

UNIVERSITY OF MINNESOTA INSTITUTE OF TECHNOLOGY

MINNESOTA Technolog

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FALL 2007

CYBER SECURITY

Protecting the nation's
electronic infrastructure

DATA
SECURE

ALSO INSIDE: Women in IT • The End of Evolution? • Personal Rapid Transit • And More!

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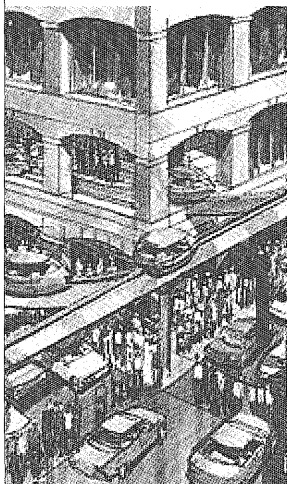
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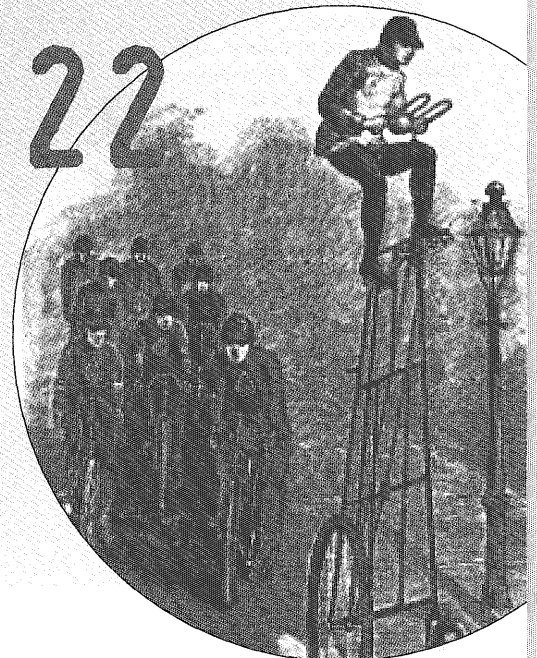
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Eblen



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Idziorek



Idziorek

Katie Idziorek is in her fourth year of the B.S. program in architecture. She enjoys doing crosswords and drinking coffee in her breakfast nook and spending quality time with the world's number one juggalette.



Moshier

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Mike Moshier, a mechanical engineering senior, is interested in energy and is about ready to search out a job where he can continue to learn or graduate school in a related field. In the mean time, you can bet he's trying to make the most of his time here or catching up on homework.



Moshier



Palanisami

Mahi Palanisami is a senior in mechanical engineering. She is surprised at how her moods can swing, depending on what words people choose when speaking to her. For example, she walked out on her job at the state fair when her boss called her mopey. "She should have said, 'tired,' instead," says Mahi.

Jennifer Purdes, a freshman who intends to major in biomedical engineering, has returned to her native soil of Minnesota after an eight year sojourn in Denver. She enjoys skiing, lacrosse, Hellgopher soccer, almost anything to do with music, and the undeniable deliciousness that is Waldmeister ice cream.



Purdes



Rusch

Anna Rusch is a junior in mass communications and English. Working for the *Technolog* has been an informative experience because she has learned more about current technology related issues. In her free time, aside from stressing about classes, Anna likes to read *Cosmopolitan*, watch *Friends*, and go out to eat.

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Shpantzer

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Steichen

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Tangen

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Thomas

Michelle Walter is a freshman who hopes to earn a degree in astrophysics. When not doing her ever-present homework, Michelle can be found watching her \$10 "free" cable, knitting a scarf before winter comes, and shopping.



Walter



Weyandt

Chris Weyandt is a mechanical engineering freshman. His only real interest is photography, most especially of nature and architecture. He openly admits to not having a clue what he wants to do with his life.

International assets

In response to the September 11 attacks, Senator Diane Feinstein (D-CA) has proposed a six-month moratorium on student visas. Other people have also attacked the loose regulation of the student visa system as an easy entry point for potential terrorists. While closer monitoring of international students may be necessary, especially as the expiration of their visas approach, international students bring a vibrant and vital contribution to the University community. Sen. Feinstein's six-month moratorium makes the United States appear closed-minded and will not solve any of the real concerns about the student visa system.

Most American universities—whether they will admit it or not—cannot function without the large cadre of international graduate students who carry much of the responsibility for teaching and research at large universities. Here at the University of Minnesota, foreign graduate students play a crucial role in IT. According to statistics published by the American Association of Engineering Societies in the fall of 2000, 307 of the 487 Ph.D. students at the University were foreign nationals. That's 63 percent of the Ph.D.s, from which one can estimate that probably over half of the TAs and RAs in IT are international students. These educational leaders are responsible for the day-to-day running of classrooms and research labs. If a moratorium on student visas is implemented until proper student visa tracking measures are set-up, IT would likely face a severe labor shortage—not to mention a debilitating brain drain.

Beyond playing an important academic role, international students in all disciplines bring to campuses across the country diverse perspectives on world affairs. By eliminating students from one particular region, like the Middle East, we are effectively shutting out one voice in the increasingly important international discussion of foreign policy in that region. At times like this, the exchange of international students is crucial for developing global understanding of the present situation. America deprives itself of an important opportunity to learn through personal interaction by restricting access to its universities. In addition, foreign students who study in the U.S. often return to their home countries better informed about life in the U.S. and better able to combat stereotypes of America abroad.

Looking at the international population residing within the U.S., the student population is only 1.8 percent of the 31 million foreign citizens who enter the U.S. on visas every year. Although one of the hijackers, Hani Hanjour, had entered the United States on a student visa, but never attended school, most of the other hijackers did not enter using student visas. Students arriving on student visas are already more carefully monitored than other foreign citizens. A six-month moratorium as proposed by Feinstein would not allow sufficient time to set up an effective tracking system, but it would be long enough to effectively prevent any new international students from arriving for an entire academic year. The intellectual cost of such a move would be priceless.

— The Editors



Technolog editors Melissa Eblen and Mike Mosher.

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Have we reached...

The end of evolution?



BY JEN IDZIOREK

Some of us are inclined to think that we are the end product of evolution. How could you possibly improve upon this? We learned to hunt, use tools, make fire, and create the computers that help produce our dear *Technolog*. So yes, our minds have improved. But what about our bodies?

Charles Darwin was the first to propose the theory of evolution. He hypothesized that species adapted to fit their environments over many generations, and that those with advantageous traits were more likely to survive to pass them on. Humans who walked upright, were taller, and whose jawbones did not protrude ultimately conquered those with opposing characteristics. Therefore, we are the result of the most useful qualities since the beginning of time; we are more fitted to our environment than any of our ancestors ever were.

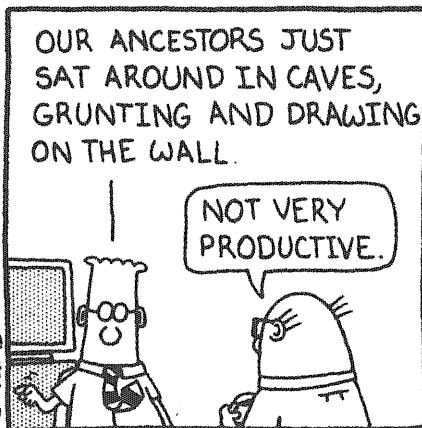
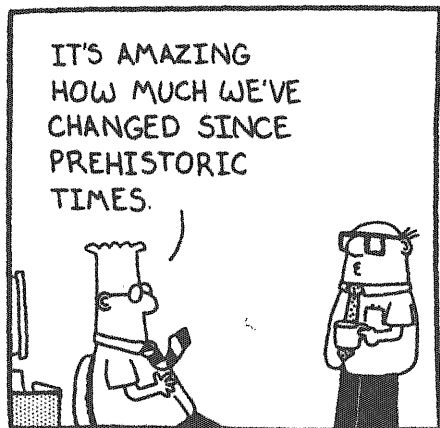
Survival of the fittest has finally done us wrong. As a species, we now change the environment to fit our needs rather than adapting to the environment. We are tearing down the rain forests, causing global warming, and polluting air and water. Ancient man could never have done such things. Have we caused the end of human evolution by changing our environment to suit us? The fit now provide for the less fit through hospitals and homeless shelters. Survival has become a right, not a privilege.

Traditionally, those better suited to

their environment survived to reproduce more of their kind. You had to have an able body to provide for yourself by working and intelligence to supply yourself with food and shelter. It's no secret that today there are some who do not fit these criteria, but now, unlike five thousand years ago, they are often given what they need to live. That is not to say the strong aren't favored over the weak, but the distinction is much smaller than it was previously.

The conclusions that one could draw from this are numerous. Humanity may be close to the end of its evolution. There are some instances in which the dominant will be weeded out. For example, not everyone who sees a coverless manhole will walk around it, but for the most part, common sense would direct you around it. A revised statement might be that humanity is near the end of its physical evolution. If a need for webbed toes or opposable toes became beneficial, we would find a quicker way to deal with the problem than waiting several hundred generations to evolve.

If we are at the end of physical evolution, what about mental evolu-



tion? As a species, we are obviously becoming more intelligent, being that we no longer squat in squalor or go through the hideous trouble to multiply large numbers by hand. Still there are those who sniff markers for fun. Natural selection has not succeeded in weeding them out. How can this be? Wouldn't those of a higher intelligence mate with others of high intelligence?

Has the human race been outdone by love? Everyone's heard the phrase, "A face that only a mother could love." That could just as easily apply to one's mind. Everyone also knows someone who has either the most horrible personality (which we're going to directly link to intelligence for the sake of argument) or someone who is too simple to ever have a chance of mating with a smart member of the opposite sex. This would entail a divide between the learned and the dense, assuming that the latter survive to pass on their genes. At least we're still getting brighter on one end; Savants and Einsteins are getting together somewhere along the line.

Discounting alcohol and luck, love seems to be the all-encompassing, all-binding thread of humanity. Human beings have the ability to love each other for reasons beyond their scent or strength. Other than mutation, this crazy idea called love leaves the only way for a weaker half of the species to survive. Why else

■ Survival of the fittest has finally done us wrong. As a species, we now change the environment to fit our needs rather than adapting to the environment. ■

would a Savant mate with a bruiser? In nature, you don't see many tigers leaving the herd to get a piece of the tiger that lost the fight for supremacy.

Well, perhaps the argument has gone too far; there can't really be an end to evolution. According to the Hardy-Weinberg principle, evolution will occur as long as there is 1) selective mating, 2) mutation, 3) gene flow, 4) limited population size, or 5) natural selection. Small sections of humanity are removed from the mass, people move across the globe, and mutations occur. These sorts of things usually only result in a change in skin pigment or extra fingers in individuals, the former of which is becoming more and more common every minute. To really change the entire human species, an event of cataclysmic proportions would be in

order.

In the movie *Waterworld*, Kevin Costner sports some pretty fly gills. These, of course, have been developed over countless generations and were not the result of a random mutation. The icebergs, which currently occupy the poles of our misshapen planet, had melted, necessitating improved body functions to survive in the aqueous environment. Likewise, if one of the crazies hiding underground decided to launch a nuclear missile into the heart of a populated continent, those who were more resistant to the radiation would survive to reproduce more with resistance. Similar circumstances may have been behind what happened to the dinosaurs: after the comet hit, those who could fly to reach more remote areas where food might be available survived, and later a need for warmth was sufficed with feathers. Speculation is a fabulous thing.

If we have indeed brought about the end of our physical evolution, let's enjoy it, instead of trying to create webbed toes for Olympic swimmers and additional arms for boxers. Let's leave well enough alone and hope that twitchy fingers are satiated with "Duck Hunt." ●

FOR MORE INFORMATION see
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CYBER SECURITY

Protecting our nation's information

BY GAL SHPANTZER

With all the attention airport security has been getting in the months since the September 11 attacks, one might think the best way to protect our country from terrorism is to put air marshals on every flight. However, the nation's airlines are also vulnerable to attacks staged from the Internet. To protect the nation against these attacks, the nation needs a well educated corps of information security experts.

In March 1997, a teenager from Massachusetts used his home computer to crack into and disable a critical component of Bell Atlantic's communications grid called a loop carrier system. This shut down radio control for the Worcester airport as well as critical services in the nearby town of Rutland. The controls for the lights on the runways were disabled, as well as phone lines to the emergency services for the airport. The U.S. Secret Service, which has jurisdiction over certain computer fraud cases, investigated the case and found the same vulnerability exploited in this particular attack present in thousands of other locations around the country. If a teenager managed to take out an airport and a small town's communications for several hours, imagine what a few skilled agents of a terrorist group, foreign or domestic, could have done.

Fortunately, officials are working to prevent such attacks or at least mitigate the effects of those that might occur. Government, business, and academia are aiming to protect critical infrastructure through cooperative efforts. Such collaborations include the FBI's National Infrastructure Protection Center, the prestigious SANS Institute, and the Critical Infrastructure Assurance Office. These agencies work to secure information systems and other critical infrastructure.

So many positions, so few people

All of these agencies and businesses face a common dilemma: a lack of trained and experienced people to help get the job done. Education in technical fields is absolutely essential to safeguarding power plants, phone and Internet communications, financial institutions and emergency services radio nets.

The problem of finding qualified staffers is further compounded by the sensitive nature of the work done by these agencies. Many positions require U.S. citizenship, and some require security clearances that give the participants access to classified materials. A high percentage of students studying computer science and other technical fields are not U.S. citizens. Although they may have the skills required for information security jobs, they are ineligible to be hired for these positions. The lack of trained personnel to staff critical positions is the weak link in the security infrastructure.

Alan Paller, founder of the SANS Institute, recently gave a talk to an industry group illustrating the nature of the problem. In the last few years, approximately 70 million computers were connected to the Internet. During the same period, only 70,000 system administrators were trained, and of those, perhaps 10 percent had sufficient security skills and training. Given that each administrator can secure about 10 to 20 machines, there is a tremendous lag between the amount

SECURITY

infrastructure

of new hardware being connected to the Internet and the ability to correctly configure and manage it.

Money is not the answer

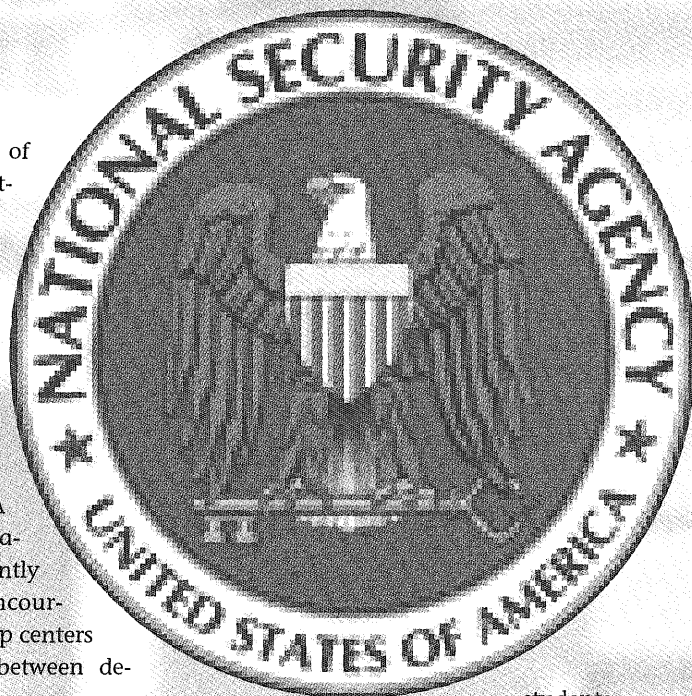
In the analysis of the Pentagon and World Trade Center attacks, several intelligence agencies revealed that they do not necessarily need more technology or even bigger budgets to intercept communications. Rather, they need more skilled personnel who can speak the languages of intercepted communications. Similarly, an infrastructure protection program provided with billions of dollars will not be effective if the people who staff the program are poorly trained or lack the background necessary to carry out the mission.

One of the efforts focusing on the educational aspects of information security is the National Colloquium on Information Systems Security Education (NCISSE). The fifth annual NCISSE gathering last May focused on the lack of structured information security education at the graduate and undergraduate levels. The National Security Agency (NSA), the U.S. intelligence agency responsible for worldwide electronic signals interception, is a major sponsor and supporter of the NCISSE effort to increase awareness of information security education.

Another program certifies graduate programs that exemplify excellence in information assurance, which includes a comprehensive information security curriculum. The NSA certifies information assurance programs based on

national standards. Most of the 23 institutions currently certified by the NSA received certification for their computer science department. Others created collaborations between computer science and other departments in order to gather resources to make the program certifiable. The NSA views the field of information assurance as inherently interdisciplinary and encourages universities to develop centers that foster cooperation between departments.

Another program targeted at information security education is the National Science Foundation's Scholarships for Service (SFS) program, announced at the May NCISSE conference. Students who receive SFS scholarships for undergraduate or graduate work will have internship opportunities with federal agencies, and, upon graduation, work for the federal government on a basis of one year of service for each year of scholarship, in a manner similar to ROTC programs. At its inception, the SFS awarded \$8.6 million in grants over four years to Carnegie Mellon, Iowa State, Purdue, University of Idaho, University of Tulsa, and the Naval Postgraduate School in Monterey California for SFS scholarships and curriculum development to address information security and assurance issues. Two hundred



students at these institutions are receiving SFS scholarships this year. The director of the NSF, Rita Colwell, in announcing the award noted, "The scholarships will encourage young people to enter the field of information security and assurance, and give them the opportunity to put their talents to work at the front lines of government cyber security efforts."

Legal responsibility for information security

Everyone should be aware of information security issues and policies. Emerging legal theory makes computer owners liable for damage done unknowingly when their computers are broken into by malicious hackers and used to launch attacks on companies' or governments' computers. Gross negligence may also be charged



The NSA employs specialists from a number of fields in addition to computer science.

against a university or company whose computers are used as pawns after a security breach. Today, the FBI can seize an individual's computer with court-ordered warrants if the machine has been used to launch Internet attacks. In the future, owners may be sued for not implementing minimum security on their computers.

Critical infrastructure protection is a broad, interdisciplinary field, and you don't have to be a computer scientist to participate in the effort. Those with different skills may work in other aspects of infrastructure protection, including planning for recovery from disasters and terrorist attacks, which are perhaps as critical as understanding the intricacies of firewall configuration and monitoring intrusion detection systems.

Nevertheless, understanding basic concepts of security management and risk management are crucial to both technical and non-technical people involved in the daunting task of securing the transportation, power and telecommunications infrastructure. In the U.S., dependence on networked computer systems is both our strength and our Achilles' heel. Fortunately information security programs are making great strides toward creating a well-trained cadre of people to create a more secure and stable infrastructure for the global economy. ●



FOR MORE INFORMATION see:

www.ciao.gov
www.nipc.gov
www.sans.org
www.ncisse.org
www.nsa.gov/isso/index.html

Hacking for the masses

BY GAL SHPANTZER

The increasing sophistication of tools available to malicious hackers is escalating security problems on the Internet. These tools automate much of the labor required to find and exploit security vulnerabilities in a computer system.

David Rhoades, founder of Virginia-based Maven Security Consulting, gave a presentation at the SANS Network Security conference in October called "Hacking for the Masses." The presentation, available online at the Maven web site, traces the history of hackers from skilled and motivated computer programmers to "click-kiddies." Rhoades coined the term click-kiddies to describe the current bumper crop of malicious hackers that have no real skill or experience in computer programming or security.

Before the advent of free and easy to use hacking tools, only a small group of hackers with experience and proficiency in programming languages and cumbersome tools could launch successful attacks on web sites and networked systems.

The click-kiddies evolved from the script-kiddies, which were the first incarnation of malicious hackers that relied on somebody else's knowledge and understanding of the innermost workings of operating systems and web site vulnerabilities. Expert hackers wrote the scripts to attack operating systems, but script-kiddies could download the scripts for free—although significant manual labor was required to launch an attack.

Unfortunately, all one needs today to launch a malicious attack is time and a computer with an Internet connection. Click-kiddies take advantage of the multitude of point-and-click hacking tools that are available on web sites with user-friendly interfaces. At these web sites, a click-kiddie can enter a URL or IP address, and the web site will automatically tell the user what vulnerabilities exist at that address. The user is then given the choice of what vulnerabilities he or she wants to attack. With the click of a mouse, the attack is launched without any labor or knowledge required from the user.

As Rhoades noted in his sobering presentation, "Automated scripts have lowered the bar to hacking, but online tools have removed the bar." ●

FOR MORE INFORMATION see:

www.clickkiddie.net
www.mavensecurity.com

(Editor's note: There are severe legal and financial consequences for using some of the tools Rhoades describes.)

Securing the private sector

BY GAL SHPANTZER

The lack of trained security personnel that plagues the on-line community is being addressed by many governmental programs. In the private sector, no single organization does more to alleviate this shortage than the SANS Institute.

The SANS GIAC program focuses on training and educating system administrators and security officers who work in the information technology areas of their organizations. The training



culminates in a certification process that has rapidly become the standard in the security industry. There are currently nine concentrations in the program, focusing on everything from the most basic introduction to networking security principles to the more technical issues of intrusion detection and firewalls. There is also training that specializes in UNIX-specific and Windows-specific issues. The instructors are experts in their field and communicate technical knowledge in an easily understood manner. The programs also offer excellent social and professional networking opportunities, as the attendees hail from all over the country and come from very diverse backgrounds. If you're at all interested in learning about information security and meeting some of the best minds in the field, these conferences provide an excellent place to begin.

System administrators are bombarded by endless security alerts regarding new vulnerabilities and attack tools that attackers may exploit. The sheer volume of information is overwhelming and can be frustrating to the people trying to plug the holes in their networks. SANS researched the problem and came up with a prioritized list of the most important vulnerabilities that, when addressed, would make for the greatest marginal increase in security. The list is a product of the cooperation between the SANS Institute and the FBI's National Infrastructure Protection Center (NIPC).

The Cyber Defense Initiative (CDI) is the most recent resource that SANS has created. Headed by Eric Cole, the CDI aims to foster greater cooperation between Internet security practitioners and researchers so that they can come up with security solutions at a pace that matches attacks on the Internet. Please see the in-depth interview with Eric Cole in the online edition of the Technology.

FOR MORE INFORMATION see:
www.sans.org/giactc.htm
www.sans.org/top20.htm
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"Excuse me, Mr. Hulk, by my calculations it's physically impossible for you to jump as high as the comic books portray..."

"HULK SMASH!!!!"

"Ok Mr. Hulk . . . never mind."

COMIC(AL) PHYSICS

BY ERIC CARON

University students are exploring the physics of the comic book universe in the freshman seminar, *Everything I Know of Science I Learned from Reading Comic Books*, affectionately called *The Science of Comic Books* by the students.

Anyone listening in could easily confuse Professor James Kakalios' physics seminar for a comic book convention. Kakalios leads the class over hot topics ranging from the number of Big Macs the Flash must eat to maintain his speed (several thousand) to the death of Spider-Man's Gwen Stacey. (Avid comic book readers not wishing to disturb their view of the comic universe may want to stop reading at this point.)

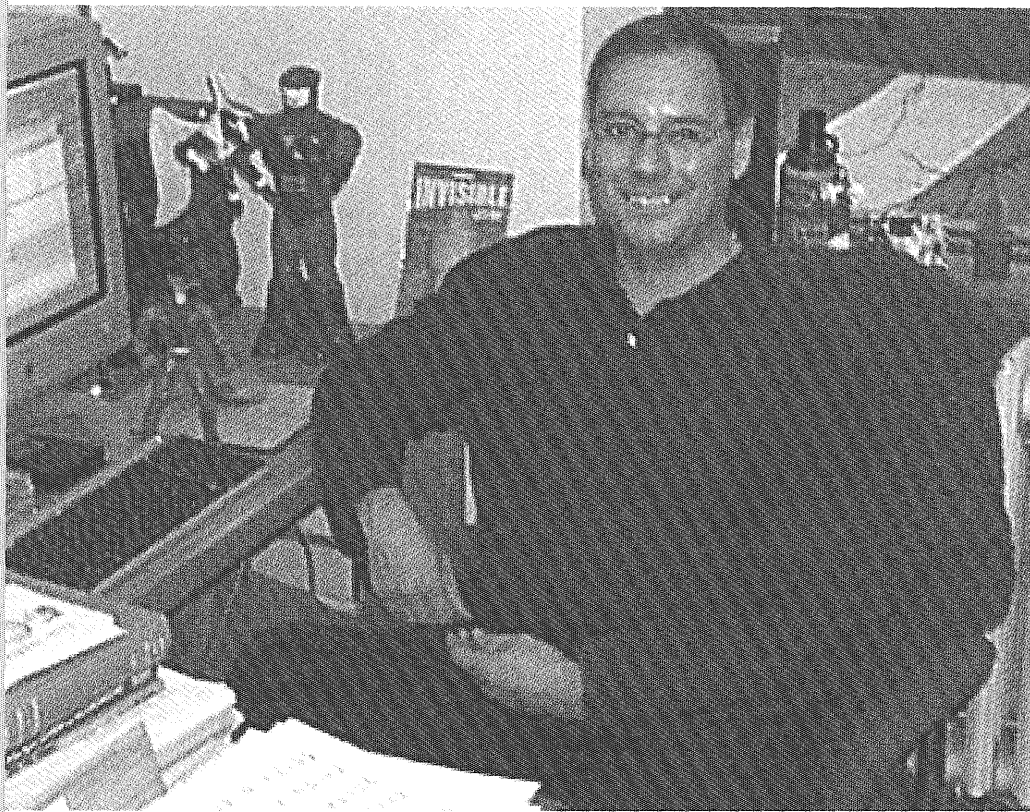
Using the laws of physics and a truly impressive collection of comic books, the class is able to conquer the seemingly toughest of problems of the comic universe. For example, the early Superman comic books said the superhero was able to leap a half-mile on Earth because of the stronger gravitational field from his home planet, Krypton. Using the laws of motion and the law of gravity, the class figured out that Krypton would need to have a radius eight times that of Earth to provide Superman with the abilities to leap so far on Earth. Unfortunately, an astronomy professor noted that a planet could not exist with such an immense size, which could explain why

Krypton blew up.

As one might expect, the homework for a class this exciting is extraordinary. Students are asked to read X-Men comics and investigate the scientific possibility or impossibility of their favorite character's mutant abilities.

Kakalios first got started in the field of real-world applications to comic books at an early age. He notes, "There was one issue of the Flash I read as a kid where the Flash lost his ability to avoid air resistance and friction. It made me aware of the fact that this was something aside from the silly notion of superpowers. There were all sorts of secondary issues associated with the ability to run super fast, for example, that I hadn't considered."

