NO ANNUAL FEE,
A $1,000 CREDIT LIMIT
AND LOW RATES.
OKAY, NOW HIT THE BEACH!

IF YOU DON'T GOT IT, GET IT.℠

MINNESOTA
TECHNOLOG
June 1994 • University of Minnesota • Vol. 74, No. 6

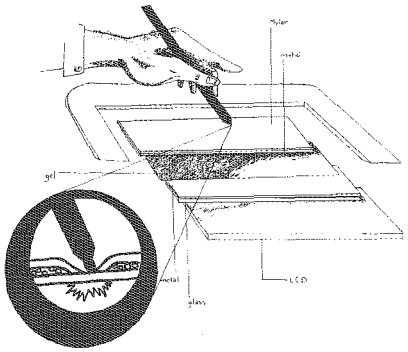
Future Images



One proposed prototype of the Sunrayce 1995 vehicle

MINNESOTA TECHNOLOG

JUNE 1994 • University of Minnesota • Vol. 76, No.6



7

7 Palmtop Computing

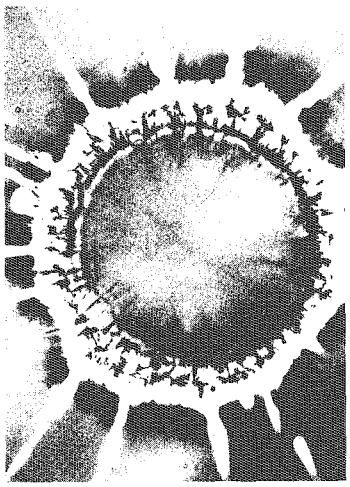
by Reed Munson

Reed Munson tried out palmtop technology with some humorous and intriguing results. He gives a quick overview of current palmtop computer technology.

10 Consolidation of Nuclear Weapons Production: Several Options

by Peter Kauffner

The cold war is over. The United States government has to consider how to best manage its nuclear weapons facilities. Peter Kauffner describes several options the government is considering: building new facilities, upgrading existing facilities and taking no action. His piece may help you draw your own conclusions about the direction the United States should take in this issue.

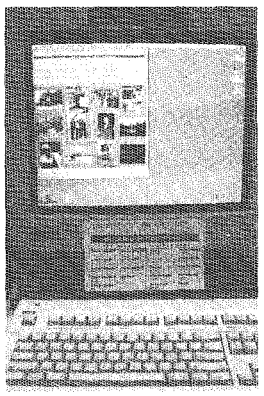


10

15 Now You See It, Now You Don't

by Tamara Lubic

New photo technology may speed transmission of photos to publications and provide amateur photographers with interesting new techniques, but it raises issues of archiving. Tamara Lubic discusses the ramifications of a technology that makes it easier than ever to erase photo images—and part of our history.



15

Departments

Correction:

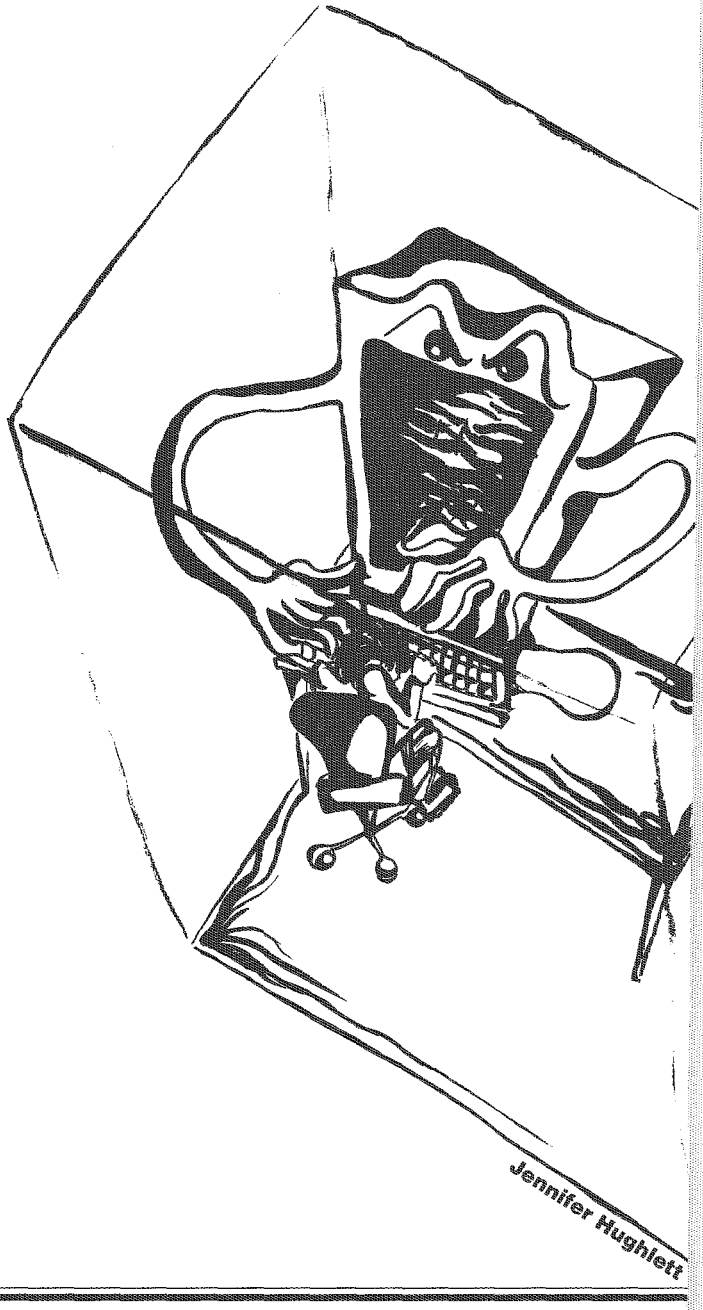
In the writer bio section of the Science Fiction issue, incorrect information was printed about Laura Sachi. Her bio should have read: Laura Sachi, a junior in Aerospace Engineering, has written much science fiction. The Technolog contest is the first to which she has submitted her work. Technolog regrets the error.

About the cover . . .

Peter Wong enhances his single photograph of runners by electronically cutting and pasting it. Used with permission of Peter Wong Photography.

virtual communication:

Sometimes it works. Sometimes it plays– with your mind



Imagine that you've been out of IT for a year or so. You're doing well. Your boss approves of your work and more importantly, trusts you. You start getting assigned more independent work. More travel. Instead of letting you kick back with this month's dog-eared *Time* or *People* on your flight, they've got you working in the salt mines in the sky: message pad linked to laptop linked to the office.

"What do you mean, you couldn't get that report done on the flight? You had three hours! Get the lead out!"

Ah, the joys of the "virtual" office. The "untethered" worker. Big Brothernet has you wrapped in his cyberhug.

Obviously, not every worker will work independently of the office. But many IT grads eventually will. The increased use of technology to maintain contact with the workplace has brought changes in corporate culture.

Electronic communication may become inseparable from other work duties. As Samuel E. Bleecker wrote in the March-April 1994 issue of *The Futurist*, "The new mobile work force doesn't so much need computer devices that communicate as they need communications devices that compute."

Written communication skills will become more crucial than ever: the less "face time" co-workers have with each other, the more clearly they'll have to write.

English will remain the primary communications language–the vagaries of the various Japanese scripts have ensured that. Ease of creating and transferring information will do away with support staff who used to clean up some of those writing errors.

Moonlighting–even multiple moonlighting–will be easier than ever. When it's just you tip-tapping away in the corner cubicle, who's to know whether you're figuring the budget for your second job or faxing correspondence for your third.

Risk will take on a new character when it can be done on screen instead of in real life. With new virtual business software you'll be able to simulate takeovers, sales and other gambles before you endanger real jobs. After all, if *SimCity* (that city-planning computer game) exists, why not *SimLeveragedBuyout*?

Along with the obvious benefits–to white-collar workers, at least–of untethered offices come risks. Some are concerned, for example, about the new virtual communities springing up called MUDs–multi-user dimensions (some say dungeons). They invoke the image of a computer isolate geeking out in front of his or her screen 20 hours a weekend, neglecting real life.

Although the lure of making real money instead of engaging in fantasy will keep business people from isolating themselves in that way, potential psychological risks of cyber–communicating exist for those who go virtual for fun, not work.

Effects of head-mounted displays on some virtual-reality users can include vertigo and disorientation, Glenn F. Cartwright writes in the March-April 1994 issue of *The Futurist*. Those people who truly live alternate "virtual lives" for hours each day–or days at a time–may lose touch with reality at best, and actively avoid facing the challenges of real life at worst.

Virtual work–and virtual play–probably won't substantially affect the majority of people living in the United States any time soon. But it will affect enough corporate decision-makers to be a legitimate concern for IT grads right now.

When you're job hunting, look at your prospective company's "virtual environment" as well as its salary and benefits packages. Don't get stuck in someone else's MUD.

Corinna Nelson

TECHNOLOG

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Sunrayce '95:
Solar goes Modular

For the U of M Solar Vehicle production team, the 39 other vehicles they will face in the 1995 Sunrayce Solar Vehicle competition are the least of their problems. Minnesota's short solar vehicle testing season–May to October only–presents a bigger challenge.

