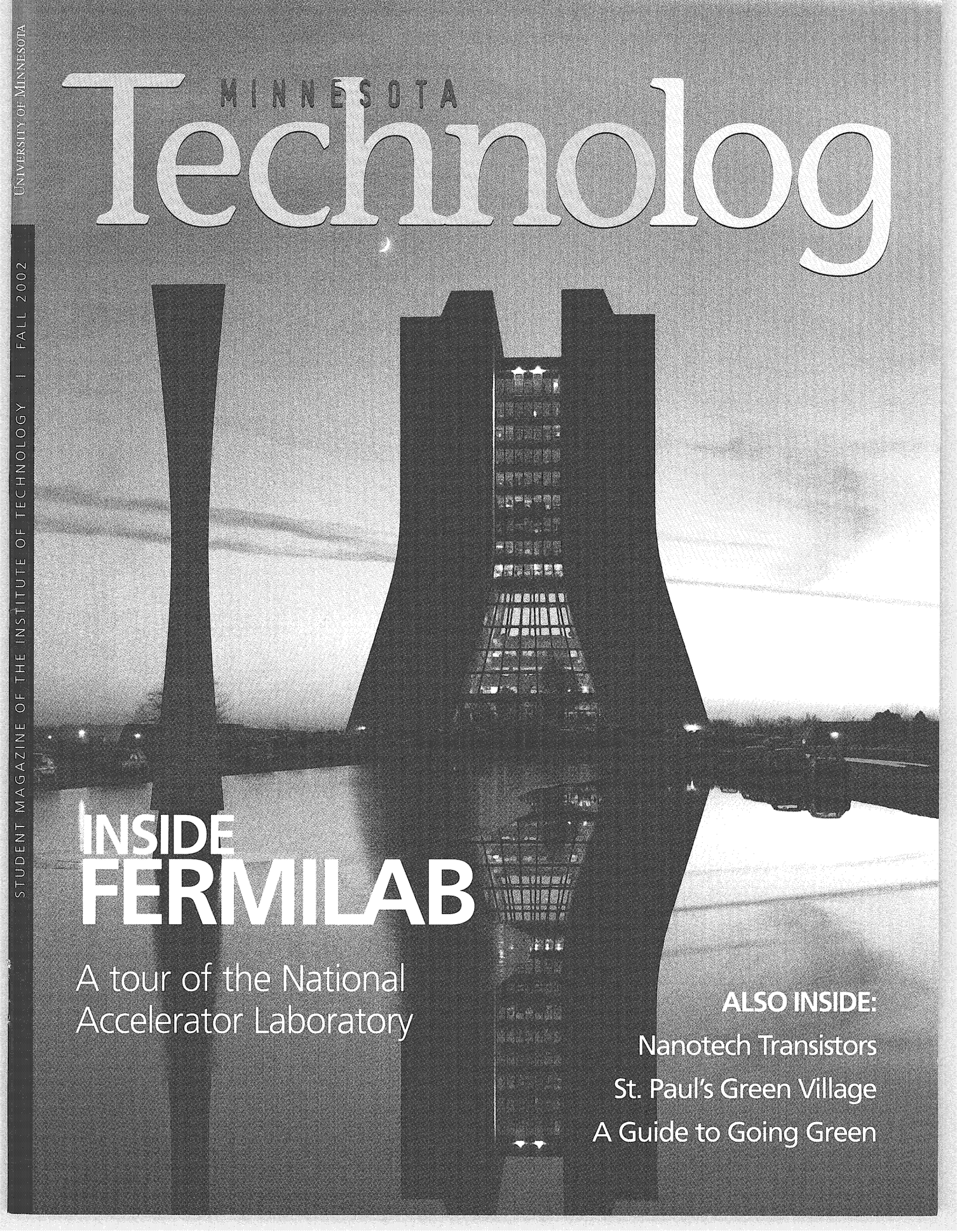
University of Minnesota

Student Magazine of the Institute of Technology | Fall 2002

Minnesota Technolog



INSIDE FERMILAB

A tour of the National Accelerator Laboratory

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Nanotech Transistors

St. Paul's Green Village

A Guide to Going Green

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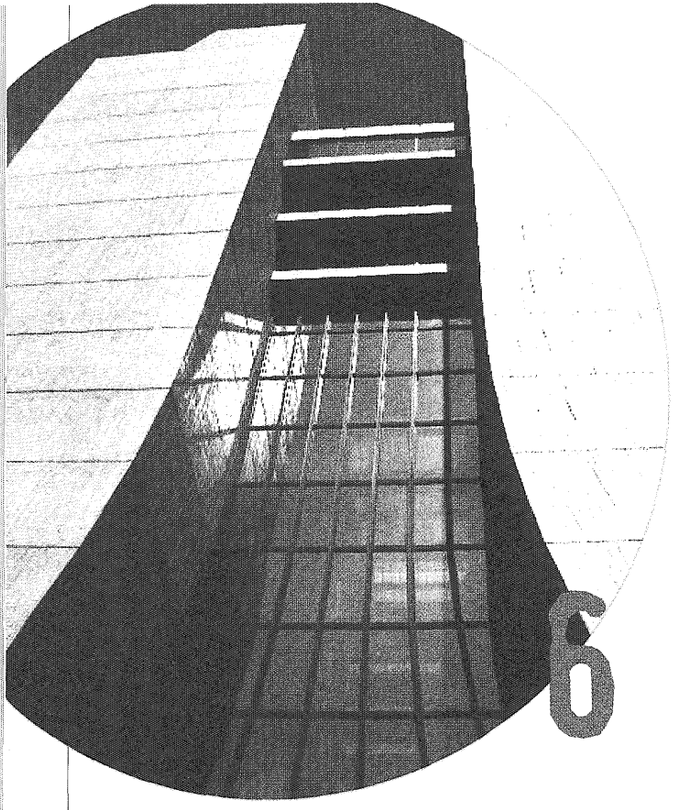
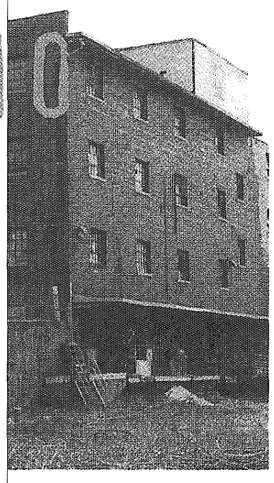


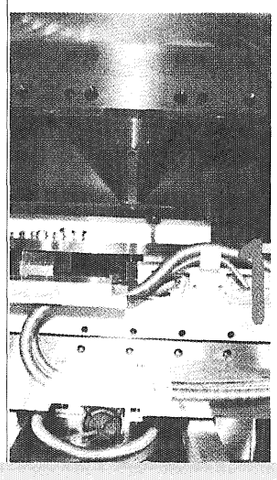
COVER STORY

INSIDE FERMILAB

Some of the world's top scientific minds work inside this building, combining their abilities to solve the questions that have puzzled researchers for decades.

FEATURES





ALSO INSIDE

CONTRIBUTORS


Caron

START BIO
name: eric caron
major: computer science
i haiku, can you?
END BIO


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, kayaking, and the outdoors.


Idziorek

Katie Idziorek is completing her last semester as an undergraduate in architecture. She plans to attend graduate school at the University of Washington in Seattle and continue her studies with an emphasis on urban design. Her favorite things to do are cooking with her boyfriend, practicing tae kwon do with her sister, and playing fetch with her cat, whose name changes constantly.


Mosher

Andrea Mosher is a civil engineering/architecture sophomore interested in environmental issues. One day, she hopes to design and build her own crazy sustainable house or farm. Jobless and out of school, Andrea spends much of the summer outside biking, gardening, rollerblading, traveling, and golfing. When it is raining, she likes to read, paint, cook, and teach her mutt new tricks. Eventually, Andrea would like to relearn French and spend her summers in Paris.


Opsal

When she's not working as an editorial assistant at the Institute on Community Integration, College of Education and Human Development, Chris Opsal enjoys reading, writing, making things, learning Japanese, and frolicking with her pit bull mix, the vivacious Meg.


Purdes

Jennifer Purdes is a sophomore majoring in chemical engineering. She is from Littleton, Colorado, and enjoys skiing, hiking, and camping in the Rocky Mountains.


Steichen

Bethany Steichen has just completed her freshman year and intends to major in chemical engineering. She's looking forward to studying abroad in Ireland next year and learning to Irish step dance. Surely, though, engineering stuff will be learned there as well.


Thomas

Daniel Thomas, a sixth-year mechanical engineering and journalism major, enjoyed the summer's opportunities for reading, camping and gardening (experimenting with vermicomposting, cuttings, etc.).


Trenda

Scott Trenda will be a sophomore in math and computer science. He enjoys playing his guitar, shopping and arranging music. You can often find him wandering about the West Bank or eating/making sushi. He likes movies a little, too...


Tsai

Eric Tsai is entering his fourth year at the University. Typical activities include: reading, writing, playing piano, running, traveling, sharing intimate conversations with friends and watching Korean soap operas dubbed in Mandarin Chinese. Watch out! He can become very obsessive about his hobbies, pursuing them repeatedly until his passions explode into something new. In addition, he overanalyzes everything (most regrettably, himself).


Walter

Michelle Walter is majoring in astrophysics. Her latest adventure is being a University admissions ambassador. She also enjoys astronomy, watching TV and movies, shopping, and hanging with friends.


Weyandt

Chris Weyandt is a mechanical engineering major. His interests include natural and architectural photography. He openly admits to not having a clue about what he wants to do with his life.

FILE PHOTOS

EDITORIAL

Welcome to the *Technolog*

Bringing home 12 awards from the nationwide Engineering College Magazine Association (ECMA) conference in April was a continuation of the *Technolog*'s strong record going back to its first issue in 1920. Although it has improved remarkably over the last few years, the Technolog has a long tradition of being one of the best engineering student magazines. This year's honors included the magazine of the year distinction plus first-place awards in the overall cover design, overall publication design, creative feature, and feature writing categories.

FILE PHOTO

Seven *Technolog* editors and writers traveled to the 2002 ECMA conference at Ohio State University in Columbus, Ohio. We received skill training in several workshops, but the best parts were probably gleaning good ideas from the staffs of other college engineering magazines and seeing Columbus with others from the *Technolog* team.

These awards were in a large part a testimony to the efforts and skill of our outgoing team of editors: Melissa Eblen, Mike Mosher, and Katie Idziorek. On behalf of the team, I thank them and the writers for work they did in transforming the *Technolog*.

As we strive to keep improving our magazine, the best benefit of the *Technolog* is the opportunity it provides students to develop communication, art, photography, design, and business skills. We are always looking for future copy editors, layout editors, and advertising or business managers, and are open to contributions from any student. I encourage you to take the opportunity to join the *Technolog* team and develop another skill.

—Daniel Thomas, Editor

Minnesota Technolog

FALL 2002
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UNIVERSITY OF MINNESOTA

Parting Thoughts

Commencement speaker Natalie Linnell encourages her classmates to find passion and joy in their life and work.

BY NATALIE LINNELL

EDITOR'S NOTE: Each year the Technolog *publishes the IT student commencement address. Natalie Linnell, who earned a bachelor's degree in mathematics and computer science, gave this year's address.*

It has been said, "Passion without precision is merely chaos." But without passion, without inspiration, there is no reason to aspire to precision. In IT, we expend a great deal of effort to master the methods of precision. But I think that the element of passion is far more essential to the technical fields than many people tend to realize, including at times those in these fields.

The human mind can find beauty anywhere, and it is often this perception of beauty that inspires scientific achievement. The aesthetic of an elegantly turned proof, when presented to the right eyes, can be more heart-wrenchingly beautiful than a Chopin nocturne.

Many people seem to think that the only reason anyone would ever choose to pursue a degree in a technical field is that they can make lots of money when they graduate. However, the call to build robots or design new drugs can be just as alluring as the call to write novels, and the desire to create and discover new facets of one's chosen profession can be just as persistent for the scientist as it is for the novelist.

In order for most people to be happy in their work, they need to feel that what they're doing is important. And if you can implement a computer program that will help a doctor diagnose illnesses, you are indeed contributing something worthwhile.

Hopefully we all feel this pull toward our fields. After all, something made us choose the majors with which we are graduating right now. The fact that we are graduating today says we've managed to hold on to those things which made our majors exciting when we first encountered them.

"This is a time in our lives when, perhaps more than any other time, we are the masters of our own destiny. We can still see the world through eyes unclouded by the overwhelming minutiae of what needs to get done today and what won't get done today and what to make for dinner."

I'm sure we've all had times when we questioned our choices. But we kept in mind the things that inspire us about our fields of study. And this is something that we must continue to do once we go out into the workplace and gain employment. This is perhaps the key to enjoying one's work, to waking up in the morning excited about what you're going to be doing that day: to remember what drew you to it in the first place.

And whether you enjoy your work should not be a secondary consideration. It should, in fact, be the most important factor in choosing a job. I was talking to a fellow the other day who held a lucrative position at a large computer company—a very lucrative position that he had decided to leave in order to attend graduate school and become a professor, simply because teaching was what he'd always wanted to do. I found this to be rather remarkable, because I've noticed that often once people enter the workplace, after a while they seem to forget that they can change their situation—that if they don't like their job, they can find a new one.

Now this may seem incredibly naive to some of you, especially those of you who already have positions and families. I realize that there is no perfect job; no matter what you do, there will always be portions of your job you dislike. However, most of us will spend almost half our waking

PATRICK O'LEARY

"The human mind can find beauty anywhere, and it is often this perception of beauty that inspires scientific achievement."

hours at work, so if you often leave those hours thinking that you accomplished nothing worthwhile, I can see no justification for failing to attempt to alter your situation.

Throughout life, there are times when we are faced with a choice, and it is easier to convince ourselves that there is no choice. That we are locked onto one path and there is no way off of it. It's hard to acknowledge that the choice is all yours, and thus the responsibility is all yours. The fear of making the wrong choice can be very strong.

But it is my feeling that, no matter where you end up in life, the situation is one of your own making; it is the one that you chose. Whether you make that choice through a conscious decision or by deciding that there is no choice, it was your decision that led you there. So have the courage to be an active participant in the direction your life takes. To take responsibility for your own happiness.

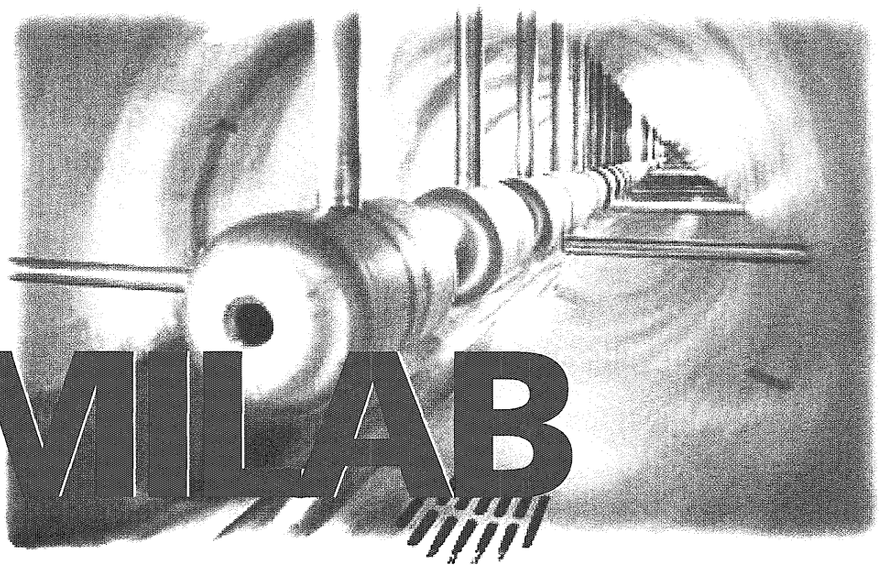
One place I see this courage manifested most clearly is in nontraditional students: people who already have jobs and families to support, coming back to school because they want to learn new things and advance in their current jobs, or because they want to find new, more exciting and more profitable work. I have a huge amount of admiration for these people who work eight hours in a day, make their children supper, and then go to class.