Some years later he was asked by *Wizard Magazine* to solve a foible caused in an early issue of Spider-Man. His mathematical proof showed that, "Gwen Stacey died by a broken-neck when Spider-Man caught her as she fell from the top of the George Washington Bridge." It was printed in *Wizard Magazine*, and Kakalios became the magazine's "unofficial rocket scientist." Eventually Kakalios got to teach a seminar where he could share his fervor with students, encouraging



Prof. Kakalios is perfectly at home in his office, where he works under the close scrutiny of the Original X-Men.

them to find their own comic problems and solve them using their physics skills.

Though the topics of the class include Newton's laws of motion, conservation of energy, biomechanics and genetics, and parallel dimensions, the underlying topics, such as Iron Man and the Fantastic Four, keep the class involved and enthused. One problem dealt with the Incredible Hulk's ability to jump over jets in flight, soaring to an altitude of over 32,000 feet. Students calculated that he'd need an initial velocity four times the speed of sound. However, the forces associated with such an acceleration would tear a normal man apart. But don't ask Kakalios about this. "I never said the Hulk couldn't do anything he wanted to!" he says.

Few corners of the comic universe are left untouched by the course. They've revealed that the Atom would turn completely solid if he used his power, and Ant-Man would become deaf and have a hypersonic voice when he shrunk down because his eardrums and vocal cords would shrink to microscopic sizes. The students also uncovered other disadvantages of shrinking. Ant-Man would be

easily blown across the room by typical air currents, and getting wet would nearly double his weight, immobilizing him like a real ant.

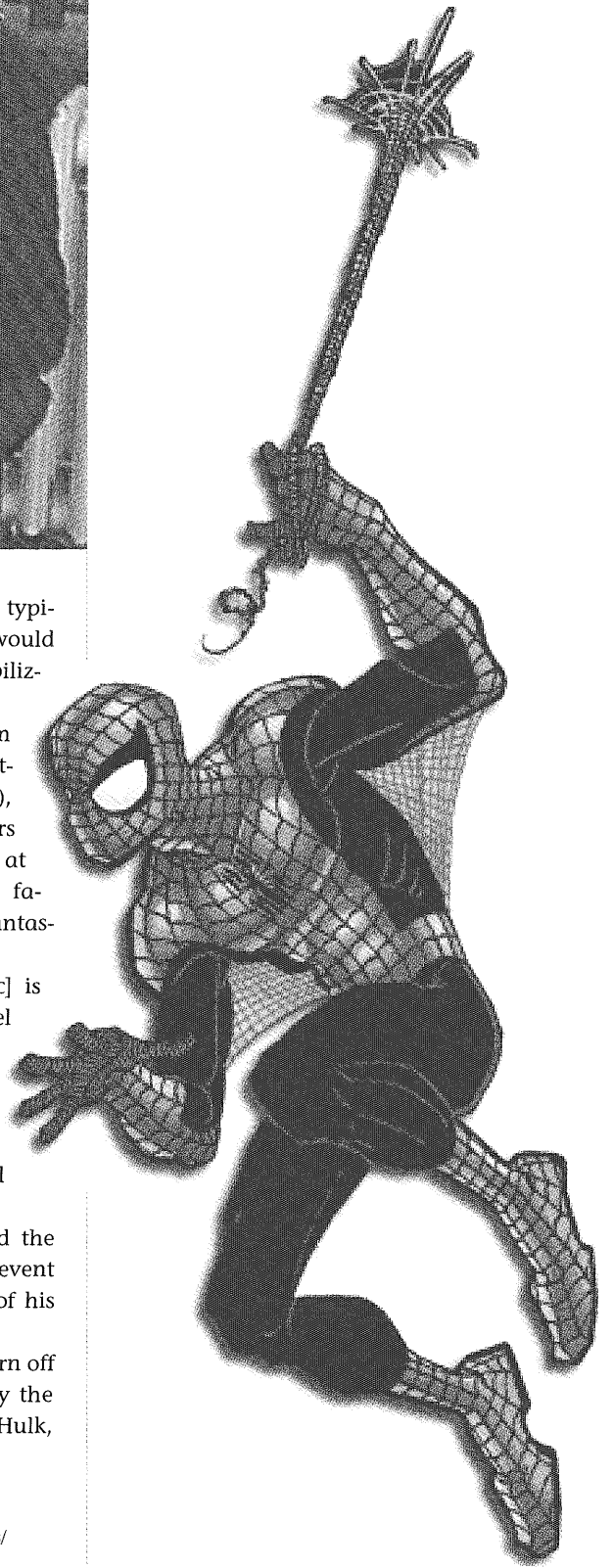
Although the only mainstream hero unscathed by this class is Batman (who has no superpowers), not all comic book characters would necessarily take offense at Kakalios' approach. One of his favorite heroes, the leader of the Fantastic Four, even enjoys it.

"Reed Richards [Mr. Fantastic] is the smartest man in the Marvel Universe, and he frequently uses his scientific knowledge to come out on top of some situation. He was an early role model that being intelligent could be cool and useful."

Kakalios says his course—and the philosophy behind it—doesn't prevent him from enjoying the exploits of his favorite super heroes.

"It's escapist fiction, so I just turn off that part of my brain, and enjoy the stories on their own terms." Go Hulk, go! ●

FOR MORE INFORMATION see
www.it.umn.edu/students/academics/freshsem.html
www.marvel.com





Women in IT: Breaking into the 'Old Boys' Club'

BY ANNA RUSCH

Today only twenty percent of the undergraduates in the Institute of Technology are women, and the percentage is similar for professionals in technology related careers. As the demand for employees with high-tech skills continues to rise, the failure to attract women to such careers presents considerable obstacles for the future of these fields. So what accounts for this gender disparity?

Sex-role stereotypes present significant barriers. Beginning in grade school, boys are encouraged to study

math and science while girls—though not directly discouraged from the study of the sciences—are often guided to subjects such as English and linguistics.

Computer games—the first computer exposure most children have—emphasize male-oriented themes such as combat and war. These games appeal to young boys in far greater numbers than girls. As a result, boys are often better acquainted with computers than girls, and thus more likely to display interest in careers in a related field.

The dearth of female role models is another contributing factor: Only ten percent of the faculty in the Institute of Technology are female.

Victoria Interrante, an assistant professor of computer science, works with IT administrators to recruit female faculty members. During her four years at the University, there have simply not been any female applicants for many positions

“We need to place an emphasis on getting

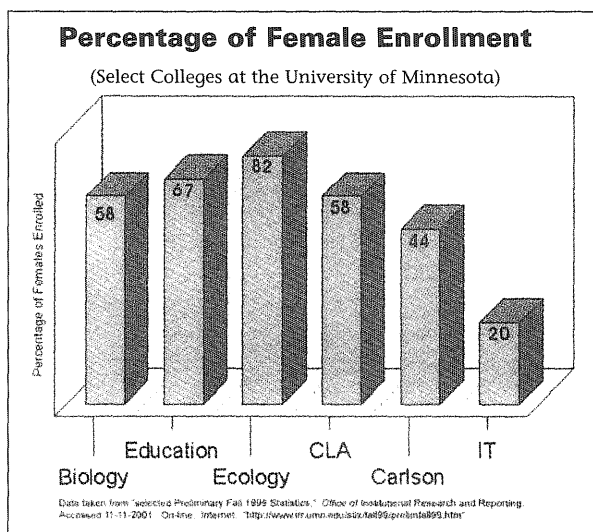
more female role models out there,” says Interrante. “More female professors will lead to more female students.” Providing female role models will encourage young women to seek higher education in IT. Subsequently, more women will fill instruction and research positions at colleges and universities.

Young women also need female role models to communicate the reality of technology-related careers. Many, like junior Abbey Sullivan, are unsure about what high-tech careers actually involve.

“I envisioned myself alone in a cubical at a computer—very little human contact,” she says. She’s not alone: Most females perceive high-tech careers as akin to solitary confinement. Female professionals in technology-related fields suggest that such widespread misconceptions are partially responsible for the underrepresentation of women in IT.

The stereotype of those in high-tech fields—as “nerds” lacking communication and social skills—is simply “not attractive,” says IT senior Megan Carney. That stereotype, supported by the mass media and popular culture, has created a perceived negative image of technology-related careers.

But once she entered IT, Sullivan



discovered that those stereotypes are simply untrue. She hopes other women will see past them as well.

Today technology-related careers require not only an understanding of the field, but also business knowledge and the communication skills necessary to promote teamwork.

Teamwork is particularly important in high-tech careers, says Interrante. "The group is there as a resource. As a team, other people can help you with your own work. In industry, teamwork is invaluable." Young women may be surprised to learn that the group interaction they thought was only available through careers in other fields is actually a cornerstone of technology-related professions, she adds.

Many of the women who enroll in IT courses focus their interests in biological fields. One explanation for this, says Carney, is that fields like biomedical engineering are relatively new and "the old boy's club is not in



Melissa Martini
Sophomore, Chemical Engineer

/// A lot of girls seem to think that they couldn't succeed in IT based upon the fact that you just don't see many girls in IT. I think girls might feel discouraged or intimidated by that. ///

STUDENT VIEWPOINT:

Keep classes co-ed

BY REBECCA TANGEN

Once upon a time, girls weren't allowed to go to school. Then, after a certain amount of struggle, boys and girls took classes together without any question. However, someone soon discovered that girls didn't seem to do as well, or care as much, about their math and science classes as the boys did. Splitting them up and placing girls in special classes, it was decided, would be the best thing we could do for those poor girls who seemed incapable of keeping up with the boys. Sex-segregated education in math and science was thus born.

Today, even though some have found benefits to single-sex education, not all researchers agree it is a good thing. According to a 1998 American Association of University Women (AAUW) study, it might help girls to enjoy math and science more. Whether single-sex education actually helps them improve their skills isn't so clear. I don't want to imply that girls shouldn't receive the chance to have separated math and science classes, but if we want to establish separate classes based on the premise that it is good for the girls, more research needs to show long term benefits. If the young women are hesitant to participate in math or science related classes because of the presence of the opposite gender, will they really participate later when men are re-introduced into the picture during college or in the work place?

Other research suggests the real problem isn't the presence of boys, but the instructor's reaction to them. Researchers have found that boys are more likely to be called upon to answer questions or facilitate class discussions. Many math and science classes tend to foster a sense of competition rather than discussion of information, which is generally more beneficial for boys than for girls, according to *Gifted Child Today*.

One of the main arguments made for separating the girls from the boys in middle school and high school math and science classes is based on the fact that only 30 percent of math and science university degrees go to females. This statistic appalls officials at AAUW. Never mind that larger percentages of females not only go to college but succeed in graduating. Also, forget that on average women get higher overall grade point averages than men. No, what is of real importance, it would seem, is that these women are not focusing on so-called "real" (read: masculine) degrees. Instead, they are gravitating towards relatively trivial (read: feminine) fields of study: English, child psychology, or even women's studies.

I find it disturbing that after decades of women's liberation the definition of equality still seems to revolve around terms of "maleness." Why don't many people worry why more male students aren't entering traditionally "female" degree areas? The Educational Testing Service reports gender gap scores in math and science have narrowed to the point of barely being significant. However, the verbal score discrepancy remains gaping with women receiving the higher scores. If we were to take the gender segregation to the extreme, do we give boys gender separated English classes? Educators generally don't propose such a solution because boys can take care of themselves, right? It's girls who need protection and help.

Separation by gender will only treat the symptom of what is wrong, not the diseases of sexism and inequality themselves. We need to recognize and accept the equality of the genders. Let boys and girls know that different fields of study don't have to be dominated by one gender or the other. Educate teachers how not to show bias in the classroom. Check up on teachers to make sure they're treating all students fairly. Once we start these processes, if young women still aren't achieving, then a discourse would become more appropriate regarding the necessity of girls splitting off and having them take classes by themselves. ☺

Separate the sexes

BY MAHI PALANISAMI

During Fall 2000, 3385 men and 813 women enrolled as undergraduates at the Institute of Technology. According to the American Association of University Women, a mere 30 percent of technology related degrees in the U.S. go to women. Studies seem to show that the gender division starts far earlier, as a result of the public co-ed school system. According to research, separating girls and boys in technology oriented classes may increase girls' interest level in technology fields without detrimentally affecting boys' experiences. Despite this, schools continue to drag their feet in establishing, or even considering, gender-separate classrooms.

One example of the strength of gender-separate classes can be found in a 2001 *Education Digest* study focusing on computer programming classes at a Canadian high school. Initially, when the classes were mixed-gender, 15 percent of the enrollment was female. When an all female class was added alongside the mixed-gender classes, the total enrollment of women jumped to 40 percent. The girls in the separated class reported an increase in confidence levels, higher teacher satisfaction, and more desire to pursue further studies in computer science as compared to females in the mixed-gender classes. Presque Isle High School in Maine attempted a similar scenario providing a girls-only Algebra I class when the girls repeatedly stated they did not want to ask questions the boys would label as "dumb". Before the peer pressure element was reduced by the gender-separate classes, girls scored 72 points lower on state standardized math tests than the boys. Once the genders were divided, that difference decreased to only 16 points. This was not the result of pure chance.

When the girls were allowed to more freely be themselves, they excelled. These young women were allowed to explore and excel in areas they weren't "supposed" to be good at, or even interested in. Once they learned how to handle themselves in a classroom and were re-introduced to the mixed-gender format, they performed better than their female peers who had not experienced the split-gender classroom.

Gender separation opponents might scoff and say girls need to learn to deal with pressure and not worry about appearing dumb. Maybe these opponents think that by creating a more enriching environment for girls, we're only enabling and rewarding dependent behavior. Such arguments overlook the big picture. Gender-separate classes open up young women's minds to the acceptance and possibility that technology-related opportunities can be options for them. For too long girls have received the message that they do not belong in the technological fields. As a result, we cannot expect them to suddenly seize the opportunity to learn math and science. Balancing the gender distribution will take time, and gender-split classes can help speed up the progress.

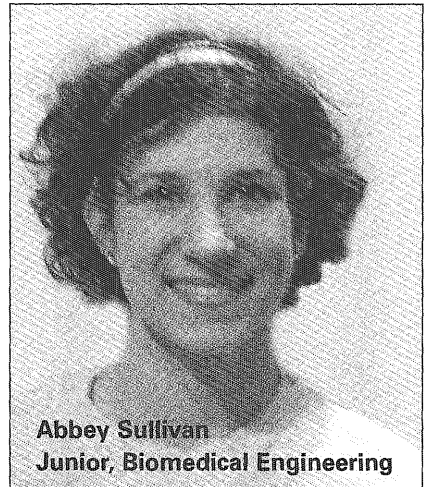
In 1972, Title IX allowed female student athletes to compete on separate but equal grounds as male student athletes. Today, the numbers of female professional athletes continues to grow. Gender split classrooms can do the same for budding female scientists. With these opportunities come power and improved self-confidence. Opponents of gender-split classrooms cry sexism, even elitism, without looking at the whole picture.

Richard Hawley, headmaster of University School of Cleveland, is right when he says the question is not why single-gender education, but instead why coed education. He says, "There's absolutely no research to support academic or social reasons for coeducation," he says in an *Education World* article. Hawley might be a little extreme, but he makes a good point. Why are schools so wedded to traditional ways of educating?

Not every young women in a gender-separate classroom will emerge as a rocket scientist. However, if you educate a girl in a gender-separate classroom, she will come away with greater interest and greater knowledge of her capabilities of becoming a rocket scientist than she would in a co-educational classroom. ●

place." Some female IT students suggest that there is an emotional connection or human aspect involved with biological fields that is not present in other areas, which could explain why more women seem attracted to careers in these fields.

According to Interrante, biological fields offer students the opportunity to impose an "immediate influence upon society," which holds particular appeals for women. A biomedical engineer can have a direct influence on human life through advances in medical technology, whereas a computer



Abbey Sullivan
Junior, Biomedical Engineering

“I think that there are stereotypes surrounding IT that could discourage women from joining, but every college has some discouraging stereotype. Once you enter IT though, you find that there are special programs like SWE (Society of Women Engineers) that encourage women to find their place in IT.”

scientist, "creates technology that will benefit society indirectly." That may make fields like computer science less appealing to women, she says.

"I wanted to do something with my career to help people," says Interrante. "I thought, 'What am I doing with computer science that's helping people?' My research is helping society, but it is an indirect influence."

Interrante is currently developing new techniques for making three-dimensional transparent surfaces and shapes appear accurately defined in computer programs. Her efforts will eventually be applied to computer diagrams that provide images of human body organs. By examining the diagrams, medical specialists will be able to determine the specific areas of the body in which radiation needs to be either maximized or minimized, and will thus be able to offer better treatment to cancer patients.

The future job market is rich with employment in technological fields, and the presence of women in these fields is critical, says Interrante.

"Women can add a different perspective [to IT fields]; they pay attention to different sorts of things."

Since technology affects both genders, women must participate in the creation of this technology to ensure that it meets the needs and expectations of women as well as men.

According to Rhonda Franklin Drayton, an assistant professor of electrical and computer engineering, several factors hinder female participation in technology-related fields. Specifically, Drayton explains women are not receiving the support necessary to generate long-term interests in high-tech careers.

In a male dominated field, women are challenged to prove their capabilities. "Because you're different, people are not sure of the level of commitment they want to make to ensure your success," says Drayton. Female students may have both interest and talent in an IT field, but do not receive the encouragement that is so crucial to retaining that interest.

Recent publicity generated a storm of interest in IT careers, but that interest has not translated into a huge

boost in participation.

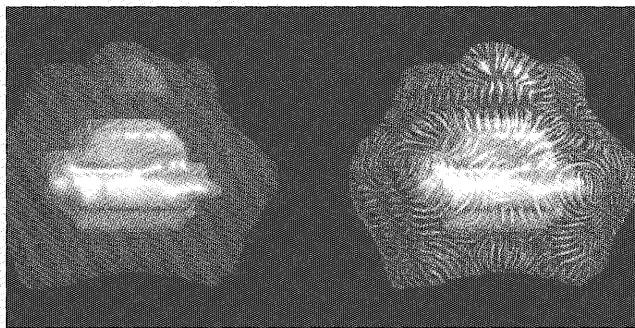
"Women were excited to get involved [in IT fields], but now we need to listen to their concerns because they are pulling out after rushing in. We need to develop solutions that accommodate their concerns" about balancing work and family, says Drayton.

"W o m e n think, 'How can I do this and still have time for family?'" she adds. Many women educated in technology-related fields never utilize their skills in a career setting because there does not yet seem to be a satisfactory answer to this question.

Outreach programs that target young women and girls can help identify and address such concerns and generate sustained interest in technol-



/// I feel like I have to do a step above what is expected of me just to prove that women can be successful in IT. ///



Victoria Interrante (right), an assistant professor of computer science and engineering, works with digital representation of transparent 3-D objects, like body organs (above). Interrante believes that more female professors in IT would provide necessary role models for young women in the sciences.



ogy-related fields. National studies recommend implementing targeted programs in elementary schools across the nation in an effort to increase female participation in technology-related fields. The programs would expose women to technology-related fields and the opportunities that a high-tech career can offer. Professionals suggest that instructors at all levels question their teaching methods to determine whether or not they are catering to the interests and concerns of female students. Communicating the reality of high-tech careers and incorporating teamwork into curricula at every level of education will also convince more women to pursue technology-related careers.

Drayton and Interrante reiterate these views. Young women must be encouraged to look beyond stereotypes to discover the realities of careers in engineering and other technology-related fields—careers that will provide women the opportunity to engineer the 21st century and a new paradigm for a job market historically dominated by men. ●

FOR MORE INFORMATION see
www.it.umn.edu/women
www-users.cs.umn.edu/~interran/

PRT

Riding toward the future

BY DANIEL THOMAS

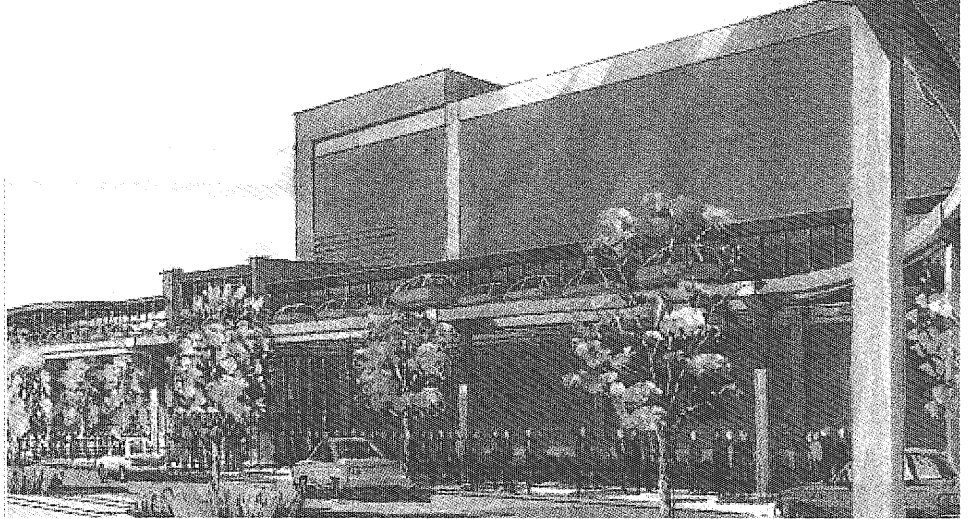
With a 1.7-mile tunnel, maintenance yard, and stations under construction, the Twin Cities' Light Rail Transit (LRT) system is progressing full steam ahead. The \$675 million project overcame a mountain of controversy, much of it from public transit experts themselves. Though many other systems were proposed, they were given little chance.

One of the main alternatives proposed was Taxi 2000, a leading Personal Rapid Transit (PRT) design for small, automated, electric cars on an elevated guideway. PRT is an attempt to improve transit speed, efficiency and comfort while allowing the personal freedom that binds commuters to their cars.

Entering an enclosed off-line PRT station, a passenger purchases a magnetically coded ticket. This ticket opens the door of the first waiting PRT car and allows a computer to plan the trip along the guideway network. The car proceeds without stops to the destination at a speed of up to 50 mph, following the shortest possible route. Sharing the three-person car allows a lower fare, and the wait for a car never exceeds three minutes.

The Taxi 2000 PRT system has its roots at the University of Minnesota, where a multi-disciplinary team of researchers started developing it in 1982. Since then, mechanical engineering professor emeritus Edward Anderson has continued development with the Taxi 2000 Corporation.

Defense contractor Raytheon Corporation bought the Taxi 2000 rights



An artist's conception of what a Taxi 2000 hub might look like outside the RiverCentre in St. Paul.

in 1993. They spent over \$40 million developing it, modifying the design, and winning a transit project contract for northern Illinois. When the Chicago Regional Transportation Authority delayed their order, Raytheon discontinued development and rights were returned to Taxi 2000.

There are many other PRT designs being developed—some very similar to Taxi 2000 and some, such as the Danish Rapid Urban Flexible (RUF) PRT, quite different. RUF uses modified electric cars that run on roads or in driverless platoons on a monorail. Areas currently considering PRT include the Seattle-Tacoma International Airport region, Cincinnati, and Northern Kentucky. The West Virginia University in Morgantown has been using a system similar to PRT since 1975.

Characteristics of PRT

Recognizing the failure of conventional mass transit systems to lure commuters from their cars, PRT attempts to combine the privacy, comfort, and freedom of cars with the safety, predictable travel times, and low pollu-

tion of public transit.

PRT vehicles are designed to be relatively small, as Anderson found the vehicle cost per seat did not decrease as car size increased. Smaller vehicles allow not only for selection of traveling companions and the option of individual travel, but also for the vehicle to wait for the rider, not vice versa. In addition, smaller vehicles put less force on the guideway, allowing the track to be lighter and cheaper.

Stations can also be smaller, cheaper and more frequent. More frequent stations do not slow PRT traffic, because all deceleration and acceleration is done on a parallel station track. There is no need to transfer between vehicles, and the system chooses the shortest route to the destination.

Automated control of vehicles allows them to travel safely with small headway, and thus allows a single PRT line to move as many people as three lanes of freeway. The uninterrupted trip not only increases trip speed, PRT vehicles also increase transit system efficiency. PRT avoids the loss of kinetic energy involved in the frequent stops

of road traffic and trains. As a result, experts estimate PRT to be about six times as efficient as LRT. PRT cars require about 145 watt-hours of electric energy per vehicle-mile at 25 mph. This is roughly equivalent to a gasoline-powered car getting 70 to 90 miles per gallon. The efficiency of PRT cars is aided by light, streamlined vehicles and electric linear induction motor, which eliminates idling at stations.

A tough ride in the Twin Cities

In Minneapolis, where most of the Taxi 2000 development has occurred, PRT has received little attention, losing out to the conventional technologies of bus and LRT.

When an initial plan for a six-lane freeway connecting the airport to downtown Minneapolis along the congested Hiawatha corridor was rejected, largely due to opposition from communities along the route, a door was opened for alternative transit solutions.

Many suggestions, including PRT, were put forward. However, according to Nacho Diaz, director of transportation for the Metropolitan Council, the governing body that operates and plans Twin Cities transportation systems, light-rail was considered the only serious alternative from early in the

groundbreaking ceremonies were held in January.

According to Anderson, the decision makers see PRT only as a "spoiler for getting light-rail." Anderson also blames over 30 years of strong lobbying and support for bringing back streetcars and potential LRT construction contracts for lack of interest in PRT. Despite the facts supporting PRT, he says many also have the idea that "bringing back light-rail has got something to do with improving the environment."

"The fact is there are a lot of people who don't look at the facts," Anderson says, suggesting that many favor light-rail based on intuition. "Our governor is one of those, and he is all behind building more rail lines around the Twin Cities."

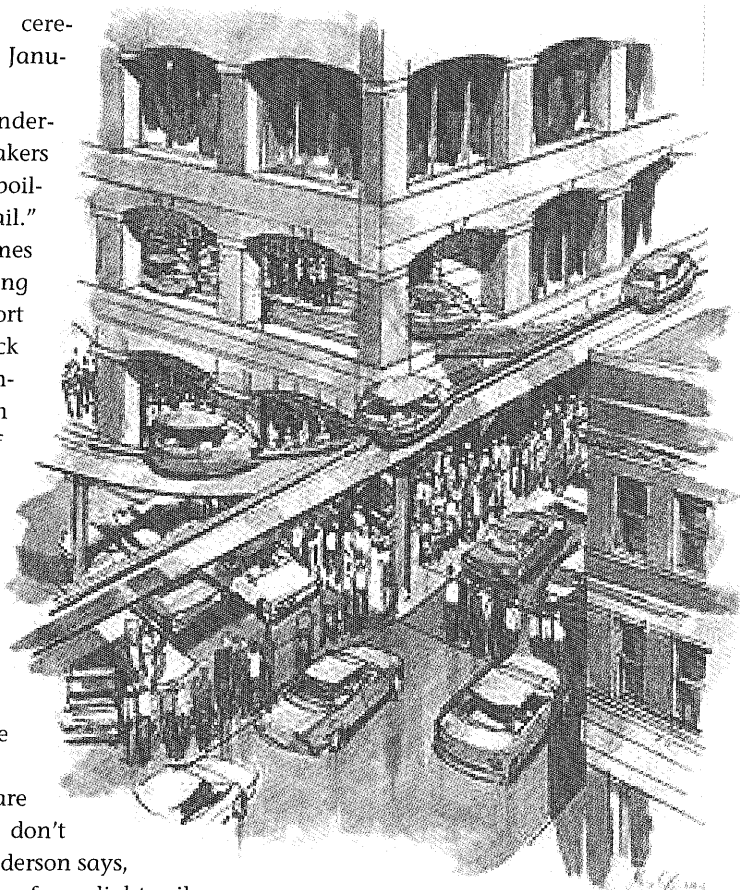
While he still sees a future for a PRT system that would connect downtown Minneapolis and feed the LRT line, Anderson says Taxi 2000 has the international market in mind.