Sunrayce, the third major intercollegiate solar car race, starts in Indianapolis and ends in Golden, Colorado.

The Solar Vehicle Project is tackling its short vehicle season by using coordinated advance planning. SVP plans to have a running chassis pod by the summer of 1994. Testing of the integrity of the frame and suspension will begin by then also.

So far, 30 entries have been accepted by the Department of Energy for the race. Up to 10 more may also race if they qualify at a closed-track event held one month before the main race.

Both the U of M's Mechanical and Electrical Engineering departments are offering senior courses concerning the design of the car. ME students are working on a chassis, EE students on a dynamometer.

After Sunrayce '93, review sessions organized by Minnesota's team concluded that future vehicles would require more testing time. A proposed modular vehicle design will make it possible to test the vehicle earlier in the production process.

Forty undergrads–from IT and elsewhere–are involved in the SVP. They're raising money for the projected budget of $300,000 by promoting their "adopt a cell" program, through which those interested in the car can sponsor it.

The Right Strategy Toward Doing the Write Thing

James Mathewson

Recent controversy in the University's administration focuses on writing requirements. The Council of Liberal Education (CLE) is asking departments to plan for writing-intensive courses. The official reason is a need for better writing in all fields. At the same time, Julia Davis, dean of the College of Liberal Arts (CLA), has proposed cutting upper-division writing requirements, reportedly due to budget constraints. Both sides claim that CLE requirements are meant to replace CLA requirements. Since CLE requirements predate CLA budget cuts, this seems like a *post hoc* justification to me.

Regardless of administrative rhetoric, CLA requirements should stay intact, because of the nature of future employment. Job markets will increase emphasis on writing skills. The computer age has not dampened the need for good communicators; it has heightened that need. The faster our international communication systems become, the better communicators we need to be. And technology will continue to drive the need for good writers.

The faster our international communication systems become, the better communicators we need to be. And technology will continue to drive the need for good writers.

For IT students, CLA upper-division writing requirements mean technical writing. This is important because technical communication will continue to be the most sought-after skill.

One good reason is the International Standards Organization (ISO). ISO 9000 requirements ensure that companies doing business with the European Community have substantial quality-assurance systems, written in a multilayered manual. Each layer represents a type of quality assurance within the company. Since these quality-assurance systems must be maintained in individual departments, everyone within a company is responsible for a share of the documentation. Companies can't simply hire technical writers to do the entire manual. In some cases, technical writers will train workers in documentation techniques. In other cases, technical writers will organize the manual. But much of the writing will be done by engineers, designers, programmers and line managers.

A company applying for ISO 9000 certification will be extensively audited by ISO representatives. Much of the auditor's job is to review the quality assurance manual, and engineers are sometimes spot-tested on their proficiency with portions of the manual under their responsibility. This is why companies seeking ISO 9000 certification have to train engineers

to document their quality assurance systems.

More companies are trying to bring their documentation systems in line with ISO 9000 requirements. As a teaching assistant for the Mechanical Engineering Co-op program, I read a lot of reports each quarter from student interns assigned to help with the documentation systems; it's a big job. ISO continues to add standards to its 9000 suite. For example, one of the most recent additions – ISO 9000-3 – requires, among other things, that all computer software companies document their manual-writing process, requiring programmers to get involved. Essentially, they are documenting their documentation.

New engineers who fail to avoid tech-speak will lack a competitive advantage.

But ISO 9000 is not the only reason future engineers and programmers need to be good communicators. New engineers who fail to avoid tech-speak will lack a competitive advantage. Most jobs today require writing clearly for a general audience — including engineers from other departments, marketers and management. This is what technical-writing classes are about.

While individual departments can teach these skills, they would need to hire teachers skilled in technical communication. Engineering teaching assistants may know how to write, but they probably can't teach writing as well as trained writing teachers. To teach writing requires knowledge of current communication models. This is why technical-writing instructors here at the university major in English, rhetoric, linguistics or philosophy. One can't solely tell students how to write; one must explain why.

If CLE requirements merely replace CLA requirements, engineering departments would have to hire technical writing instructors from the composition and rhetoric departments. This would not save money; it would simply divert funds from one department to another.

My question is, why not have both? Technical writing classes can explain to students why they should, for example, assume their readers know little about the topic. The departmental writing assignments, on the other hand, can clue students in on the particulars of writing in their fields. It seems to me this was the intent of those who drew up CLE writing-intensive requirements in the first place. CLE requirements should be carried through as originally conceived–as a means for much-needed improvement of undergraduate writing experiences, not as a means of creative accounting.

Sources

Weiss, Edmond H. "The Technical Communicator and ISO 9000," *Technical Communication*, Second Quarter 1993, pp. 234-238.

For further reading:

Gumpp, Gunther. "ISO 9000: Questions and Answers & Quality Systems Manual, Quality Control Systems and Services," 1992; PO Box 4417, San Clemente CA 92674.

Weiss, Edmond H. "The ISO 9000 Quality Manual: a Handbook/ Workbook." *Edmond Weiss Seminars*, 1612 Crown Point Lane, Cherry Hill NJ 08003; (609) 795-5580.

James Mathewson

When he's not occupied with his editor-in-training duties, James writes science and technology stories for The Minnesota Daily, where he has taken a new job as opinions editor. He is also a teaching assistant in mechanical engineering. He is changing academic departments from philosophy to rhetoric, where he will pursue a M.S. in scientific and technical communication. In his spare time, James paints watercolor landscapes, enjoys a variety of music, reads mystery novels and is practically obsessed with baseball. Oh, and of course there's *Star Trek*.

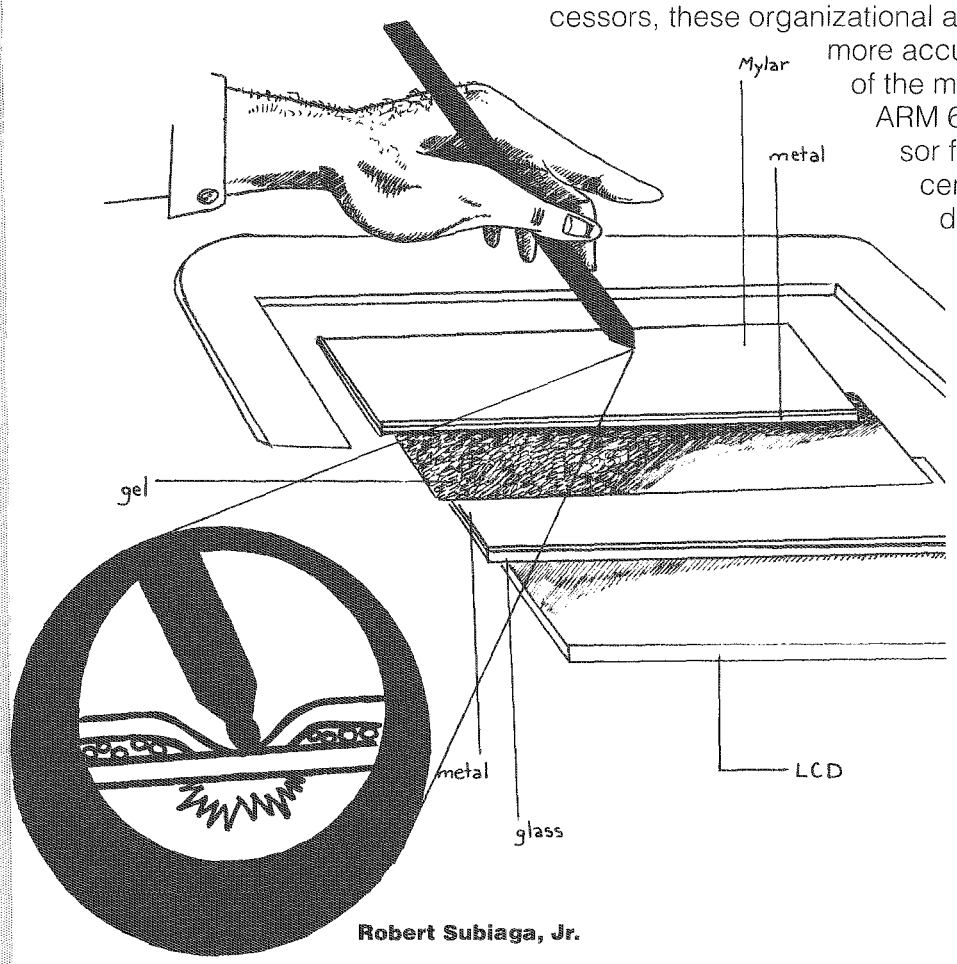
PALMTOP COMPUTING

Reed Munson

Palmtop computing is one of the latest developments in the computer industry's unending quest for smaller, faster and cheaper machines. These new computers utilize several cutting-edge technologies and could point the way to the future of desktop computing.

Several palmtop computers are on the market; Apple Computer's Newton MessagePad, the Sharp Wizard and the Casio Zoomer are among the most popular. These PDAs (personal data assistants) are being used primarily as organizational and communications tools. Introduced shortly before Christmas, palmtop computers have been popular with business people because the software they use manages large quantities of information efficiently.