It has been my pleasure to become friends with a few of these students, and I have found it to be a wonderful experience. It has given me insight into certain facets of the person that I hope to be in a few years. And that is someone who is willing to put forth the hard work to switch careers if necessary so that she can do something she feels passionately about.

And it is important to apply this ideal of passion not only to one's professional life, but to one's personal life as well. As gratifying as the right career can be, most of us need our family and friends in our lives. Since we do spend so much time with our work, it can be difficult at times to keep in mind the fact that our accomplishments would mean little if we couldn't share them with the people close to us. It is important to love your work, but it shouldn't rule your life. Once it does, your life ceases to belong to you and begins to belong to your work. And if there's one thing that it's important to maintain ownership of, it's your life.

This is a time in our lives when, perhaps more than any other time, we are the masters of our own destiny. We can still see the world through eyes unclouded by the overwhelming minutiae of what needs to get done today and what won't get done today and what to make for dinner. We are poised at this moment between an ending and a beginning. And from this vantage point, we can still see clearly the entire future spread in front of us as a whole and decide consciously what we want from that future. Do not allow yourself to be held captive by your work. Allow it to inspire you. ●

INSIDE FERMILAB



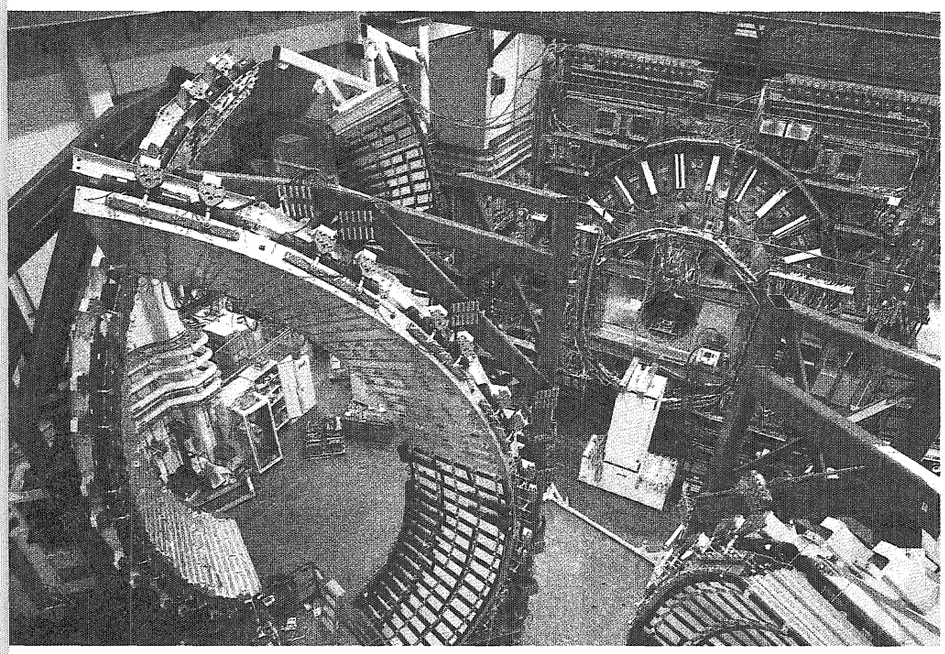
BY ERIC CARON, JENNIFER PURDES, AND MICHELLE WALTER

What do you get when you combine over 80,000 tons of scientific equipment, 4,000 workers, $304 million in annual spending and particles at almost a trillion electron volts? Hopefully, one of the smallest things in existence. This is what a large group of University physics students learned April 6 at Fermi National Accelerator Laboratory in Batavia, Illinois.

The facility commonly known as Fermilab is actually a multibillion dollar research complex, internationally renowned for its influential discoveries. The 6,800-acre complex is certainly not what is typically expected of a facility of this type. Approaching the headquarters are pi-shaped electrical poles that tower above the lush native grasses where a herd of buffalo roams over government-protected prairie. Here 55 species of birds reside in its woodland areas.

The power lines aren't the only giveaways: A 32-foot stainless steel obelisk leads the way to a 16-story office building that allows a view of Chicago on clear days.

Some of the top scientific minds in the world work inside this building, combining their abilities to solve questions that have puzzled scientists for decades: What is the smallest piece of matter in the universe? Why is there more matter than antimatter in the universe? Do neutrinos have mass? What is dark matter? Why does matter have mass? Are there forces and particles we have not yet discovered? How did the universe begin? What is matter, anyway?



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What are they doing?

Fermilab uses highly accelerated particles in many of its experiments. These high-energy particles are obtained through a series of accelerators several miles long. The process starts with ionized hydrogen gas and a pre-acceleration energy of 75 keV. The ions then enter the Linear Accelerator. During the tour of the facility, the physics group got a chance to see its 1950s sci-fi-esque beginning. The Linear Accelerator's 500-foot-long copper tube accelerates the ions to 400 MeV using oscillating electric fields and then strips the electrons off, leaving only protons.

The protons pass through the Booster along their way to the Main Injector. The Main Injector has an el-

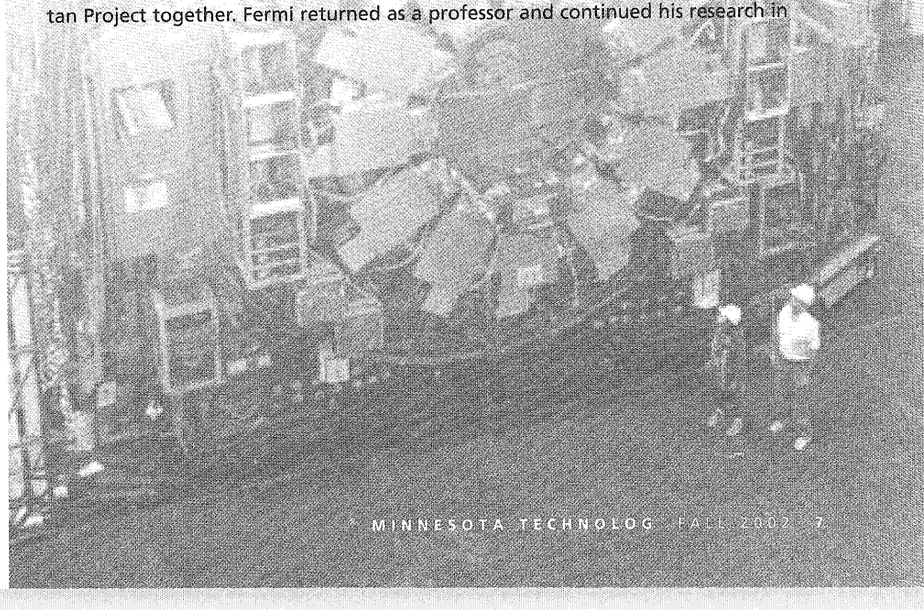
liptical circumference of about two miles. Completed in 1999, this unit accelerates the protons to 120 GeV using superconducting magnets and then sends some of them to the Antiproton Source. The protons are then smashed into a nickel target and result in antiprotons and other particles. The antiprotons, which have the same mass as protons but are negatively charged, are collected and stored in the Accumulator Ring.

The Main Injector also sends a portion of the 150 GeV protons and antiprotons into the Tevatron. The Tevatron is a ring similar to the Main Injector, although much larger, with a four-mile circumference. This structure, which is about 30 feet under ground, accelerates the protons and antiprotons to almost one teraelectron volt, 99.9999 percent of the speed of light. Because antiprotons and protons have a way of annihilating each when they come into contact, the particles are accelerated in opposite directions and far out of reach of each other.

Next the physicists and engineers do what they love best—smash these speeding particle to smithereens! In experiments located along the Tevatron ring, scientists study the interactions of certain particles and search for predicted ones.

In the Collider Detector at Fermilab (CDF), the proton and antiproton beams come together and collide at the rate of one million collisions per second, producing a mess of secondary particles. The CDF itself is three stories tall, weighs nearly 5,000 tons ,and consists of 130,000 smaller detectors that record statistics about the secondary particles, such as speed and direction.

For every year's worth of data collected by the detector, scientists are



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CDF (left and right) is one of two detectors that physicists use in the Tevatron tunnel to observe collisions between protons and antiprotons. As large as a three-story house, each detector contains many detection subsystems that identify the different types of particles emerging from collisions at almost the speed of light. Analyzing the "debris," scientists explore the structure of matter, space, and time.

Enrico Fermi: The man behind the laboratory

BY JENNIFER PURDES

The Fermi National Accelerator Laboratory in Batavia, Illinois, was named to honor Enrico Fermi, a man dedicated to particle physics, knowledge, and discovery. Fermi was born in Rome in 1901. After studying at the universities of Pisa, Leyden, and Gottingen, he became a professor of theoretical physics at the University of Rome. Here he earned the nickname "the Pope" from fellow physicists for being utterly infallible.

As tensions were building in Europe during the 1930s, Fermi came up with the theory of beta decay, the process of neutron decay in which an electron and a neutrino are emitted. It was his theory explaining the interactions of this process that led to the recognition of the weak interaction force, one of the main topics of research at Fermilab.

Fermi continued experiments on his theory, bombarding various elements with "slow neutrons," and observed an odd phenomenon that would later be recognized as nuclear fission. Luckily this was not realized at the time; the experiments were conducted in Italy, which would soon become one of the Axis powers of World War II.

He received a Nobel Prize in 1938 for his work on nuclear processes. The award ceremony in Stockholm offered Fermi and his wife, Laura, an opportunity to escape the increasingly intolerable political climate of fascist Italy.

The next year, at Columbia University in New York, Fermi and Hungarian scientist Leo Szilard coinvented the first nuclear reactor. Soon afterwards, he and many of the top physicists in the country were assembled at the Metallurgical Laboratory of the University of Chicago to work on the Manhattan Project.

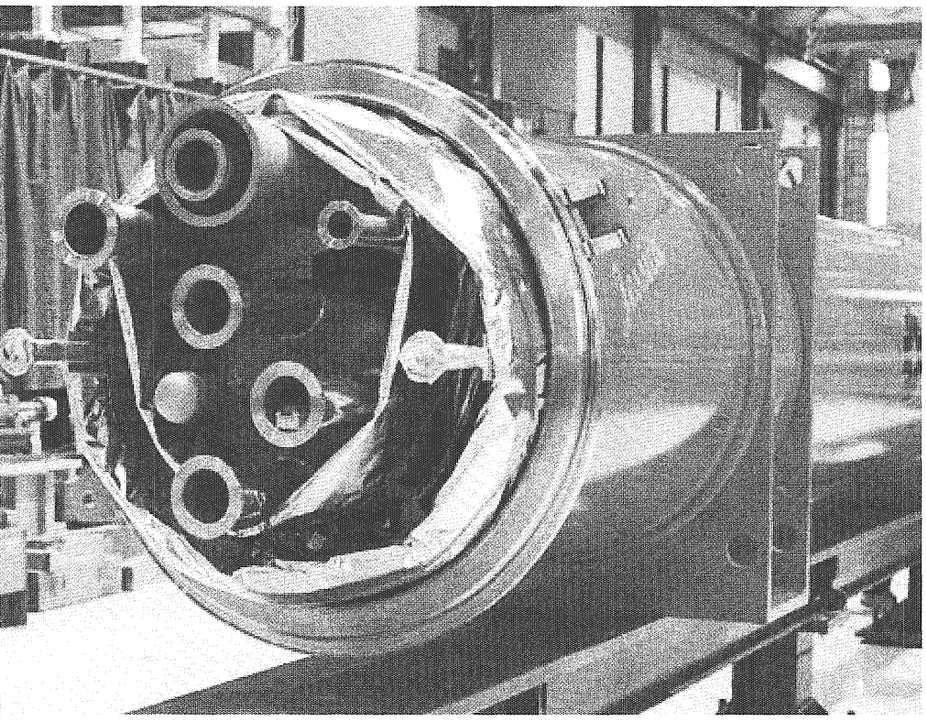
On December 2, 1942, he produced the first sustained nuclear fission reaction in his lab in an unused University of Chicago squash court. With this step accomplished, research on the atomic bomb in Los Alamos, New Mexico—where Fermi became associate director of the National Laboratory—went quickly, and the first atomic bomb was detonated in the desert in July 1945.

Not content to simply sit back and watch, Fermi conducted an experiment during the detonation, tossing paper balls into the air and observing the deflection due to the blast.

After the war ended, the University of Chicago formed the Institute for Nuclear Studies (now the Enrico Fermi Institute) to keep the brilliant minds of the Manhattan Project together. Fermi returned as a professor and continued his research in

confronted with five years' worth of analyzing. The physicists determine the masses, momentums, and energies of the secondary particles in hopes of finding out what kind of events happen right at the collision.

DZero is another detector on the Tevatron. It is similar to the CDF and was originally designed to detect particles without using a magnetic field, as the CDF does. In 1995 the CDF and DZero jointly reported the discovery of the top quark, the counterpart to the bottom quark discovered at Fermilab in 1977.



To create very strong magnetic fields, scientists use superconducting wire that conducts electricity without resistance when cooled to extremely low temperatures. This 20-foot-long cylinder contains a superconducting magnet coil, outfitted with cooling pipes for liquid helium. Technicians will build 16 additional magnet systems for shipment to a new accelerator in Geneva, Switzerland.

The top quark is 100,000 times more massive than the up and down quarks, and theorists think it will play a key role in the solution to the different quark masses. These discoveries greatly contributed to the Standard Model, which represents our understanding of subatomic particles.

Neutrino physics is a growing part of research at Fermilab as well as the University. In 2000, scientists discovered the tau neutrino, which completed the neutrino trinity, joining muon and electron neutrinos. Physicists are very interested in neutrinos, which have a tendency to "change flavor," or switch from one type to the other, during long-distance travels. If these oscillations can be proven, it would imply that neutrinos must have mass, which makes them accountable for up to five percent of the "missing" or unseen mass of the universe.

Two new experiments now underway will expand our knowledge of matter even further. MiniBooNE (Mini Booster Neutrino Experiment), a study of neutrino oscillations over short distances, is currently under construction and is expected to begin taking data later this year.