New horizons for PRT

The current focus of Taxi 2000 is raising money for a 2200-foot test track with three vehicles and one station, for which detailed plans have been made. This is an attempt to overcome the major obstacle to PRT acceptance: the lack of existing models.

The first phase of this test track would be a single prototype vehicle and 60-foot track, which together would cost less than \$1 million. This is the length of prefabricated track modules that would allow quick installation at an estimated cost of about \$7 million per mile.

Citizens for Personal Rapid Transit, a grassroots volunteer organization promoting PRT in Minneapolis, carries

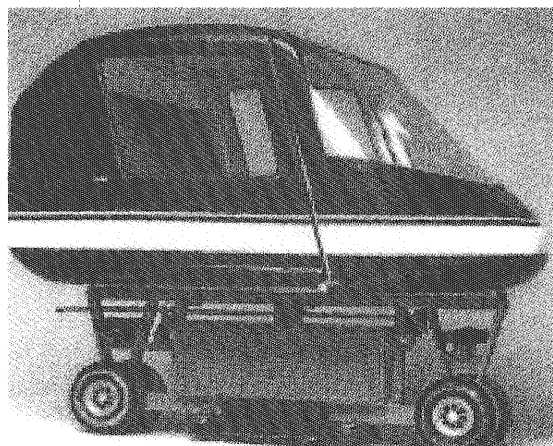


PRT would add another layer to transportation infrastructure, leaving streets freer for cars and pedestrians.

out its mission to educate politicians and the public about PRT. According to Anderson, there are now several state legislators who support PRT.

While disappointed that PRT has yet to be seriously considered by planners, supporters say it can become integrated with the current LRT development. Brian Finley, chairman of Citizens for Personal Rapid Transit, says PRT would now be most effective as an LRT feeder in Bloomington, with a line from the Mall of America along I-494 to Highway 100 and a link running up France Avenue to Southdale. If practically accepted, with a line up and running, PRT may yet find its golden days. ●

FOR MORE INFORMATION see
www.taxi2000.com
www.cprt.org
www.vinnova.se/publ/pdf/vr-01-03.pdf



A scale model of Taxi2000. This vehicle seats three adult passengers comfortably.

process. With a strong LRT lobbying force effectively blocking consideration of other options, the city of Minneapolis went ahead with LRT plans and the

The future of medicine?

Expanding stem cell research to develop a promising new level of medical therapy

BY JENNIFER PURDES

Imagine a world where one can simply stop by the cell bank, order a new liver, and drop in to pick it up a few days later. While it may never be quite as

simple as this, the new and controversial field of stem cell research has been taking giant steps toward making this approach to medicine a reality.

Human stem cell research began making its way into mainstream medical research only in the past few years. In 1998, a pluripotent human stem cell, one that is able to differentiate into any type of cell in the body, was first isolated from human embryos donated by couples undergoing infertility treatment. Since then, scientists have made steady progress toward discovering countless potential applications of



Dr. Catherine Verfaillie coordinates research projects for the Stem Cell Institute.

stem cells in the treatment of common, and to date incurable, diseases like Alzheimer's, Parkinson's, and diabetes.

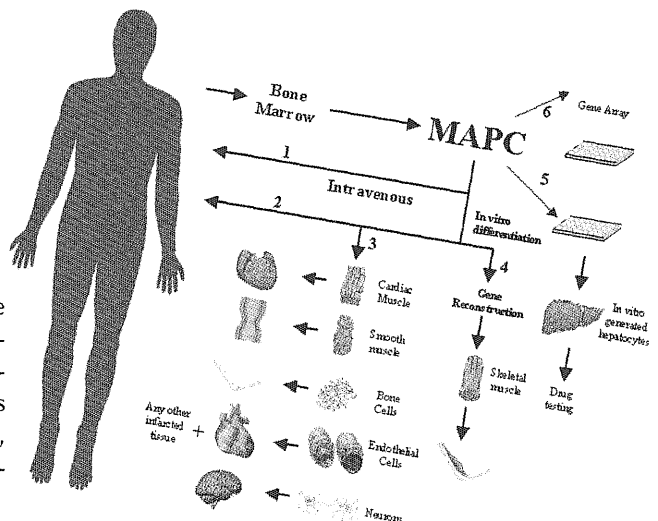
The world of stem cell research is no further away than the 14th floor of Moos Tower, where the University of Minnesota's Stem Cell Institute resides. The institute has been working to unlock the secrets of human stem cells, with the goal of applying this knowledge towards creating therapies to treat many debilitating diseases.

What is a stem cell?

There are two types of stem cells: embryonic and adult. An embryonic stem cell has the ability to self-replicate indefinitely as well as to differentiate into cells of any tissue in the body. Embryonic stem cells are taken from the inner mass (30-34 cells of the 200-250 cells making up the embryo) of the blastocyst stage five days after fertilization. The embryonic stem cells are known to be pluripotent.

While adult stem cells possess the ability to replicate in large quantities, they do not replicate indefinitely and exponentially like embryonic stem cells do. As for function, embryonic stem cells give rise to the rest of the body whereas adult stem cells generally maintain homeostasis and replace cells that die.

Adult stem cells are taken from tis-



such as bone marrow, the retina, the cornea, dental pulp, the brain, the liver, and skin. These cells, found in specialized tissue, are still undifferentiated, though for the most part they are already "programmed" to differentiate into a certain line of cells. Those cells found in the bone marrow tend to develop into new blood cells among other cells, while those found in the liver tend to differentiate into liver cells. At least this had been the hypothesis in the past. The ability of adult stem cells to differentiate into cells not typical for the tissue in which they are found, known as plasticity, is a hot topic in today's research and one being tackled by the Stem Cell Institute.

The Stem Cell Institute

The main focus of the Stem Cell Institute is to study the biology of human stem cells, how they grow, and how they differentiate. The institute has grown more than 10^{50} cells from single mouse and rat stem cells over the course of the past two years. For human cells, the number is about 10^{35} . One of the major breakthroughs that the Stem Cell Institute has made is the discovery that a single human stem

GROWING PAINS:

Controversy over federal funding for stem cell research

BY JENNIFER PURDES

Federal policies stipulate that federal funding for stem cell research be given only under certain conditions. Under Bush's plan, federal funding is provided for work done with fundamental research; none is given for studies done involving applied therapies. Bush's policy also states that research may be done on the roughly 60 existing embryonic stem cell lines for which "the life and death decision has already been made," as well as human adult stem cells and any animal stem cells, but that no new human embryos may be used. Many scientists feel that this extremely limited policy will retard the research process and put the United States behind many European nations on the road towards scientific discovery in this field. ●

FOR MORE INFORMATION see
www.whitehouse.gov/new/releases/2001/08/20010809-1.html

cell from bone marrow can be introduced into foreign soft tissue, where it will survive and replicate.

Currently, the institute is anxiously awaiting the approval of a recently submitted paper by the institute's director, Dr. Catherine Verfaillie. This paper outlines recent experiments that have shown an adult stem cell placed into a mouse blastocyst will differentiate into cells types that make up all body tissues. This exciting result shows the possible pluripotency of adult stem cells, which have conventionally been thought as already set to differentiate in a specific direction.

STEM CELLS continues on page 21

PLAY THE NUMBERS FOR \$10,000

BY ERIC CARON

RSA Security, a security consulting firm, is offering \$10,000 to whoever can find two factors of a 174-digit number, and if you're feeling exceedingly adventurous (not to mention like a super-genius), they will give \$200,000 for factoring a 617-digit number. Unfortunately, this is by no means a get-rich-quick scheme.

One contender in the contest, distributed.net (both the organization's name and its web address) is combining the donated computing power of over 307,744 computers to try and solve the problem. Testing 18,446,744,073,709,551,616 possible factors takes a long time, and distributed.net anticipates breaking the code in 504 days at their computing rate as of October 9, 2001.

RSA defines security standards of data encryption used everywhere from the encoding of government messages to the security used for online personal shopping. RSA hosts these contests because they give RSA and the government an idea about how much it would cost to buy the computing power needed to decrypt a single message. Finding the factors for the contest does not break any real encryption scheme, but the speed with which the factors are found provides an estimate of what level of security various encryption schemes provide. By current estimates, factoring the 174-digit number would take 95,000 500 MHz Pentiums, each with 4 gigabytes of RAM, a year to compute. Therefore, encoded messages that are worth more than the set-up of 95,000 computers would need a higher level encryption scheme, and messages worth less than that can use shorter numbers for encryption.

While RSA expects the 174-digit problem to be solved in a year, they expect the 617-digit problem to stand for at least a decade. If you're bored, with time to kill, the 174-digit number is on this page, and links to helpful web sites to get you started are on the online edition of the technolog. If you do manage to discover the factors and win the prize, don't forget what magazine told you about the contest and gave you that helping hand...●

How the eight contest numbers were generated:

1. First, 30,000 random bytes were generated using a ComScire QNG hardware random number generator, attached to the laptop's parallel port.
2. The random bytes were used as the seed values for the B_GenerateKeyPair function, in version 4.0 of the RSA BSAFE library. The private portion of the generated keypair was discarded. The public portion was exported, in DER format to a disk file.
3. The moduli were extracted from the DER files and converted to decimal for posting on the Web page.
4. The laptop's hard drive was destroyed.

The \$10,000 number:

18819881292060796383869723946165043980716356337941738270076
33564229888597152366548531906060650474304531738801130339671
6199692321205734031879550656996221305168759307650257059

FOR MORE INFORMATION see
stats.distributed.net/rc5-64/
www.rsasecurity.com/rsalabs/challenges/factoring/numbers.html
n0cgi.distributed.net/faq/index.cgi?file=28

Magnetic therapy: A cure-all for the average hysterical Bourgeois woman?

What do certain modern athletes and 18th century French aristocratic women have in common? The answer: both have turned to magnetic therapy for healing

BY BETHANY STEICHEN

Today, over 140 million people worldwide use magnet therapy. Magnets are placed in bracelets, mattresses, back supports, knee braces, necklaces, and other devices to help heal everyday aches and pains. Professional athletes such as tennis player Lindsay Davenport, quarterback Dan Marino, baseball player Hideki Irabu, and golfer Jim Colbert, along with others, have used magnet therapy and increased popularity of the products considerably.

Magnet therapy has today become a multi-billion dollar business, but its origins go back to pre-Revolutionary France. In that era, women frazzled by problems with the estates, the servants, politics, and goodness knows what else turned to Dr. Franz Mesmer, father of magnetic therapy, for relief. Anyone who was anyone paid Mesmer a visit, even Marie Antoinette.

Upon arrival at Mesmer's, a visitor was taken to a room with plush furnishings embroidered with astrological symbols and a magnetic bathtub. Iron filings and glass powder lined the inside of the tub. After soaking for a few minutes, Mesmer himself came in, clad in purple velvet robes and brandishing a white wand. He touched the patient's temples and a few pressure points with the wand. Patients raved

about finding themselves cured of all their woes thanks to this fantastic treatment.

In 1784, however, a committee of distinguished doctors was appointed by King Louis XVI of France to investigate the validity of Mesmer's magnet treatments. They concluded that Mesmer's success was due to his convincing salesmanship and the placebo effect. In spite of this inauspicious beginning, the field of magnet therapy has grown, experiencing a resurgence of believers lately.

Despite the increasing popularity of magnetic therapies today, few studies validate the use of magnetic therapy. This leads to confusion in both the marketing and use of magnetic therapies. In fact, several manufacturers have been sued and forced to remove "false and fraudulent claims." Additionally, people have neglected a physician's care for broken bones, diabetes, cancer, HIV/AIDS, and other serious diseases believing that magnets will cure them.

Magnetic therapy is intended to heal small wounds and relieve pain by increasing the flow of blood to the injured area. An increase in blood flow to a region is thought to increase the local oxygen supply and also to help in tissue repair by delivering more proteins and leukocytes (white blood cells) to the wounded area.

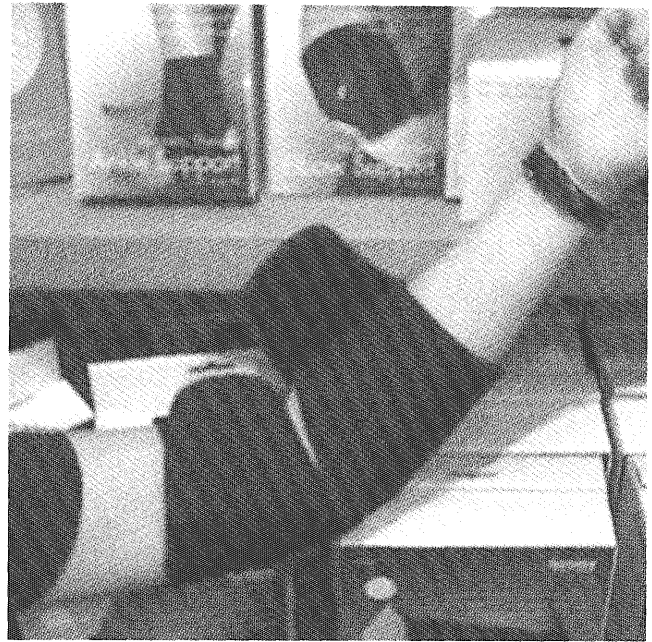
Magnet therapy companies make



Franz Mesmer worked more magic on his patients than did his therapeutic methods.

two claims for a static magnet's ability to influence blood flow. First they purport that iron contained in hemoglobin is attracted to the magnetic field. However, the magnetism of blood depends not on iron, but on the presence of oxygen carried by the hemoglobin. Oxygenated blood is diamagnetic, meaning that it is slightly repelled by nonuniform magnetic fields, not attracted as the companies would claim. Only a small proportion of blood is paramagnetic, and therefore attracted to nonuniform magnetic fields, and even that responds only to magnetic fields above 3,500 gauss. For comparison, the magnetic field of the earth is less than 1 gauss and a typical refrigerator magnetic is about 100 gauss.

The second claim made by magnet companies is that negative and positive ions in the blood plasma and polar molecules on the red blood cells themselves are attracted to the magnet. Studies of these ions predict that a magnetic field of 140,000 gauss would be required to have an impact on blood flow. In contrast, the magnets in magnet therapy products often hold only ten sheets of paper to a refrigera-



Magnetic therapies today fill a range of niche markets. These are some products that can be purchased at your local Discovery Channel Store.

tor. This suggests that any benefits of magnet therapy are not due to the magnets themselves. This does not necessarily mean that relief felt by users is entirely imagined. Magnetic wraps provide physical support and insulation, both of which can help heal aches and pulled muscles. Nevertheless, the committee appointed by King Louis XVI was correct in asserting that good salesmanship over good medicine was the reason behind the popularity of Mesmer's treatment. The same is true for magnetic therapy today. ●

FOR MORE INFORMATION see
www.magnapak.com/magnetic-therapy
www.magnetictherapy.co.uk/system/index.html
www.buyamag.com

STEM CELLS

continued from page 19

Another goal of the Stem Cell Institute is to apply the information gained from its research to fashion therapies using these adult stem cells. At the moment, the institute is attempting to differentiate adult stem cells into mature liver cells. Presently only the differentiation to early stage liver cells has been achieved. The institute, however, has grown fully mature cells of all three types of tissues that comprise an artery. The remaining question is how to assemble these grown tissues so they form an actual artery.

What does the future hold?

While it was once thought impossible to repair damage to the nervous system, an experiment carried out by researchers at Johns Hopkins University has proven that new neurons can be grown out of adult stem cells and will function when inserted into an organism. A mouse was subjected to a virus that destroys the motor neurons and thus became paralyzed. After receiving stem cell therapy, the mouse showed movement, while those that did not receive treatment remained paralyzed. Currently incurable problems such as neural dis-

eases (including Alzheimer's) and paralysis may become a thing of the past.

Looking towards the future, Verfaillie paints a picture of what would seem to be science fiction. A person would have a culture of their own stem cells, retrieved earlier either from a sample of bone marrow or from their own embryonic stage, stored in a cell bank. These cells could later be used to grow entire new organs such as a bioartificial liver or create a "heart patch" to replace scar tissue that forms on the heart if the blood supply to the heart is cut off.

These examples are just a taste of what may be possible in the future thanks to stem cell research. Verfaillie speculates, "Ten or twenty years from now, medical science is going to be a completely different ball game." ●

FOR MORE INFORMATION see
www.umn.edu/stemcell
www.news.wisc.edu/packages/stemcells
www.nih.gov/news/stemcell/

The air up there

Tall bikes take transportation to an extreme

BY ANDREA MOSHER

In a small cafe on 50th Street, I sat and enjoyed my lunch. Undisturbed, I gazed outside at the afternoon traffic, daydreaming between bites of salad. The cars passed in a hypnotic pattern and my mind blurred into a semi-trance. Whoosh. The soothing pattern was suddenly broken. Cruising down the sidewalk went a tower-like structure on a set of wheels and, from what I could see, the bottom half of a person pedaling the thing. Was I still dreaming? No, but what was that thing? The mechanism and its rider immediately intrigued me, and I realized that other restaurant patrons were also astonished by what had just passed.

Tall bike riders enjoy the attention generated by their unusual mode of transportation. But attention is not the only appeal—there's also fun and thrill in this unusual hobby.

"Imagine cruising through town 10 feet from the ground with nothing but a few pipes and two wheels beneath you," says Brad Graham, a tall bike enthusiast. "In fact, you can barely see the bike, only the road ahead of you for miles." And for those that think 10 feet off the pavement is high enough, some of these bicycles



tower more than 13 feet from the ground.

Tall bikers could be compared to sky-divers and bungee-jumpers, says Graham. "We are the extreme, and everything must be taken to the very limits."

The cycles themselves are dangerous. Not only are they tall, most are not professionally engineered.

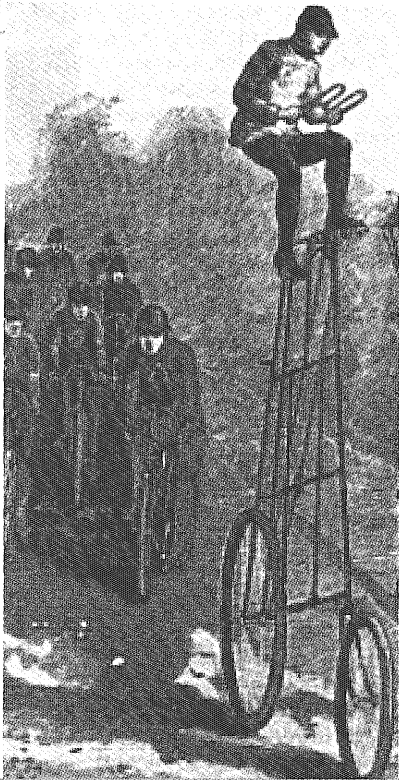
According to Graham, the recipe for making one includes "a welder, a

few scrap bikes and a warped imagination." Basically, a tall bike is made of whatever will hold a person up and allows him or her to pedal down the road. Parts are found just about anywhere, from the side of the road to an auto parts store.

And how does a builder know what works? Well, that is where much of the danger comes in. These bikes are made by trial and error. Weld some scrap metal onto an existing bike frame, get an old garage door chain, as found on one bike, make a few alterations, and try it out. Climb up onto the seat and try pedaling to determine if the creation is a successful tall bike.

Once these mechanical Frankensteins have been assembled, one's life is again in jeopardy. The rider must push off to get the bike moving, climb up and mount the seat, and finally pedal—all while keeping good balance. For the novice, mounting the bike from a high fixed position, such as a ladder or even a roof is more efficient.

And what about stopping? There are a few common methods. One has three options: climbing down, in the same way one climbed up, pulling up to a tall stationary object and dismounting, or using the classic jump



Left: The Eiffel Tower Bicycle, the progenitor of the modern tall bike. Center: A variation on the tall bike on display as part of an exhibit at Gus Lucky's Gallery in Minneapolis. Right and opposite: A freewheeler rides "The Organ Donor," a custom-made (and appropriately named?) tall bike.



and crash method.

Building tall bikes is about the challenge of building something spectacular. To some degree, these creations are engineering feats. However, they can also be considered an art form. Either way, they undoubtedly express a sense of individuality

These bikes are not new creations. The modern styles and forms were modeled after crazy bikes created as early as the 1890s. Today, tall bikes are remarkably popular. Across America, clubs and organizations dedicated to weird bikes hold races, rodeos, parades, and various outings. One group in Massachusetts takes day trips with their mangled-metal friends. Their adventures are not only dangerous, but they are illegal. The Massachusetts law states, "No bike

These bikes are made by trial and error. Weld some scrap metal onto an existing bike frame, get an old garage door chain, as found on one bike, make a few alterations, and try it out.

shall be operated upon a way with handlebars so raised that the operator's hands are above his shoulders while gripping them. Any alteration

to extend the fork of the bike is prohibited, and the operator can be fined up to 20 dollars." Breaking the law must be an additional thrill. Common to most of these organizations is an enthusiasm for defiance. It is one more challenge to overcome.

You'll probably see some of these bikes tooling around campus when biking season rolls around in 2002. Some tall bike gurus name Minneapolis among the capitals of tall biking. In fact, there is a club right in our neighborhood—The Hard Times Bike Club, formed at the colorful Hard Times Cafe on the west bank. ●

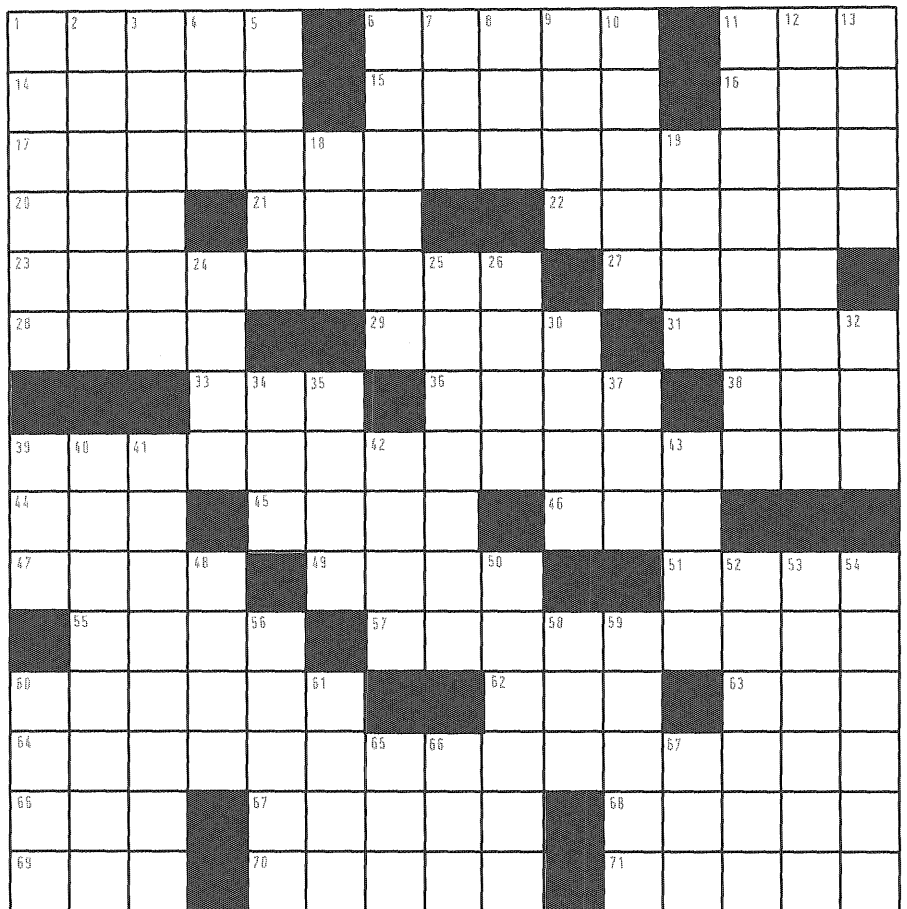
FOR MORE INFORMATION see:
www.rebcorp.com/guslucky.htm
www.dclxvi.org/chunk/meet/tall/index.html

Test necessities

BY TIM FISTER

ACROSS

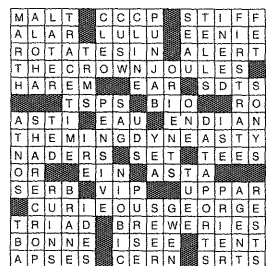
1. Swedish cars
6. Saccharine
11. Microelectronic tech.
14. Trip a crosswire: "It's ___!"
15. Exclamation following headcount
16. Heston's grp.
17. Test necessity #1
20. UK analog of DOC
21. Help
22. Forgotten bread does this
23. Scenic way?
27. Tints
28. Consequently
29. Revel
31. Word of comparison
33. Unrefined
36. "___ an idea!"
38. Back then
39. Test necessity #2
44. Spanish article
45. Student grant
46. French refusal
47. Athletic org.
49. Appear
51. 552 to a namor?
55. Sheriff Wyatt
57. "___ of fact"
60. Comforts
62. Type of logic gate
63. League preceder
64. Test necessity #3
66. Exaggeration ending
67. European lake
68. Shakespearean sendoff
69. Enzyme suffix
70. Season ending tournament for a Gopher?
71. See *Technolog* bios...