Software tools such as to-do lists, address books and calendar/daytimers are common to all PDAs. These tools work essentially the same way as their pen-and-paper counterparts, but since they can access and store their data with the help of microprocessors, these organizational applications are much faster and more accurate. The processor that several of the most popular palmtops utilize is the ARM 610, a 20 MHz 32-bit RISC processor from ARM Ltd. Compared to central processing units used in desktop machines, the ARM 610 is twice as fast as Intel's 386 processor and Motorola's 68030 processor.



Robert Subiaga, Jr.

The main selling feature of these personal data assistants is their handwriting-recognition capabilities. Using a pencil-like plastic wand, or *stylus*, you write on the computer's screen. The LCD touch screen is designed to transfer the pressure of the writing stylus through three layers in the screen: The first layer is a piece of Mylar coated underneath with transparent metal; the next is made of a gel that contains microscopic plastic balls; the third

is a piece of glass coated on top with transparent metal.

When you "write" on the PDA screen, the pressure of the stylus pushes the tiny plastic balls in the gel layer out of the way. The two metal surfaces touch, creating electrical resistance. The palmtop's system software recognizes this resistance and directs pixels at the location of the resistance to darken on the LCD screen.

After a word is written on the screen, the PDA transforms the writing into clean, formatted text: a neatly typed phrase—as if typed with a keyboard.

Writing on the screen and instantly viewing what's written in "digital ink" is one thing; having the palmtop understand and recognize what has been written is another. Handwriting recognition, while one of the most sophisticated innovations of palmtop computers, is one of their weakest features. Imagine trying to read a stranger's handwriting and then typing out what you just read–or thought you read. This is exactly how handwriting recognition works. The PDA software recognizes individual handwritten letters and words and then transforms them into easily readable type. Problems arise quickly and frequently, however.

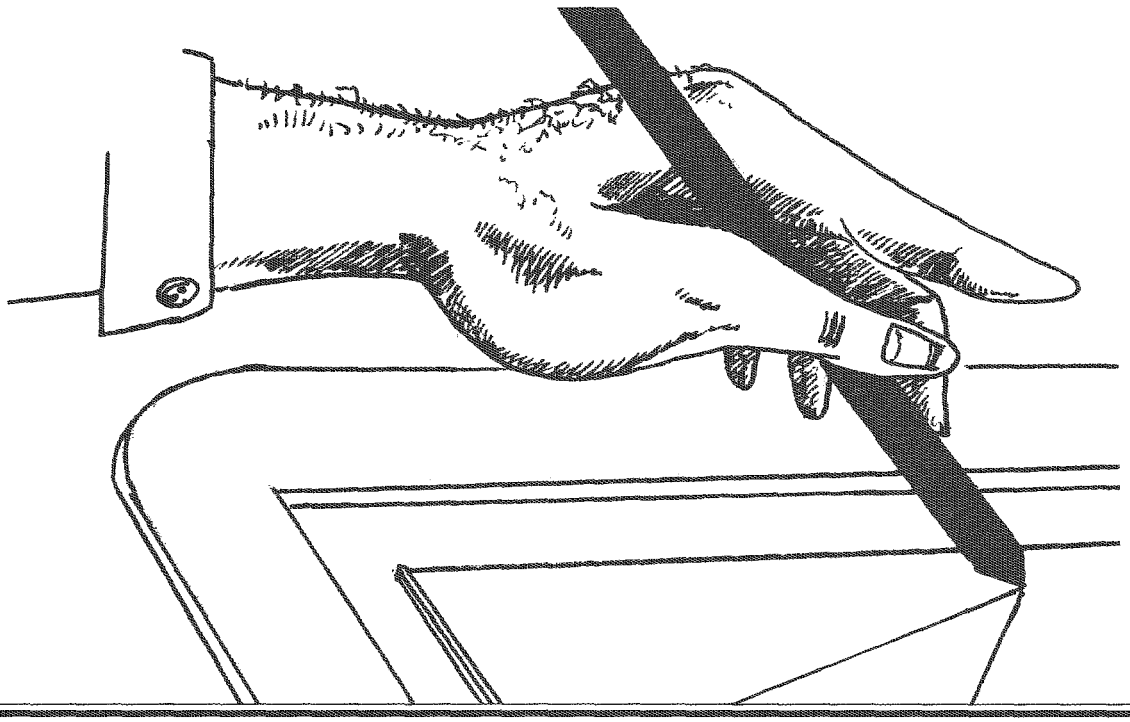
The first time I worked with this handwriting-recognition feature, I tried writing my name. A second after I signed my name, the palmtop's screen displayed: "freed lighters."

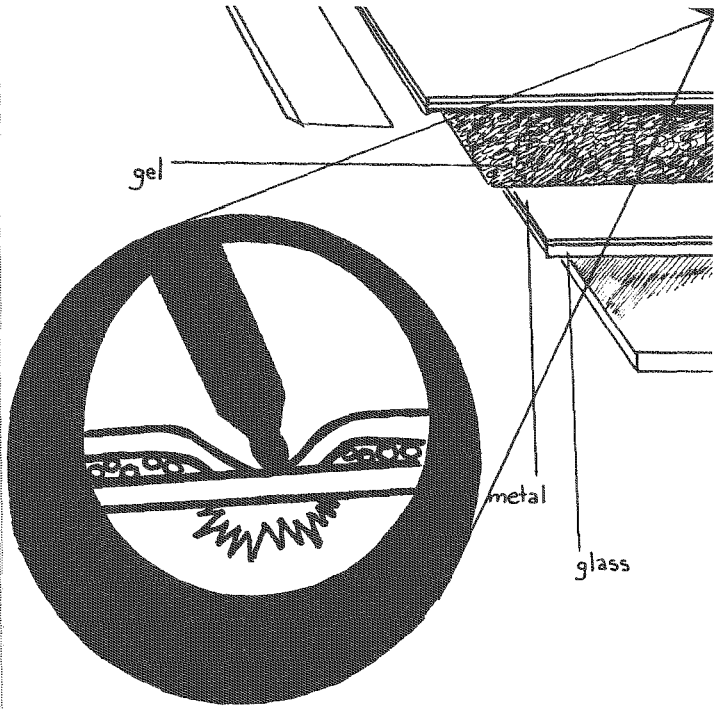
The first time I worked with this handwriting-recognition feature, I tried writing my name. A second after I signed my name, the palmtop's screen displayed: "freed lighters."

Most users will find that it takes some time for a palmtop computer to get used to their handwriting, but using a PDA is a two-way exchange. The more you use the computer, the more familiar the recognition software becomes with your handwriting. And as you use the palmtop, you learn to adjust your handwriting so the PDA recognizes it more easily.

In addition to handwriting recognition, the new palmtop computers feature state-of-the-art communications capabilities. Wireless data transmission is a feature built in to most popular PDAs. Data can be sent between two palmtops via an infrared beam. Beaming uses the same concept as a TV remote control, with which digital information is sent and received using an infrared transceiver. The computers must be within three feet of each other

Writing on the new palmtops is more accurate, and newer models also have more RAM and longer battery life.





in order to send and receive the beam.

Most palmtops also have data/fax modem capabilities. Using the modem, palmtops can connect to such services as the Internet and Compuserve, as well as send and receive faxes. A PDA can also serve as a beeper, which usually requires purchasing a PCMCIA-based pager card.

This spring computer companies introduced the second generation of palmtop computers. The first palmtop computers were heavily hyped, but failed to live up to users' expectations. The new PDAs are confronting and fixing the problems users have reported. Many users were disappointed with the poor performance of the handwriting-recognition feature, which was advertised as one of the PDA's major uses. Writing on the new palmtops is more accurate, and newer models also have more RAM and longer battery life. In the near future, look for PDAs with built-in cellular phones, larger displays and faster modems.

Palmtop computing is still in its infancy. The palmtops on the market today can be compared with early personal computers. In comparison with the machines on our desks (and in our laps) today, those old IBM ATs and Mac 128Ks seem like obsolete calculators. Palmtop computing is destined to go the same route. Today's PDAs will no doubt seem feeble in contrast to the palmtop computers created five years from now.

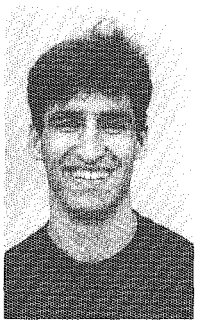
Sources

Bortman, Henry. "The Newton Generation." *MacUser,* October 1993.

Desposito, Joe. "Computing on the Go." *Microcomputer Journal,* March/April 1994.

Cohen, Raines. "Slimmed-down MessagePad." *MacWeek,* February 14, 1994, Vol. 8 No. 7.

Newton In-Store Demonstration Program Training Materials. Training session manual provided by Apple Computer and American Passage company. Taught by Jane Keer-Keer, November, 1993.