The detector is a tank with a 12-meter diameter filled with mineral oil. The walls are lined with photomultiplier tubes to detect light that should be produced when muon neutrinos oscillate to electron neutrinos. If the results of this experiment are partially conclusive, MiniBooNE will be upgraded to BooNE with the addition of a 40-meter-diameter tank. The goal of this upgrade would be to find oscillation parameters and other relevant information.

The University is more heavily involved in the second experiment: NuMI (Neutrino at the Main Injector). This is Fermilab's source of neutrinos for the MINOS (Main Injector Neutrino Oscillation Search) experiment, which will receive the neutrinos and study the possible oscillation over a long distance.

MINOS is housed in the Soudan Underground Mine in northern Minnesota, and the University's experimental high-energy group is the largest university group involved in designing and building the huge detector. NuMI is still under construction and should begin sending the neutrino beam to Soudan by 2004.

Why are they doing it?

One may look at all these processes and wonder exactly what justifies Fermilab's $297 million annual budget. Fermilab's extensive research has long- and short-term goals.

At present, Fermilab researchers have already discovered remarkable applications. Fermilab has been using particle beams to treat cancer and has achieved a very impressive medical success rate. The laboratory has also been influential in developing technologies for accidental discoveries. One such invention in which Fermilab played a part was the World Wide Web. The Web was originally developed at CERN, the European Particle Physics Laboratory in Geneva, Switzerland, by physicists looking for an efficient way to share information. Fermilab's web site has been online since 1992, making it one of the first Internet sites.

Fermilab's research has led to new ways of working with electrical currents and magnetism, such as making circuits more effective and magnets more powerful, two essential parts in the equation for making electronics faster and smaller. Alan

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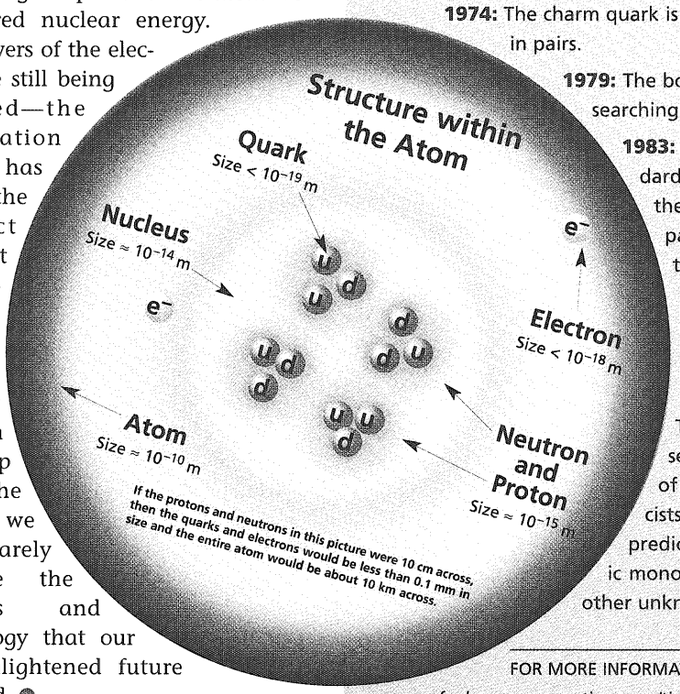
Greenspan and other economists have also cited the work produced by this research team of 2,200 as a driving force behind the U.S. economy.

Secondly, Fermilab's experiments, both past and present, show that basic physics research not only expands our understanding of the world and the nature of the universe but also improves what we do have and creates untapped knowledge for future inventions.

When the electron was originally discovered in 1897, it was said to be "useless." Dr. Leon Lederman, 1988 Nobel Prize winner and former Fermilab director, explains, "In 1680, Isaac Newton worked on the abstract problem of gravity and changed the world. In 1820, Michael Faraday discovered a connection between the exotic phenomena of electricity and magnetism, and his discovery electrified the world."

Ever since Einstein published the famous equation $E=mc^2$, the world has come to appreciate basic physics discoveries; the more basic the discoveries are, the more profound the consequences.

Without knowledge of electrons or Einstein's theories we would not have microwaves or chemotherapy. By harnessing the power of the atom we discovered nuclear energy. The powers of the electron are still being realized—the Information Age has been the product of that discovery. Science has only begun to tap into the quark; we can barely imagine the wonders and technology that our new enlightened future will hold. ●



IMAGES FROM HTTP://WWW.FNAL.GOV/. PARTICLE MAP USED WITH PERMISSION FORM THE PARTICLE DATA GROUP

Mind over matter: A particle physics timeline

BY ERIC CARON

From the beginning of known civilization, humans have speculated about what we're made of. Possibilities have ranged from water and the four elements to quarks and the Higgs boson.

624 B.C.E.: The Grecian Thales suggests that the basic substance of everything is water.

424: Empedocles claims all matter could be reduced to earth, fire, wind, and water.

370: Democritus hypothesized that all matter is made of indivisible particles called atoms.

1898 C.E.: Joseph Thompson presents the "plum pudding" model of the atom, seeing it as a sphere with raisin-like electrons scattered throughout. This theory came on the heels of discovering electrons.

1909: Ernest Rutherford leads an experiment that finds a dense, positively charged nucleus at the atom's center.

1919: Rutherford's team finds the proton within this nucleus.

1931: James Chadwick discovers the neutron, completing the first-generation atomic model. Paul Dirac proves the existence of positrons (an electron with a positive charge) the same year. This is the first example of an antiparticle.

1937-1961: Physicists' examinations of cosmic rays produce evidence for muons, mesons, pions, and leptons—particles left over from the Big Bang.

1957: Physicists learn that protons and neutrons are made of even smaller particles.

1963: Quark Theory, although very controversial at the time, creates a way to categorize the 150 known particle types. It postulates that protons are made of smaller particles with fractional charges: up, down, and strange quarks.

1974: The charm quark is found, helping physicists realize that quarks come in pairs.

1979: The bottom quark is observed, leading physicists to start searching for the top quark.

1983: Gauge bosons are discovered, confirming the Standard Model of Particle Physics. Gauge bosons, of which the most familiar is the photon, are nonmaterialistic particles responsible for such forces as magnetism, the strong force, and the weak force.

1995: After 18 years of searching, Fermilab finally discovers the top quark. This completes the quark model, though the behavior of the top quark still baffles scientists.

The jigsaw puzzle of matter is still not solved. The search continues for the Higgs boson, the only particle of the Standard Model that has yet to be seen. Physicists are also looking for the supersymmetric particles predicted by String Theory, proton decay, and the magnetic monopoles predicted by the Grand Unified Theories, and other unknown particles. ●

FOR MORE INFORMATION see: superstringtheory.com/experm/exper1.html, www.fnal.gov, or www.time.com/time/time100/scientist/profile/fermi.html.

St. Paul's GREEN VILLAGE

BY ANDREA MOSHER

At a time when every American road seems to be swarming with gas-guzzling sport utility vehicles and farmland is developed into residential neighborhoods practically overnight, hope for saving the environment appears to be dwindling. But through the media, formal education, and general knowledge, environmental awareness among Americans has actually been strengthening over the past years. Many Americans are facing and addressing the realities of depleting natural resources and damage to the environment.

Relatively simple and effective answers include recycling and composting. These solutions have been beneficial and continue to play a tremendous role in reducing waste, yet the problem of an unhealthy environment persists.

New possibilities for eco-friendly lifestyles are emerging, not only through published guides like *The Twin Cities Green Guide*, but also through broadening new concepts in sustainable living.

The once unimaginable idea of a sustainable village has recently come to life in the Lowertown area of St. Paul. The Lowertown Depot, a user-friendly and Earth-friendly place to live, is being created from an area that was a natural shame.

The four-acre piece of land on the city's east side is edged by the Lowertown Bluffs behind and railroad tracks on the west. The land is currently littered with trash and is considered a brownfield (spoiled land, unsuitable for general use). The soil is contaminated, and the expanse along the railroad tracks is populated only by an occasional homeless person.

Building a vision

Despite the area's bleakness, Jeff Wallis of Mondo Management was able to see in it an innovative opportunity. Its proximity to downtown St.Paul, westward-looking view of the skyline, location within the urban core, and easy access to bike trails and highways all recommend it as an affordable and convenient site for almost any sustainability project.

When Wallis bought the land and its dilapidated brick building, the remarkable location and Wallis's interest in alternative transportation led him to consider using it for housing. It could provide housing that would allow people to bike to work and not have to live in downtown. The transportation possibilities pushed Wallis to further explore the potential of sustainable design. With no formal background but an itch to develop an Earth-friendly community, Wallis decided to research sustainable design, technology, and products.

The Lowertown project will essentially be a sustainable village that will include commercial, living, and office space. The total project, which will include nine to 12 buildings, should be complete in five to seven years.

The first housing unit will be created from the existing industrial brick building. The structure will be retained, but insulation, a new facade, and an additional level will be added. To address the soil contamination problem and at the same time provide parking, the soil below the building will be excavated and replaced with a parking garage.

The building will become customized condominiums. Two other buildings that will hold additional living and commercial space will be included in the first phase, which will be completed in 2003.

Sustainable designs

Saving resources and sustaining the environment is an integral and defining part of the village—whether it's considering energy sources, appliances, or construction.

"We're doing everything possible in the confines of our budget," Wallis says as he explains how they are working off a normal building budget and replacing as much as possible with sustainable features.

In addition to using the existing building, the plan includes on- and off-site wind turbines and a limit of one car per condo. Owners will be charged for an additional car, unless

it is a hybrid or electric car.

Most of the wind towers will probably be off-site, although some smaller windmills will be set up on-site, primarily as a backup. One wind tower can produce nearly enough power to fuel 250 homes, and Wallis hopes to use wind to power the whole village when construction is complete. Residents will share ownership of the towers, and any remaining energy will be sold to Xcel Energy. They will still be connected to the power grid, but this net billing practice will keep energy costs low and improve the environment.

Other ideas, which have yet to be deemed sensible and effective for the project, include greywater and blackwater systems of water recycling, biocomposting toilets, geothermal heating and radiant floor systems. Although he hopes to include these ideas, Wallis says they are trying to avoid anything that is experimental or uncertain.

The Lowertown design is not solely based on new technologies. One way to help the environment is to reduce the use of cars. The Lowertown design has taken an old idea, Main Street U.S.A., and reused it to encourage people to live and work at the same place. Both residential and commercial units are being built together on site so residents don't have to commute. Other more primitive forms of Earth-friendly living, such as on-site gardening and composting, will also be supported.

Carrying the idea through

"There is a lot of serendipity in this project," says Joe Otte, an environmental engineer involved in the project. Obviously, the project will be the product of much thought and hard work, but it seems Wallis had some luck. Not only was the land and price right (the site was cheap because of the contaminated soil)—the time was also right. The Bruce Vento Nature Sanctuary has been proposed for 26 acres next to the site. The projects complement each other, and both groups are able to work together to improve the whole area. The park's bike trails, for example, fit both groups' objectives.

ANDREA MOSHER

Wallis and a business partner initially funded the project, but he says he is hoping to obtain city assistance, through grants for sustainable design features and monetary aide for cleaning up land long used as a dumpsite.

Prices of the first phase units range from $100,000 to $300,000. The units are intended to be affordable to provide the sustainable living alternative to everyone.

"There are a lot of people who would choose the sustainable alternative if it were a choice, but it's just not a choice," Wallis says. The demand already exists, he says, and the Lowertown Depot project is just "providing the choice."

Although there will be no formal regulations beyond the car limit, Wallis expects that building tenants will share concern for the environment and will encourage others in the village to follow sustainable living practices. Wallis predicts that once people move into the community, they will be more conscious of what they do.

Wallis says the title "village" does not indicate it will be a utopia of extreme environmentalists; rather, it will be a neighborhood where "the infrastructure is there for the people to live sustainably." The buildings and community will be much like any other community. Compared to a suburban neighborhood, Wallis says, "you're gonna see the odd wind turbine, but other than that you won't know the difference."

Wallis looks to the future with concern. He wants to "have the system ready when it really does get down to the critical point," which he implies is essentially the present. "We're going to do it. That is the difference with this project—it is not a conceptual project."

The Lowertown project is the nation's first sustainable urban village on this scale, but Wallis hopes that "if this is a model project, other developers will do it. We don't want to be the only ones doing it; we hope that other people will pick up on the idea and that someone else will create sustainable communities." ●

FOR MORE INFORMATION see
www.merriam-park.org/landuse.html or
www.lowertown.org/LRC/index.htm

NANOTECH TRANSISTORS

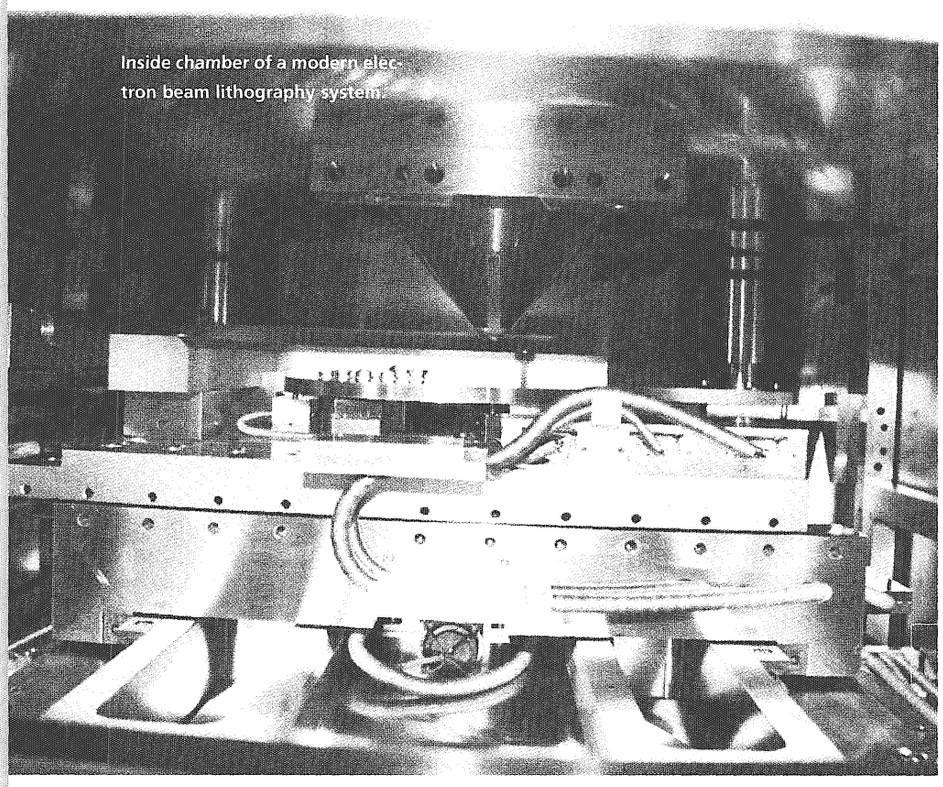
Tiny particles help the transistor take a giant leap forward

BY NEIL GRAF

Without question, the transistor ranks among the most important devices used to develop the technology that surrounds us in our everyday lives, such as radios, TVs, and computers.

A transistor is a three-terminal solid-state device that acts as an on-off switch. Transistors have many important applications, including producing the current, voltage, and power gains of signals; coupling circuits of differing impedance levels; and manipulating signals in the frequency domain.