DOWN

1. Summer footwear
2. One helper in math or chemistry
3. Ready for battle
4. One ancient civ.
5. Unit of asparagus
6. Analogies to a high schooler
7. $W - \pi/8$ on a compass?
8. Istanbul : Constantinople :: Tokyo :
9. Comp. workers
10. Gear cogs
11. Actor Holbrook, to his niece
12. Epic tale of canal construction?
13. Musicians Bachman and Farlow
18. Brave or Grande
19. Oceanic abbreviation
24. 1999 loser?
25. Deals with lightly
26. Too good to leggo
30. Singer Pete
32. Rejections
34. Bio. energy source
35. Miseries
37. Thermo Electron corp.
39. Sneaky
40. On the streets
41. Heighten
42. Type of circus
43. Erg or dyne
48. Asian sea
50. Japanese comic books
52. "___ the cards"
53. Flood precautions
54. Rehearsal
56. Road cone
56. A stooge
59. Primitive matrix
60. Locale
61. N' ___
65. Golden Girl Arthur
66. Grocery chain
67. Summer quencher

Crossword solution will be printed in the next issue of the *Technolog*. Here's the solution to last issue's crossword:



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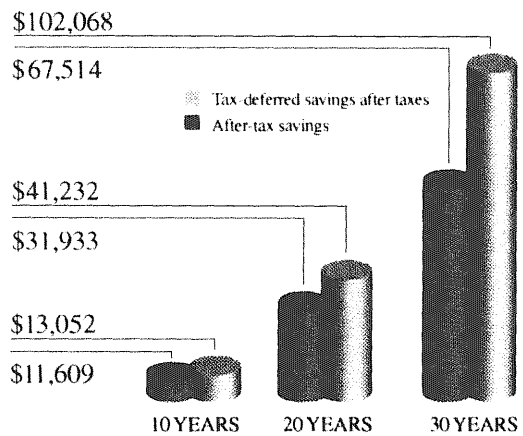
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In this hypothetical example, setting aside \$100 a month in a tax-deferred investment with an 8% return in a 28% tax bracket shows better growth than the same net amount put into a savings account. Total returns and principal value of investments will fluctuate, and yield may vary. The chart above is presented for illustrative purposes only and does not reflect actual performance, or predict future results, of any TIAA-CREF account, or reflect expenses.

*Note: Under federal tax law, withdrawals prior to age 59½ may be subject to restrictions, and to a 10% additional tax.



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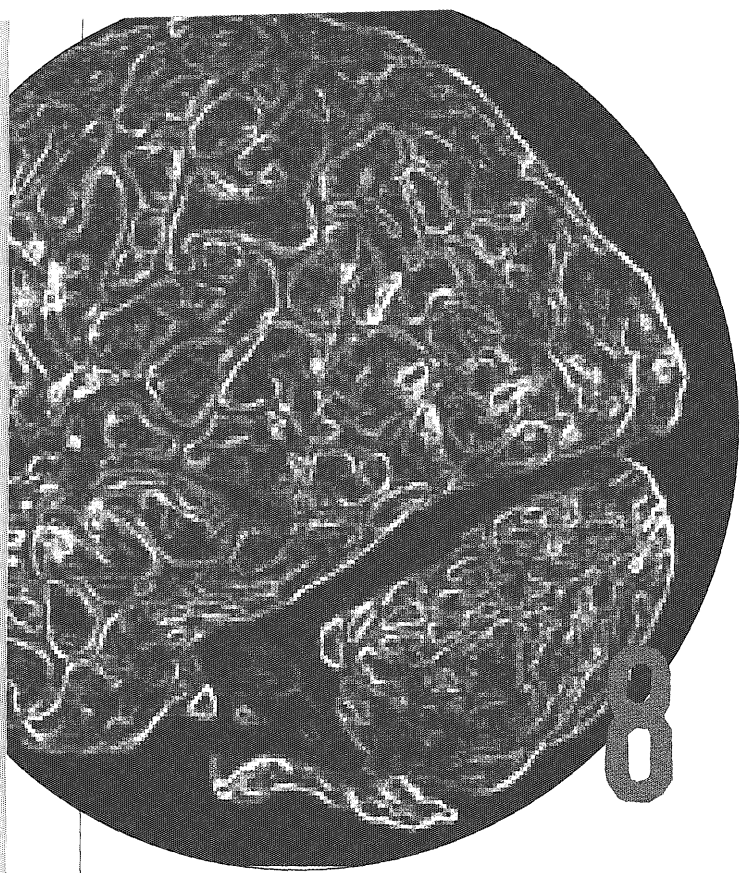
STUDENT MAGAZINE OF THE INSTITUTE OF TECHNOLOGY

SPRING 2002



COMPUTATIONAL NEUROSCIENCE AT THE CROSSROADS OF THE HUMAN MIND

ALSO INSIDE: The MINDS Factory • Walter Library • MNTap • And More!



COVER STORY

At the Crossroads of the Human Mind

Quantitative modeling of the nervous system requires new interdisciplinary collaborations in the sciences, mathematics, and engineering.

FEATURES



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10 Architectural addition

Steven Holl couples visionary architecture with innovative engineering to unite CALA's two schools.

12 The search for neutrinos

The local MINOS factory helps build an experiment to locate and record the behavior of neutrinos.

16 Simply the best

UMD students find a simple solution to a complex engineering problem: flyfishing for the disabled.

18 What's old is new again

An overview of current remodeling and a blast-from-the-past *Technolog* article from when Walter was new.

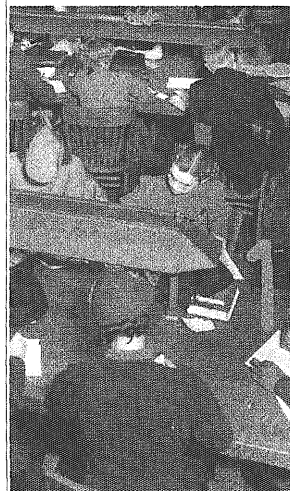
22 The Bakken Museum

An institution that provides its visitors with hands-on experiences with electricity and magnetism.

26 MNTap: This isn't your ordinary summer job

An extraordinary internship opportunity gives students a chance to show corporations how to save time and money while preventing excess waste.

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CONTRIBUTORS



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At the end of the semester, he'll graduate with a degree in physics.



Graf

Neil Graf is an electrical engineering graduate student. His research interests include using nano/microtechnology to improve the quality of life for others. His interests include reading, politics, world affairs, economics, running, biking, skiing, hockey, and the outdoors.



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Jen Idziorek is a pre-med student majoring in biology. She hopes to be a surgeon someday, (unless she comes up with enough money to move to Tahiti.) No one can help you if you can't help yourself.



Idziorek

Katie Idziorek is a senior in the architecture program. She can almost always be found in her design studio, where she injures herself frequently. She plans to very soon take up yoga as a stress-relief aid. She also very much enjoys Tim's corny word games and especially *spicy* cooking.



Leland

Jeanette Leland is a junior majoring in physics, with a possible double major in English. She is actively involved with the Society of Women Engineers, and in her spare

time she enjoys music, reading, rollerblading, and (when the weather permits) hanging out at the beach with her friends. This "fool" was born on April 1st, and admits to recently acquiring a Harry Potter addiction.



Mosher

Mike Mosher, a senior in mechanical engineering, is a firm believer that people can make miracles happen, and among other miracles, he hopes to eventually get caught up on all his homework and remembers to turn his graduation application in on time.



Opsal

Chris Opsal is a rookie staff member at the Institute on Community Integration in the College of Education and Human Development, where she is an editorial assistant in

the publications office. A 2000 grad of the University of Wisconsin-Madison, she says, "Writing for the *Technolog* makes me feel like a kid again."



Purdes

Jennifer Purdes is a freshman who plans to major in biomedical engineering. She hails from the lofty peaks of the Rocky Mountains and enjoys playing lacrosse, skiing, watching movies, and jumping in puddles!



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Bethany Steichen is a freshman in chemical engineering from Manhattan, Kansas. She enjoys soccer, shoes, music, cooking, tennis, politics, internet quizzes, friends and things that don't involve lifting heavy objects. Next on her personal to-do list is study abroad.



Thomas

Daniel Thomas, a fifth-year mechanical engineering and journalism major, enjoys books, conversations about traveling, history, God, and philosophy. In the spring, he looks forward to canoeing, camping and gardening.



Trenda

Scott Trenda is a freshman majoring in computer science and math with a minor in Japanese. He spends his leisure hours watching, talking about, writing about, and taking his friends to movies. Occasionally he takes breaks for visits to Middlebrook, Snood, and guitar.



Tsai

Eric Tsai believes that conduction and convection would be much easier to tell apart if they were called "Malik" and "Dookie." When not meditating, reading, volunteering, playing piano, or traveling, he spends much of his spare time pondering: Who do I want to be? The person I hope to be or the person I fear I actually am?



Walter

Michelle Walter is a freshman majoring in astrophysics. Her latest adventure is being an Admissions Ambassador. She also enjoys astronomy, watching TV, movies, shopping, and hanging out with friends.

Bush's EPA: Environmental Politics Agency

Much of the money annually injected into our nation's economy is spent in ways that encourage continued exploitation of natural resources rather than environmental friendly growth. In an economy in which consumers buy goods and services based on short-term cost, Bush's efforts to roll back environmental regulations threaten the longterm move toward sustainable development. The United States must maintain serious environmental protection regulations and laws to garner international respect for its role in global affairs and to ensure that its economy continues to thrive on the face of a planet with a highly valuable yet resource-limited environment.

Even as we continue to degrade the resources around us, Bush is putting more and more responsibility for environmental protection in the hands of big business. Bush argues that business partnerships mean progress—allowing businesses to deal with environmental issues in ways that will not hurt the economy. However, at some point, the oil economy must be hurt enough to provide incentives to create an economy based on sustainable technologies. One example of Bush's partnership with the oil industries is his agreement to roll back the CAFE (Corporate Average Fuel Economy) standards set by Congress in 1975. These standards set a minimum limit on the average fuel efficiency of vehicle fleets made by American auto-makers. Designed to encourage the auto industry to reduce development of gas-guzzling vehicles and explore alternative vehicle concepts, such as hybrid-electric and hydrogen fuel cell cars, the CAFE standards aimed to promote new directions in environmentally friendly automotive development. Without such standards, the incentive to market innovative, "green" vehicles is reduced.

It is optimistic at best (unrealistic is perhaps a more appropriate word) to assume that big business will achieve environmental protection on its own. Hefty coffers and government partnerships allow businesses to fund dubious scientific studies on the environment and to stage significant—and sometimes effective—public relations and marketing campaigns that purport environmental altruism while they continue to damage the environment in the quest for short-term profits.

Environmental protection in an industrial society must be achieved through innovation fostered by meaningful regulation, not through the type of bargaining and partnerships Bush and others are pushing. Business is simply too self-interested in its bottom line to care to about long-term environmental issues. Environmental regulations allow businesses to continue operating while establishing needed limits on pollution and economic incentives for research and development.

The environment is too important for the federal government to put at the disposal of corporations. If Bush and other politicians continue to roll back environmental regulations for short-term business interests, individual citizens must rise to the occasion and promote their right to the long-term health of the environment, demanding that their representatives in Congress enact new legislation to protect it. Environmental regulations provide a real economic incentive for the technological innovation that will bring about sustainable development. If citizens do not continue to loudly demand that environmental protections be put in place and rigorously enforced, politically and economically motivated cycles of exploitation of the environment will continue with little meaningful change.

— The Editors



Technolog editors Mike Mosher and Melissa Eblen.

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Searching for the source of happiness

A look at the alternatives to achieving a state of heavenly bliss

BY JEN IDZIOREK

"Life is divided into the horrible and the miserable."

—Woody Allen

While most of us don't have such a bleak outlook on life, we all think that our lives could be happier. What makes people happy? Millions of people have spent billions of dollars trying to answer this question for ages, yet no definitive answer has emerged. Or if someone has found the answer, they've cleverly kept it to themselves.

People are still proposing solutions to this age-old question. Some of the better-known answers include money, power, virtue and, the old standard, sex, drugs and rock'n roll. Others think sugar, ignorance, material possessions, and love are the secret to contentment. Let's take a look at the credibility of some of these options.

Ignorance is the most amusing option on the list. Would we all be happy if we didn't know there were better cars and warm tropical islands? Would we attack other countries if we didn't know they had things that we wanted? You couldn't want something if you didn't know it existed. Jealousy is the

cause of many tumultuous events. Avoiding jealousy could stop many of the world's ills. Knowledge has made many wonderful things possible, but it has also created the nuclear arms race and impoverishment. Most people wouldn't want to go through life in ignorance, but what if we didn't know any better?

Money and power go hand in hand. If you've got a lot of money, you've probably got a considerable amount of influence. Do these things cause happiness? Maybe. Hugh Hefner, a playboy millionaire with considerable influence, seems to be a happy man, but is his polar opposite, the Pope, happy? Is the president happy? How about the Queen of England? Of course they're all happy occasionally, most people are. But are these rich and powerful people happier than your next-door neighbor? Maybe they're not. All that money and influence has a price. A lot of people depend on the powerful. They have a lot of responsibility. All that responsibility causes anxiety. What does your next-door neighbor have to worry about---the future of his coffeehouse band?

Hugh has a lot of money, but he doesn't seem to be responsible for anything that affects the lives of millions. He must be as happy as a child. Children laugh up to 25 times a day more than adults. They worry about very little. Could irresponsibility be the an-

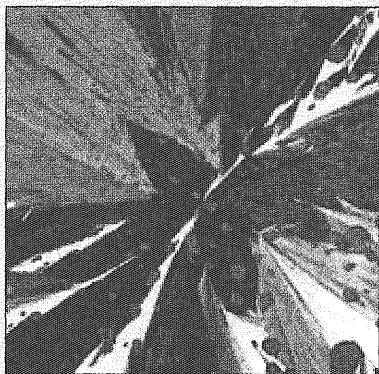
swer to it all?

Virtue might create happiness, but do any of us possess it? Who is virtuous? Religious leaders? Just read the paper. There are fewer and fewer virtuous religious leaders every year. The monks of Tibet tell us that peace comes from within. Perhaps they're on to something.

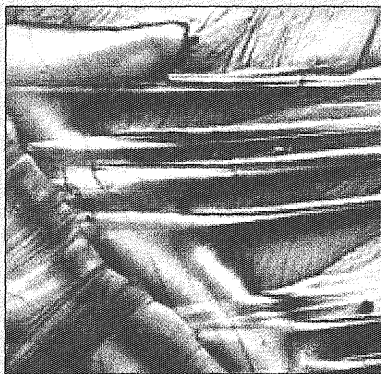
A large portion of the economy is geared towards making people happy or at least making their lives easier and more enjoyable. Candy bars exist so that you can relish their taste. Jaguars were made so that those who ride in them could feel an adrenaline rush from driving such a beautiful machine. Yet not everyone who is riding in a Jaguar is happy. Candy bars become tiring. When the population tires of one experience, Madison Avenue creates a new one. We are not interested in experiencing the same things over and over again (well, with a few exceptions). We're only interested in it if it's new and exciting. Variety is the spice of life and we'd like extra, please.

And you might as well face the truth. Your significant other doesn't always make you happy. Your family is great, but sometimes they are whiners, nags, and jerks. Best friends can stab you in the back, and your buddy can let you down. But despite their faults, friends and family can make you happier more consistently than the other 10,000 people you walk by in a given

The (legal) drugs that get you through the day



Dopamine: The only thing keeping our staff from quitting.



Epinephrine: The official drug of marathons everywhere.



Serotonin: Mmm...serotonin.

day. They help you deal with your problems and provide a constant source of entertainment. Their hugs and kisses can make you feel better, and get you through hard times.

So what will make us happy? Money, power, fame? Actually, there is only one thing that will make us happy—drugs. No, not those kinds of drugs. The natural hormones of the body trigger the release of the neurotransmitters that communicate information from nerve cell to nerve cell. These neurotransmitters are responsible for happiness and prevent unhappiness.

The most prominent of these natural drugs is serotonin. Serotonin is regularly released into the central nervous system and causes a normal, healthy human to feel content. Low levels of serotonin can cause depression, insomnia, and fatigue. Since it produces an opiate-like high during periods of elation and eases short-term tension most anti-depressant drugs contain serotonin.

There are other natural drugs we can't do without. Dopamine regulates movement (a deficiency in dopamine causes Parkinson's disease), controls emotional states, and helps the body cope with stress. Epinephrine, known as the "runner's high" neurotransmitter or adrenaline, helps protect our body. It is responsible for our "fight or flight" response and also acts as a

powerful painkiller. It is three times more potent than morphine. Who needs the fake stuff when the most potent stuff is homegrown?

// What makes people happy? Millions of people have spent billions of dollars trying to answer this question for ages, yet no definitive answer has emerged. Or if someone has found the answer, they've cleverly kept it to themselves. //

Neurotransmitters leap into action before we know it. They fight stress caused by jealousy, responsibility, and trauma. It's serotonin that fights the aggravation you feel when your neighbor plays his music too loud or the anger you experience when your manager explains something you already understand for the third time.

Dopamine doles out its healing power when stress attacks, and epinephrine provides surges of energy during new experiences or extremely pleasurable ones.

Is happiness the ultimate purpose in life? There's no immediate way of knowing, unless you're an atheist and then hopefully the answer is yes. Here are some of the overriding factors that have been discovered in the course of this article: ignorance may not be bliss, but irresponsibility might be; being entertained makes us happy, but only if it's new; happiness may come from within, but only if you want it to. And all of this is fueled by the release of the body's natural drugs from excitement, personal joy and lack of stress.

But there are still many other questions to ponder: Does laughter cause happiness or is it the other way around? Is it possible that we are constantly in pain and "happiness" is just when we experience less pain? Did all of the people who discovered true happiness also discover that each person defines their own reality, and now exist on another plane of life? Is innocence the root of "bliss," not ignorance? Can we choose to make ourselves happy?

Who knows? Maybe Woody Allen has the answer. ●

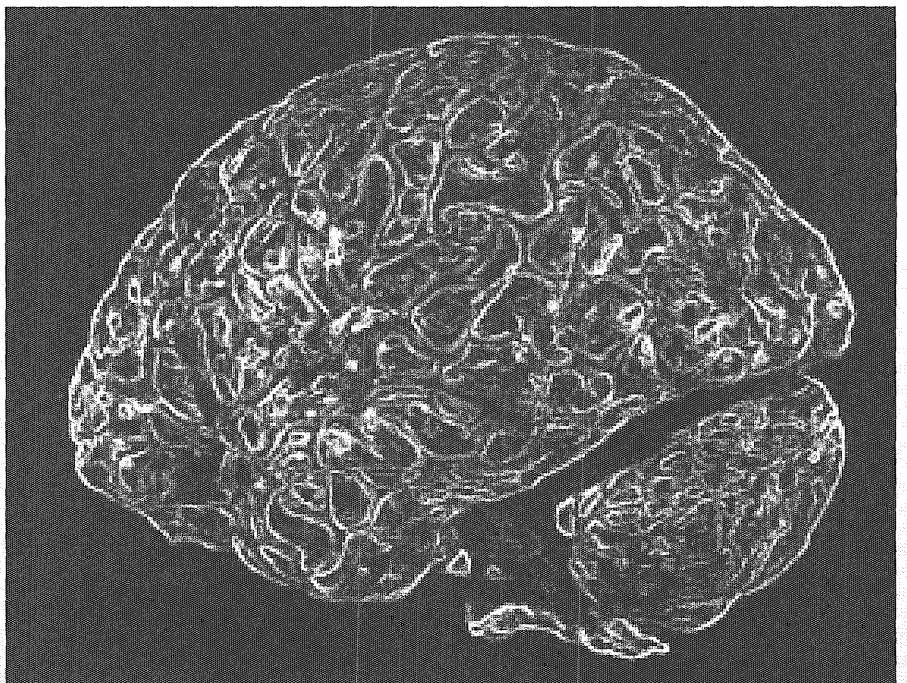
FOR MORE INFORMATION see
www.csuchico.edu/psy/BioPsych/neurotransmission.html
www.micro.magnet.fsu.edu/micro/gallery/

At the Crossroads of the Human Mind

BY NEIL GRAF

Evolution's most complex and versatile achievement¹, the human nervous system, provides a challenging research frontier for scientists. The nascent interdisciplinary field of neuroscience seeks to study the development, structure, and function of the nervous system in humans and other organisms. Although traditionally based in the life sciences, as the field of neuroscience matures, the need for quantitative modeling and insights from the physical and computational sciences grows according to Professor Timothy J. Ebner, head of the University's neuroscience department.

To foster training in this area, the National Science Foundation funds the Integrative Graduate Education and Research Training Program (IGERT) at the University. This program combines the knowledge, skills, and expertise of three existing resources on the Minneapolis campus: the Graduate Program in Scientific Computation, the Graduate Program in Neuroscience, and the Minnesota Supercomputing Institute. Participating faculty from many departments across the University have projects that include molecular modeling of receptors and ion channels, imaging and eigenvalue problems, sin-



gle neuron models, motor control neurophysiology, modeling visual information processing and perception, neural networks and evolutionary algorithms, and problems in information control. IT graduate students in departments with participating faculty—biomedical engineering, chemistry, physics, chemical engineering, computer science, or math—are eligible to apply for the IGERT fellowships, as these departments have participating faculty.

One specific example of IGERT research in computational neuroscience is the work being done by Dr. Tony Varghese in the lab of neuroscience assistant professor Linda Boland. Varghese studies the kinetics of potassium ion channels using the mathematical theory of Markov models. This research requires skills in molecular biology, neuroscience and physiology, chemistry, and mathematics.

Ion channels are proteins that span

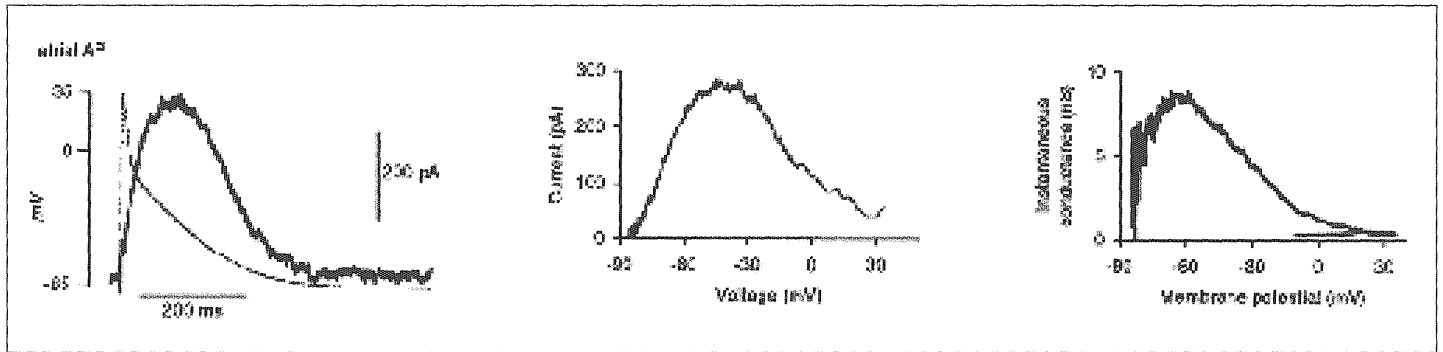


Figure 1. Response of HERG K⁺ channels during different cardiac AP waveforms. A, typical current responses (continuous current traces) from the same transfected CHO cell for single endocardial, epicardial, Purkinje and atrial AP waveforms (dotted traces). The zero current level was at the -85 mV level in all panels. B, current-voltage relationships for each AP waveform. C, instantaneous conductance-voltage (G-V) relationships for each AP waveform.

a cell membrane to permit specific ions to enter and leave the cell. This flow of ions triggers the electrical activity that transmits signals along cells. Last December Varghese and his colleagues published a study of the effect of premature stimulation of HERG K⁺ channels². HERG is a human gene, which manifests itself as a potassium (K⁺) ion channel in the brain and heart. The HERG K⁺ channel demonstrates some unusual kinetics that are consistent with their putative role of providing people protection by suppressing cardiac arrhythmias sparked by premature heart beats. According to this study, ventricular arrhythmias are responsible for over 300,000 deaths per year in the United States. These statistics provide a sense of the enormous benefit this research could bring to medicine.

Varghese and his collaborators compared experimental findings about the effects of premature stimulation on HERG K⁺ channels with computer simulations using Markov models. Markov modeling is a branch of statistics that describes a physical system that can exist in a number of different states. The transition between states is memory-less; the future state only depends on the current state.

The researchers used cutting edge

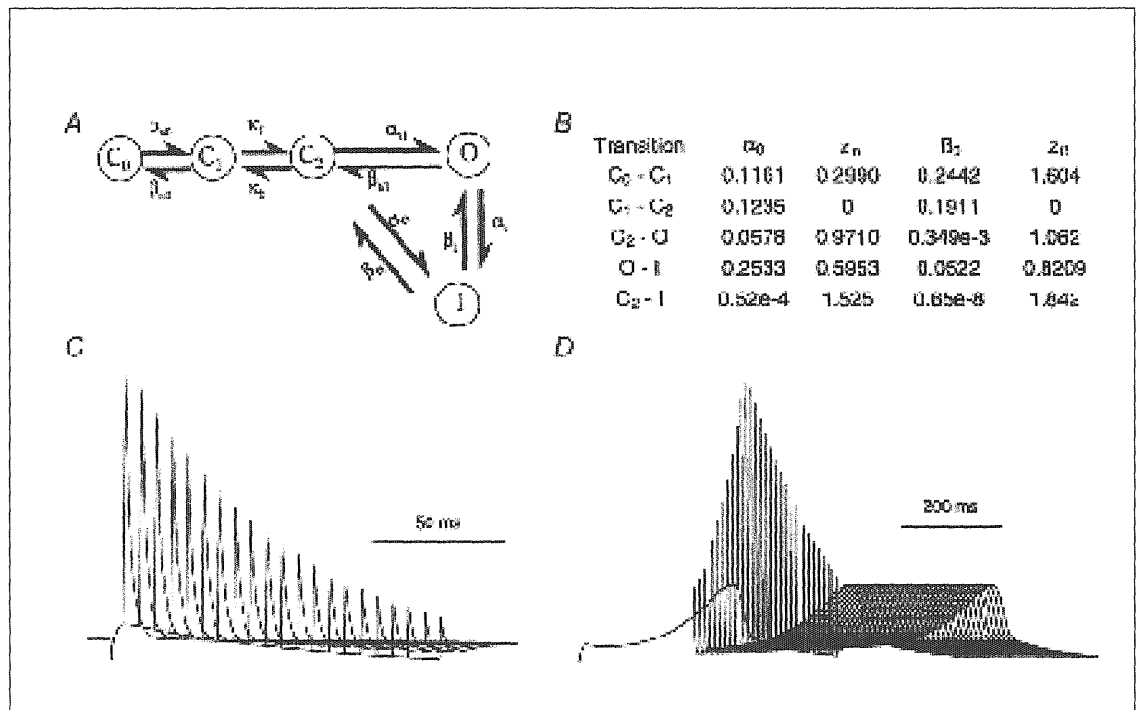
“The fellows in the program are the best in the country. The opportunities before them are tremendous. They are bound to make a tremendous impact on the field of neuroscience. We should see the shock waves in the next three to five years.”

molecular biology techniques to transfect a human HERG gene into a cultured Chinese hamster ovary cell. Then they employed a technique used extensively by neuroscientists called patch clamping. Patch clamping can be used to study the current flow, or ionic activity, of a single ion channel or a large number of channels in a single cell. A very fine hollow glass micro-

pipette tip filled with a solution that closely mimics intracellular fluid is pressed against the cell's surface where a negative pressure differential is applied to form a pressure seal between a small patch of cell membrane and the pipette tip. The patch is then ruptured to allow an electrical connection between the inside of the cell and the pipette. Neuroscientists can then use sophisticated electronic equipment to monitor ionic currents through the channels. Currents as small as a few picoamps can be measured, and the technique exhibits microsecond time resolution. With such a high degree of resolution for current and time, scientists can observe how fast the channel opens and closes, how frequently it opens, and how long it stays open. One can get a sense of how remarkable this technique is by observing Figure 1, which shows the response of HERG K⁺ channels during delivery of different cardiac signals to the channels.