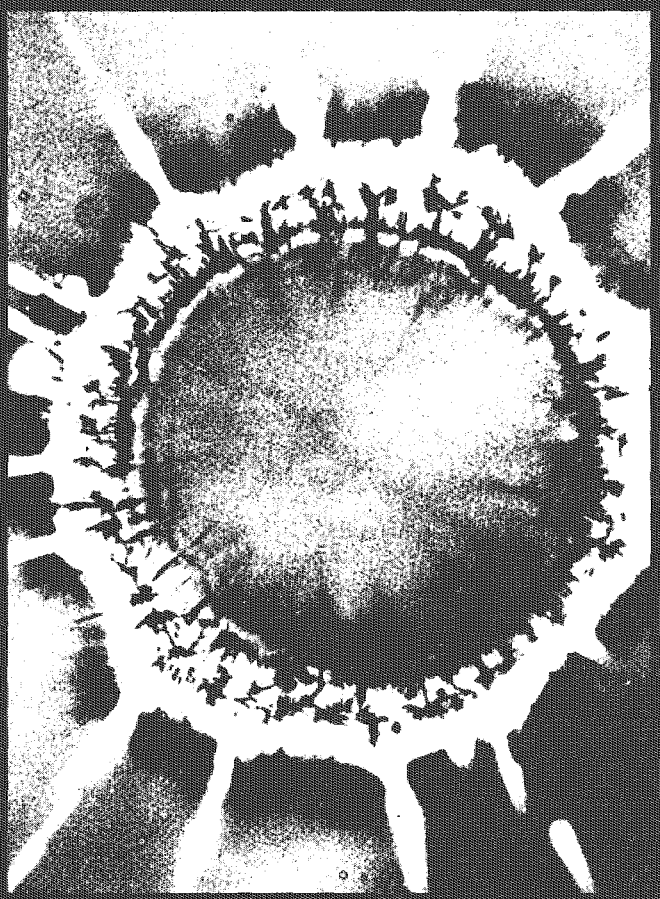


Reed Munson is a senior in the School of Journalism. He will graduate this June. Upon graduating, Reed plans to crusade against DOS chauvinists and to convert them into Macintosh users.

Consolidation of nuclear weapons production:

SEVERAL OPTIONS

PETER KAUFFNER



With the Cold War over and production of nuclear weapons at a halt, you might expect the Department of Energy's nuclear weapons program to be shutting down. In fact, spending increased from $9.6 billion in 1990 to $12.1 billion in 1993 (an increase of 17 percent after inflation), largely because of the rising cost of cleaning up contaminated sites.

In 1992, President George Bush announced a halt to the production of nuclear weapons in his State of the Union message. In fiscal year 1994, the DOE plans to dismantle some 2,000 nuclear warheads. Under the 1992 Strategic Arms Reduction Treaty II (START II), the U.S. strategic nuclear arsenal will decline from nearly 13,000 warheads in 1990 to a maximum of 3,500 in the year 2000.

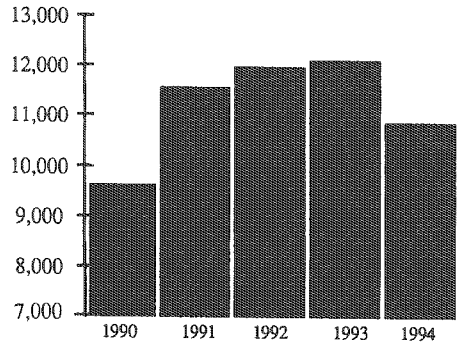
The DOE's nuclear weapons program has appropriated $10.86 billion for 1994, including $5.18 billion for environmental cleanup, $1.87 billion for stockpile maintenance and $403 million for test explosions of nuclear weapons.

Cleanup won't be the nuclear build-down's only cost. Aside from a $300 million tritium replenishment facility at Savannah River and some upgrading at the Nevada Test Site, no major nuclear weapons facility has been built since 1963. Many sites are now shut down because of safety concerns or because they are approaching the end of their useful lives. The

DOE would like to replace these aging facilities, close down unneeded sites and consolidate functions to create Complex 21, a weapons production and disassembly complex for the 21st century.

In a notice of intent released in July, Peter Brush, the DOE's principal deputy assistant secretary for

Appropriations for DOE atomic energy
(billions of dollars)



SOURCES: *Congressional Quarterly, Budget of the U.S. Government*

environment, safety and health, outlined three alternative approaches to reconfiguration: constructing new facilities, upgrading existing facilities and "the no-action alternative."

One advantage of building new facilities is that it would allow the DOE to consolidate all functions dealing with each special nuclear material at a single site. This would end the current "duplicative infrastructure and overhead costs" as well as the "needless transportation of nuclear material between sites," according to Brush.

The major special nuclear materials are plutonium, tritium and uranium/lithium. In addition, Brush argues that warhead assembly and disassembly should be done at a single site, together with work on high explosives. These functions would be performed at separate "modules." The modules could all be at a single, giant Complex 21 site or spread out among several sites.

The five candidate sites for building new facilities are: the Savannah River Site in S.C.; the Pantex Site near Amarillo, Texas; the Nevada Test Site near Las Vegas; the Idaho National Engineering Laboratory and the Y-12 plant in Oak Ridge, Tennessee.

The upgrade and no-action alternatives

Under the "upgrade in place" alternative, existing facilities would be modified to meet anticipated needs. "We think that the upgrade option is the most likely because Congress won't want to fund a new facility," said Ralph Hutchinson of Oak Ridge Environmental Peace, an anti-nuclear watchdog group. The Complex 21 proposal "is a toy for scientists like the supercollider or the space station," said Hutchinson.

Proposed upgrades include increasing the capacity of the uranium/lithium plant at Oak Ridge and expanding the plutonium pit manufacturing plants at Los Alamos National Laboratory and Lawrence Livermore National Laboratory. No existing DOE facility can be upgraded to produce tritium, so "a new tritium production source [is] needed," wrote Brush.

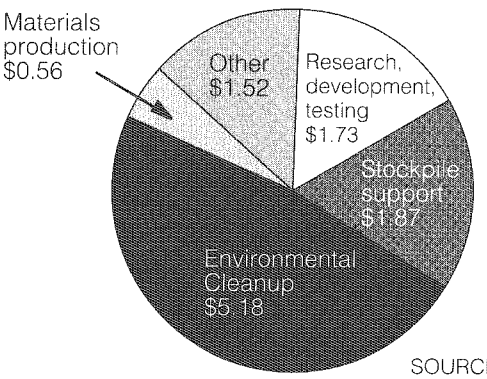
The "no-action" alternative would not meet the "requirements for the maintenance of the future weapons stockpile" and is therefore "not considered to be reasonable," according to Brush.

Rocky Flats

The Rocky Flats Plant in Golden, Colo., is perhaps the most troubled site in the nuclear weapons complex. It was used to produce plutonium "pits" until 1989, when it was cited for safety violations by the Federal Bureau of Investigation.

A pit–a hollow sphere of plutonium in the core of a nuclear warhead–is a fission nuclear device similar to the one dropped on Nagasaki in 1945. The

Atomic energy programs of the Department of Energy: Appropriations for fiscal year 1994
(billions of dollars)



Total: $10.86 Billion

SOURCE: *Congressional Quarterly* Dec. 11, 1993

explosion of the pit triggers nuclear fusion in the surrounding tritium, a type of radioactive hydrogen.

Anti-nuclear feeling is strong in Colorado, and a proposal to restart the plant caused "a great deal of

alarm to people in the Denver metropolitan area," said Sen. Timothy Wirth (D-Colo.) in a 1991 hearing of the Senate Armed Services Committee.

Savannah River Site

The Savannah River Site, with nearly 22,000 employees, is the largest U.S. nuclear weapons site. It's also the DOE's center for tritium storage and processing. Since tritium disintegrates at a rate of 5.5 percent annually, the tritium reservoir of every U.S. nuclear warhead is brought to Savannah River for replenishment every few years.

Congressman Butler Derrick (D-SC), whose district includes the Savannah River Site, told a House appropriations subcommittee that "the strongest attribute of the site is the overwhelming support of the surrounding community, the state, and the South Carolina congressional delegation." South Carolina has several members of congress in senior positions on the Armed Services committees and on the House Rules panel.

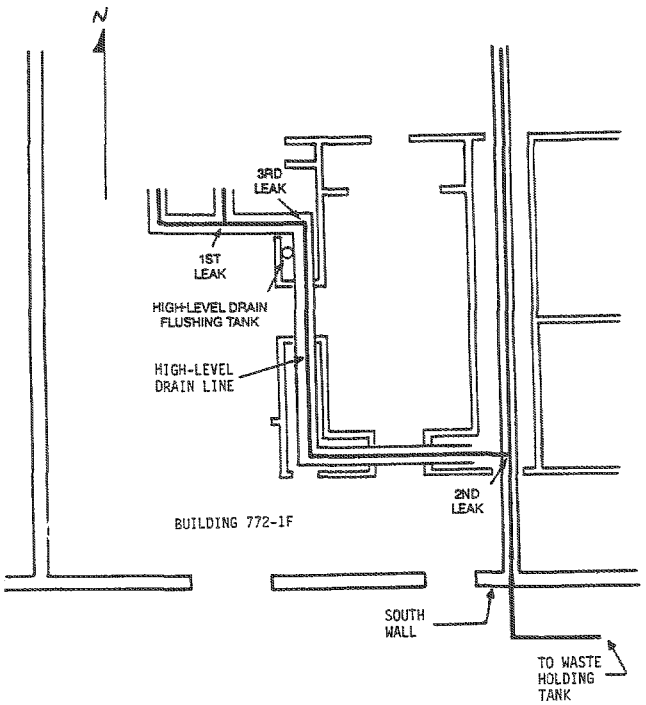
Tritium production at Savannah River was shut down in 1988 due to safety concerns caused by an operator error. An attempt to restart the plant in 1991 resulted in a tritium leak. Brush says the shutdown "effectively eliminates the DOE's ability to produce tritium to support the projected stockpile requirements."