The transistor was invented December 23, 1947, by a trio of scientists—experimentalist Walter Brattain and theoreticians William Shockley and John Bardeen—who shared the 1956 Nobel prize in physics for the invention.



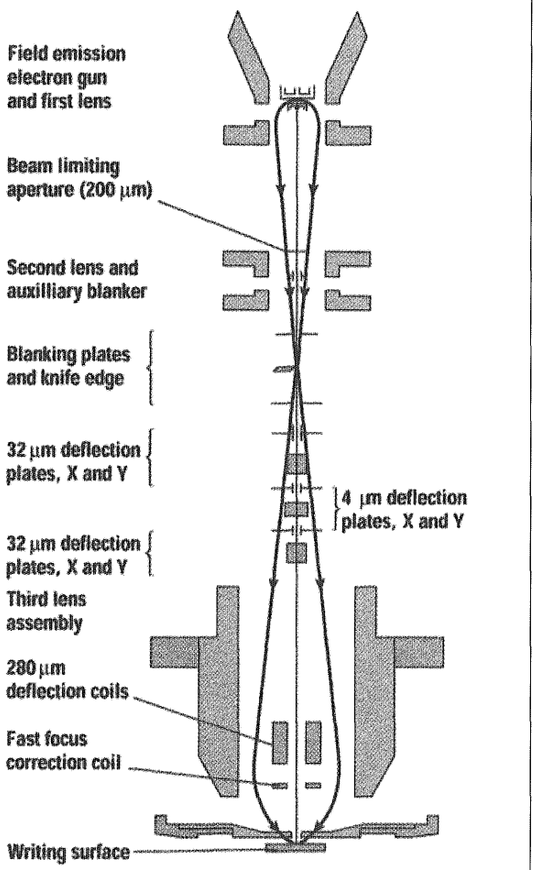
Inside chamber of a modern electron beam lithography system.

Although the first transistor was developed at Bell Labs, New Jersey, the history behind its invention has a rich and venerable connection to the Minnesota. Brattain earned his doctorate from the University in 1929, and Bardeen was on the University faculty from 1938 to 1941. After spending World War II at the U.S. Naval Ordinance Laboratory, Bardeen considered returning to the University's physics department, but decided to accept a position at Bell Labs.

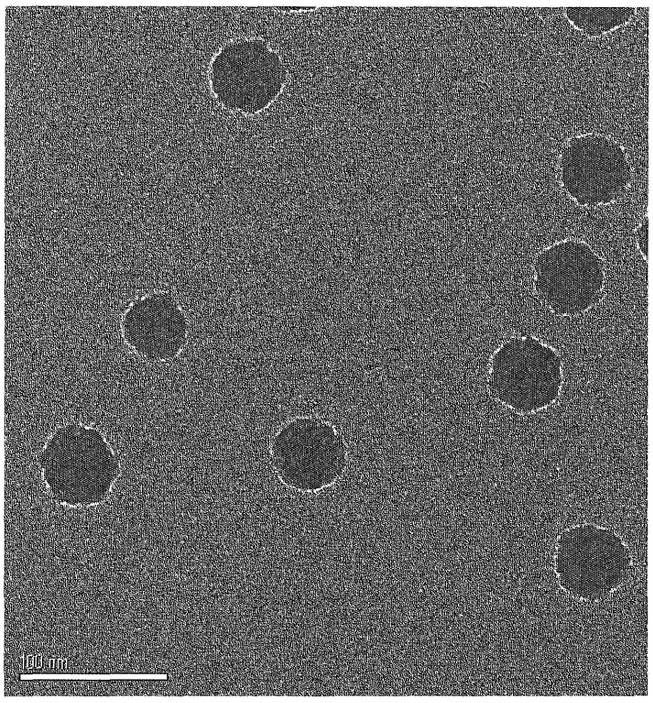
The invention of the transistor sparked what many would call "a solid-state electron device revolution." This revolution was in large part made possible by "Moore's Law."

In 1965, Gordon Moore, then chairman of Intel, predicted that the number of transistors per silicon chip would double every year for at least the following two decades. To date, Moore's Law has been uncannily accurate. Currently, a 2.2 GHz Pentium 4 microprocessor holds approximately 55 million transistors on a silicon chip slightly larger than one square inch.

One might ask, "What is the limit of the density of transistors that can be put on a silicon wafer?" Answers may differ, but the density limit may be reached as soon as 2010. However, nanotechnology—typically defined as any technology dealing with structures smaller than 100 nanometers—will likely come to the rescue.



System schematic of an early EBES system. The basic column is similar in current generation EBL systems *(After Herriot et al., reprinted by permission. Copyright 1975 IEEE).*



Spherical silicon particles (about 50 nm in diameter) on a substrate.

Nanotechnology's role

A group of IT faculty is conducting research aimed at using nanometer-sized single crystal silicon particles to improve the manufacture of electronic devices such as computer chips.

To fabricate nanotransistors for this project, the researchers synthesize controlled-diameter spherical silicon particles in a silane (SiH_4) plasma. The particles are extracted from the plasma chamber and put through a series of postprocessing steps to acquire various properties. Then they are deposited at predetermined sites on a wafer using electrostatic techniques.

The nanoparticles can be used to make transistors and various single electron devices. A unique feature of this approach is that chips can be built on any kind of substrate plus they can freely mix different kinds of single crystal materials. Steve Campbell, professor of electrical engineering and director of IT's Microtechnology Laboratory, says we might someday see high-performance computers woven into clothing or built on a contact lens.

Transistors are built with nano-particles using electron beam lithography, a process in which a focused beam of electrons strikes the surface of the substrate coated with a thin film called a resist. When the wafer is put in a chemical developer solution, areas on which electrons were deposited are removed, leaving the desired structure.

Looking ahead

Using electron beam lithography, it's possible to create physical structures with very precise dimensions and shapes—such as an image of the University logo—composed of lines 1,000 times smaller than a human hair.

Thanks to nanotechnology, the capacity to make electronic devices increasingly small, intricate, and complex will no doubt continue for many years. The applications for such atomic-size electronic devices are countless, and the possibilities of this burgeoning field of science seem limited only by the imagination.

Whatever the future may bring in the form of nanotechnological advances, it would be hard to argue that this technology will not affect people and the planet in dramatic ways. One can expect to see nanotechnology bring out the best in scientists and engineers across the globe as they make the world a more hospitable place by increasing the quality of life and standard of living.

As Campbell says, "The previously unimaginable world we live in today, with streaming video, laptops, PDAs and cell phones, was brought about by microtechnology innovations. There is every reason to believe that nanotechnology will provide at least as many changes to our lives that we cannot yet foresee." ●

FOR MORE INFORMATION see www.thestudy.qc.ca/students/History/Transistors/Links.html or www.rohm.co.jp/en/transis-

A guide to Going Green

A new publication provides everyday solutions for sustainable living

BY ERIC TSAI

Ami Voeltz was frustrated with being an environmentalist.

On the Web. On the phone. In the library. She explored every avenue to research new ways of making her lifestyle more environmentally sustainable. But after hours of waiting on hold with organizations, leafing through outdated encyclopedias and surfing convoluted web sites, she found that it took too much work to get answers that should have been easy to find.

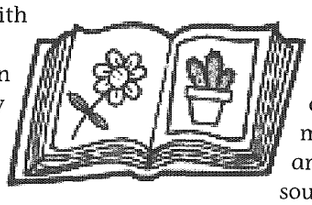
What Voeltz really needed was an easily accessible book that could not only provide information on a wide range of sustainability issues but also suggest simple lifestyle changes in light of those issues. Unable to find a suitable source, Voeltz decided to design her own book. The aim was simple: to condense a large amount of information from disparate sources into one easy-to-use guidebook.

"I thought that by making some of this information more accessible, people would be more likely to make changes because they wouldn't have to take those extra steps that I had to take," says Voeltz.

Now, in addition to asking questions about sustainable living, Voeltz is helping to provide the solutions with *The Twin Cities Green Guide*, Minnesota's first comprehensive guidebook on sustainability.

A user-friendly guide

The *Green Guide* is a user-friendly guide that educates Twin Cities residents about environmental issues and serves as a resource for sustainable and community-oriented living.



The 300-page book takes a comprehensive approach to sustainability, elaborating on core issues like transportation, consumption, waste, energy, and citizen action while also exploring more unconventional approaches like do-it-yourself projects, arts, and recreation.

Aiming at changing thinking and lifestyle, the book raises awareness of the products we buy, the businesses we support and the waste we create.

"I wanted to try and get as many people involved in sustainability by showing them simple ways to adjust their lives," explains Voeltz. "If you can just teach someone one idea and get them interested in it, they will want to learn more and do more because it feels right."

The *Green Guide* itself can be read through cover to cover or leafed through occasionally. The guide is divided into 17 categories, each consisting of in-depth articles written by Minnesota experts. For example, in its "Energy" section, you'll find articles that explain the use, benefits, costs, and availability of alternative energy sources. Other articles in the Energy section give tips on increasing home energy efficiency and energy-use reduction.

Each article gives a thorough explanation of sustainable practices with plenty of information for both avid and novice environmentalists. For further research, each article also features a resource box with relevant Web sites, books, and local organizations.

Design of the guide

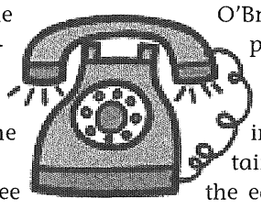
The *Green Guide* was released in January, but the vision began two years earlier. Voeltz decided to create her own nonprofit organization to allow full freedom in designing the book. She obtained grants from the state of Minnesota and private donors to create the Green Guide Organization (GGO) in August 2000.

Above all, Voeltz wanted the *Green Guide* to be written for and by the community. She started a grassroots campaign to rally local support behind the GGO. Members put up posters, distributed e-mails, and called local organizations to recruit

IMAGES COURTESY *THE GREEN GUIDE*

writers and volunteers from around the Twin Cities.

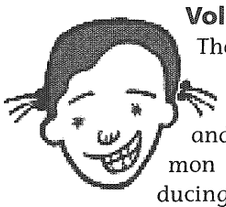
As Twin Cities residents heard about the GGO, Voeltz soon found she was not alone in her cause. Five others joined her to form the Green Guide staff, which organized all GGO activities, and over 200 Minnesota volunteers lent a helping hand throughout the project.



"It was really exciting to see how the word spread about what we were creating, and great to have so much support from so many different people and organizations," says Voeltz.

As a group, the *Green Guide* staff decided to become a living example of the practical advice they set forth. The guide was produced under a strict code of ethics that examined the environmental impact of almost all levels of activity.

They corresponded by email and made business cards with rubber stamps. The guide itself was printed on 100 percent post-consumer paper; the binding was made with nontoxic, water-based glues; and the guide's compact design ensures an efficient use of paper.



Volunteer effort

The GGO grew, attracting volunteers with diverse backgrounds and talents. But the common vision remained producing a clear, accessible guide that could serve as a resource on sustainability for the entire community.

Many volunteers balanced work, studies, or both to contribute to the *Green Guide*.

"The common motivation that the group had was that everyone was able to envision what a resource the guide could be," says Mark Snyder, a GGO volunteer who also works for the Minnesota Office of Environmental Assistance. Snyder joined the GGO as a volunteer writer and editor after discovering his employer contributed a grant to the project.

Marnie O'Brien, another GGO volunteer and residency program associate at the University Medical School, heard about the GGO after discussing environmental issues with a friend. O'Brien quickly joined the project, liking what she saw as a supportive, noncondescending approach to sustainability. Serving on the editorial board on the *Green Guide* allowed O'Brien to voice her environmental beliefs in a respectful way.

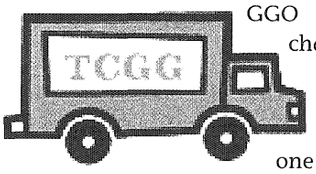
"I didn't want to sit and preach to people about changing their lives. I just want to live it and in that end be an example for my kids and the rest of society," she says.

Even the main staff, who supplied the driving force behind the *Green Guide* team, contributed largely as volunteers. The Minnesota Office of Environmental Assistance grant was a "one-to-one" grant in which all funds acquired were to be matched by the GGO.

Because the GGO lacked the capital to match the grant, staff members contributed their work hours for the project as in-kind donations.

"For every four hours that the staff contributed to the guide, three hours were volunteer time or in-kind. So a job that would normally pay $10 per hour actually paid $2.50 per hour," explained Snyder. "It was a volunteer project at all levels."

A focus on the community



In many ways, its dedicated, community-oriented approach to the *Green Guide*'s production was central to realizing many of the GGO's goals. Because the guide was a community effort that drew from a large diversity of opinion, the guide was able to remain sensitive to environmental issues at the local level and tailor its message to suit those needs.

According to Voeltz, focusing on the local level helps strengthen communities, which is one key factor in promoting sustainability. "Working and living locally gives people the opportunity to see the changes they are making by their contributions and support [local spending] in their communities," she says. "It makes it easier for people to see how many resources they use and how their lifestyles affect others."

The GGO's reliance on strong volunteer support helped make the *Green Guide* available to people of all income levels. They kept the price to $10, part of which funds an online edition of the guide. Free copies were also distributed to schools, recreational centers and park buildings to make the guide as available as possible.

Moving forward

The GGO will continue to update *Green Guides* every four years to meet the changing needs of the community and broaden the range of opinion. The staff is already busy collecting feedback from readers for improving the guide. Profits from this issue are also being set aside for the 2005 issue. The debut issue is already inspiring change in some of its readers.

"I know this book has already helped many people find the answers to questions they have had for a long time," says Voeltz. "Readers are marking pages, taking notes, and getting involved in the areas that interest them for the first time."

Although the *Green Guide* focuses on the power of the individual, the GGO hopes that individual changes will have a cumulative effect on society at large.

"Clearly, there is no one magic that will solve all of the problems that face Americans today," says staff member Joel Helfrich. "But if everyone took one idea from the guide and made ... changes within themselves, we would have a better United States." ●

FOR MORE INFORMATION see www.thegreenguide.org

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Physics: ESOTERICA?

Review:
The Best American Science Writing 2001
Timothy Ferris, Ed. New York: Ecco, 2001.

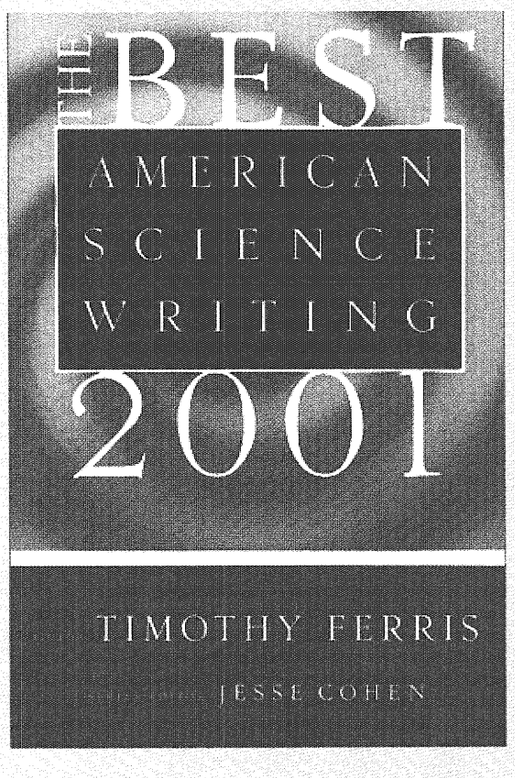
BY CHRISTEN OPSAL

If *The Best American Science Writing 2001* truly reflects its genre, then American science writing comes in a handful of basic forms: portraits of individual scientists, scientific assessments of social problems, explanations of new scientific conclusions, explorations of the history of science, descriptions of technological advances, observations of animal behavior, and examinations of physics.