For the study's modeling component, researchers set-up a Markov state model as a system of non-autonomous ordinary differential equations, with an algebraic equation to represent the conservation of states property of Markov chains. Figure 2 illustrates the differential equations being used in

Figure 2. Markov state model for HERG K⁺ channel gating. A, the model scheme where the rate constants for each transition are of the format: $\alpha = \alpha_0 \exp[z_n V_m / (RT/F)]$ and $\beta = \beta_0 \exp[-z_n V_m / (RT/F)]$, as described in Methods. F and b are voltage-independent transition rates. B, rate constants for each equation used in the model. C, model predicted response to double-pulse protocols. D, paired endocardial AP stimuli.



the model. In section A of this diagram, the circles with C₀, C₁, C₂, O, and I represent the different states or three dimensional protein shapes of the HERG ion channel. The Greek symbols above the arrows represent rate constants of the forward and reverse configurations. Anyone who has taken a second semester, general chemistry course can appreciate the similarity of the representation in Fig. 2A showing different ion channel states to that of a chemical reaction in equilibrium.

The Markov model computer simulations were found to agree with the data obtained in the patch clamp portion of the experiment. Varghese is presently following up on this report with a computational study of changes in HERG kinetics when the channel interacts with other proteins with disease mutations.

Because research in this area is diverse and multi-faceted, it is rare to find a researcher capable of carrying out every aspect of an experiment like the one described above. Instead, groups of highly talented individuals with expertise in disciplines such as molecular biology, neuroscience and physiology, chemistry, and mathematics, come together to understand complex biological phenomena.

"The Computational Neuroscience

Markov modeling is a branch of statistics that describes a physical system that can exist in a number of different states, where the transition between states is memory-less. The idea is that the future state only depends on the current state.

Program at the University is aimed at producing a group of Ph.D's each of whom will have interdisciplinary training and research experience," says Varghese. "The fellows in the program are the best in the country. The opportunities before them are tremendous. They are bound to make a tremendous impact on the field of Neuroscience. We should see the shock waves in the next three to five years."

Another interdisciplinary research project underway within the computational neuroscience program can be found in Professor Timothy J. Ebner's lab. Ebner, a neurophysiologist and head of the neuroscience department, studies the cerebellum and its role in an organism's movements. Characterizing and elucidating the spatiotemporal patterns of neuronal population activity in neuronal networks is crucial to understanding the cerebellum, as well as the nervous system as a whole. Understanding the awesome parallel wiring patterns formed by neurons in the brain will help physicians to better treat patients with brain lesions and other nervous system abnormalities.

One aspect of Ebner's research is to study the activity of specific neuronal architecture within the cerebellum of rodents in response to peripheral stimulation, using optical imaging techniques. In one study³, researchers used tungsten microelectrodes placed in the cerebellar cortex, brainstem, and the ipsilateral vibrissa (whisker) pad to provide stimulation. The neuronal activity resulting from this stimulation changes the pH within the affected cells. The researchers used a pH sensitive dye called Neutral Red to map the location of active neurons. A sophisticated setup with a fast, high-resolution

charge-coupled device (CCD) camera recorded the changes in pH. The optics was an integral aspect of the signal recording technique used in the experiment.

The general schematic of the basic recording technique is shown in Figure 3. The setup is based on the optical principle of epi-fluorescence. Epi-fluorescence is the process of emitting at one wavelength of light, and observing a different wavelength being emitted. Neutral Red's optimal excitation wavelength is 546 nm. After excitation, the signals pass through a dichroic mirror and an emission filter for wavelengths ≥ 620 nm, which contains the peak emission for Neutral Red. The signal finally enters the CCD camera, which records rapid digital sequential images before, during, and after the stimulation. Researchers extract the optical response to the stimulation by subtracting a non-stimulus frame from frames obtained during and after the stimulation. To quantify the optical responses, a two-dimensional fast Fourier transform analysis removes undesired horizontal artifacts like blood vessels, and high spatial frequency noise, leaving the desired signal intact for scrutiny. Researchers then use various computational techniques to characterize the optical images; for example, principle component analysis helps define the independent spatial patterns of activity present.

More recently, Ebner's group assembled an electronic device to drive a piezoelectric bimorph load. This setup will provide a more natural means of stimulating rodent whiskers. A piezoelectric bimorph is basically a capacitor that will deflect if a voltage is applied between the two plates. If mounted as a cantilever, the bimorph will bend such that it acts as an actuator, capable of moving rodent whiskers in a periodic fashion. It turns out that a rodent's cerebellum responds best with stimulations to the whisker pad delivered at a frequency between 6-8 Hz. To drive the bimorph at this frequency, the researchers designed a virtual function generator on LabView, a computer using the software package sold by National Instruments.

“Though the expertise brought together by researchers in this new and exciting field is diverse, they are all united by their common goal to solve scientific problems that would otherwise be extremely difficult to pursue as individuals.”

Computational neuroscience is a highly dynamic and interdisciplinary area of research that spans engineering, mathematics, and the physical and biological sciences. Though researchers bring diverse expertise, they are all united by the common goal of solving scientific problems that would

be extremely difficult to pursue as individuals. The computational neuroscience program is an ideal program for those graduate students whose interests lie in multiple areas and wish to conduct research that benefits people's lives.

Kenneth Reinert, a graduate student in the program, agrees,

“The Computational Neuroscience Program is probably the most exemplary of the NSF IGERT training grant programs.” ●

FOR MORE INFORMATION see www.compneuro.umn.edu or email the program's administrator, Kathleen Clinton, at clinton@compneuro.umn.edu

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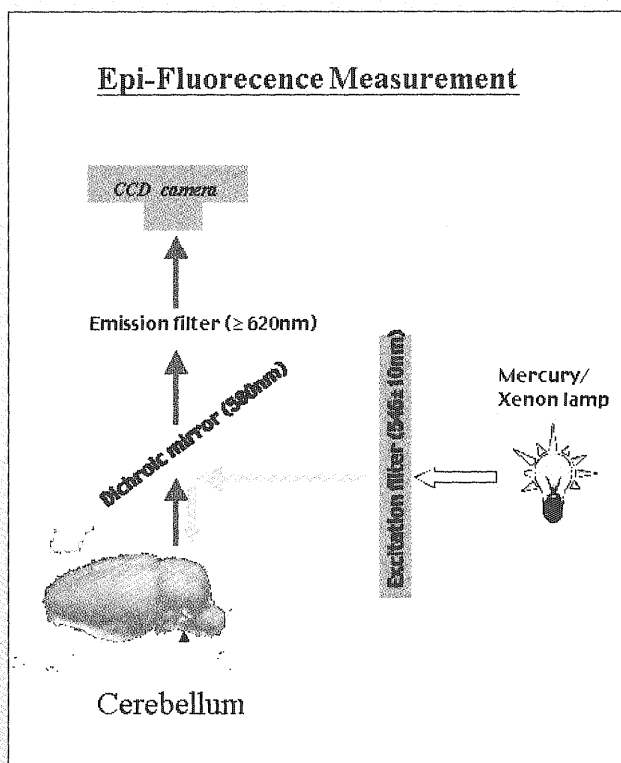
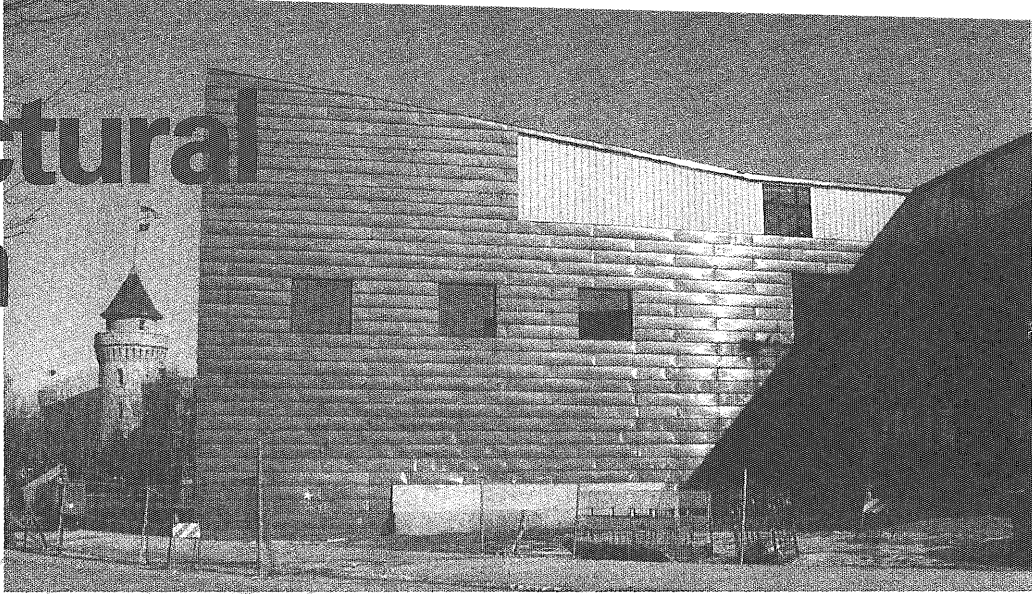


Figure 3. Optical image recording technique used to image the cerebellum of rodents with the pH sensitive dye Neutral Red. Photons emitted from the Mercury/Xenon lamp are filtered with an excitation filter, reflected onto the cerebellum with a dichroic mirror where photons of a different wavelength are emitted from the tissue's surface. These photons with a different wavelength leave the cerebellum surface where they pass through the dichroic mirror and emission filter before entering the lens of the CCD camera, where the images are recorded.

Architectural addition



With time, the shiny copper facade will darken to a bronze-red. It will then turn a light patina green—allowing it to blend with the planned gardens and perhaps the rest of the campus.

BY DANIEL THOMAS

"I don't know a thing about architecture, but your building is just too smooth."

Steven Holl remembers hearing these words from a member of the Board of Regents in 1998. With them his design for the architecture building addition was rejected. "It should be more like Pillsbury Hall over there," he was told.

Holl, *Time* magazine's 2001 Architect of the Year, had just presented a concrete block-clad design. After thirteen years living with the project, he thought it was dead. He was already stretching the budget, and remembers thinking, "What could be cheaper than concrete block?"

Holl kept at it, though, and switched to the copper sheets with horizontal standing seams that recently began to appear on the building. This design not only satisfied the board, but also allowed for a lighter structure that cost \$250,000 less than the previous design.

A Driving Vision

When he graduated from university in 1971, Holl says he was ardently idealistic, and didn't want to have anything to do with the mundane details of

building. And although he soon saw the necessity of architecture's practical side, he never lost his passion for visionary architecture driven by a simple, central idea.

Beginning his design of a dormitory complex currently being built at Massachusetts Institute of Technology, Holl handed out an organic sponge to each of his designers, telling them, "Study that—we've got to make a building like this."

The driving idea for the College of Architecture and Landscape Architecture addition was the integration of the two schools—architecture and landscape architecture. According to CALA dean Thomas Fisher, the college was already working towards this idea in its philosophy and academics.

Holl's original 1988 design was for a large circular addition joined to the current square building to form an 8-shape. But it took ten years for the new addition and current building renovation to rise high enough on the University's priority list to receive most of the \$26.4 million request. By that time, the budgeted money wasn't enough to pay for the 110,000-square foot addition that was originally planned.

So Holl drew up a new design, changing the inward-looking circle into an outward-looking cruciform shape. Holl said his brother called the design "the project that was a zero—and became a plus."

The four arms of the building interlace with the four gardens between

them and symbolize the integration of two schools, Fisher says. Although the building used up the project funds, he says the college is still fundraising to pay for the gardens. The planned gardens each reflect one of the four seasons, and come together at the center of the cruciform, where the lobby lies between large picture windows.

"When you're in the building you look out into the landscape and when you're in the landscape, you can look right through the building," Fisher explains.

Fisher adds that the emphasis on integrating landscape and building will become even more apparent as the trees in the gardens grow and the building's copper exterior oxidizes to a patina green, a process that takes about a decade.

While it may eventually merge into its gardens, the building is not designed to meekly blend in to the campus. Rather, Holl intends the three projecting end walls to terminate views along Church Street and Pillsbury Drive. The building contrasts significantly with its neighbors on Pillsbury Drive, falling more in line with the appearance of the Weisman Art Gallery and McNamara Alumni building. When asked about the campus' two other metal-plated buildings, Holl merely said, "I admire the courage of the University to hire such people."

The location and unconventional design have already elicited strong opinions, and Fisher admits that, with-

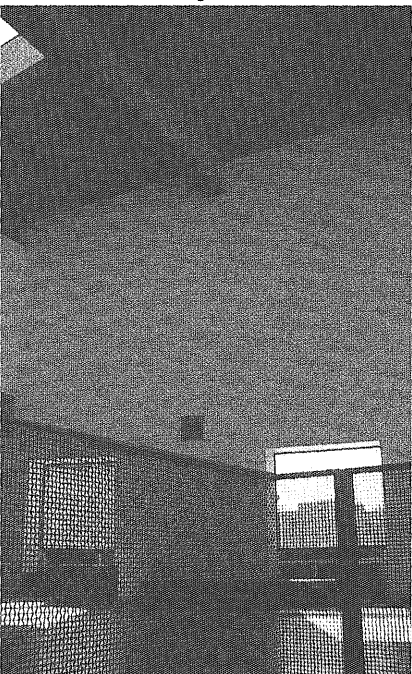
out its gardens, the new building "looks very severe." In an October 1999 article, *Minnesota Daily* columnist Dan Maruska said the addition conformed to fleeting architectural fashion and clashed with the functional, subtle beauty of the original 1958 building.

The Engineering Inside

The building's unconventional engineering goes deeper than the 55-mm copper shell. Between two layers of gypsum, the 3-foot thick exterior walls contain heating pipes, HVAC ducts, structural members and rigid insulation. Together with Holl, Guy Nordenson, the structural engineer, conceived of the thick walls as a cost-saving measure, Fisher said. According to Jay Biedny, project manager for Ellerbe Becket, this addition was less expensive for its size than most of Holl's designs.

Since the narrow arms of the plan allow the ductwork to feed the whole building from the sides, there is no need for a hung ceiling. This allows the possibility of redesigning floor-space; the walls can be moved without worrying about ductwork and wiring in the ceiling. The thick walls also make for some nice window seats.

Entering through the main west doorway, this design makes the building's skeleton immediately evident. The bare concrete planks over the cen-



tral reception area reveal another innovation in the spine. The lobby also boasts of it by allowing a clear view through the whole structure.

In order to eliminate the need for structural shear walls, the planks were suspended on scaffolding while the concrete floors and pillars were poured on top of and around them. With another thin finish pour on top and the smooth pre-cast planking below, the combined concrete floor takes the shear loads and has the smooth texture Holl envisioned. These 13-inch concrete floors work together with a 15-ton truss to support the library above and allow the open lobby space to span both floors.

Leaving the ground level offices and auditorium, the second-story library gives off a bright welcome with a two-story wall of glowing glass flooding the reading room and stacks with white light. According to Steven Weeks, member of the Building Space Planning Committee, this was the largest such channel glazing installation in the country when it was designed. Two 10-inch wide glass U-channels trap encase a layer of translucent white insulation and give a combined U-value of 0.6.

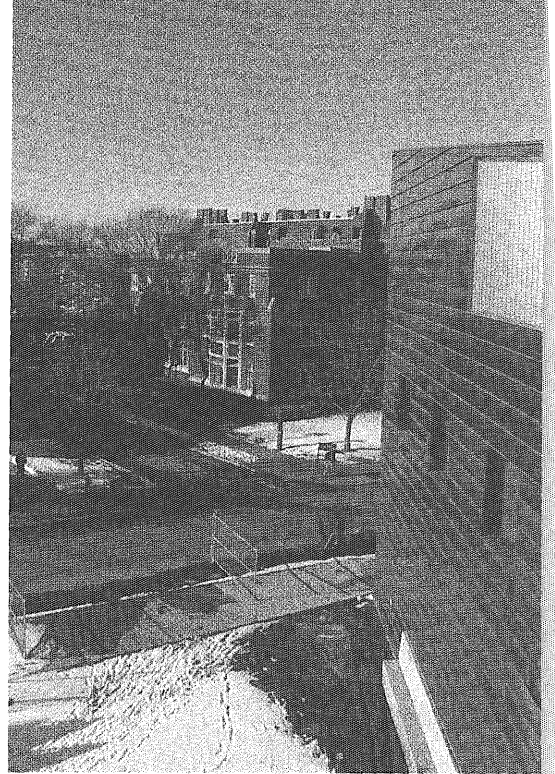
The channel glazing windows also surround the top level studio space for third-year graduate students. It is even brighter than the library, with what Holl calls a "silky glow" almost straining the eye in full sun. The studio spreads out on three wings and cannot be subdivided because of fire code regulations. Still, as Fisher notes, it is a great room with wide window benches and the best view around.

Moving in

Architecture student Robin O'Brien is eager to move in and see what she says has been kept secret as a "big mystery." Fellow Masters degree student Finn Boulding looks forward to sharing the addition's studio space with landscape architecture students.

"They're right there, but we never see them," Boulding says, motioning across the original building's central

The structure's beams and planks are in full view above the sunlit library atrium.



The top floor graduate student studio commands some of the best views on campus.

courtyard to the strangers who will soon be neighbors.

Architecture major Tiegen Leonard is looking forward to using the large library. The closed stacks and tiny temporary library in the Architecture building basement were part of the challenge to overcome for the college, which has been spread all around campus. Though many problems were solved when the renovations on the original building were completed at the end of last semester, Fisher says that, even with the new addition, the college has already run out of space.

The renovated and new buildings are fully air-conditioned. Since more classes will now be held during the summer term, the college will move towards a trimester system. Fisher hopes to move into the building in May.

So, naysayers who don't like the building's exterior will just have to learn to live with it. Holl has faced his critics down before. When people complained about his ear-shaped sinks at the Helsinki Museum of Modern Art, he simply responded, "But you've never seen a sink like that before." ●

FOR MORE INFORMATION see
www.cala.umn.edu/BuildingCALA.html
www.stevenholl.com

THE SEARCH FOR NEUTRINOS

Detecting these tiny, elusive particles requires big machines and a big effort

BY MICHELLE WALTER

How do you learn about something very small and nearly impossible to catch? Physicists studying neutrinos—elusive, subatomic particles that barely interact with anything—face just this problem. Currently a 5600 ton neutrino detector being assembled here in Minnesota.

What makes something so small worth all the effort? Understanding the neutrino may allow physicists to unlock the mysteries of the basic building blocks of the universe. Neutrinos, tiny neutral particles, are produced in nuclear reactions, such as those in stars and man-made nuclear processes. A million billion neutrinos pass through you every second, but they don't interact with you.

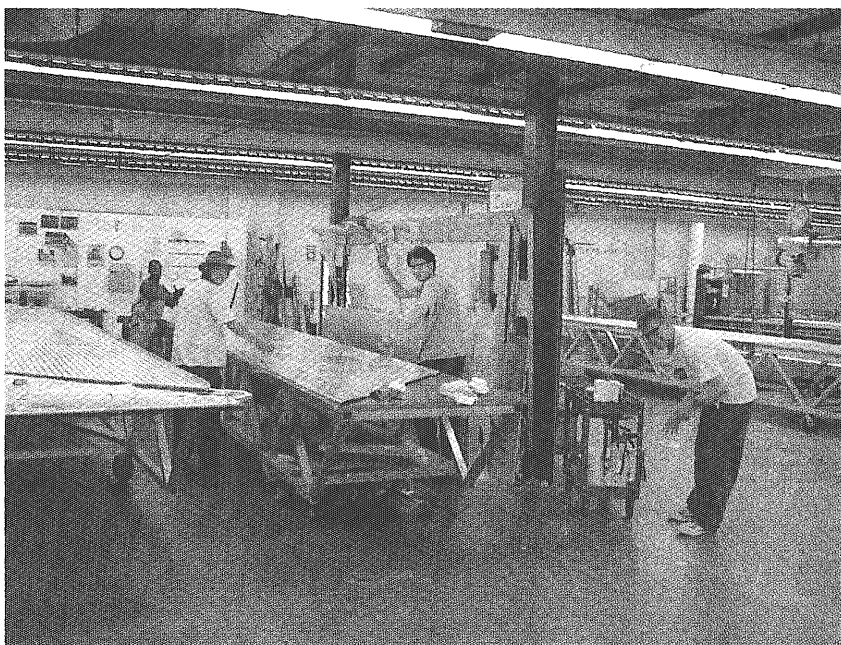
Billions of stars with billions of beta decays occurring every second produce most of the universe's neutrinos. These neutrinos shoot off in all directions with very high energy and little mass. Until recently, neutrinos were thought to have no mass. If they do—and if there are more than 100 neutrinos in every cubic centimeter of the universe—neutrinos may account for most of the mass in the universe.

The history of the neutrino problem

Wolfgang Pauli first proposed the neutrino in 1930. He noted that in beta decay (a neutron decaying into a proton and electron) the resultant energy doesn't add up to the initial energy. He figured that an additional particle might be produced in this reaction, but he didn't think it would ever be found. Enrico Fermi named this particle the neutrino and invented the theory of weak interactions to explain why it sel-

each neutrino flavor of neutrino in the universe, but the numbers didn't add up. For example, the sun produced less than half of electron neutrinos expected. In addition, the ratio of muon neutrinos to electron neutrinos resulting from the interaction of cosmic rays with atoms in the upper atmosphere was predicted to be two, but experiments showed this ratio was closer to one. From this, scientists predicted that the flavor of a neutrino could change

as it traveled through space, oscillating from one type to another. But in order to change flavors, the neutrinos had to have mass. Physicists realized that precisely determining the mass of a neutrino as well as the quantity of neutrinos might help them figure out the mass of the universe and account for the "dark matter" thought to make up most of the cosmos.



Students glue aluminum to the top of a module for the MINOS detector.

dom interacts with matter. Although rare, the interactions of neutrinos with matter can be observed, and the first observation came in 1956 by Reines and Cowan.

Over the years scientists discovered three types, or "flavors," of neutrinos: electron, tau, and muon. Experiments determined the output and number of

and to determine the neutrino masses, physicists must find a way to detect neutrinos—a difficult proposition considering how infrequently they interact with matter. Unlike many particles that easily react with matter, neutrinos can travel through the earth without being stopped. Therefore neutrino detectors are placed deep underground,

Catching neutrinos

To better understand neutrino oscillations

so that other types of particles are blocked by the earth.

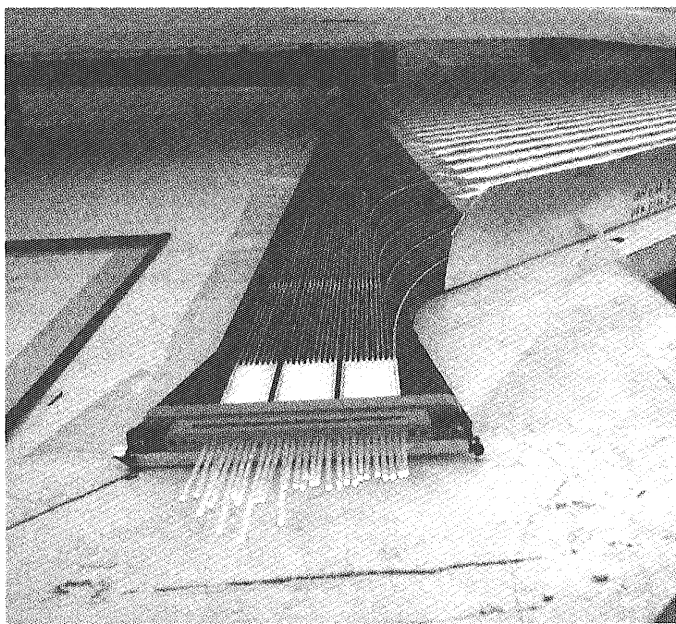
Current detectors employ two main methods for catching neutrino events. Both require a large mass so there is more chance of a traveling neutrino interacting with a particle.

Some detectors consist very large tanks of liquid placed deep underground. This liquid produces a noticeable discharge—a flash of light—when hit with a neutrino.

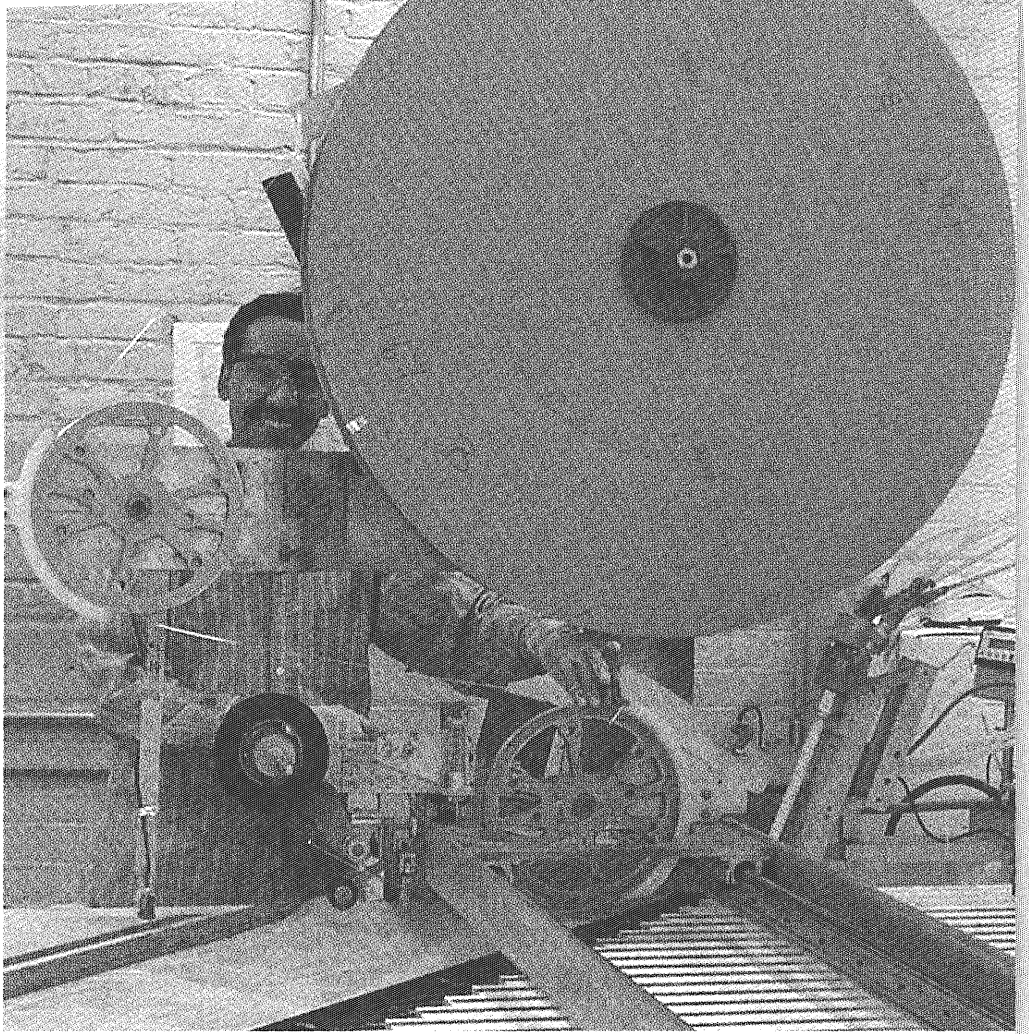
Others use a very dense material coupled with a detecting device. If the detectors contain enough liquid or solid material, a tiny fraction of the neutrinos will interact with it.