The DOE projects that if the United States chooses to maintain all of the nuclear weapons it is allowed under START II, its current stockpile of tritium will last only until 2008. Recent plans to scale down the nuclear stockpile have reduced the projected need for tritium. "Three years ago, it was thought that we would have to build a new reactor to produce tritium, but now the thinking is that a linear accelerator might produce enough tritium to meet our needs," said Rick Ford, a public affairs specialist for the Savannah River Site.

"THREE YEARS AGO, IT WAS THOUGHT THAT WE WOULD HAVE TO BUILD A NEW REACTOR TO PRODUCE TRITIUM, BUT NOW THE THINKING IS THAT A LINEAR ACCELERATO MIGHT PRODUCE ENOUGH TRITIUM TO MEET OUR NEEDS SAID RICK FORD

To avoid the cost of building a new facility to meet tritium needs after 2008, Sen. Jim Exon (D-Neb.) has proposed that the United States buy tritium from foreign nations. Several nations produce tritium in commercial reactors that also produce electricity. This cannot be done in this country because of a longstanding federal law that forbids the use of civilian reactors for military purposes. This restriction was imposed in the hope that if other nations followed the U.S. example, nuclear proliferation would be slowed.

Of course, importing tritium would mean that the U.S. nuclear weapons program would no longer be self-sufficient.



In 1991, soil adjacent to the Savannah River Site Building 772-1F was contaminated due to piping leaks. Location of the three leaks in Building 772-1F of the site.

Diagram taken from: "Augmented Evaluation of Soil Contamination at the Savannah River Site Outside Building 772-1F," July 1991, United States Department of Energy.

Pantex

Pantex now does disassembly and high explosives work and also stores plutonium pits after disassembly. "Pantex's safety and environmental record has been one of the best in the nuclear weapons complex," said Amarillo Congressman Bill Sarpalius (D-Texas) at a 1992 hearing of a House appropriations subcommittee. "Local newspaper polls find support for expansion [to be] as high as 85 percent," he said.

Pantex boosters focus on its site's potential for expanded storage and processing of plutonium. The plutonium "is already here and facilities can be

expanded more cheaply here than anywhere else," according to Walis Madden Jr., co-chair of Panhandle 2000, an Amarillo-based group which promotes Pantex expansion.

"Pantex is the logical repository for plutonium, particularly if it is to be used in research," said Madden. Three Texas universities, University of Texas, Texas A & M and Texas Technological College, have proposed that a research consortium be formed that would allow their researchers to use the facilities at Pantex.

Other sites

Some Nevada politicians adamantly oppose the high-level nuclear-waste storage facility the DOE is building at Yucca Mountain, near the Nevada Test Site. Sen. Richard Bryan (D-Nev.) denounces DOE proposals to store plutonium at NTS as an attempt to get Nevada to accept nuclear waste under "another name." But Nevada's other U.S. senator, Harry Reid (D-Nev.), says that "the issue should be studied." NTS has an $89 million warhead disassembly plant which is nearly complete.

Anti-nuclear activists would like to see plutonium disposed of permanently after being removed from a warhead. "Plutonium has only one purpose — making bombs," said Don Hancock of the anti-nuclear Southwest Research and Information Center in Albuquerque, N. M. "We need to get rid of it so it can no longer be used in bombs."

France, Japan, Germany and Switzerland already use reprocessed plutonium–the plutonium extracted from nuclear waste–to make electricity in commercial light-water reactors, the same type of reactor used by U.S. utilities. Hancock questions whether such an arrangement includes "safeguards to make sure Iraq and Libya don't get any plutonium."

But according to Loring Mills, a retired nuclear engineer and a former vice president of the Edison Electric Institute: "The fuel can be manufactured under tight controls and once it's in fuel form, control is easy."

Plutonium production at Hanford, Wash. was halted in 1987 as a result of safety concerns. Since warhead disassembly supplies the DOE with a growing stockpile of plutonium, there are no plans to restart production. Plutonium has a half-life of 24,000 years, compared to 12 years for tritium. Hanford was considered as a possible site for a future weapons facility in a 1992 implementation plan, but is no longer being considered because "the Department considers it unreasonable to . . . spend billions of dollars in order to restore [Hanford] for other uses, and then reintroduce nuclear weapons program construction and operation activities which will prevent other uses of the site for the long term," wrote Brush.

ANTI-NUCLEAR ACTIVISTS WOULD LIKE TO SEE PLUTONIUM DISPOSED OF PERMANENTLY AFTER BEING REMOVED FROM A WARHEAD. "PLUTONIUM HAS ONLY ONE PURPOSE – MAKING BOMBS," SAID DON HANCOCK OF THE ANTI-NUCLEAR SOUTHWEST RESEARCH AND INFORMATION CENTER IN ALBUQUERQUE, N.M. "WE NEED TO GET RID OF IT SO IT CAN NO LONGER BE USED IN BOMBS."

BUT ACCORDING TO LORING MILLS, A RETIRED NUCLEAR ENGINEER AND A FORMER VICE PRESIDENT OF THE EDISON ELECTRIC INSTITUTE: "THE FUEL CAN BE MANUFACTURED UNDER TIGHT CONTROLS AND ONCE IT'S IN FUEL FORM, CONTROL IS EASY."

The DOE is funding research by General Atomics of San Diego on burning undiluted weapons-grade plutonium in a modular helium reactor. Edward Davis, president of the American Nuclear Energy Council, the commercial nuclear industry's lobby, suggests that if such a reactor was built at NTS, it would provide both jobs and electricity for Nevadans while disposing of warhead plutonium.

The Idaho National Research Laboratory has long been one of the largest employers in Idaho. Some 52 types of reactors were developed at the site since it began operation 40 years ago. In 1986, the DOE proposed building a $1.2 billion plutonium-production facility at INEL. At the time, the proposal was a crowd pleaser and a feather in the cap of then Sen. Steve Symms (R-Idaho). But a fickle Idaho public later turned against the idea, and the DOE dropped it in 1990.

Y-12 is one of three DOE plants in the Oak Ridge

Reservation, which has a total employment of about 15,000. Oak Ridge has historically been at the cutting edge of weapons research. "Most good things in the nuclear weapons program had their genesis in Oak Ridge," said former Oak Ridge mayor and DOE site supervisor Roy Pruett. Y-12 now disassembles and stores the uranium and lithium parts of nuclear weapons. "It's the Fort Knox for uranium," Pruett said. Proposals to expand Oak Ridge have the support of the Oak Ridge City Council and "very, very positive support" from all the communities surrounding the site, according to Pruett.

Appropriations for DOE Nuclear Weapons Program
(billions of dollars)

	1990(act.)	1991(act.)	1992	1993	1994
Research, development, testing		1.720	1.944	1.955	1.729
Nuclear defense labs					0.957
Test explosions		0.505	0.514	0.474	0.403
Production, stockpile support		2.537	2.537	2.613	1.866
Environmental cleanup	1.975	3.160	3.681	4.832	5.182
Waste management		1.720	2.297	2.830	2.84
Cleanup of sites		0.877	1.054	1.381	1.54
Materials production		2.279	1.840	1.256	0.562
Other					
TOTAL, DOE atomic energy	9.636	11.567	11.968	12.119	10.861

SOURCES: *Congressional Quarterly, Budget of the U.S. Government*

The components of nuclear weapons that do not use special nuclear materials are currently manufactured in Mound, Ohio; Kansas City, Mo. and Pinellas, Fla. In 1994, the DOE plans to begin consolidating these activities at the Kansas City plant.

Meanwhile, the efforts to consolidate DOE sites that deal with special nuclear materials continue to inch forward. Decisions concerning which sites will be shut down and which ones will be upgraded "will be made by the Galvin Commission, and their report is expected this fall," said DOE press secretary Christie Kieffer.

Sources

"Environmental Impact Statement for Reconfiguration of the Nuclear Weapons Complex," *Federal Register*, July 23, 1993, pp. 39528-35.

Carter, Luther J., "The Other Side of the Mountain: Politics Aside, Burying Warhead Plutonium at Nevada's Test Site Makes Sense," *Washington Post*, August 22, 1993.

"Energy and Water Development,"*Congressional Quarterly*, December 11, 1993, pp. 71-73.

Cunningham, Ann Marie, "The Tritium Factor," *Technology Review*, April 1990.

Derrick, Butler, "Statement of the Hon. Butler Derrick, A Representative from South Carolina," *Hearings on the National Defense Authorization Act for FY93: H.R. 5006 and Oversight of Previously Authorized Programs. Department of Energy Defense Programs.* Washington, DC: Government Printing Office, pp 661-68.