Six of the 23 pieces in this year's anthology are about physics. But half are so technical that I couldn't comprehend them enough to classify them further. Most of the (non-physics) pieces in the anthology are cross-disciplinary works written for a general audience by career writers; half of the articles on physics-related subjects were penned by nonliterary academics and lack the universal relevance of the other pieces in the collection.

This preponderance of highly technical physics articles may be attributable to the editor of this year's collection, Timothy Ferris. (The series, which began last year with *The Best American Science Writing 2000,* edited by technology writer James Gleick, assumes a new editor each year.) Ferris wrote such "classics" of physical-science writing as *Coming of Age in the Milky Way* and *The Mind's Sky*.

A professor emeritus of journalism at Berkeley, Ferris possesses more knowledge of physics than the general reader. In choosing the physics articles, he may have assumed that readers would have a greater knowledge of physics than the subjects of the other pieces. Of course, the public may have more conscious experience with subjects like medicine and natural resources than it does with subatomic particles and space-time.



Whatever Ferris's motivation for including them, I found three essays on physics to be among the least engaging selections in the book. They frustrated me because they lacked a crucial component of any good writing for a general audience: They failed to explain their subject adequately, so I could understand why their argument about it should matter to me.

In "More Than Meets the Eye," Michael S. Turner gushes, "In the next fifteen years ... astronomers will finally be able to identify the nature of the full inventory of ingredients that make up the universe." Once scientists understand this, the University of Chicago astrophysics professor explains, they will be able to predict the behavior of the universe. Is that something we would want to do? What would those predictions tell us, really? Turner fails to address the ramifications of the desired achievement.

Erik Asphaug's personal obsession is asteroids. As an assistant professor of earth sciences at the University of California, Santa Cruz, he seeks to answer many questions about them: "Are they solid inside or aggregate assemblages? What minerals are they composed of? How do they survive collisions with other small bodies? Could a lander or astronaut negotiate an asteroid's weird surface?" Again, the author fails to convince me that I should care about the answers to these questions.

Finally, Princeton physics professor emeritus John Archibald Wheeler

asks, "How Come the Quantum?" In three pages, he identifies the quantum as a persistent scientific mystery, notes his personal contributions to quantum physics, and concludes that the answer to this question will also help us answer another: "How come existence?" I suspect that speculative answers to the latter question could take up a book in itself; Wheeler only breeds confusion by mentioning it in passing.

In contrast, two of the remaining essays on physics—Joel Achenbach's "Life Beyond Earth" and Alan Lightman's "A Portrait of the Novelist as a Young Scientist"—are by writers who know that we need to understand the subject in order to care about their conclusions. They go to great pains to bring us up to speed.

Achenbach, a reporter and columnist for *The Washington Post*, seems accustomed to explaining scientific concepts to a lay audience. He writes carefully, taking no background knowledge for granted: "Our ideas about extraterrestrial life are what Sagan called 'plausibility arguments,' usually shot through with unknowns, hunches, ideologies, and random ought-to-bes," he explains.

Lightman, a "novelist, essayist, physicist, and educator," engages us in a brief personal reminiscence about how he out-aged theoretical physics, simultaneously explaining and bemoaning the loss of his field. He clarifies his discipline for the lay reader: "Theoretical physics, and many other kinds of science, work in a world of the mind." With one brief sentence, Lightman opens his essay to nearly every reader.

Achenbach, Lightman, and most of the other writers featured in the collection don't assume that readers have a background in their field, and they also aren't condescending about bringing you up to speed. This is a good thing: Given the breadth of subjects and styles that appear in this collection of science writing, we need all the help we can get.

FOR MORE INFORMATION see www.amazon.com

Grad school applicants multiply in bleak job market

BY DANIEL THOMAS

With three weeks remaining before graduation, mechanical engineering major Jon Robelia quickly rewrote his resumes career objective statement: "Enthusiastic to obtain a permanent position in mechanical engineering" became "enthusiastic to continue my education in mechanical engineering."

Last summer, prospects were rosy for the Maplewood, Minnesota, resident. He was hired by Boeing after an internship and given a leave of absence to complete his senior year at the University.

But in March he was laid off. Now, like a growing number of engineering graduates, he is looking to graduate school as an appealing option while employment is hard to find.

Robelia says the reason for this decision was "not just the bad job market, but that certainly was a factor."

Apparently, others have had the same idea. So far, Robelia has only applied to the University, where the mechanical engineering graduate program has seen a 22 percent increase in applications over last year's numbers. In other departments the increase has been more dramatic: Electrical engineering, the largest IT graduate program, has seen an increase of about 65 percent.

Job slump

The current job market is a stark change for engineering graduates, who just two years ago could choose between four or five lucrative job offers. Engineers were in great demand during the period of rapid economic growth leading up to the slowdown in 2001.

Engineers reaped the benefits of the hi-tech boom fed by telecommunications deregulation in 1996, the Y2K spending of 1998-1999, and the dot-com bubble of 1999-2000. But average annual raises for engineers, which peaked at $7,300 in 2000, fell to $100 the next year, according to an *EE Times* study.

Layoffs began to creep in as salaries leveled off. The events of September 11 and the fall in the 2001 third quarter gross domestic product precipitated another wave. Robelia was one of the 30,000 layoffs Boeing announced following the airline slump at the end of the year.

According to Sharon Kurtt, director of IT Career Services, the slowdown in hiring was already evident in 2000. Manufacturing companies experienced a decline near the end of 1999, and the mechanical engineering job market was the first to feel the effects.

Graduates now are lucky to get one good offer by May. The number of companies coming to campus for interviews dropped off sharply last year, and many companies delayed start dates for recently hired students.

"Companies were less confident in making commitments to students," Kurtt says. Students have had to put much more effort into their job search and look for jobs using other methods.

For Thomas Manley, who majored in electrical engineering and computer engineering, that extra effort paid off. He started searching in September 2001, signing up for every career service interview he was eligible for, sending his resume to every com-

GRADUATE continues on page 20

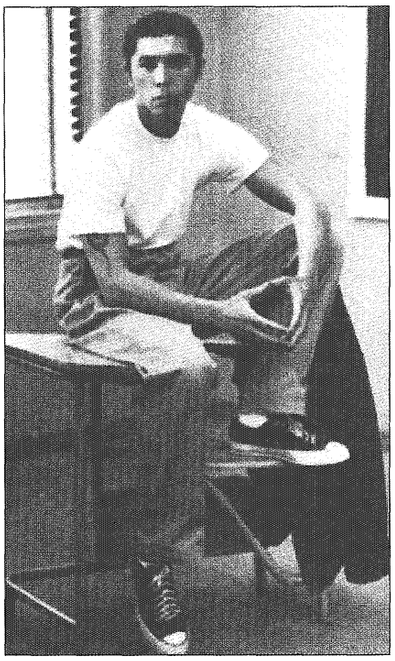
STAND AND DELIVER (1988)

Starring:
Edward James Olmos *(Selena, Blade Runner)*
Lou Diamond Phillips *(Courage Under Fire, Brokedown Palace)*
Andy Garcia *(Ocean's Eleven, Hero, The Godfather Part III)*
Directed by: Ramon Menendez *(Money for Nothing)*

Synopsis: Based on a true story, Jaime Escalante begins teaching math at an inner-city Los Angeles high school. Initially, the students have trouble with simple addition, but Jaime encourages them, challenges them and eventually feeds them AP calculus. The class takes the AP test, which every student passes, but the testing board doubts the scores because they're almost perfect.

Bethany's Rating: ☆☆

First of all, this movie isn't bad per se—if you are interested in math and Spanish, you should definitely see it. But chances are if you've been in math and Spanish classes, you've also already seen it. The story line is extremely predictable even though there really aren't other movies made along these lines, but fortunately the dialogue holds the movie together pretty well. On the down side, the scripting isn't memorable or lasting in any way, and the whole thing doesn't wear well. I've grown steadily less impressed with this movie each successive time I've watched it, starting in my eighth grade geometry class. In sum, it's worth a look if you've always pined for a film with a math hero in it, but I wouldn't put it in my video collection either.



Scott's Rating: ☆☆☆

I love this movie! Although I saw it twice in high school (both times in Spanish class), I bought the DVD because it was $7 and watch it all the time now. *Stand and Deliver* has a quality of remaining enjoyable even as background entertainment. I know I'm a little biased because I'm a math major, but the acting is well done despite the rather standard script and stereotypical situations. Even though I know the film isn't brilliant beyond a standard true-story-of-overcoming-social-status Hollywood movie, the production makes this drawback very easy to overlook.

STARTUP.COM (2001)

Starring:
Kaleil Isaza Tuzman
Tom Herman
Directed by: Chris Hegedus *(Depeche Mode 101, Woodstock Diary),*
Jehane Noujaim *(Down from the Mountain, Only the Strong Survive)*

Synopsis: As its name implies, this film is a documentary of the rise and fall of one dot-com business. Kaleil Tuzman and Tom Herman, friends since high school, toss around ideas for Internet businesses until finally settling on govWorks.com. Although the exact services provided were not stated, it was implied that simple traffic violations or tickets could be taken care of online by using their software. After deciding on a business and name, the two face challenges of finding sponsorship, competing with dozens of other start-up companies, meeting facility needs for a growing employee base, and trying to run a business while keeping their friendship intact.

Bethany's Rating: ½

I found myself very distanced from this movie: The characters were not engaging, and much of the action seems to take place on cell phones. Attempts were made to draw the audience into the lives of the two dot-commers by showing Tuzman's girlfriends, Herman's daughter and mother, and shots of social settings, but they remained just attempts because these scenes came out of nowhere. The depiction of the harsh, cut-throat politics required to survive in Silicon Valley and the strain on working friendships were good but could not outweigh the slowness and distance of presentation. Overall, I left this movie with only the knowledge that it is my right to apply for a fishing license from home at 3:15 a.m.

Scott's Rating: ☆☆☆½

I found myself very surprised by this movie. I had heard very little about it, and it did not initially strike me as a documentary. I thought it showed a good case study of friendship vs. business, and the effects of our rapidly changing economy. As I saw the possibilities of success for govWorks.com diminishing despite company enthusiasm and personal ambition, I felt sorry for the founders. Although Tuzman's actions seem harsh and Herman's responses seem contrary to their initial friendship, the reasoning behind their actions is evident, so the only antagonist is the situation the world put them in. This perfectly sets up the circumstances for an enjoyable movie, and the execution is done almost to perfection as well. If I were to change anything, I would have either enhanced or completely removed the score, and perhaps increased the pace. Other than that, it's a great movie.

STAND AND DELIVER IMAGE COURTESY WARNER BROS.; *STARTUP.COM* IMAGE COURTESY ARTISAN ENTERTAINMENT

A.I. (2001)

Starring:
Haley Joel Osment *(The Sixth Sense, Pay it Forward)*
Jude Law *(The Talented Mr. Ripley, Gattaca)*
Directed by: Steven Spielberg *(Saving Private Ryan, Minority Report)*

Synopsis: For over 20 years, Stanley Kubrick planned and developed the story for *A.I.*, but he died in 1999 before it could be completed. Steven Spielberg took over and finished the project. In the far future, the world's polar ice caps have melted, technology has improved to godlike proportions, and humanoid robots have taken the place of humans in many banal positions of society. David (Osment) is a new protocol, a child robot programmed solely to love unconditionally. A family (whose son has been cryogenically frozen-to await the cure to his rare disease) buys David to take his place. However, the son miraculously recovers and returns to his family and new "sibling" David. Problems arise, and the family decides to return David for destruction. David is only programmed to love that specific family, so he goes on a mythical journey a la Pinocchio to find the Blue Fairy who will turn him into a real boy so he can return to his family.

Bethany's Rating: ☆☆

The concept is thought provoking and scary, not surprisingly for a Kubrick movie, but it suffers from several disconnects. The family's decision to keep David—and their natural son's reaction to him—are joltingly one-dimensional. But Osment and Law mimic a robotic humanity wonderfully and easily. Graphics and animation in this film are also done very well, including my favorite character Teddy—the super Teddy Ruxpin toy of the future. Another strong point is the juxtaposition of emotions and images of both people and machines. Unfortunately, this movie is a half-hour too long. A logical stopping point wraps up all the loose ends, but the end credits do not follow. Instead, a complete mood shift takes place, destroying the rest of the movie. The final scenes were some of the film's largest faults.

Scott's Rating: ☆

I will echo every other critic here and say that the styles of the two directors involved in creating this movie did not mesh well at all. Each is fantastic in his own right, but each has his own quirks. Kubrick likes to fashion dynamic characters who can sustain a film on their own, without the help of many extraneous characters. Spielberg likes to create universes inside his movies with dependable characters who react logically to their situations. Combine the two, and you have a discontinuous movie with a range of characters who do not work well together. Also, Kubrick's films tend to end on a contemplative note, not allowing an easy definition of the film. Spielberg's films tend to end with complete, satisfying Hollywood endings. Spielberg tried to pay homage to the late Kubrick and included both styles in the actual ending of *A.I.;* it turned out horribly. The movie would have been a lot better if it had ended about half an hour earlier or if it had skipped one part of it. The one saving grace of the movie was the talented Osment. But all in all, this movie did not work well for me.

A.I. IMAGE COURTESY WARNER BROS.; *YOUNG FRANKENSTEIN* IMAGE COURTESY 20TH CENTURY FOX

YOUNG FRANKENSTEIN (1974)

Starring:
Gene Wilder *(Blazing Saddles, Willy Wonka and the Chocolate Factory)*
Peter Boyle *(Monster's Ball, Taxi Driver)*
Directed by: Mel Brooks *(Blazing Saddles, The Producers)*

Synopsis: Dr. Fredrick Frankenstein (Wilder), an American medical specialist, inherits his grandfather's famous Transylvanian castle. While at first disgusted by his ancestor's infamy, he gradually becomes obsessed with the notion of recreating life and building a superhuman.

Bethany's Rating: ☆☆

This movie is a classic Mel Brooks film—but an early and perhaps not so polished version nonetheless. Several of the jokes and gags were refined and reused to better effect in later films, like *Blazing Saddles* and *Robin Hood: Men in Tights.* Despite this flaw, Wilder is a comic genius, and the small cast pulls everything together to make this more than just a run-of-the-mill Frankenstein spoof. It's very playful, except for one scene: The monster's rape of Frankenstein's fiancée is an extremely tacky and inappropriate forum for cheap laughs. Outside of a few such poorly thought-out jokes, it is a true Brooks film.