Planning the MINOS experiment

A promising new detector is currently being built for the Main Injector Neutrino Oscillation Search (MINOS) at



The plastic endpiece that guides all of the fibers into a photo tube.



MINOS technician Yebio Semere works at the threading machine.

the Soudan Underground Research Lab, a former iron mine in northern Minnesota.

The MINOS detector will be more effective than the lab's current detector, Soudan 2, which was originally constructed to search for nucleon decay. Like many other detectors, the Soudan 2 is examining muon and electron neutrinos in the upper atmosphere. But scientists cannot control the composition of neutrinos coming from the sun or the universe in general.

The MINOS detector, howev-

er, will focus on a beam of neutrinos being shot at it from Fermilab in Chicago, some 735 km away. In this controlled environment, physicists will know the type of neutrinos shot toward the detector.

MINOS was designed and built in part by University faculty and students.

"Following the submission of several competing proposals and a lot of politics involving several independent reviews, the experiment proposed for Soudan was approved and the Department of Energy granted over \$100 million to the experiment," says physics professor Keith Ruddick. "There are over 200 physicists from many institutions and more than 5 countries involved. The University's experimental high-energy group is the largest of the university groups."

Determining how to detect and record each neutrino interaction posed a significant challenge, says Ruddick. "Only about one trillionth of the neutrinos that come through the 5,600 ton



Mark Johnson checks a finished module for light-leaks. Any normal light that enters a module will effectively prevent detection of neutrinos.

detector will interact in it, producing a few thousand interactions per year. When they interact, muon neutrinos produce highly penetrating muons that are easily recognized, while if they have turned into electron or tau neutrinos, they produce electrons or taus that also have characteristic tracks in the detector."

The detector design alternates one inch-thick iron plates with a detecting layer. This layer, made of specially doped plastic developed after two years of University research, is called a scintillator.

When a neutrino hits a particle of matter in the iron plates, a charged secondary particle can fly off (a muon in the case of a muon neutrino). If this happens, the particle will travel into the scintillator and excite the particles in it that emit ultraviolet light. Normally the light would be absorbed very quickly, but the plastic is doped with a wavelength-shifter, or fluor (like fluorescence) that adsorbs the UV light and shifts it down to blue light that bounces around, aided by a white re-

flective coating that covers every piece of plastic.

The light then travels into a special fiber that shifts it from blue light to green. (This fiber only changes light of wavelengths less than that of green light; if you shined red or yellow or orange light on it, it would not emit any light because the wavelengths are too long.) About five percent of the green light is transmitted through the fiber

into sixteen-pixel phototubes in a multiplexing box, or "mux box." The mux boxes are hooked up to a computer system that analyzes the data when a neutrino is detected.

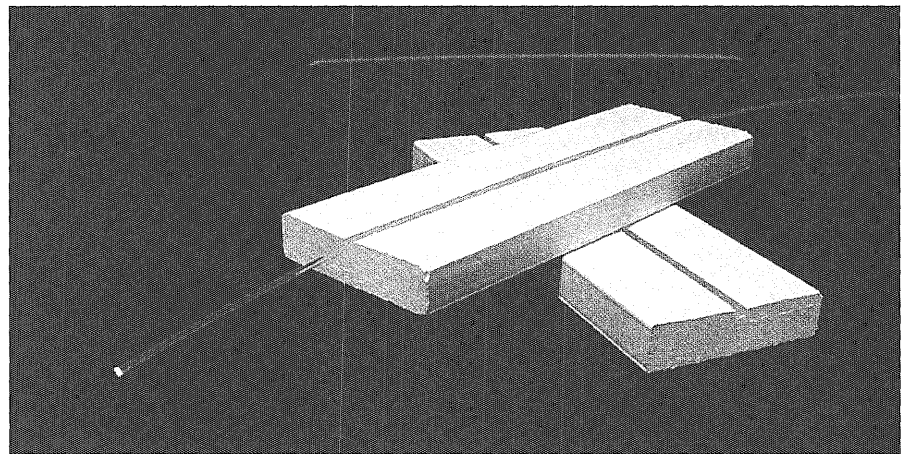
The detector itself is an eight-meter wide octagon and 31 meters long. Each active layer of the scintillator is divided into eight modules. (The module layers must be cut into even smaller pieces because everything must fit in the 1880s-era elevator that that goes down the mine-shaft.)

"When complete this will be the largest amount of plastic scintillator ever assembled—around five football fields," says Ruddick.

Building a Behemoth

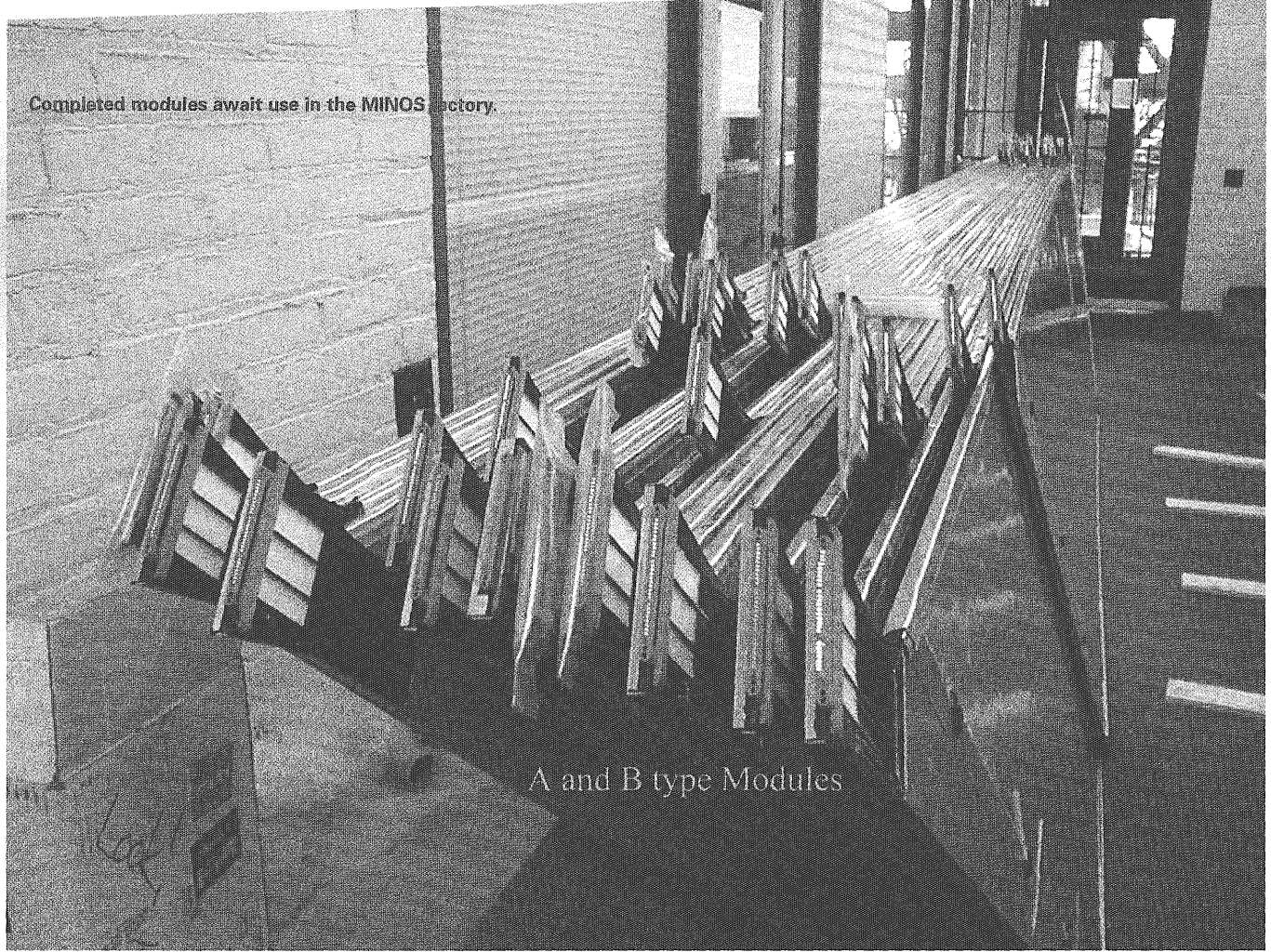
Half of the MINOS detector is being built at a temporary specially designed factory at the Minnesota Geological Survey building on University Avenue, about a half mile from campus. The other half is being constructed at the California Institute of Technology.

The first step in manufacturing one of the MINOS modules is to cut to size and bend the edges of an aluminum sheet. This serves as the base of a box to hold the plastic scintillators for one



Small pieces of plastic and wavelength-shifting fibers are used in the active scintillator.

Completed modules await use in the MINOS factory.



A and B type Modules

module. Then the 24-foot long plastic strips are cut to size and laid in the box. These strips are grooved on top for the fiber optics and have a white covering. The strips are glued together, covered in a plastic sheet, and the air is sucked out of them to allow the epoxy to set, leaving the plastic strips tightly glued to the aluminum.

After the glue has dried, the module is wheeled over to the threader, a cleverly-designed machine that runs on a track up and down the length of a module. The threader lays a green fiber in the groove of each plastic strip, adds glue, and then tapes the fiber down with aluminized mylar tape. The fibers at the end of the module are placed into light manifolds that guide them to an optical connector so they don't get shaken or damaged. These manifolds and many other plastic parts were designed by mechanical engineering professor Thomas Chase, who has worked closely with the physicists in the design of this project.

The third step in the production of the modules is to cut out of aluminum

a top for the box. This "lid" is then glued on with epoxy, and then the box is further sealed using a technique designed by Chase. A hand-run device called a crimper runs up each edge of the aluminum and flattens and bends the edges neatly and consistently to facilitate handling and keep light out. Then the air is sucked out of the module again so the glue will dry. It takes 18 man-hours to produce one completed module.

Finally, every module is tested to make sure the fibers weren't stressed to the point of being unable to transmit light. Testing is done by a strong radioactive source, a small Cesium-137 gamma-source housed in a four-inch square lead container that walks up and down the module. Each wavelength-shifting fiber is connected to its own phototube for testing. This process maps the light output of the module. A module is rejected if it has more than two damaged fibers. The production goal was to have less than one percent rejection due to fiber damage. Of the more than 1,000 modules the Universi-

ty has made, only six have been rejected.

The Minnesota MINOS factory has been in production for more than a year and is ahead of schedule. They have made over 1,000 modules and are scheduled to finish production in January 2003. Also at this time, about 100 of the 489 layers of iron and scintillators have been installed in the mine.

Although researchers hoped to have MINOS fully assembled and collecting data by 2003, operation of the neutrino beam at Fermilab has been delayed until 2005. In the mean time, the detector will study atmospheric neutrinos and other products of the cosmic rays. If all goes according to plan, MINOS will soon propel University researchers to the forefront of neutrino research, aiding them in the search for more a better understanding of the building blocks of the universe. ●

FOR MORE INFORMATION see
www.hep.umn.edu/minos/images/minos-minnesota.html
www.numi.fnal.gov

Simply the best

UMD engineering students win ASME International Engineering Design Contest

BY CHRISTEN OPSAL

The team of University of Minnesota-Duluth industrial engineering students who took first place in the American Society of Mechanical Engineers (ASME) 2001 International Student Design Contest may owe their win to their strict adherence to a fundamental principle of innovation: Keep it simple, stupid. Then-seniors Joseph Higgins and Michael Anderson triumphed in the face of a complicated problem with extensive contest specifications and competitors with sophisticated-looking devices because they persisted in their quest to solve the problem in the simplest way they could find.

The Challenge

The problem was anything but simple. Student members of ASME from around the world were asked to “design and demonstrate a well-tested, cost-effective, and reliable prototype apparatus which would allow a quadriplegic (someone with total or near total paralysis from the shoulders down) to cast accurately a fishing lure using a specified rod and reel.”

According to the contest statement, while quadriplegics have access to sip-and-puff technology for wheelchairs and other everyday assistive devices, “a definite need still exists for outdoor sports equipment which integrates sip-



This year's challenge was to develop an apparatus to assist quadriplegics in fishing.

and-puff technology for control of the device.” The problem asked ASME student members “to demonstrate the potential of mechanical and electronic technologies to meet the recreational needs of a part of the disabled population.”

In recent years, others have attempted to solve this problem. A fishing rod and reel for people with disabilities is available, but it still needs to be cast by someone with full use of their arms. Several other devices are available for people who have the use of one arm. But a rod-and-reel system that allows a quadriplegic to cast a fishing line and reel using only the mouth remained undeveloped until the ASME design contest organizers decided to make a contest out of it.

The Contest Rules

As though the problem itself wasn't enough of a challenge, ASME added some further criteria to define how it was to be solved.

The “specified rod and reel” turned out to be the “Snoopy Catch' Em Kit,” available at Wal-Mart stores. Higgins notes that for the UM-D team this one rule was the most difficult to follow. He says the problem would have been easier to solve if the use of a more sophisticated rod and reel had been permitted. But that also may have exceeded the team's budget for contest supplies. They went through six Snoopy rod-

and-reels!

The original problem required contestants to use sip-and-puff technology to control of the fishing rod and reel, but contest organizers later modified this rule because sip-and-puff sensors are expensive. In adaptive devices, sip-and-puff sensors trip switches that open and close electrical circuits, powering the device. Contest organizers decided that the fishing rod-and-reels entered in the contest could begin with the switches—in effect, rendering the sip-and-puff sensors “implied.”

The switches were to be located on a control box connected to the rod and reel by an electrical cable. The control box could not contain any batteries or other power sources. The device itself, however, could be powered by no more than five electromagnetic devices including motors or solenoids, (magnetic devices that charge a coil to drive a piston upwards). To encourage of use of “inexpensive and robust off-the-shelf technology,” contest organizers recommended a motor available at Radio Shack.

Excluding the rod and reel, the entire device had to fit into a Popular Mechanics 16-inch toolbox prior to its assembly. Higgins says that by the final competition, they could have fit three of their devices in the box.

At the contests, team members had to fasten their device to a pole mounted on a mock “dock”—a square plat-

form of plywood. Then, one team member, seated on the dock, had to cast the device using only the control box. Each team got two tries at three targets marked on the floor in front of the dock. The line connected to the lure had to be fully retrieved by the reel after each cast. The "lure," a 40mm x 60mm cloth bag filled with 20g of sand, was provided for each team. The score was based on the distance between the lure and the target. The team with the lowest combined score would be declared the winner.

The Winning Device

As Higgins and Anderson experimented with different ways to solve the problem, they kept trying to translate their complicated ideas in simple terms. According to Higgins, "There's got to be an easier way" became their mantra. "Some ideas just didn't make sense."

They finally designed a device powered by a solenoid and directed with three switches. It took four steps to cast and retrieve the device. (See photo.) Pressing button #1 (closing circuit #1) engages the solenoid. Pressing button

#2 (closing circuit #2) brings the rod back. Releasing button #1 (opening circuit #1) releases the solenoid, sending the rod forward in a casting motion. Once a fish has been caught, pressing button #3 (closing circuit #3) reels it in.

The team's device actually went through two incarnations. The first clunky, inefficient version was demonstrated at the seven-state regional competition held in March 2001. Higgins says it resembled "a spider web of duct-taped wires." The streamlined model that Higgins and Anderson brought with them to the finals in New York City last November was downright primitive in contrast to some of the other 12 devices. One team's device used a digital camera to "sight" the targets. A team of students from India—the only international team to make it to finals—attached a telescope to their device for the same purpose. Other devices cast "underhand" or to the side. One even utilized custom-made gears.

Remarkably, all the devices that made it to finals worked well. But the two guys from Duluth still topped

them all with a score of 218. The runner-up, Old Dominion University of Virginia, had 242. The last place team, New Mexico State University, scored a whopping 1318.

What's Next?

Higgins and Anderson hope to eventually market their device. In the meantime, they will replace the Snoopy rod-and-reel and continue to simplify. The device still has to be adapted for use by quadriplegics or others with limited use of their limbs through "sip-and-puff" sensors, head paddles, or a voice-activated computer program. And there's still the problem of how to get the fish off the hook. Maybe ASME will make that the next design problem. ●

FOR MORE INFORMATION see www.asme.org/students/Competitions/designcontest/2001/Y2001index.html www.tecsol.com.au/SwitchSuckBlow.htm Joe Higgins's personal website, which includes an animation of the device: www.geocities.com/higginsj3

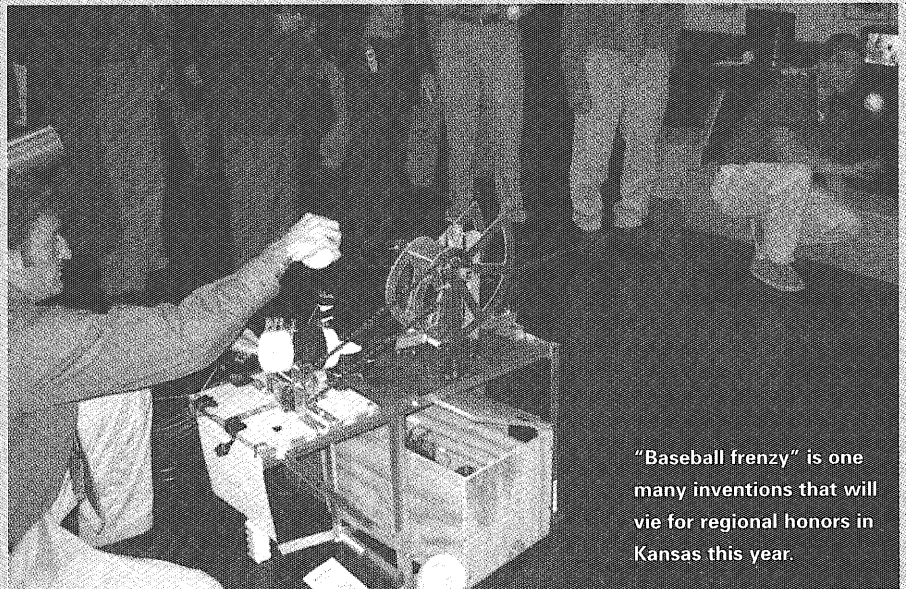
ASME Student Design Contest

The ASME Student Design Contest is held in conjunction with the annual ASME International Mechanical Engineering Congress & Exposition, bringing engineers and scientists together to discuss and demonstrate advanced technology.

The 125,000-member ASME is a worldwide engineering society focused on technical, educational and research issues. ASME conducts one of the world's largest technical publishing operations, holds some 30 technical conferences and 200 professional development courses each year, and sets many industrial and manufacturing standards.

Student design contests challenge engineering students to design and build functional and dynamic devices that perform tasks within certain constraints.

A group of Twin Cities campus mechanical engineering students developed a "Baseball Frenzy" machine for this year's



"Baseball frenzy" is one many inventions that will vie for regional honors in Kansas this year.

ASME Student Design Contest as an offshoot of a design class. This team's project is slated to be on display at a regional contest April 6-8 at Wichita State University in Wichita, Kansas. ●

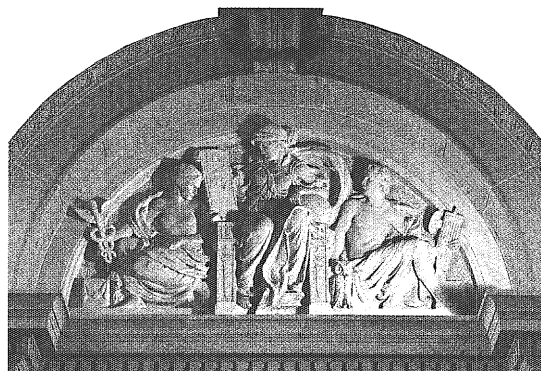
FOR MORE INFORMATION see www.asme.org

Walter Library

What's old is new again

BY TIM FISTER

Two years ago, Walter Library's lofty reading rooms may have seemed outdated. Intricately carved marble covered with nearly 80 years worth of grime and second-hand smoke contrasted with the steely-clean, angular surfaces of recent construction. In response to structural and technological deficiencies, the University closed the library for a two-year, \$63 million renovation. Walter's reopening this semester reveals a state-of-the-art facility outfitted with new computers and wireless Internet access. The dilapidated interior has been painstakingly restored to its former glory. Spotless marble pillars and floors reflect the saturated colors and complex moldings on the ceiling and walls. Greek figures representing the arts and sciences overlooking the reading room still seem ancient, yet no longer obsolete. The same can be said for the library, 78 years after its cornerstone was laid. Remarkably, the *Technolog* predates Walter Library. Paul Nystrom's December 1922 article describes the original project—the focus of efforts to make the University a world-class institution—in glowing terms. In recognition of the historical significance of Walter Library in the wake of its restoration, we run excerpts of Nystrom's article.



Marble lunettes in the Great Hall are representative of the attention given to Walter Library's intricate details.

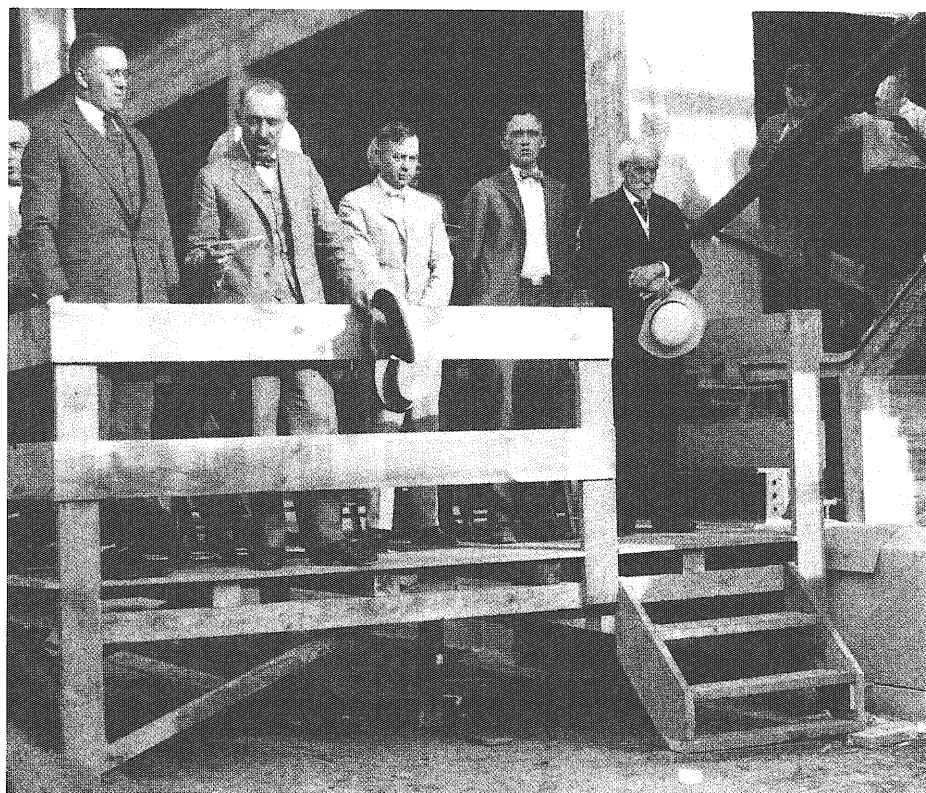
The New University Library

Minnesota's newest building to be five stories high, embodies latest library designs

BY PAUL E. NYSTROM

For some time departmental expansion has marked the progress of the University. This is evident in the case of the new School of Music, and also in the case of the School of Mines. Of late, the interests of the University as a whole have predominated, and while we are awaiting the erection of the auditorium and stadium, the skeleton of the new library building has come into existence.

A congested library will soon be unknown to Minnesota students. It has long been desirable to provide better library facilities so that a greater number of undergraduate students as well as advanced research scholars might be accommodated. In short, a library

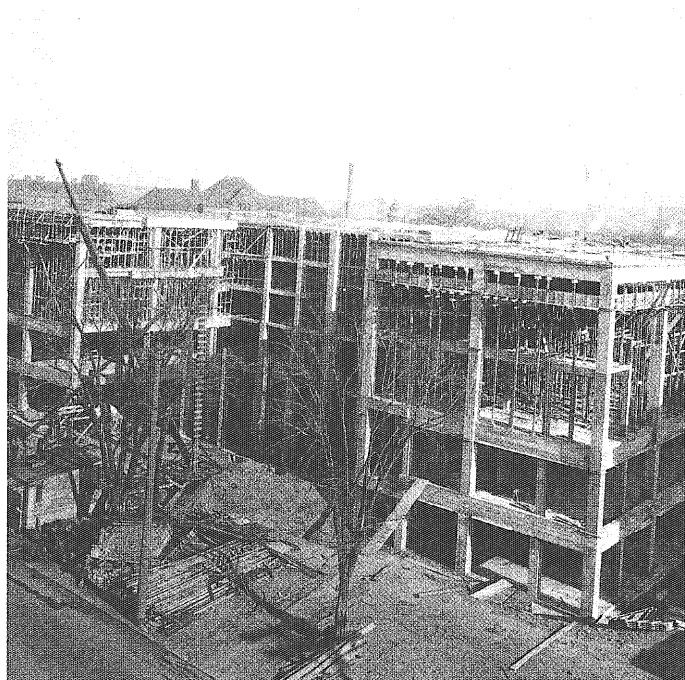
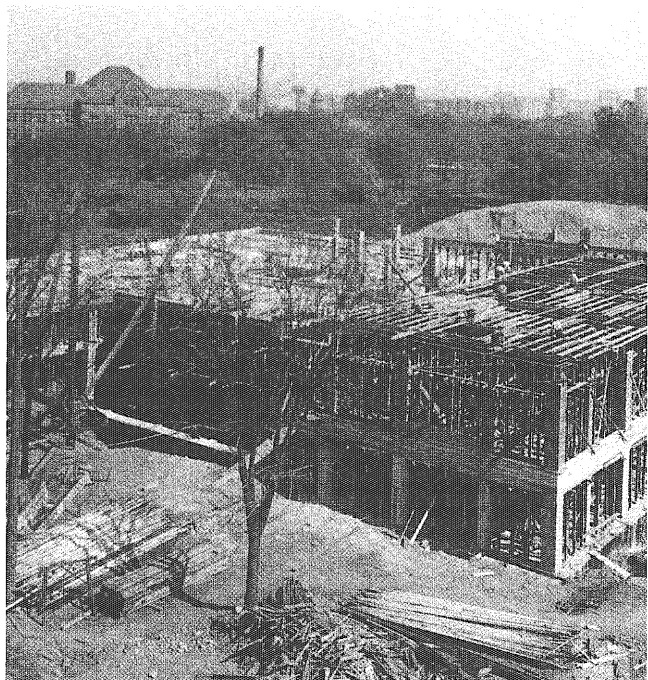


1924: The cornerstone ceremony was attended by some of the library's champions - third from left, then-University president Coffman and fifth from left, former president Folwell.

building for the library, free from administrative and executive offices having no direct hand in its supervision, has been the ultimate aim of those who have been working out the intricate problem of providing for the present and also for the anticipated future

requirements of a Greater Minnesota.