Ford, Rick. Interviews, December 1993 and January 1994.

Hancock, Don. Interview. December 1993.

Hutchinson, Ralph. Interview. December 1993.

Idelson, Holly, "The Tritium Question," *Congressional Quarterly*, April 25, 1992.

Kennedy, J. Michael, "Idaho says `Enough' to Nuclear," *Los Angeles Times*, Sept. 1, 1990, p. A1.

Madden, Walis. Interview. December 1993.

Mills, Loring. Interview. December 1993.

O'Leary, Hazel R., "Reconfiguration of the Weapons Complex," *Energy and Water Development Appropriation for 1994. Part 4: Department of Energy FY94 Budget Justifications.* Washington, DC: Government Printing Office,p.40.

Pruett, Roy. Interview. December 1993.

Sarpalius Bill, "Statement of the Hon. Bill Sarpalius, A Representative from Texas," *Hearings on the National Defense Authorization Act for FY93: H.R. 5006 and Oversight of Previously Authorized Programs. Department of Energy Defense Programs.* Washington, DC: Government Printing Office, pp. 642-43.

Smith, Laura. Interview. December 1993.

Smith, R. Jeffrey, "Ultimate Recycling: Nuclear Warheads," *Scientific American*, May 24, 1991, pp. 1056-57.

Peter Kauffner

Computer Science senior Peter Kauffner was an intern at the National Journalism Center in Washington, D.C. After he graduates in June, he aims to become a Technical Writer.

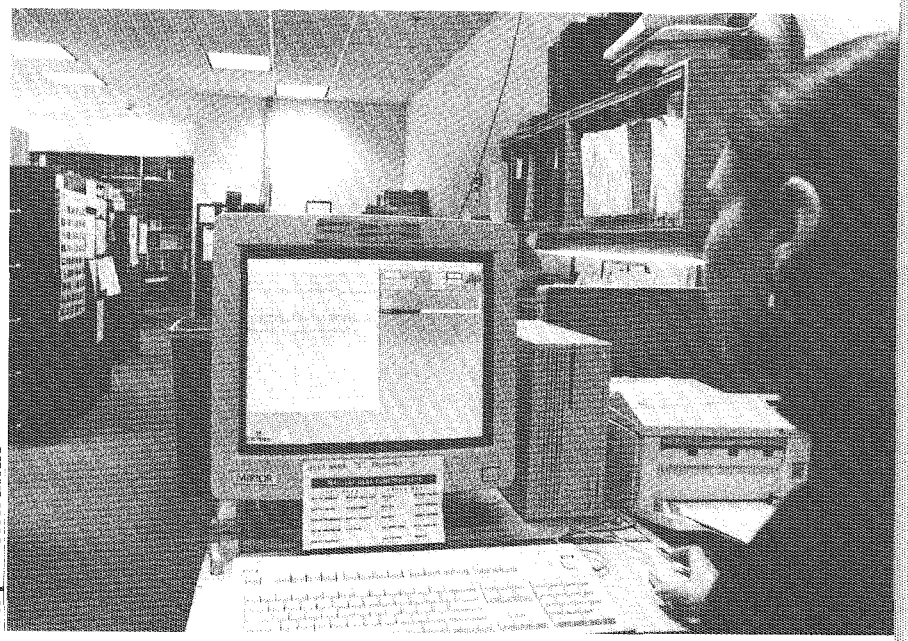
Now You See It,

Tamara Lubic

As digital photography relegates darkrooms to the Dark Ages, will the "Kodak Moment" become a nanosecond in cyberspace, lost forever to history?

Preserving the past is one of the challenges of future photo technology, but no one's wedding or family reunion memories are in jeopardy just yet. Although a few digital cameras are available on the consumer market, their quality and price mean that most people will be snapping, developing and storing photos of vacations and celebrations the old-fashioned way . . . at least for a while longer.

Dave Husom, assistant professor in the Department of Extension Classes, says, "What drives the photography market now is the amateur photographer, but the amateur will be last to use this technology because of price. Amateurs want quick and cheap." He says the new technology has hit the commercial market first.



Dilip Vishwanat

A St. Paul Pioneer Press librarian views part of a menu of photos available from AP.

Husom has been teaching noncredit courses in digital photography through the Continuing Education Compleat Scholar program since 1992. The classes are held after business hours at Dicomed Inc., a manufacturer of electronic imaging equipment headquartered in Burnsville.

In the basic "old world" of commercial printing, Husom explains, "One person would take a picture, develop it, hand it to a separator, who would give it to a platemaker, who, in turn would give it to the printing press operator. With digital technology, graphic designers can do separations and page layouts, and so can photographers." One result, Husom notes, is that

Now You Don't

engineers will need to know more about color, graphics and printing. He cites a 1990 book by Fred Ritchin that overviews the future: "In Our Image: The Coming Revolution in Photography: How Computer Technology Is Changing Our View of the World."

Husom says, "The people who will lose out first are the color separators. The photographer will take a picture, get the negatives developed and feed them through a scanner. The next step will be getting rid of film. You'll go directly from camera to page layout." Where this will be useful, he says, is in capturing at-the-scene events in politics and sports–things that happen very quickly. He adds that although a third generation of Kodak digital cameras is still not film quality, a test camera that the company had at the Olympics in Lillehammer for journalists' free use became popular in a flash. He says, "No one wanted it until Tonya Harding and Nancy Kerrigan were skating; then people were fighting to be the first to send photos back to the U.S."

Not surprisingly, one of the biggest customers for the new digital photo technology is The Associated Press. A recent issue of *InformationWEEK* reported that "A typical newspaper receives 350 photos a day from The Associated Press alone, 85% to 90% of them in color."

In 1992, AP introduced the PhotoStream service, which electronically delivers digital photos to newspapers. According to *InformationWEEK*, as part of the service, AP now installs its Leaf Picture Desk, a digital imaging system developed for AP by Leaf Systems Inc.

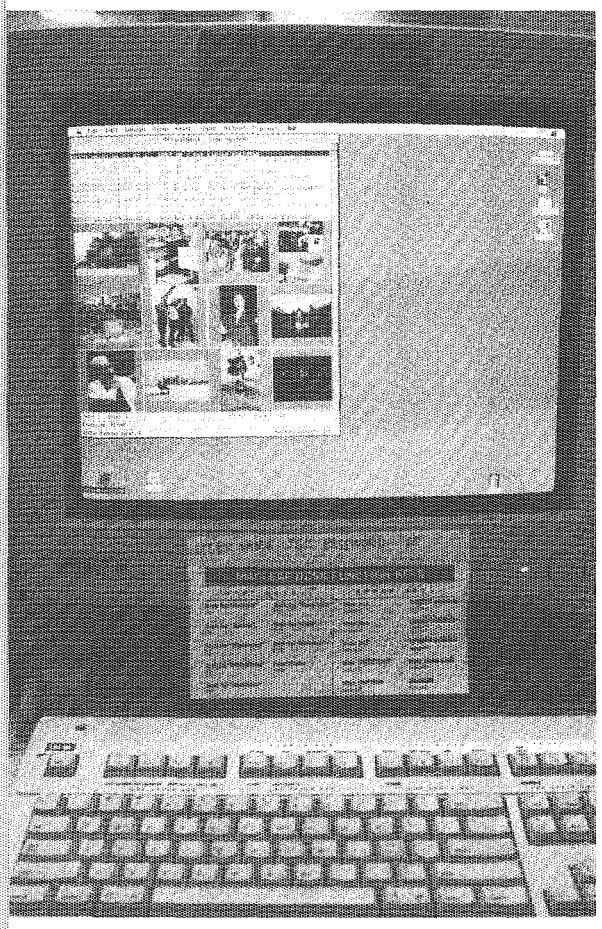
But Linda James, head librarian for the Saint Paul Pioneer Press, says that since the system's inception, archiving has been a problem. The volume of photos flowing into newspapers from wire services means that news librarians have always had to make decisions about what to keep.

"You apply the same principles the photographer does," James says. "Does it have news interest? Does it tell a story, or is it the 3000th photo of a celebrity? Our photo collection goes back to the turn of the century."

Selection and storage has "never been a precise system," but James says that the historic value of many of the saved photos is hard to estimate.

The new equipment, however, has limited capability for long-term storage of images. She says, "If you have two feet of shelving in a book library, and you try and put more than two feet of books on it, they'll fall off the end. When this system reaches capacity, the same thing happens."

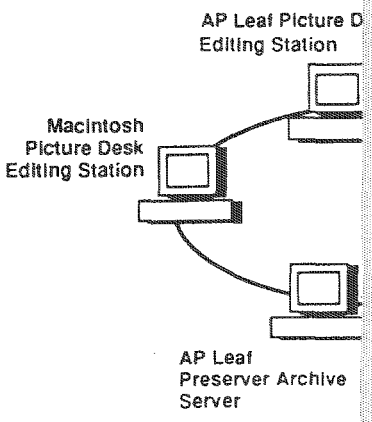
James cites statistics showing that about 30 percent of the images appear-



Dilip Vishwanat

Multiple images can be viewed on screen simultaneously.