Scott's Rating: ☆☆

I didn't dislike the movie, but I felt that good ideas could only go so far without good execution. Many of the parts of the movie made me laugh hysterically ("Blücher!"), but others were simply overdone and extremely cumbersome. I like Brooks more in his silly, inane ideas ("Springtime for Hitler" from *The Producers*) which make you laugh by being funny and at the same time make you giggle by being silly. Many scenes made me groan rather than laugh. I don't like to groan. Well thought, Mel, but not well done.

GRADUATE

continued from page 17

pany he could think of (about 50), and calling up contacts in some of these companies. Manley received an offer in March 2002, soon enough to jettison his backup plan—filling out graduate school applications.

Graduate school boom

The total number of applications to the Graduate School rose 13 percent since last year, and much of this rise was due to a 24 percent increase in applications to the physical science departments.

"The slump has hurt people, but it has helped us," says John Gardner, adviser for the mechanical engineering graduate program. In addition to seeing more applications from graduating seniors, he has also received many from junior engineers who have been laid off and are returning for a master's degree.

David Champion, a 1997 electrical engineering graduate, decided to start working on his master's when he found himself without a job in June 2001.

"I knew it was going to be a long time before I found something," he says. He continued his job hunt with declining enthusiasm during fall semester. But after the September 11 attack, his intuition about its effect on the job market joined his academic record in compelling him to concentrate instead on his studies.

The booming job market of Champion's undergraduate years left a bite. He had a job three months before graduation and rushed through to start it a few days after graduation—with a GPA of 2.5.

"The idea then was to get through as fast as you can, not to get the best grades," Champion says. Even though he didn't make the 3.0 entrance GPA, he was accepted into his current program through an adult credit option. But this option requires him to maintain the entrance GPA for his first nine credits.

In addition to the stress of making the grade, Champion has moved out of his Uptown single apartment into a house with three roommates, a situation better suited to his new student budget.

Despite these sacrifices, Champion is happy with his decision, seeing it as a chance to move into a different field of work and to improve his skills for the economic rebound he says is nearing.

Nationwide trend

Andrea Scott, admissions director for the Graduate School, says delegates to the recent conference of the National Association of Graduate School Admissions Professionals discussed the increase in graduate school applications most had noticed. They attributed the rise largely to the bad job market and to the possibility that applicants are filling out more applications.

Even if prospective students are inflating the numbers a bit with extra applications, the greater number of applicants will intensify competition for places because the number of students accepted for most programs does not change. In fact, a downturn in the economy means there is less funding available for graduate education.

As competition for both jobs and graduate school places gets tougher, many graduates are also examining other options. Mechanical engineering senior Neil Olness, who has already had 10 interviews, is considering staying on at his campus bookstore job when he graduates in May.

As the economy shows signs of recovery, Kurtt says, this year's graduates may be the last class to deal with the problem in such severity.

"All the signs are that people graduating in the 2002-2003 year will see a much better job market," she says. ●

FOR MORE INFORMATION see
www.grad.umn.edu/ or
www.it.umn.edu/students/services/advising.html

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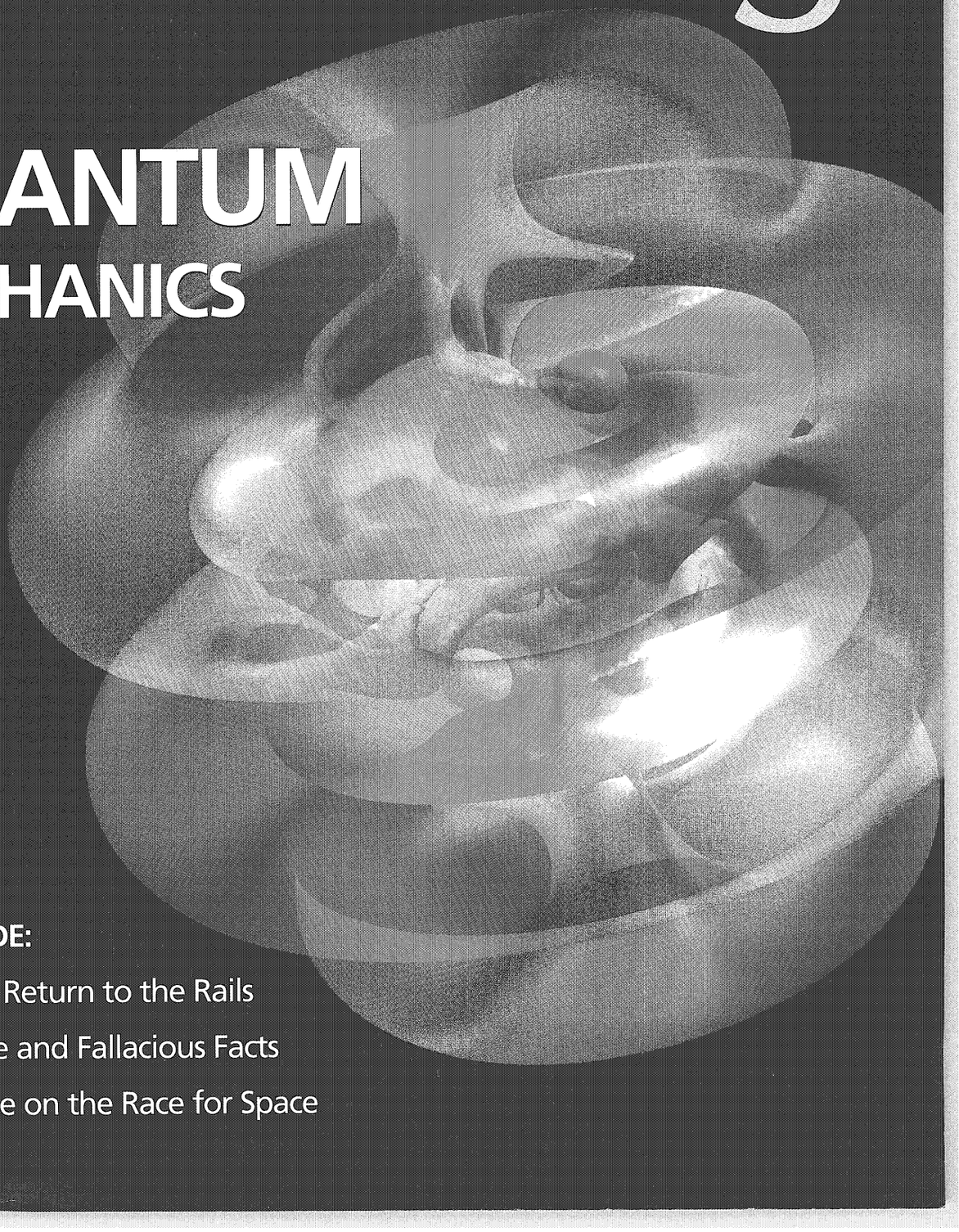

QUANTUM MECHANICS

ALSO INSIDE:

Twin Cities Return to the Rails

Silly Science and Fallacious Facts

A New Take on the Race for Space

Minnesota Technolog

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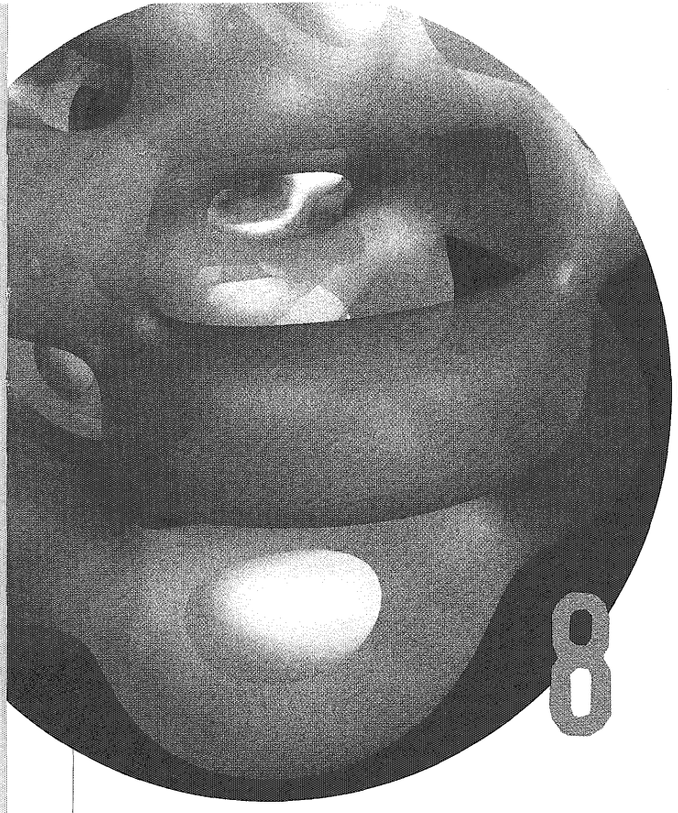
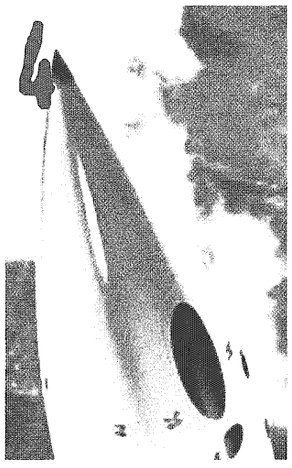
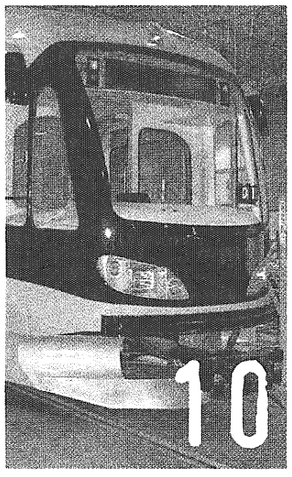


COVER STORY

Quantum Leaps

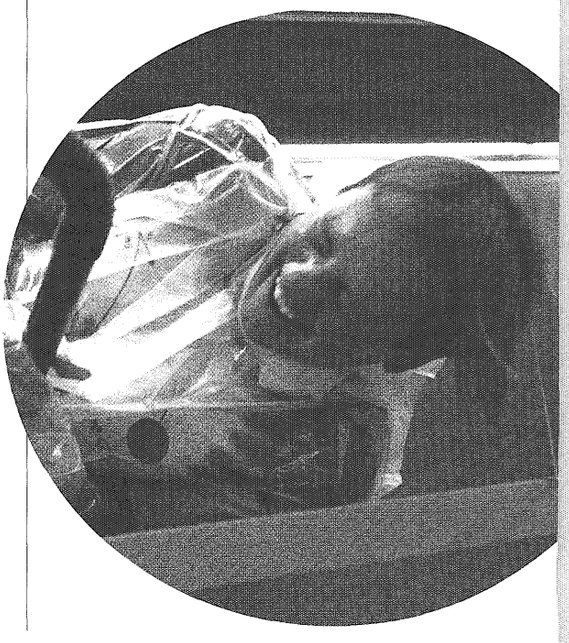
A curious branch of physics holds the key to understanding our world.





FEATURES

ALSO INSIDE



CONTRIBUTORS


Basit

Electrical engineering junior **Abdul Basit** enjoys working with the *Technolog*, playing violin, collecting new tech-gadgets, roller-blading, playing cricket and tennis, cooking spicy Pakistani and Mediterranean food, and doing homework (yeah, right!). He also enjoys reading books to educate himself more about God, watching *CSI: Miami*, and standing in rain and dark heavy clouds, which he unfortunately has not seen in Minneapolis for a while. His next goal is to get an internship for this summer.


Blodgett

Aric Blodgett is a chemical engineering junior. When not busy with homework or waiting tables he spends his time exploring the astral plane and doing low frequency sound wave modulation. His other pasttimes include getting in touch with nature and becoming one with the Universe.


Covault

Ever wish you could get paid to wander around the globe? If you figure out how, stop by the fencing club and impart your secret to **Rachel Covault**. (And no, there's nothing of the chain link or picket variety there.) If practice is not in session, she is either ordering foils from a German company as the Officer at Large or waiting impatiently for snow.


Gierke

Ryan Gierke is an IT freshman. When he's not studying to maintain straight A's in his 19-credit semester, he spends his time hanging out with his synchronized swimming team buddies and raising turkeys in an empty building down the street from his house. He hopes to someday successfully shock but not paralyze himself somehow with engineering equipment, and spend the rest of his life at home with his work-related injury.


Johnson

Nate Johnson is an electrical engineering freshman. In his spare time he enjoys reading, baking pastries, writing, watching movies, working on computers and computer networks, and learning to play the guitar.


Idziorek

Jen Idziorek is a third-year chemistry student who writes other people's bios when they are incapable of doing so themselves. She spends her spare time doing research in the emergency room (don't get hurt this summer), roller blading through Riverside, and taming tiny lions. Her new favorite proverb is, "People generally shout at each other when they are far apart," and she believes that everyone needs two palm threes and a hammock.


Liimatta

Kenny Liimatta is an aerospace engineering and mechanics freshman. Originally from Milwaukee (and now a resident of ones of its suburbs, New Berlin), he takes pride in his large and costly CD collection of hip-hop and R&B. He also enjoys attending concerts at First Avenue, playing sports (especially football, basketball, and baseball), making trips to Mystic Lake Casino to lose money, and just chilling out. He also has an odd fascination with population information of U.S. cities and can tell you much more than you'd ever want to know.


Mosher

Andrea Mosher is a second year student departing the IT world for a nice and long trip to the College of Architecture and Landscape Architecture. One day, after she has learned enough in college, she will probably work in design. She is not particularly fond of writing bios, but knows an expert in the field.


Steichen

Bethany Steichen would be in her sophomore year in IT except that she is currently pursuing study abroad at the University College Cork in Ireland. While there she has learned that if something is worth doing it can be done in buckets of rain. This includes kayaking, visiting many ancient buildings that have no roof anyway, and hillwalking. Yes, the people are grand, the places are brilliant and everything is good craic!


Thomas

Daniel Thomas is a sixth-year mechanical engineering and journalism major looking forward to finally graduating in May. He recently got into leatherworking, and otherwise enjoys cross-country skiing, hiking, woodworking, and reading about God, society, Middle-earth, and other topics.


Walter

Michelle Walter is a sophomore in between majors. Soon she will be exploring the exciting field of scientific and technical communication. This semester she will be busy with writing many, many papers—but at least she's done with physics! Also occupying her time are teaching math to children and giving tours of the campus. Procrastinating activities include watching TV and movies, astronomy, shopping, and skiing when possible.

STAFF PHOTOS

EDITORIAL

Public must debate morals, merits of cloning research

The Raelians' announcement of the birth of the first human clone last December proved to be a publicity stunt, but the bizarre cult's claim underscored the urgency of formulating a response to cloning. The U.S. House of Representatives has passed a ban on all human cloning, but the bill faces a tougher challenge in Senate. The Raelians may not have deserved the attention their claim drew, but the issue of cloning warrants a great deal more—especially as the initial laws on it are drawn.

All technologies have the potential to change our lives, but few have as great potential—for good or bad—as cloning. Cloning advocates promise it will help cure diseases like Parkinson's and Alzheimer's; critics remind us that it would for the first time make human reproduction asexual—challenging our understanding and experience of society, family and humanity. The urgency of this issue is heightened by the fact that cloning has already begun: several labs have announced their creation of a human embryo since 2001. All of these clones died or were destroyed in the lab; the race among Clonaid and other maverick scientists is to implant the clone in a surrogate mother and keep the embryo alive until birth.