Before long we will view the consummation of endless recommendations, months of study and planning, in the form of a building which will give the capacity and equipment, and distinctive in its appointments.



Construction of the library accelerated in the fall of 1922. Between October (left) and December (right), several floors were added.



Although clothing styles may have changed a bit since the 1920's, one thing remains constant: the need for a library to accommodate clusters of studying IT students.

Preparation of the Site

The building, which is now being erected, covers a ground area of 205 feet by 182 feet just to the north of the present Chemistry building. It will contain a basement and five floors with a total cubage of 3,000,000 cubic feet.

Before construction could commence, the Northern Pacific R. R. shifted their tracks six feet to the north and covered them in order that the north portion of the building might not be delayed in construction.

The huge earth pile east of the site represents about 20,000 cubic yards of earth which was excavated for the foundations. It is peculiarly interesting

that a great part of this is going into the actual construction in the form of aggregate for the concrete.

Structure to Be Five Stories High

The features of the basement floor will be the library school and the map rooms. The remaining space will be occupied by locker rooms, toilet rooms, and equipment rooms.

The administrative offices of the library will be located on the first floor. Considerable space will be devoted to the catalogue rooms, reserve book reading room and delivery desk. A Treasure Room for the exhibition of valuable articles will be one of the

points of interest on this floor. Very appropriate, indeed, is the standard library, which is to be equipped similar to a private library containing a representative collection of such books as one might find under those conditions.

Characteristic of a library, the reading rooms are on the second floor. These are two stories in height. The largest reading room is across the front of the building and is designed to seat 350 students. The periodical room will have a capacity of 250 persons. A smaller general reading room will accommodate 250 people. These elements are grouped around a central delivery space at the head of the main

stairway.

Seminar rooms occupy the major part of the fourth floor. They are of various sizes, it being the intention to accommodate seminar libraries of a great many kinds. Certain of these rooms are to be equipped with lanterns for lecture purposes.

On the fifth floor, which has but half the area of the lower floors, are the private study rooms, and a book bindery spaced around a central court.

It is estimated that about 1,800 students can be seated in the various rooms at one time. This is approximately six times the capacity of the present library, and is greater than that of any educational institution in the country.

Highest Stack Room in the Country

On the west side of the building, running the full height of the structure, is the stack room. It will comprise twelve stories of stacks, and will have the distinction of being the highest stack room in the country. On the west side of each stack story are a series of cubicles or carrels for research scholars.

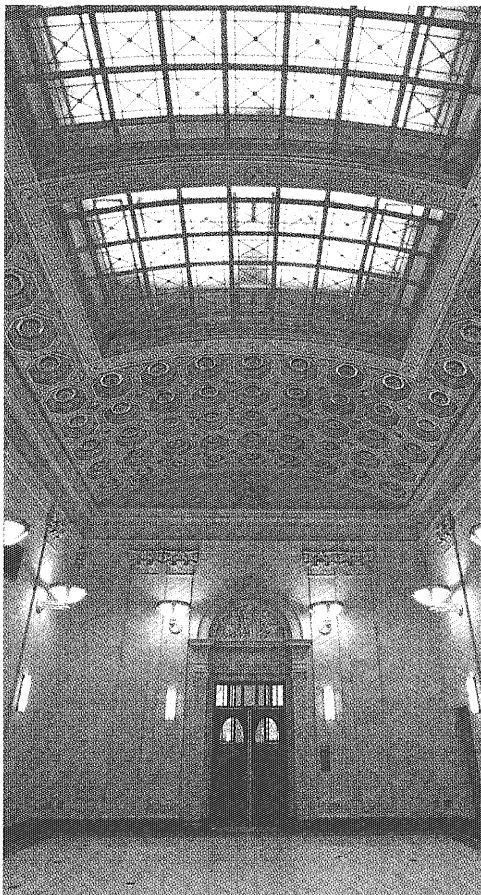
The book capacity of the stacks as designed at present will be about 1,250,000 volumes. Provisions are made for expansion so that approximately 1,750,000 may be accommodated.

New Departure in Construction

The skeleton frame of the building is of reinforced concrete. This is a departure from the typical construction used in the buildings on the new campus in which the walls are carried up to support the floors, columns being used only in the interior. The floors are of steel tile with concrete joints.

Occupying a position equal to that of the Chemistry building with respect to the Mall of the Greater Campus Plan, it is obvious that the exteriors should harmonize. In general mass, the buildings will be quite similar. In detail, the library will have characteristic refinements. Two-story windows, with steel frames and sash, will express the reading rooms. Modification of the cornice design will add to the interest of the exterior.

The interior of the building



One can easily understand Nystrom's enthusiasm at the prospect of the library simply by walking through Walter's towering halls.

throughout will be finished with simple and dignified decorations and substantial furnishings. The public rooms are to be finished in marble with ornamental plaster ceilings. The floors will all be of marble and tile. The walls of

the main reading rooms are to be faced with a stone quarried at Winona resembling Italian Travertine. Linotile floors are used to aid in sound deadening.

Mechanical equipment plays an important part in the development of the design. A recirculating system of ventilation arranged to operate in units is to be installed. This will allow the various portions of the building to be ventilated independently of each other.

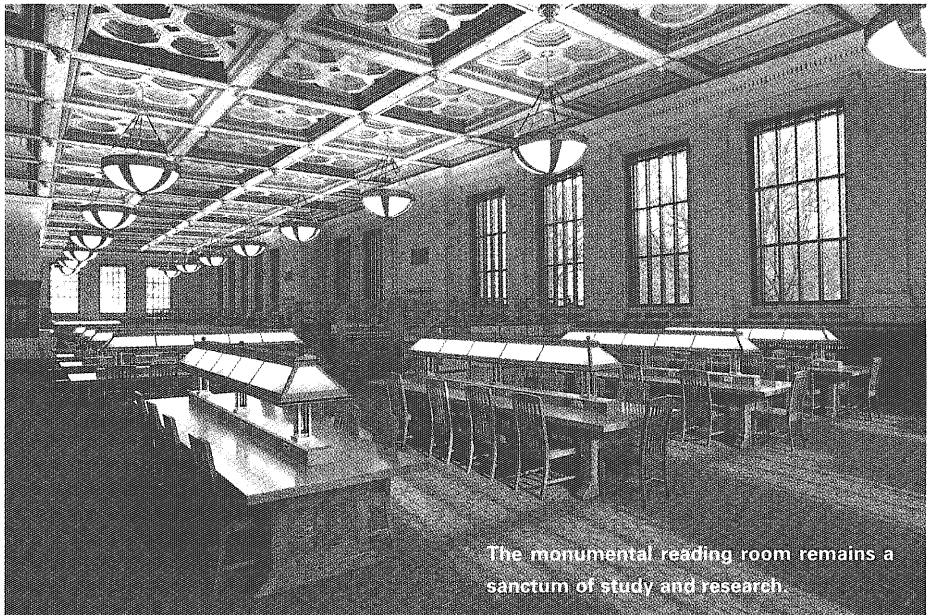
Building Will Cost Almost a Million and a Half

To date, contracts have been awarded to the amount of \$1,350,000.00 and \$100,000.00 is to be expended in equipping the building and all its departments.

It is anticipated that the building will be completed and ready for use about September 1, 1923.

It is apparent that no thought has been spared and that no detail has been overlooked to make the new library building so complete and so modern in its entirety, that it will not be surpassed by any institution in the country in its facility for effectively serving the student body. ●

FOR MORE INFORMATION see <http://www.it.umn.edu/walter>



The monumental reading room remains a sanctum of study and research.

The Bakken Museum

Demonstrating the multi-dimensionality of science

BY ERIC TSAI

Belying its elegant Tudor exterior, the Bakken Library and Museum is a lively treasure trove of information and history dedicated to the role of electricity and magnetism in life.

Like its architecture, the unique fusion of science, history and art makes the Bakken far from your typical science museum. Founded in 1975 by University of Minnesota alumnus and Medtronic co-founder Earl Bakken, the modestly sized museum takes a broad approach in promoting the study of electricity and magnetism, emphasizing not only its applications, but also its history, cultural context, and societal contributions.

The diversity of the Bakken's hands-on exhibits is evident at first glance. Visitors can create a 60,000 volt spark by winding a Wimshurst electrostatic generator or listen as the electrical impulses of eels are converted into sound in an aquarium. Mirroring the pervasive influence of electricity and magnetism in our world, the Bakken's exhibits cover the role of electricity in nature, a historical overview of magnetism and its diagnostic and therapeutic applications, a celebration of the battery, and even an interactive collection of 18th-century electrostatic toys.

A prime focus of the Bakken is to bring science to life with direct visitor interaction, says Kathleen Klehr, manager of marketing, public relations, and events for the museum.

"We not only want people to realize how approachable science can be, we want them to leave the Bakken believing that they can do science," she says. A few examples include a geomagnet-



A group of young students gets hands-on experience in the Earl Bakken Science Program.

ic earth with a magnetic field that can be turned on and off and an interactive human battery in which visitors join cathode and anode with their own two hands. A meter even displays how many milliamps of current are flowing through their body.

Instead of dazzling visitors with the latest in modern technology, the Bakken immerses them in the drama of the past, using historical narrative to add color to the study of electricity and magnetism. To get visitors interested in 18th-century scientists like Michael Faraday and Hans Christian Oersted, the Bakken illustrates the human element that permeates both past and present. Instead of looking at them as dusty relics, the Bakken portrays historical scientists as humans fused with the same curiosity about our natural world that people have today.

"Science hasn't changed as much as you think," notes David Rhees, the museum's executive director. "The science of today is still shaped by the same aspirations, scientific approach and social conditions as science throughout history."

The Bakken unites science and history to reveal how the historical development of science can serve as a mechanism for studying history in a broader context. "When we look at science's history, we not only see the discoveries but the culture and society of that time," says Klehr. "Science can allow visitors to make a personal connection with history."

Driven by the belief that science and the arts are linked by the common thread of creativity, the Bakken also houses a vibrant 1937 French mural, *La Féé Electricité*, which colorfully depicts the "harnessing of electrical ener-

gy" by illustrating the historical development of electrical science. Moving chronologically from right to left, the mural portrays more than 50 of the most influential electrical scientists gathering together in a scientific forum of epic dimensions (for example, Marie and Pierre Curie can be seen chatting alongside a pondering Thomas Edison). Above the scientists, a rapidly changing landscape evolves from subsistence farms, to coal plants, power lines and locomotives, demonstrating how scientific invention has transformed our modern world.

The Bakken's integration of science, history, arts, and active visitor participation is embodied by its theremin display. The theremin, one of the world's first electric musical instruments, was created by Leon Vistor Theremin in 1917. The instrument produces a wide range of pitches and volumes by detecting electrical interference, triggered by waving one's hands above the theremin. Visitors can read about the history of the peculiar device, see videos of a professional theremin performance, receive a theremin lesson, and even try their own hand at the instrument—often to the chagrin of other museum visitors.

Science and Society

Although The Bakken predominantly focuses on the ways electricity and magnetism have benefited society, it isn't afraid to explore both sides of society's relationship with science. The Frankenstein exhibit is a prime example.

Staged in a recreation of Frankenstein's laboratory, the exhibit successfully captures the terror, alienation, and sympathy of the original novel by Mary Wollstonecraft Shelley. The lights dim and thunder crashes as the voice of Dr. Frankenstein narrates his tragic struggle with the mysteries of science and creation, a hauntingly accurate recreation of the original.



The Bakken Museum's elegant architecture reflect's a synthesis of science, art, and history.

Far from the Hollywood spin-offs that degrade the novel to a horror film, the Bakken's Frankenstein exhibit boldly confronts the issues of blind ambition, creation and the danger of pushing science's role beyond its usefulness. The exhibit epitomizes The Bakken's message—that the study of electricity extends far beyond circuits and is deeply immersed in all the complexities of life.

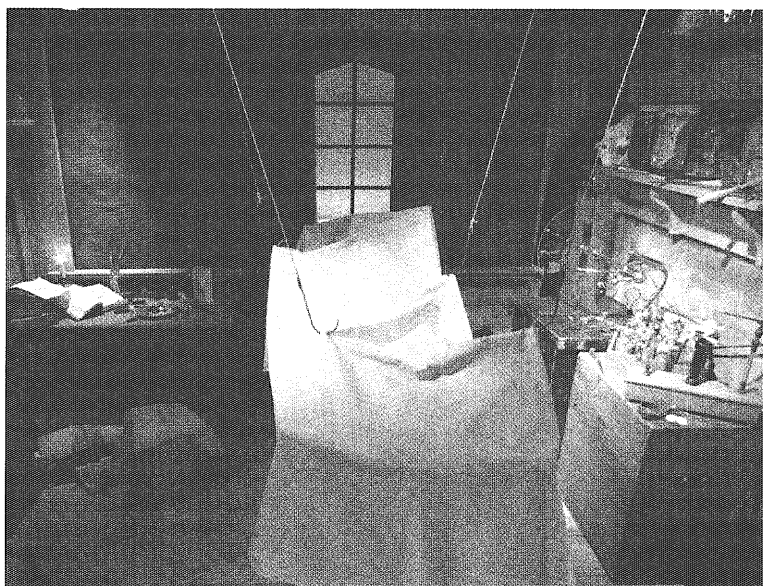
"In our Frankenstein exhibit, we wanted to show how science has impacted our conceptions of ethics and values and raise broader questions of

how science has been utilized," says Rhees. At one point in the 12-minute long recreation, Frankenstein even pleads to the audience to avoid his past mistakes, "Avoid ambition, even the innocent one of distinguishing oneself in science."

According to Klehr, the museum encourages its visitors to question science's influence on society, as well as society's influence on science. "The Bakken tries to put science out there for you. Our role is not to decide whether it is good or bad," he says. "We want visitors to come away from their visit to The Bakken and form their own questions."

Lighting a Fire

The museum is only a small part of how the Bakken seeks to educate the public about electricity and magnetism. With the aim of motivating youth into the path of discovery, it launched the Earl Bakken Science Program, a diverse set of youth programs that links students with scientists and engineering mentors to promote self-directed invention and innovative learning. Participants explore the past in order to inspire



The Bakken's Frankenstein exhibit, complete with Leydan jars and electrostatic generators, resembles a lab that Victor Frankenstein might have used in his experiments with creation.

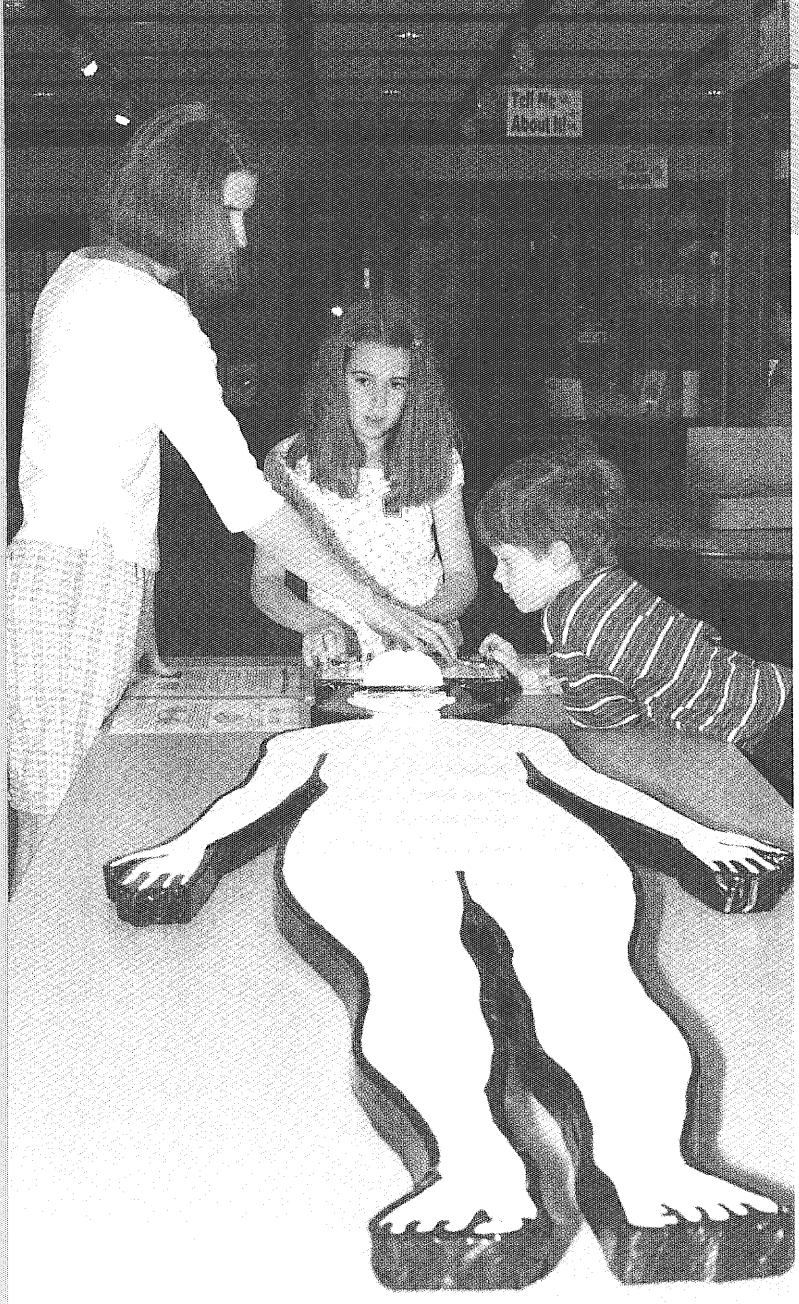
The Bakken Museum

Museum Location: 3537 Zenith Ave South, Minneapolis

Museum Hours: Tuesday - Saturday, 10 am to 5 pm

Admission: \$5 Adults; \$3 Students & Seniors; Children under 6 years old free

Phone: 612-926-3878



An adult mentor at the Bakken guides children through one of the many hands-on exhibits.

them to invent their own creative projects. "Individuals recapitulate the history of science when participating in the learning process," adds Rhees. "That's why we start our students with electrostatics and the fundamentals that were discovered centuries ago and then progress toward modern developments."

In the year 2000, more than 115 students ages 9 and older participated in the Earl Bakken Science Program. The programs are designed so that kids can participate at a young age and continue in the program as they get older. "We want to ignite a passion for

science in our students that will be self-perpetuating," says Rhees. Quoting William Butler Yeats, Rhees adds, "Education is not the filling of a pail, but the lighting of a fire."

The passion is still burning bright for Mike Waddick, 16, who started participating in the Earl Bakken Science Program when he was 12. After he and another student showed interest in designing a Tesla coil, a 19th Century high-voltage transformer that sends out radio waves and radiates large sparks, the Bakken funded the materials for them to make their own.

After designing and fabricating their own Tesla coil in about a year, The Bakken approached Waddick to make one for the museum. "It's been an experience that has changed my life," he says. "Without The Bakken, I never would have gotten into all these projects before." Now, four years later, he volunteers to mentor other students like Sam Lane, 14, who designed his own Tesla coil with Waddick's help. Both plan to follow career paths involving electricity and magnetism when they grow older.

Another initiative, the Historic Docent Program, offers students the unique opportunity to connect science

with the performing arts. Youth ranging in age from 11-13 actively "take on the part" of a historical scientist, exploring both their life and work. Students apply their research by acting out the role of their famous scientist, dressing up as the historical figure and interpreting some of the Bakken's exhibits for museum visitors.

Other Bakken educational programs include summer science camps, school field trips, and Earl's Garage, a traveling workshop that brings science-related activities to inner city schools in order to spur involvement in science for girls and underrepresented minorities. All of the programs emphasize the importance of allowing youth to liberate their imaginations while working on hands-on science projects, bringing them in direct contact with scientific innovation.

"The Bakken really creates a sense of 'Wow!'" adds Richard Johnson, a retired fire-chief who now volunteers at the museum three times a week. "It's all about showing people the magic of science."

The Bakken's true heart was evident during a recent school field trip in which Johnson led a group of young students in creating a "circle shock," a static shock transferred around a ring of joined hands. Trying not to disturb Nobel Prize winner Sir Andrew Huxley, who was giving a lecture on his life's work in the adjacent hall, Richard told the children to remain as quiet as possible. "But when the shock went around the circle, they all broke out into these huge, wonderful squeals of laughter and joy," he says.

"Did you just hear that?" quipped Sir Andrew Huxley, after being interrupted by the children's screams. "Now that's the sound of science!" ●

FOR MORE INFORMATION see www.thebakken.org

BIODIESEL:

A new alternative to petrol

BY JEANETTE LELAND

By the year 2010, humans will have consumed about half of the crude oil on Earth. This is important news, considering oil accounts for about 40 percent of the energy consumed by Americans, and the bulk of that petroleum is imported from countries in the politically unstable Middle East. These facts, in addition to environmental concerns at home and abroad, have caused the search for alternative fuels to increase in magnitude. One fuel developed and found to be an increasingly important alternative to petroleum is biodiesel.

Biodiesel is an environmentally friendly alternative to petroleum because it is produced from renewable sources such as vegetable oils, animal fats, and recycled cooking oils.

One bushel of soybeans produces about 1.5 gallons of biodiesel, and Minnesota is the third largest soybean producer in the United States. Soybeans are the state's largest agricultural crop; Minnesota farmers produce more than 200 million bushels a year. To investigate the feasibility of a state biodiesel industry, the Minnesota Department of Agriculture has conducted several studies on the economic impact of soy diesel production on the state. As a result, the Minnesota legislature is considering a bill that would provide incentives for new production of biodiesel. One department study showed that the production and use of soy diesel in Minnesota could generate \$185 million to \$460 million in total economic development and include the creation of 900 to 2,000 jobs.

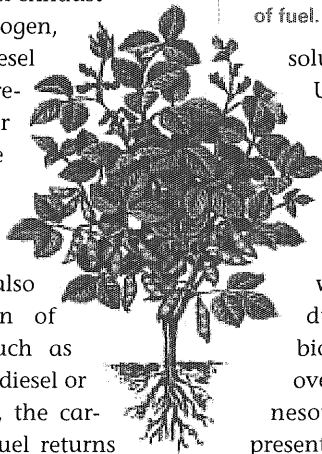
Biodiesel is created through a process called transesterification that involves mixing methanol with sodium hydroxide, and adding vegetable oil, such as soybean or canola oil, to that mixture.

Biodiesel is biodegradable, and produces significantly less air pollution than diesel fuel. Diesel exhaust is a potential carcinogen, and the use of biodiesel has been found to reduce risks of cancer because it reduces the production of cancer-causing compounds, such as carbon monoxide. Biodiesel also displaces production of greenhouse gases such as CO₂. When either biodiesel or petroleum is burned, the carbon content of the fuel returns to the atmosphere as CO₂. Plants grown to make oils for biodiesel draw CO₂ out of the atmosphere for photosynthesis, causing a recycling process that results in less accumulation of CO₂ in the atmosphere. Thus, biodiesel does not contribute to global warming in the same way that petroleum does. According to the U.S. Department of Energy, biodiesel produces 78 percent less CO₂ than diesel fuel.

But can biodiesel perform as well as regular diesel? Pure biodiesel can be used in all the same places as regular diesel, including motor vehicles, boats, and generators. However, special systems are required for its usage, since biodiesel thickens in cold temperatures. Bad news for those of us in Minnesota? Not necessarily. Blends of 20 percent or 35 percent biodiesel with regular diesel can be used in almost any diesel engine. Biodiesel mixes well with diesel, and actually reduces the wear and tear on engines because it is a much more effective lubricant than plain diesel. Blends of 20 percent biodiesel have also been found to degrade twice as fast as regular petroleum based fuels. Pure biodiesel decomposes at the same rate as sugar.

But how much green is this green

Above and left: The soybean plant, a relatively common agricultural crop, could provide a new and more sustainable form of fuel.



solution going to cost consumers?

Unfortunately, since biodiesel is still so new, it is expensive. Pure biodiesel sells for \$1.50 to \$2.25 per gallon before tax. There is hope, however. The U.S. Department of Energy is working with the biodiesel industry to reduce the cost of biodiesel to less than \$1 per gallon over the next five years. In Minnesota, the state government is presently working on legislation that would provide a reduction in the gas tax on biodiesel blends.

So where to buy this wonderful fuel? Biodiesel is not yet available everywhere. However, it is being sold in bulk to large customers such as school bus fleets. Also, a local petroleum distribution company or biodiesel producer can deliver B20, a 20 percent blend of biodiesel.

In Minnesota, the state legislature is currently considering a bill that would require that all diesel fuel sold in Minnesota contain at least 2 percent biodiesel by volume. So, if you are interested in buying biodiesel, begin asking for it at your local gas station, or email your state representative asking that he or she vote to pass meaningful biodiesel legislation. The greater the demand, the sooner biodiesel will become more available. ●

FOR MORE INFORMATION see
www.greenfuels.org/bioindex.html
www.afdc.doe.gov/altfuel/biodiesel.html
www.cgfg.org/projects/biomass/
www.ott.doe.gov/rbep/

To view the progress of the Minnesota biodiesel legislation referenced in this article, see www.leg.state.mn.us/leg/legis.htm

MnTAP:

Not your ordinary summer

BY MELISSA EBLEN

Internship programs and research experiences dominate the summer agendas of many ambitious IT students. Unfortunately, many undergraduates find that an internship means three months of menial office labor, and a research experience is defined as doing the grunt work for researchers. This is not the case for the eight students every summer who participate in the Minnesota Technical Assistance Program (MnTAP). Last summer alone the eight MnTAP interns each working at a different Minnesota company saved their employers a projected \$1,353,749!!! Yes, that's correct, over one million dollars in savings thanks to the work of eight individual students.