AP Leaf Preserver Typic



Used with permission of David Tomlin

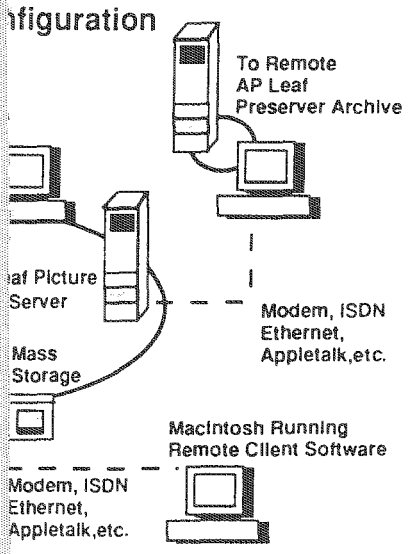
PHOTO FINISH

David Knopp, principal engineer Dicomed, Inc. and a 1984 IT grad mechanical engineering, says he ha also done about "99-and-a-half" pe cent of the electrical engineerin coursework.

Knopp explains that the credentia of his engineering co-workers incluc bachelor's degrees in chemistry ar chemical, mechanical and electric engineering–as well as a master's d gree in divinity. About one-third a IT grads. The main requirement for job in his field, he says, is a stror math background and a goc grounding in physics.

Another key, he says, is taking "th liberal electives that a lot of enginee don't want to take." For exampl Knopp, emphasizes the value of second language in today's world. H has found his French minor useful ar suggests that German would also b a good choice, since many journal a ticles on film and photo technolo are published in German.

Knopp says the liberal-electi training can help in other ways. Ty



ciated Press Director of Technology Marketing.

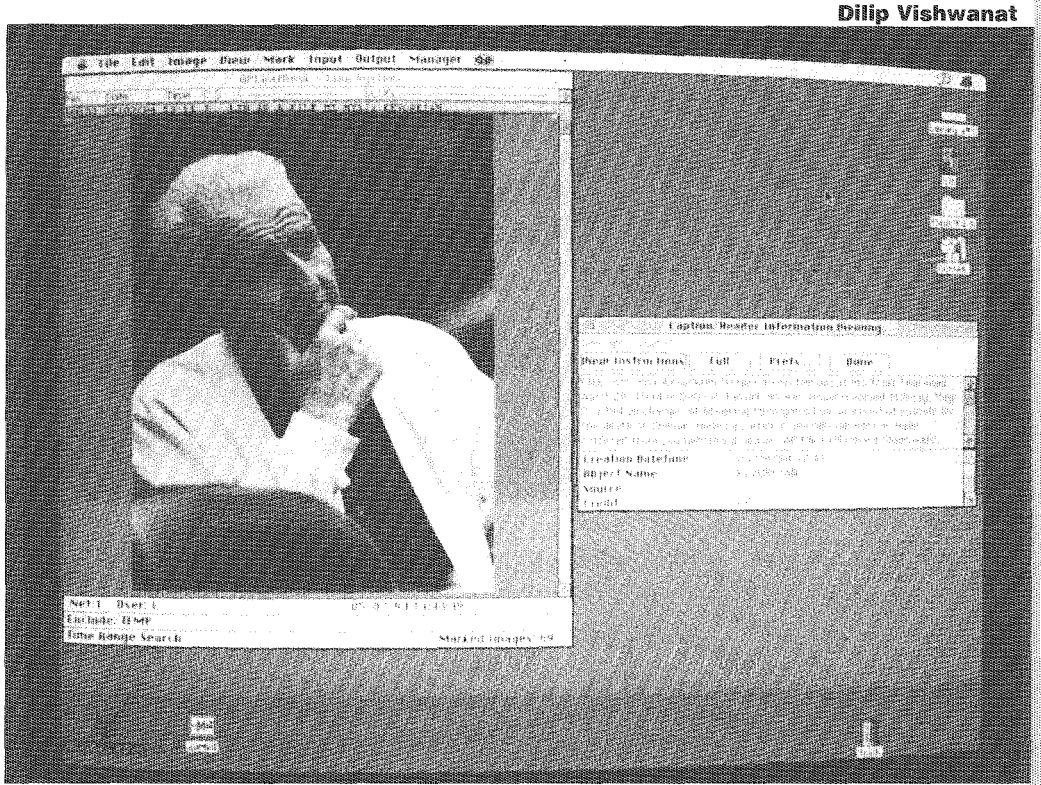
ing in the newspapers come through a news library, meaning that they are pulled from storage. She says one of the dangers of lacking archival capability is that something that seems like an insignificant incident at first may become one piece of a larger news story days or months later.

"When you think about historic images like the raising of the flag at Iwo Jima," she says, the implications become clear. "Fortunately, in the past year or so, enough people realize the impact, and archiving systems are being [more aggressively] developed. In the future I think what you're going to see is extensive photo–archiving libraries available to newspapers and researchers."

training and education."

The "camera-to-page-layout" capability of the new digital imaging systems is also becoming popular in science research and publication. Dr. Fred Boyd, Assistant Professor in the University Medical School's Lab Medicine and Pathology department, uses it in conducting electrophoretic densitometry tests. The tests measure the photographic density of DNA bands and separations via transmitted and reflected light. In the past, the test required a dedicated densitometer that cost about $10,000.

Dilip Vishwanat



The AP Leaf Desk Screen allows newspapers to view images at enlarged sizes.

James notes that the move to digital transmission and storage of data in the news industry has other repercussions; one of the television networks this year decided to send its fall lineup to newspapers on CD-ROM. She says, "What about the smaller newspapers of the world? There's a huge gap between what can be done with technology and what is being done in the real world, and closing that gap can be expensive; it requires

Today a Macintosh IIcx with a digital–imaging board connected to a Sony CCD camera–combined with public domain software from the National Institutes of Health–can do the same thing for about $4,200.

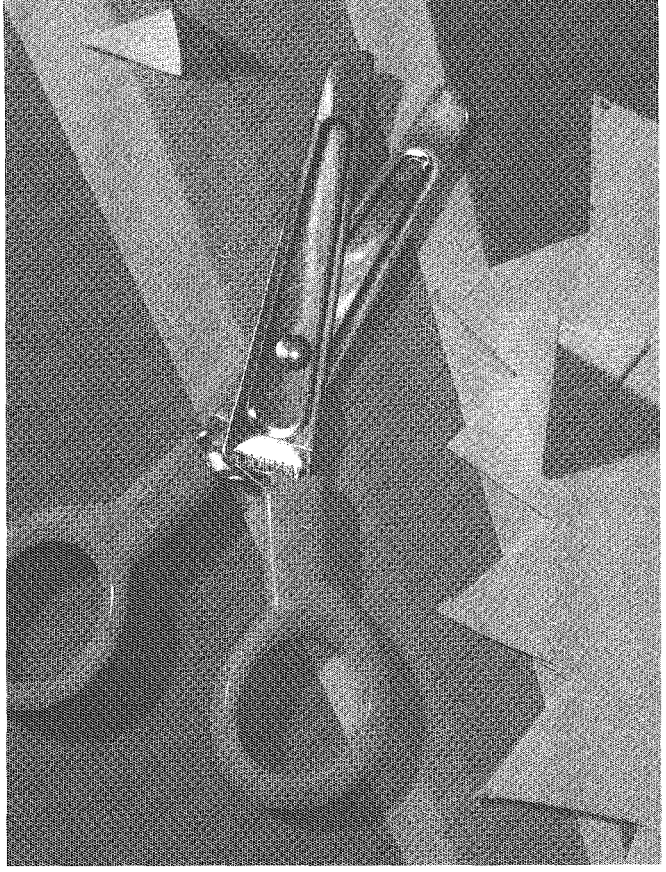
At the point of previewing an image, Boyd says, "The only cost we have so far is electrons. If we like it, we can print it out." Without ever going to photo, Boyd says he can make a publication-

rad David Knopp talks about his eer in photographic technology

lly, in finding a solution to a nebu-us on-the-job problem: "You need draw from a lot of disciplines to be le to make it fly." He also notes the portance of understanding busi-ss. "Things that are technically ssible may not be economically ssible."

Knopp says that one of the emerg-g concepts in the industry is de-ce-independent color, which en-res that photo colors from different urces can be matched. The pro-ss requires significant mathemati-l manipulation, particularly "map-ng from one 3-D space to another." Knopp says, "In general, the photo arket is going to get a whole lot re electronic. The more you know out it from beginning to end, the tter off you're going to be." And he ys that someone who is a photog-pher by hobby is going to be "way ead of the game."

Knopp offers a final bit of advice all electrical engineering majors: ay attention in Bill Peria's analog ctronics class!"



Leaf digital image capture by Popular Front Studio, St. Paul, MN.

quality image and import it into his research manuscripts, saving "time, effort and money."

The process is becoming standard operating procedure at scientific journals, but the ease with which digital images can be manipulated raises issues of data authentication. A recent issue of *Science* reports no known cases of "deceptively doctored digital images in the scientific literature," but quotes several scientists who advocate establishing safeguards. One proposal recommends requiring researchers to provide an electronic "history" of an image when submitting it for review and publication.