This new technology must be brought to public debate, not left to the judgment of scientists or legislators. Many citizens are not aware of the larger implications of cloning, and recent media attention missed the opportunity to highlight these ethical issues. The news has focused predominantly on the safety hazards of cloning, stressing for example that perhaps hundreds of embryos would need to be cloned to produce a single survivor and that most of these survivors would have genetic defects.

These are compelling arguments against cloning, but this pragmatism ignores the deeper ethical objections. For instance, cloning will allow individuals or infertile couples to have biologically-related children, or provide a perfect organ donor. But when it's moved from sexual intercourse to the laboratory, reproduction becomes a form of manufacturing. By transforming our perspective on childbearing and offering an opportunity to improve the product, it becomes a new form of eugenics.

Not surprisingly, few support cloning babies. Apart from a cult's promise of eternal life or the challenge of being the first to succeed, it has little appeal for scientists. However, cloning embryos for stem cell research is a much more interesting and appealing prospect for many researchers. While embryonic stem cell research avoids the pragmatic questions about safety after birth, most of the deeper ethical questions remain. Allowing such research to proceed would also result in the manufacture of thousands of embryonic human lives. This prompts us to question our attitude towards this emerging human life and the nature of the embryo. When does life begin? Is there enough change in the embryo after two weeks to justify this common suggestion for a research age limit? What will come next? What if scientists suggest there is vital knowledge to be gained from research on older embryos? Or research on animal-human hybrids? (Inserting human DNA into an animal egg has already been tried in China.)

One argument against cloning for research is that there are alternatives to embryonic stem cells and tissue: much work remains to be done on adult stem cells and animal embryos. This can deflate some arguments for research cloning, but it is only a temporary objection. Getting beyond the risks and alternatives to discuss the foundational ethical issues in cloning is crucial—and perhaps even more fascinating than UFO cult news. ●

Daniel Thomas, editor

FOR MORE INFORMATION see www.bioethics.gov, www.bioethics.umn.edu, www.cbhd.org

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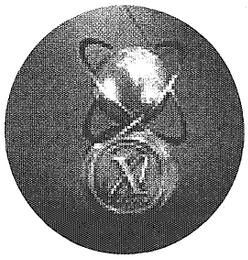


A NEW TAKE ON THE RACE FOR SPACE

BY KENNY LIIMATTA

What would you do for $10 million? More than 20 teams from around the world are building spaceships in a race for the $10 million X-Prize, a reward for the first team to create a suborbital vehicle that can carry three people to the edge of the earth's atmosphere (62.5 miles above the surface), return to land safely, and repeat the trip two weeks later.

A team from Ontario is already looking for pilots to test their Canadian Arrow, a 54-foot, two-stage reusable spacecraft that launches vertically and lands parachuting into water. Other entrants have pursued a less standard approach, launching from water, a runway, the back of a carrier airplane, or behind a tow plane. Perhaps the most intriguing is the other Canadian team, the da Vinci Project. Their submarine-shaped "Wild Fire" will be lifted to 80,000 feet by a 25-story helium balloon before firing its rockets.

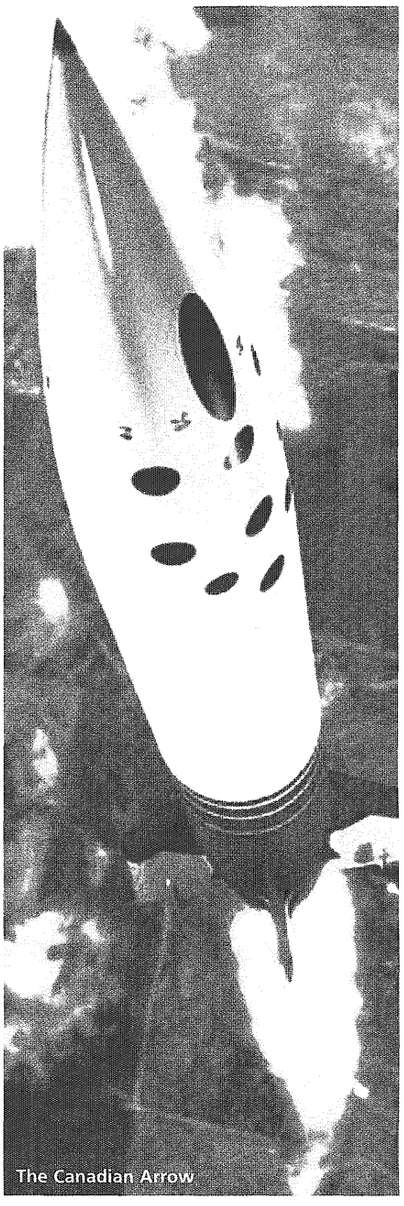
The X-Prize has kindled healthy competition in the reusable vehicle "race to space."

There is more at stake than $10 million. The prize is merely a booster for the commercialization of space travel. Creating a viable reusable spacecraft will lower the cost of the space travel, which is vital to the creation of a space industry. The X-Prize—funded in 1996 by donations from businesses in St. Louis—has provided the motivation to kindle a healthy competition in the reusable vehicle "race to space." This competition is similar to that created among pilots in the early 20th century by the $25,000 Orteig prize, which was awarded to the first pilot to fly an airplane from New York to Paris. (Minnesota native Charles Lindberg won that award with his plane "Spirit of St. Louis," but the X-Prize competitor closest to Minnesota is an unnamed rocket under construction in Bath, Michigan.)

By spurring the development of airplanes, the Orteig award helped air travel grow into a $250 billion industry. Backers of the X-Prize hope it will do the same for the space travel industry.

Another step toward this new reality is space tourism.

The first space tourist was businessman Dennis Tito, who paid the Russian Space Program $20 million for an eight-day stay in space aboard the International Space Station. Opposed to bringing civilians into space, NASA officials initially refused to let Tito enter the U.S. part of the station. Tito told MSNBC News that he hoped that he could convince NASA officials to "think a little bit differently" because he thought it unwise to not invest in space commercialism.



The Canadian Arrow

PHOTO COURTESY CANADIAN ARROW TEAM

At a conference over the summer Walt Anderson, founder of venture capital company Gold & Appel, also criticized NASA for hindering the growth of a space industry.

"As long as NASA competes politically by giving some people access to space and others not at a lower than actual commercial cost, it will continue to damage the commercial space industry in the United States," he said.

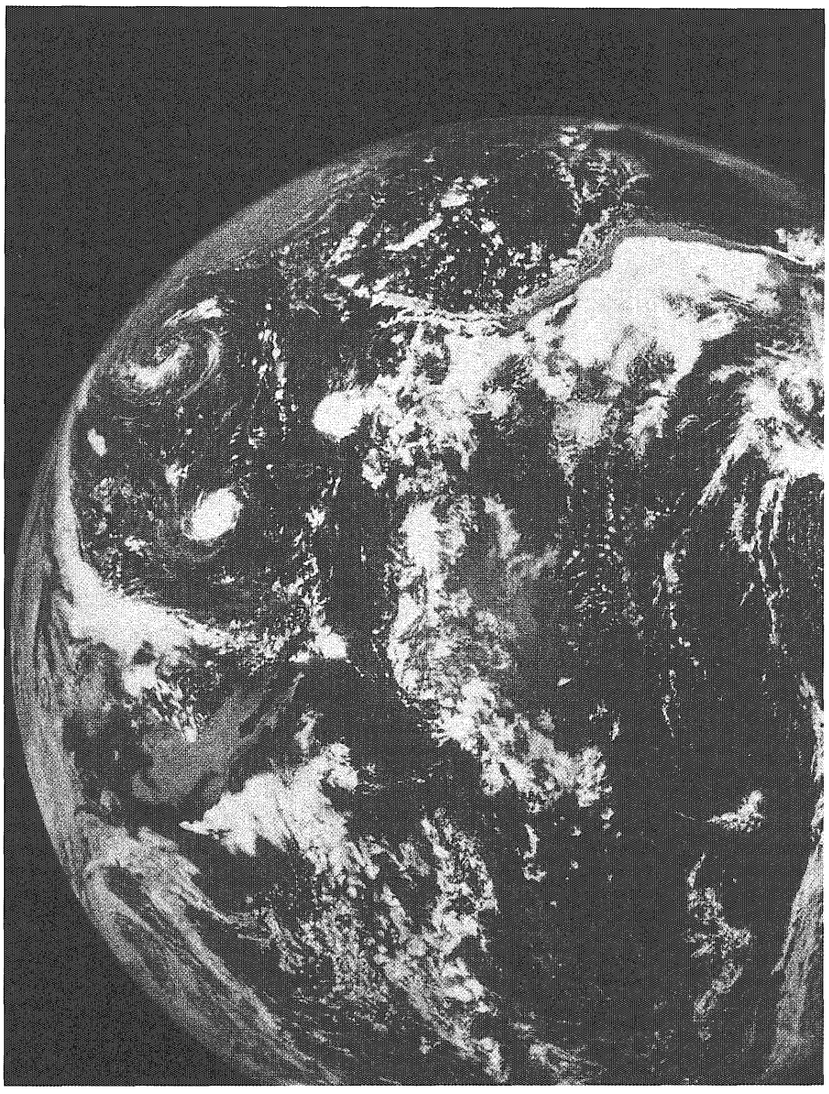
Part of the reason for NASA's resistance to the commercialization of space travel is their current monopoly over the space travel in the U.S. If private companies begin to make trips into space, NASA is sure to lose some funding.

But NASA could have a lot to gain in suborbital vehicles promoted by the X-Prize. By providing their own commercial flights to space with reusable spacecrafts, NASA could become more self-sufficient, relying less on tax money.

NASA missed out on another opportunity to be a part of commercial space travel later in the year, when Mark Shuttleworth of South Africa took a trip similar to Tito's. The Russian space program received another $20 million for transporting Shuttleworth to the International Space Station. These two trips show how much some are willing to pay for the opportunity to take a trip to space.

Of course, the average American can't afford the $20 million price tag on a trip into space, but as with any other new commodity, the retail price begins high and decreases when it adjusts to the market. DVD players, for a simple example, cost about $400 when they first came out a few years ago but now go for less $50.

Competition will help bring the price down, and there already is private-sector competition for the space travel industry. Xcor Aerospace, for example, created the first low-cost, reusable rocket engines, and has its sights set on space tourism. They have used these engines for over a year on their EZ-Rocket prototype, Time magazine's 2001 Transportation Invention of the Year. Now they are in the process of creating Xerus, a reusable suborbital spacecraft.



FILE PHOTO

Like most of the other suborbital vehicles in development, the Xerus would only give its passengers a few minutes of zero gravity, but it promises spectacular views of earth and the black, star-filled sky. They estimate customers will be able to begin rides on the Xerus in the next four years.

With the technology of suborbital vehicles almost here, other features of the space travel industry are falling into place. Space Adventures, the company that facilitated Tito and Shuttleworth's trips to the International Space station, is ready to become a booking agency for suborbital flights. They have contracted with Xcor for flights on Xerus and are already reserving tickets. They anticipate flights beginning before 2006, and "flights are filling up at a steady pace," even at $98,000 per person.

This is still out of reach for the average American, but it looks like a bargain compared to the $20 million Tito and Shuttleworth paid for their trips. And knowing our appetite for adventure and extreme experiences, the market will doubtless continue to grow and drive the price lower. Spring break in space may be just a few years away. ●

FOR MORE INFORMATION see:www.xprize.org www.xcor.com, www.spaceadventures.com

What do physicists enjoy doing the most at baseball games? The 'wave'

SILLY SCIENCE AND FALLACIOUS FACTS

BY BETHANY STEICHEN

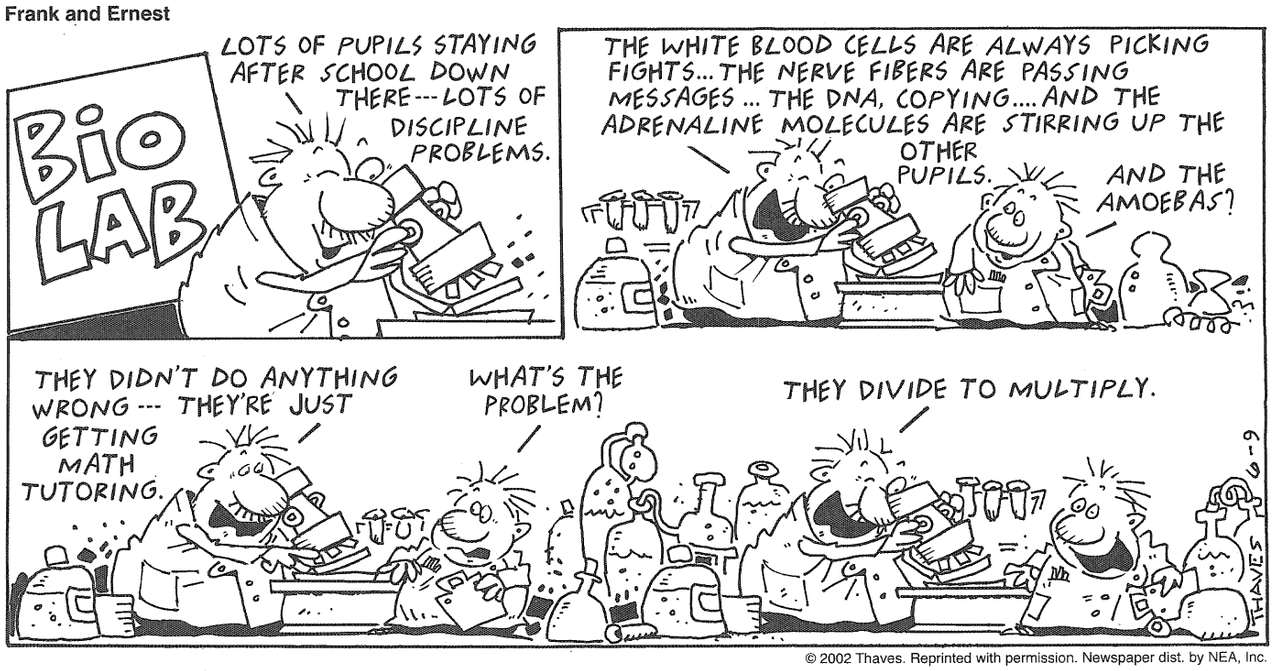
Brainy kids are often the butt of jokes—just look at Martin from *The Simpsons* and you'll see. Those kids often grow up to be scientists and engineers. But when professors and professionals bear the brunt of this sort of humor, do they get it?

According to Des MacHale, a noted researcher of the connections between science and humor, they do! MacHale, professor of mathematics at University College in Cork, Ireland, says that while people admit to theft, arson, and murder, absolutely no one will claim to lack a sense of humor. In fact, humor is one of the staples of sciences; without it, new discoveries and the long, arduous hours in the lab required to make them would hardly be possible.

If this is the case, then why are so many professional science journals, textbooks, and classes utterly devoid of humor? According to MacHale, it is because science is perceived as serious and difficult, and humor is not. Besides, governments and corporations might not fund research if they thought it was becoming too entertaining.