What is MnTAP?

The Minnesota Technical Assistance Program, founded in 1985, helps businesses prevent pollution and better manage waste. The program, housed in the Gateway Center, is part of the University of Minnesota, and it is funded by a grant from the Minnesota Office of Environmental Assistance. Approximately ten full-time professional staff with backgrounds in science and engineering and work experience in industry provide free technical assistance to businesses hoping to reduce costs by reducing waste.

The intern program is an extension of MnTAP's mission to reduce and manage waste. Each summer, interns are hired and paid to work with various Minnesota companies, researching how to reduce waste within the companies. At the end of the three month internship, students suggest alterations in manufacturing processes that will allow the companies to save on disposal and raw material costs, reduce waste, and decrease the regulatory compliance burden.

Project for Pillsbury

Nancy Mahagnoul, a chemical engineering major, spent her summer trying to reduce wastewater output at Pillsbury Bakeries and Foodservice in Chanhassen, Minnesota. She was not sure what to expect from the internship. "At first, I was very timid—afraid to make a mistake or talk to people I didn't know. I finally realized that

the project would not be successful if I didn't involve anyone else. With only three months to make a difference, I had to work fast."

The first step Mahagnoul took was to quantify the water used by each piece of equipment in the plant. This allowed her to identify where the most water consumption was occurring, in addition to comparing the actual water consumption to the manufacturer's specifications quoted for particular pieces of machinery.

Mahagnoul gives an example of the types of problems she encountered. "I found that a pan washer was using 2.6 GPM [gallons per minute] while the manufacturer said it should be using 1.6 GPM. Maintenance staff and I located a hidden rinse line that was



Chemical engineering major Nancy Mahagnoul worked to lessen the amount of waste water produced at Pillsbury.

PHOTO COURTESY DOTTI SHAY, PILLSBURY

damaged. That part was replaced, and I observed the pan washer to use only 1.0 GPM. I didn't think that a savings of 1.6 GPM sounded like very much, but in a 22.5 hour production day, this [savings] amounted to 2,100 gallons per day!"

At the end of the summer, Mahagnoul compiled all of her work in a report which she presented to the managers at Pillsbury. The report included the results of her findings as well as a guide to continuing waste reduction efforts. Mahagnoul's work has led Pillsbury to reduce its annual wastewater output by over 1.8 million gallons!

Finding Solutions for Fiberglass Fabricators

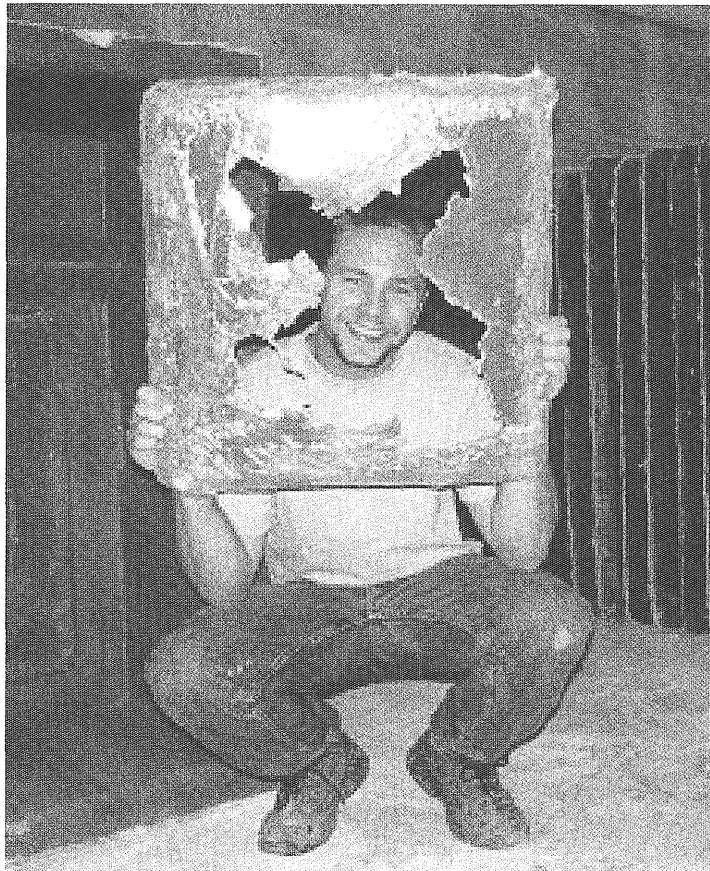
Fiberglass Fabricators, a small company in Le Center, MN which produces fiberglass structures for the utility, electrical, and telecommunications industries, benefited from the hard

work of Kevin Sandstrom. Sandstrom's task was to find ways to reduce the waste generated in the manufacture of fiberglass boxes, namely how to avoid spraying fiberglass past the molds and onto the floor. Alternatives included either careful training of the fiberglass gun operators or installing robotics to do the spraying.

"My job was to study the rate of waste production, the feasibility and savings of re-training the operators, to research the cost and waste savings of employing robotics, and to investigate the grinding and recycling of the fiberglass scraps into polymer concrete," explains Sandstrom.

With so much resting on his shoulders, Sandstrom set to work. "The work was very dirty and very hands-on, and I had to start working very early each morning, but I really enjoyed it just the same."

Sandstrom became an integral part of the company through his three months on the job. "The people I met at FibFab are a great bunch of guys, as



Kevin Sandstrom spent the summer getting down and dirty at Fiberglass Fabricators determining waste reduction factors.

well as Deb McKinley and Randy Cook of MnTAP. Being able to work with these people and become friends with all of them was the best part of this job. I worked with a wide variety of people at FibFab, including the president and the plant operator, so I learned a lot about the business in general as well as my specific project goals."

After examining all of the alternatives to reduce waste and save money, Sandstrom developed a report with the results of his analysis. "My findings were that the company was wasting a lot of money and raw materials and sending tons of solid waste straight to the landfill."

Sandstrom found that the best option for maximum savings was to install two robots to spray the fiberglass. According to Sandstrom, "This would cost approximately \$400,000 to buy and install, but would reduce (along with recycling the remaining waste) their raw material use by \$125,000 annually and save about one hundred

tons of solid waste per year from entering the local landfill."

Individuals Making a Difference

Both Sandstrom and Mahagnoul agree that MnTAP is a unique experience. Sandstrom says, "You are your own boss."

"The success of the project is up to the intern," concurs Mahagnoul. "Students should apply if they want to see a project develop as their own and see their knowledge applied to a real industrial setting."

The independence of the projects requires a lot of work on the part of an intern, but the rewards are immense. At the end of every summer, MnTAP compiles a summary of projected annual savings and the amount of waste reduction resulting from each intern project. Last summer alone the projected

waste reduction resulting from MnTAP intern projects include 83,600 pounds of paper waste, 5,300 pounds of coolant, 216.5 tons of fiberglass, 32,935 feet of wire, and 25.4 million gallons of water.

"It was a much better experience than any job I have had before," Sandstrom reflects. "I learned a lot and feel my work was very beneficial."

Mahagnoul concludes, "[MnTAP] gave me a chance to educate the decision-makers [at Pillsbury] in resource conservation. It was a great sense of accomplishment to do something good for the environment." ●

FOR MORE INFORMATION see
www.mntap.umn.edu

To learn about the possibility of applying for MnTAP internships, contact Deb McKinley at mckin013@umn.edu

With today's technology in films, science is intrinsically everywhere in them, from filming to audio to editing. However, the storyline of many movies is left to the CLA folk. In this article, we take a look at films based on scientific people and events, from the new (*A Beautiful Mind*) to the fairly ancient (*Tron*).

BY BETHANY STEICHEN AND SCOTT TREENDA

A BEAUTIFUL MIND

STARRING: Russell Crowe (*Gladiator*, *The Insider*), Jennifer Connelly (*Requiem for a Dream*, *Labyrinth*), Ed Harris (*The Truman Show*, *The Abyss*)

DIRECTED BY: Ron Howard (*Apollo 13*, *Ransom*, *The Grinch*), 2001

SYNOPSIS: *A Beautiful Mind* centers around the life of John Nash, a Nobel Prize-winning mathematician, and his battle to develop an original theory. However, his task is complicated when he is forced to confront the delusional world of schizophrenia he has created for himself.

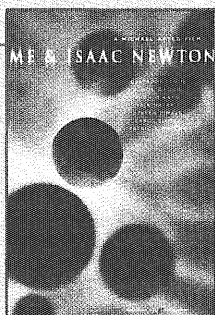
Bethany's Rating: ☆☆☆

This movie struck me as good overall, but there were certain omissions and discontinuities that bothered me. I liked how Crowe and Connelly portrayed the Nash family grappling with Nash's schizophrenia, but other characters were scripted in a confusing manner. For example, people who had formerly disliked Nash suddenly give him a second chance. This created transitional gaps in the story for me. Also, issues of homosexuality, arrests, and problems with children—discussed in the book by Sylvia Nasar on which the movie is based—were left out entirely. While perhaps not the most accurate story, it is a sweet movie.



Scott's Rating: ☆☆

I must say, I was somewhat impressed with the movie until about the last 10 minutes. Ron Howard does a decent job of painting an image of schizophrenia and the pain of uncertainty of one's environment. However, I think he also indulges a little too much in corny sentimentality that leads to certain moments in the movie being out of sync and uncharacteristic of the portrayed personalities. Personally, I was not incredibly moved by the movie, but I can see it winning lots of awards.



ME & ISAAC NEWTON

Scott's Rating: ☆

I think this movie makes a mediocre documentary but a sub-par movie. The pacing is done well, but the flow is choppy. Each story follows a similar progression, and so we have to continue to re-identify with each new scientist as the former one's portion of the story ends. This would be okay if you were watching it in a classroom setting, but as entertainment it leaves much to be desired.

Bethany's Rating: ☆☆

Me & Isaac Newton would make a good video showing the diversity of scientific fields to sixth graders. The stories are appealing in and of themselves, but I wouldn't seek this sort of documentary out on my own. The filming is paced well, ensuring that one does not become bored with each of the scenarios before moving on, but once again, it isn't an entertaining film to watch on a Saturday evening.

STARRING: Gertrude Elion, Ashok Gadgil, Michio Kaku, Maja Mataric, Steven Pinker, Karol Sikora, Patricia Wright (Scientists)

DIRECTED BY: Michael Apted (*Nell*, *The World Is Not Enough*), 1999

SYNOPSIS: *Me & Isaac Newton* interviews and follows seven scientists working in different fields of research. They describe where they're from, what they're working on, what they've discovered, and where they plan to go with their data.



π

Bethany's Rating: ☆☆☆☆

The casting, cinematography, directing, and editing in this film were quite impressive. However, at times, I found myself unable to follow the plot. There are also some scenes in this movie that may be objectionable to audiences, a human brain being poked by a pencil for example. I personally wasn't bothered by the graphic sections, and I absolutely loved the surrealist dream-like quality of black-and-white cinematography. Coupled with stark, sometimes jarring scene shifts in editing, I thought the black-and-white highlighted the contrasts between the pure logic of mathematics and Max's steady descent into insanity. While there were several elements about this movie that I was taken with, overall I felt like I had been holding my breath for the whole film waiting for a relaxing sigh only to end up with a confused, let down exhale.

Scott's Rating: ☆☆☆☆

I think it's safe to say that everyone loves a good movie. Yet I think it is so much more impressive when a good movie is made with no studio backing and a budget of approximately five dollars. Pi was amazing for me because it's the only movie I have ever seen that was both interesting and confusing. I could not understand the entire film my first time through. I think there's a certain feeling that one gets from a good flick, and I got that feeling throughout this whole movie, even though I consider it a little difficult to pay attention during black-and-white films. Overall, this is a breakthrough masterpiece from one of my favorite directors.

STARRING: Sean Gullette (*Requiem for a Dream, Artifacts*), Mark Margolis (*Ace Ventura, Jakob the Liar, Hannibal*)

DIRECTED BY: Darren Aronofsky (*Requiem for a Dream*), 1998

SYNOPSIS: A computer and mathematical genius, Max Cohen is striving to find a pattern to "millions of human hands at work, billions of minds... a vast network, screaming with life: an organism" – the New York Stock Exchange. While searching, his computer seems to go insane and, right before it dies, spits out a number which could be the key to discovering something more important than Max could ever imagine.

HACKERS

STARRING: Jonny Lee Miller (*Trainspotting, Dracula 2000*), Angelina Jolie (*Tomb Raider, Girl, Interrupted*)

DIRECTED BY: Iain Softley (*K-PAX, Wings of the Dove, Backbeat*), 1995

SYNOPSIS: Dade Murphy is a hacker who created a virus that crashed 1500 computers, including Wall Street, when he was 11. Banned from using computers or touch-tone phones until his 18th birthday, he turns 18 and resumes hacking, becoming part of a hacker community. With his new friends, he gets himself into a twisted situation with an online bank. Now they must rally to prove that the hackers are the innocent ones.

Scott's Rating: ☆☆☆

I have to admit that this isn't the best made or most brilliant film in the world, but I also like this movie a lot more than my rating would indicate. The script is delightfully corny, the plot all too predictable, and the acting well below par, but whereas *Tron* horrifically fell short as a film, I don't think the same elements that annoyed me in *Tron* affected me at all in *Hackers*. I laughed both at and with this movie, which is a new feeling for me. I wouldn't recommend this to a film society looking for a good conversation piece, but I would wholeheartedly recommend it to anyone looking for a fun movie without thinking too hard or paying too much attention.



Bethany's Rating: ☆☆

A movie whose humor hinges on jargon puns can swing either way on the spectrum of good to bad, and for me this movie was definitely the latter. Not only did I find the dialogue trite, but I was also bothered by the portrayal of teenagers' clothing, actions, and general lifestyle. They, like the plot line, were too contrived. I did like some of the collage-like sequences of old movie scenes and digitized images swirled together. Conceptually I like the idea of protagonists who use brain rather than brawn; I commend it for that, but little else.

TOP IMAGE COURTESY ARTISAN ENTERTAINMENT; BOTTOM IMAGE COURTESY UNITED ARTISTS PICTURES

OCTOBER SKY

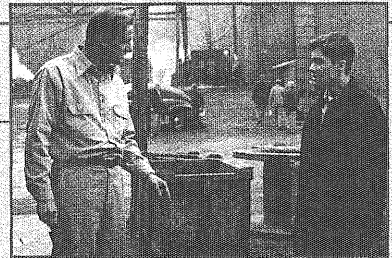
STARRING: Jake Gyllenhaal (*Donnie Darko, Highway*), Chris Cooper (*American Beauty, The Horse Whisperer*), Laura Dern (*Jurassic Park, Novocaine, Focus*)

DIRECTED BY: Joe Johnston (*Jurassic Park III, Jumanji*), 2000

SYNOPSIS: Set in Coalwood, West Virginia, a traditional coal-mining town, Homer Hickam is expected to become a regular coal miner, like his father, after graduation because he can't play sports well. He learns about the Sputnik satellite and takes an interest in rocketry despite the stern disapproval of his father. His science teacher encourages him and a few classmates join him in his research, while they aim toward the national science fair.

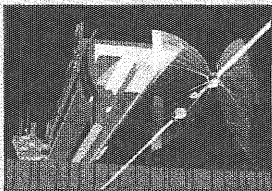
Bethany's Rating: ☆☆☆☆

While it is easy to see where this movie is headed even from the beginning, there are some nicely unexpected turns in the film. It's a triumphant tale that would be difficult to watch if you didn't know that it was a true story. At a few points the acting is a bit overdramatic, but in the context of the quintessential American Dream story it is quite excusable. The soundtrack fits well and the whole movie transitions nicely. Overall, this was an easy movie to watch because it's just plain happy, and it's the kind of story that begs to be told. Very uplifting.



Scott's Rating: ☆☆☆

I was very impressed that the story line was almost verbatim to real life – it makes it much more remarkable. I liked the ideas and foundations of the film – it's an inspiring story. Although the acting is a little overdramatic and the script a little corny, the movie flows well and there's enough happening in the plot to divert your attention. In all, it's a decent feel-good movie that's just plain amazing when you look at it from a true-story point of view.



Bethany's Rating: ☆☆

This movie would be perfect for background party amusement. If you overlook the complete absurdity of the technology portrayed and the bland emotional acting, you can find a whole lot to amuse you. The computer graphics used in *Tron* were an amazing breakthrough at the time of its creation, and that lends this movie credibility. Overall, if you treat this movie like a b-film that can be laughed at rather than with, you might enjoy it. This would be okay if you were watching it in a classroom setting, but as entertainment it leaves much to be desired.

Scott's Rating: ☆

Aside from the technological value of the time, this "film" is in strong competition with *Chairman of the Board* for Worst Movie Ever. Half a star is very generous for this—it's extremely funny when it's trying very hard not to be. The acting is far below lackluster, the plot is painfully linear and easy to predict, and the script makes every computer term of the time cliché within under three minutes—a record for most computer movies. It's bad enough when a movie insults your intelligence—there are enough of those films already—but when they do it under a guise of an atmosphere that's intrinsically intelligent, the result is an idea for a movie that should have remained just that—an idea.

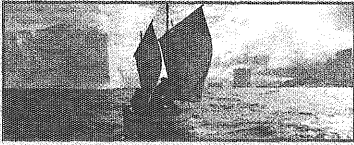
TRON

STARRING: Jeff Bridges (*K-PAX, The Contender*), Bruce Boxleitner (*Kuffs, Six-Pack Annie*), Cindy Morgan (*Caddyshack, Galaxis*)

DIRECTED BY: Steven Lisberger (*Slipstream, Hot Pursuit*), 1982

SYNOPSIS: Flynn is a computer programmer who invented several million-dollar video games that were stolen from him by his former company. When he goes back into the company with two ex-coworker friends to try to set things right, he ends up getting sucked into the inner mainframe of the massive computer system by the evil main program running the company. From there, he must fight his way free by playing gladiator-like electronic games.

THE ENDURANCE



Scott's Rating: ☆☆☆☆

Wow. That's all I can say. While this is not the most entertaining movie I've ever seen, it is an incredible story and the best documentary I have ever seen. To describe the plot, I'll paraphrase a quote from the movie: After their ship collapses, the crew is stranded on a pack of ice. They must row 250 miles to get to the nearest island. The story of the crew of the HMS Endurance is an incredible one, and the bravery and courage of the heroic Shackleton despite the hellish conditions inspired me. While I fell asleep the first time I watched it, I saw it again and was entranced by its excellence.

Bethany's Rating: ☆☆☆

This is one of the best documentaries I've seen. Rather than being bogged down in dates and times, I felt amazed by the perseverance and success of the explorers. The historical context was intriguing. More of the story could be told. This, to me, is as much a marker of a good documentary as an interesting subject, quality directing, and pacing. While I was consistently surprised by the story of the Endurance's crew, the film is rather long, and dragged a bit in places.

STARRING: Liam Neeson (*Schindler's List*, *Les Misérables*)

DIRECTED BY: George Butler (*In the Blood*), 2001

SYNOPSIS: Intending to map across Antarctica, the crew of *The Endurance* set out in 1920, but was stranded in an iceberg field just on the outskirts of the continent. This movie is the true account of how the Captain, Sir Edmund Shackleton, and others kept all twenty-seven crew members alive despite being trapped for ten months. The film includes almost an hour of actual footage and dozens of pictures from the voyage.

THE DISH

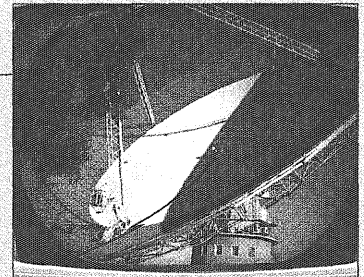
STARRING: Sam Neill (*Jurassic Park*, *Event Horizon*), Patrick Warburton (*Seinfeld*, *The Tick*)

DIRECTED BY: Rob Sitch, 2001

SYNOPSIS: This is the true story of how the moon landing almost wasn't a monumental event—not because of problems with mission control, but because of technical difficulties with a TV transmission station in rural Australia. *The Dish* outlines the heroics of a small team of reception dish operators at the station who made it possible for the world to watch the moon landing.

Scott's Rating: ☆☆☆☆

I have to proclaim this my feel-good movie of the year. I was incredibly impressed with this, considering I had heard nothing of it from anywhere. Off-hand, I don't think I can remember a movie made from a true story that made such a cute plotline. The soundtrack is fantastic; along the lines of *Forrest Gump*, it has some good classic American rock songs. One of my favorite moments of the movie is when they're revving up the satellite dish and "Classical Gas" is playing in the background. *The Dish* has the magic that makes a movie enchanting, and it gave me the perma-smile that I love after seeing a good movie.



Bethany's Rating: ☆☆☆

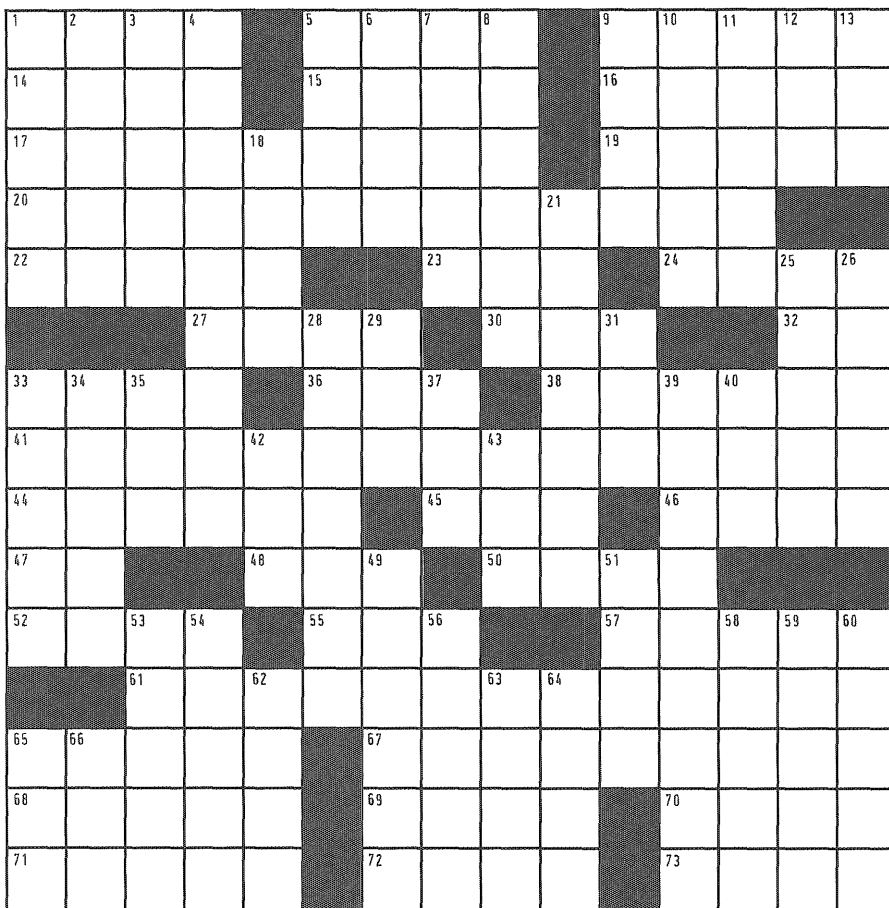
This is one of those movies that just leaves a person feeling good. It's humorous without being riddled with puns. The characters aren't the deepest I've ever seen, but I did grow attached to them. *The Dish* is also a welcome change from the typical space mission movie. I thought that there was something for everyone in this film and would recommend it to anyone.

Lost in Space

BY TIM FISTER

ACROSS

1. Fellow
5. Resting on
9. P. Wellstone, for example
14. 3600 seconds
15. Italian sendoff
16. Similar
17. Canopies that won't stay up?
19. Oscar winner Jessica
20. Brucie Willis' Space Movie?
22. Razor brand
23. Knit
24. Penn or Connery
27. Indian Prince
30. Anthony Hopkins or Lancelot
32. Just ___ it
33. ___ spumante
36. Tokyo, once
38. End-of-day-eats
41. Heston's Space Movie?
44. Hydrogen or Helium
45. Enemy
46. Title
47. Popular TV show
48. Drunkard
50. Court order
52. A Python's favorite meat?
55. Netherlands, on an envelope
57. Coral reef fish
61. Gary Sinise's Space Movie?
65. Skull epidermis
67. Winterized Michelins
68. Hanky ___
69. African Republic
70. ___, mene, tekel, upharsin
71. Accumulate
72. Love god
73. Utopia



DOWN

1. Pillar base
2. Simpson patriarch
3. Even, in Romania?
4. Obtaining
5. Laptop manufacturer
6. Puny
7. Order of the Arrow Troop Reps
8. A pocket full of ___
9. Spanish surrealist
10. Families
11. Char
12. MD's heart test
13. Born in France?
18. Chicken of the sea
21. Three pointer, ideally?
25. Bear off
26. Scandinavian
28. Family of the future?
29. Fuss
31. Regret
33. Church sections
34. Straw noise
35. Sunbathe
39. Express theatrically
40. Phenylpropanolamine, lazily

42. Sloths
43. Pull
49. Gloomy
51. Outfielder call, "___ it"
53. Fridge company
54. Works an udder
56. Contributor
58. Revealed
59. Me, Myself, and ___
60. German industrial center
62. LeCarre characters
63. Aborted mission, to walkie talkies
64. Deuces
65. Resort
66. Curved wedge for clamping

Crossword solutions will be printed in the next issue of the *Technolog*. Here's the solution to last issue's crossword:

S	A	A	B	S	S	W	E	E	T	U	E	T		
A	T	R	A	P	A	N	D	M	E	N	R	A		
N	U	M	B	E	R	T	W	O	P	E	N	C	I	L
D	T	I	A	I	D	S	T	A	L	E	S			
L	O	N	G	R	O	U	T	E	H	U	E	S		
E	L	S	E	O	R	G	Y	T	H	A	N			
R	A	W	I	G	O	T	A	G	O					
S	H	E	E	T	O	F	F	O	R	M	U	L	A	S
L	O	S	P	E	L	L	N	O	N					
Y	M	C	A	S	E	E	M	I	L	L	D			
E	A	R	P	A	S	A	M	A	T	T	E	R		
A	L	L	A	Y	S	N	O	R	I	V	Y			
R	E	A	L	L	Y	B	I	G	E	R	A	S	E	R
E	S	T	O	N	E	G	A	A	D	I	E	U		
A	S	E	N	C	A	A	S	Y	E	N	S	N		

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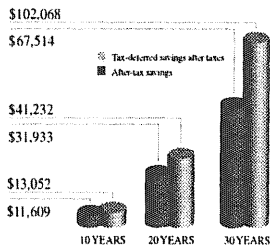
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