Boyd says some journals already require a written history describing: "Here is what I did to make my figure. This is how I cropped it, and this is how the LUT (Look Up Table) map was altered to enhance the image contrast." In this way the images are subject to peer evaluation and replication along with the rest of the data.

In Boyd's opinion, the old mechanical process of creating images was less subject to tampering only to the extent that it required "a smarter, more trained person to do it." He adds, "If one is motivated to be dishonest one can do that by method A or method B."

If recording the history of a document can help preserve its integrity, preserving history, itself, remains a problem. Linda James recalls an off-line incident that showed her how easily history can be erased. She says, "Several years ago, somebody had a digital camera at a newspaper celebration I attended. I imagined that the photos were something we might want to use again, so I asked the photographer for hard copy and/or a copy of the disk." A few weeks later she asked him again. "He had re-used the disk. The pictures were gone."

Sources

Anderson, Christopher "Easy-to-Alter Digital Images Raise Fears of Tampering," *Science*, Jan. 21, 1994, pp. 317-18.

Appleby, Chuck. "News Photos in A Flash: AP Leads A Revolution in the Management of Digital Photos," *InformationWEEK*, Sept. 20, 1993.

Boyd, Fred. Interview, March 31, 1994.

Husom, Dave. Interview, March 8, 1994.

James, Linda. Interview, March 29, 1994.

Ritchen, Fred. *In Our Image: The Coming Revolution: How Computer Technology Is Changing Our View of The World*, (New York: Aperture), 1990.

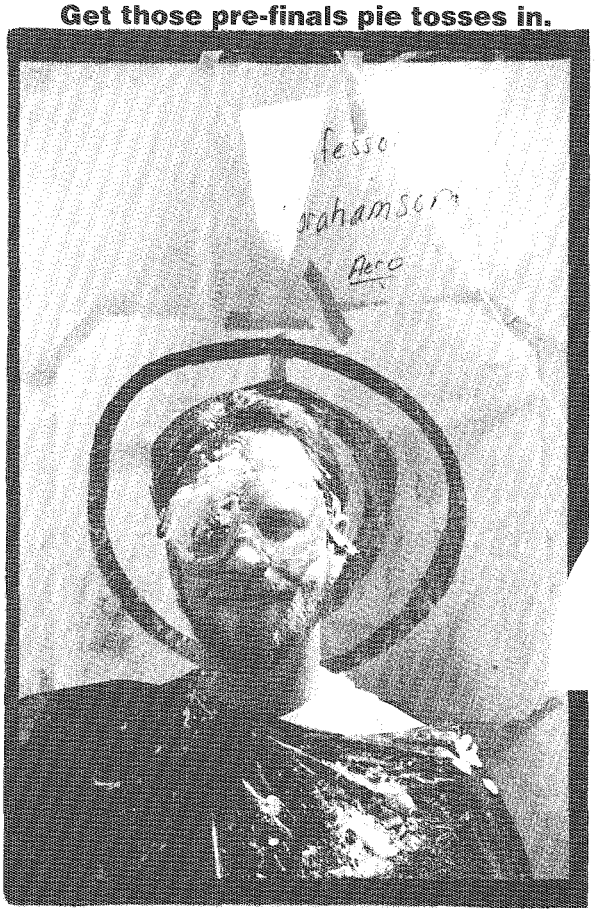
Taubes, Gary. "Technology for Turning Seeing Into Believing," *Science*, Jan. 21, 1994, p. 318.

Tamara Lubic

Tamara is extremely interested in how people decide what is right, wrong or unavoidable. A journalism graduate student with a minor in Biomedical Ethics, she sees writing as a way of getting answers.

IT week

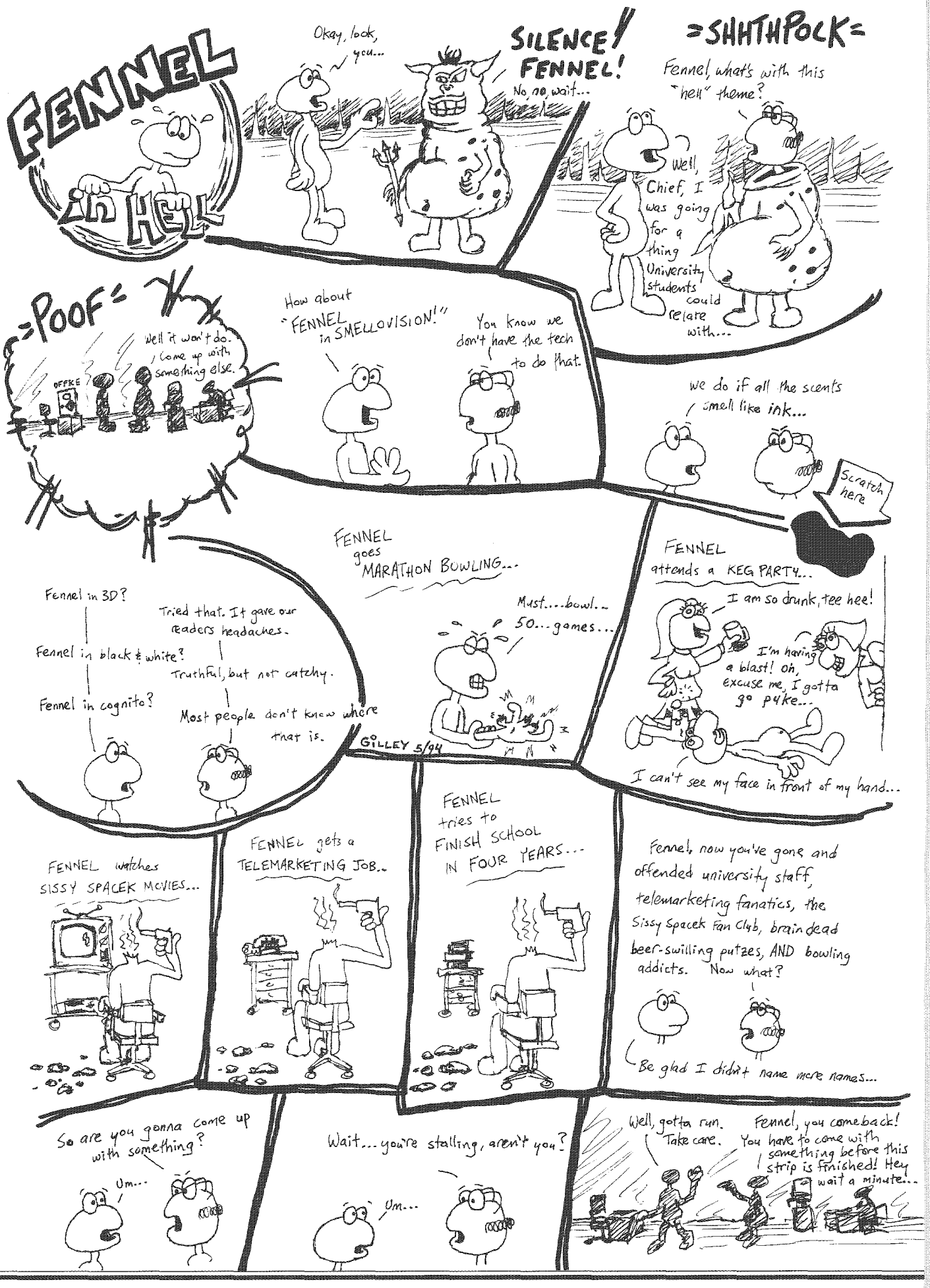
Get those pre-finals pie tosses in.



A stripped-down bed race entry.

Photos by Mark Trockman

At least it's not pecan pie.


FENNEL IN HELL
Okay, look, you...
SILENCE! FENNEL!
No, no, wait...
=SHHTHPOCK=
Fennel, what's with this "hell" theme?
Well, Chief, I was going for a thing University students could relate with...
=POOF=
Well it won't do. Come up with something else.
OFFICE
How about "FENNEL in SMELLOVISION!"
You know we don't have the tech to do that.
we do if all the scents smell like ink...
Scratch here
FENNEL goes MARATHON BOWLING...
Must....bowl... 50...games...
FENNEL attends a KEG PARTY...
I am so drunk, tee hee!
I'm having a blast! Oh, excuse me, I gotta go puke...
I can't see my face in front of my hand...
Fennel in 3D?
Tried that. It gave our readers headaches.
Fennel in black & white?
Truthful, but not catchy.
Fennel in cognito?
Most people don't know where that is.
GILLEY 5/94
FENNEL watches SISSY SPACEK MOVIES...
FENNEL gets a TELEMARKETING JOB...
FENNEL tries to FINISH SCHOOL IN FOUR YEARS...
Fennel, now you've gone and offended university staff, telemarketing fanatics, the Sissy Spacek Fan Club, brain dead beer-swilling putzes, AND bowling addicts. Now what?
Be glad I didn't name more names...
So are you gonna come up with something?
Um...
Wait... you're stalling, aren't you?
Um...
Well, gotta run. Take care.
Fennel, you come back! You have to come with something before this strip is finished! Hey wait a minute...