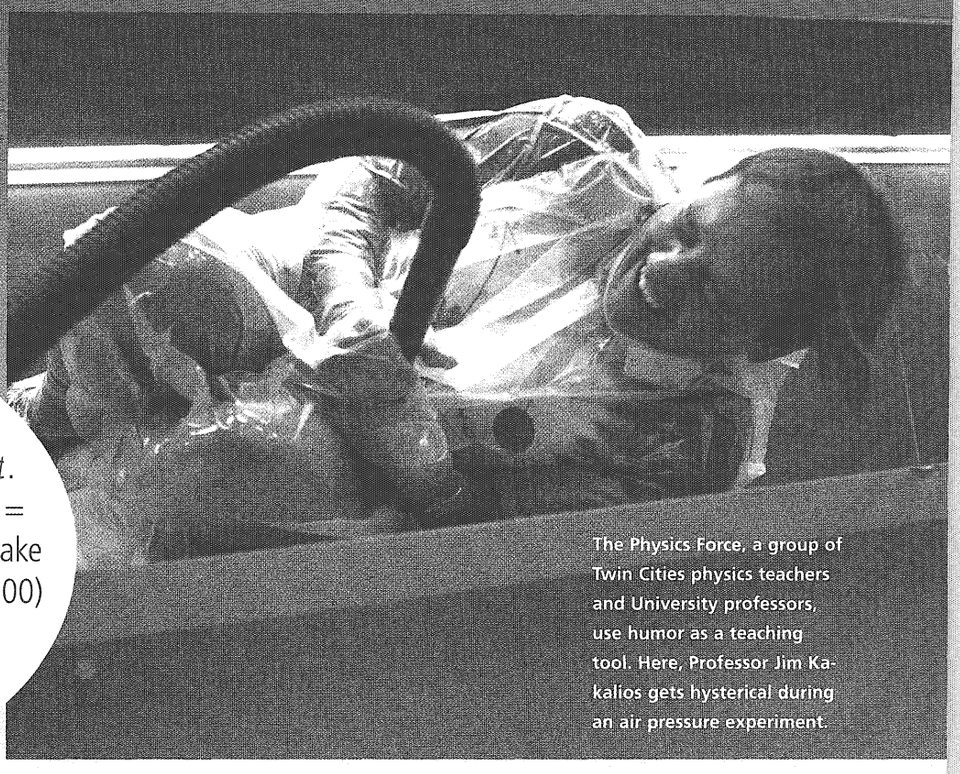
Still, many of the world's most notable scientists possess a childlike sense of humor, even in the most serious of situations. For example, activities of British scientists during World War II can be described as a series of grand April Fool's Day jokes. Scattering large pieces of scrap metal in the air to fool radar detectors; building entire 'armies' of wood and plastic in East Anglia, England, to trick German troops into preparing for an attack north of British troops' actual

Frank and Ernest



A neutron walks into a bar and asks the bartender, 'How much for a beer?' The bartender looks at him, and says 'For you, no charge.'

Theorem:
$1 = 10¢.
Proof: We know that $1 = 100¢. Divide both sides by 100: $1/100 = 100¢/100 => $1/100 = 1¢. Then take square root of both sides: sqr($1/100) = sqr(1¢) => $1/10 = 1¢. Multiply both side by 10: $1 = 10¢



The Physics Force, a group of Twin Cities physics teachers and University professors, use humor as a teaching tool. Here, Professor Jim Kakalios gets hysterical during an air pressure experiment.

JONATHAN CHAPMAN

position; and parachuting exploding decoys behind enemy lines on D-day may have seemed amusing to the scientists at the time, but they also helped win a war.

Existing technology and theories aren't the only sources of humor among scientists. Often new and revolutionary theories are regarded as preposterously comical at the time of their inception. The alchemists who formed an early foundation for chemistry were thought to be madmen for trying to transform lead into gold. Their dream has since been realized; the gold yielded just isn't enough to pay for the process.

Mathematics had to be rethought after the introduction of the following riddle:

3-3 = 2-2
3(1-1) = 2(1-1)
3 = 2

Perhaps you look at this now and think to yourself, "one can't possibly divide by zero. All numbers would have to be equal!" However, this question wasn't satisfactorily examined until George Berkley, Bishop of Cloyne in Ireland, grappled with its implications for calculus in the 1700s.

Today, evolution is considered perfectly logical by some and absolutely ridiculous by others. Not all new theories have lead to an upheaval in scientific thought, but many have provoked a good laugh along the way.

Both science education and science practice can be enhanced by humor. Serious research has found that peppering lectures with jokes increases information retention and improves test scores. Rhymes are also often used to help students remember information. For example:

Johnny's life was such a bore
He swallowed H_2SO_4.
His father was concerned, you see
And gave him $CaCO_3$.
Now he's neutralized, it's true
But he's filled with CO_2!

$H_2SO_4 + CaCO_3 \square CaSO_4 + H_2O + CO_2$

Or the poem that explains how a Klein bottle (a single-sided bottle with no edge made by attaching the edges two Möbius strips—loops with only one surface and one edge—in four dimensions) is created:

A mathematician called Klein
Thought the Möbius strip was divine;
And he said, "If you glue
The end edges of two,
You'll get a weird bottle like mine."

Small jokes and memory devices also help humanize the subject and make it more palatable for future scientists.

And as technology progresses with computers, so does the humor of technology. The latest step in both the humor of science and the science of humor (the two are completely different after all) is to discover if computers can learn to make up jokes.

This area of study is relatively new-starting in the mid-90s. Given a set of inputs, today's computers have come up with humor on the level of "Why did the kid stick a knife in the corn flakes? To become a cereal killer!"

Jerry Seinfeld, beware. Then again, in the 1950s no one believed a computer could ever rival a Grand Master in chess. ●

FOR MORE INFORMATION see: *Comic Sections: The Book of Mathematical Jokes, Humour, Wit, and Wisdom* by Desmond MacHale.

Quantum leaps

A curious branch of physics holds the key to understanding our world

BY RACHEL COVAULT

You can walk through walls. You can cheat death by being alive and dead at the same time, and you may even have uncountable identical twins acting out variations on your life in zillions of parallel universes.

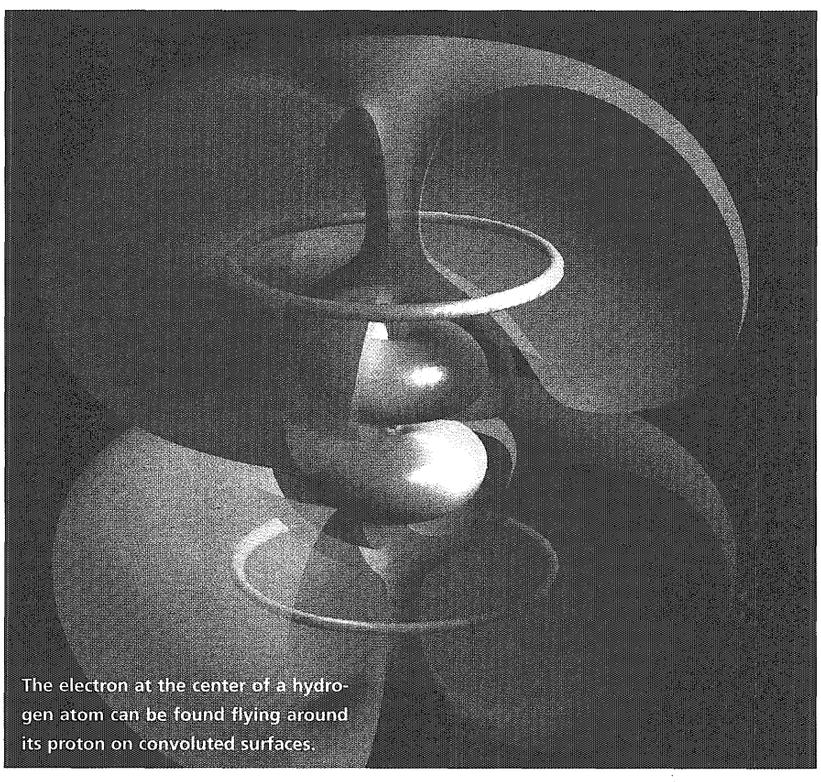
But before you start using brick walls as back doors, read the fine print. These are everyday happenings in the sub-nanoscopic kingdom of fleeting photons and escaping electrons, tiny crumbs of matter that behave as both particles and waves. These are the qualities that inspired the inventions of the laser and electron microscope, superconductivity and semiconductivity, the diode and transistor, and other fantasies in the making. The direction of our technological future is pointed by our understanding of these properties, dubbed quantum mechanics.

One of Albert Einstein's chain of epiphanies from 1905 (an idea that Max Planck had also championed earlier) was the revelation that light only comes in multiples of a certain base amount. In other words, light is quantized into indivisible particles called photons. This realization explained the mysterious photoelectric effect, the observation that it is not the intensity of light (the amount of photons) but the amount of energy each photon carries that affects the voltage of a photocell when exposed to light.

Scientists thought this was very peculiar, since light does not always behave as a particle. If light shines through a small double slit in a barrier, it shows up on a wall on the other side as an interference pattern of alternating bright and dark bars, analogous to water waves passing through a narrows. The ripples that emerge from each slit interfere with each other when the crest from two ripples combine at the wall and appear as a bright spot. When a crest and a trough meet, they cancel each other out and show up as a dark spot on the wall. Light can be viewed as both a particle and a wave.

In 1924, Louis De Broglie showed that the opposite was also true: Particles could also be seen as waves. Repeating the double slit experiment with electrons, interference patterns appeared again. When one electron was allowed through the slits at a time, each appeared as a dot upon reaching the wall, but the telltale stripes still emerged when the final destination of many individuals were marked. It was as if each electron turned into a small packet of waves while passing through the slits, let the waves interfere with themselves, then returned to its particle incarnation in one of the bright stripes on the wall.

Enter Erwin Schrödinger and his feline martyr. Schrödinger was the man who applied a bit of mathematical formalism to the situation, forming an equation describing the wave function of any particle. Solving the equation for the wave function results



The electron at the center of a hydrogen atom can be found flying around its proton on convoluted surfaces.

IMAGES COURTESY OF BERND THALLER, INSTITUTE FOR MAHEMATICS, UNIVERSITY OF GRAZ

in a picture of how pieces of matter look like waves.

So what does matter look like? What happened to those idealized models of solar-system-like atoms wrapped with dutiful electrons following perfectly circular orbits that school children are taught?

Bernd Thaller, a professor at the University of Graz, Austria, where Schrödinger once worked, is currently translating his predecessor's opaque numbers and letters into colorful, three-dimensional windows into the atomic world.

"In the strange world of quantum mechanics the application of visual techniques is particularly rewarding, for it allows us to depict phenomenon that cannot be seen by any other means," writes Thaller in the prologue to his book, *Visual Quantum Mechanics.*

With the help of Mathematica software, he has depicted the hydrogen atom in various energetic states. The rubbery surfaces correspond to the electron's wave function, and the hue to the phase of the function's imaginary parts. The imaginary parts are as important as the real ones because when they are combined by integrating the product of both parts, they produce the particle's "probability wave." This wave represents the places where the particle is most likely to be found. Far from the simplistic, concentric spheres of Niels Bohr's model, this quantum mechanical view of the atom reveals a convoluted complexity to the tiny things that make up the universe.

Any wave can be seen as the combination, or superposition, of many smaller waves, and particle waves are no exception. This means that matter can be thought of as a superposition of many different states, and the resulting wave function is used to determine the probability that matter is in one of those states.

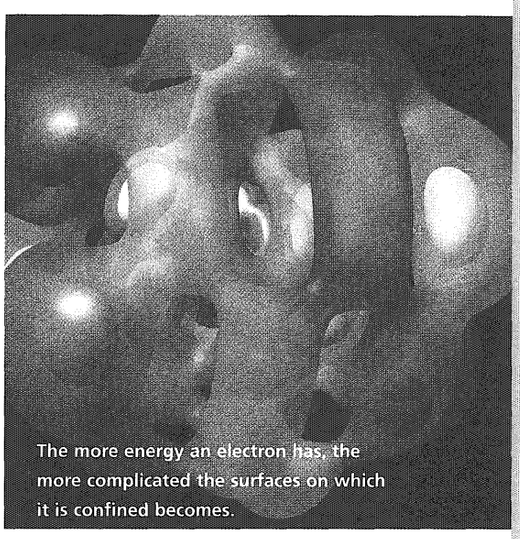
Schrödinger volunteers his cat to demonstrate this. It is shut in a windowless box equipped with a time bomb set to expel a lethal gas the instant a certain radioactive atom decays. Scientists outside the box have no way of determining the imprisoned cat's status. Even if they knew the average decay rate of the triggering substance, it is impossible to say when this particular atom will chose to radiate. The cat could be in one of two states, life or death, but until the researchers open the box, they regard their pet as being in a superposition of both states. To them, the cat is both alive and dead at the same time.

The moment the suspense is broken, the wave function describing the opposing states "collapses" into either dead or perfectly healthy. Thus, observation is not a passive act. The universe is built on statistics calculated from wave functions (for example, the likelihood of decay), but nothing can be said of a single event. This means that if Schrödinger kept a zoo of his deadly cages, at some point half of the animals would remain bright-eyed and bushy-tailed, while the other half would have embarked on their next lives. But that fact says nothing about the well being of Polly the Platypus, who remains in both states until an observation proves otherwise. Such a nondeterministic viewpoint is known as the Copenhagen Interpretation of quantum mechanics and is the standard school of thought.

The Many Worlds Interpretation is more exotic. It admits to the nondeterminism of our universe, but goes on to suppose there are infinitely many universes forming a deterministic multiverse. At every instant, every possibility hinted at in every wave function occurs somewhere in the multiverse.

Returning to the menagerie, Polly is lively in one world but lifeless in another. Since zookeepers can observe only the events of their resident universe, each universe's keepers can make bets on their platypus' outcome, but a theoretical inter-universal traveler would see the multiverse as a whole and could inform the keepers of the vitality of their charges.

If only the beasts knew how to walk through walls, they would be out of danger. When a particle or a platypus encounters a barrier that it does not have enough energy to overcome, it retreats in search of other escape routes. Similarly, a marble rolling up a ramp stops and reverses its direction when it runs out of momentum. Particles, however, also have the ability to take advantage of their wave duality to tunnel through the barrier to the other side. When a particle bounces off a wall, a fraction of the particle's wave function seeps through the wall and there is a very small chance that the particle will be observed on the other side of the wall. (Unfortunately, the wave function for mammals is so complex that Polly would have to spend longer than the age of the universe in front of her cell door before she would suddenly find herself in the hedges outside.)



The more energy an electron has, the more complicated the surfaces on which it is confined becomes.

Radioactive decay works off this principle. Particles spit out by the atom do not have enough energy to break away from the clutches of the nucleus, but occasionally they do escape. Scanning tunneling electron microscopes take advantage of this "tunneling" effect as well, recording electrons as they bridge supposedly impassible gaps between the object material and the head of the measuring device.

Quantum mechanics is still a bustling field of study. Someday PCs may be replaced by quantum computers that use qubits (quantum bits) to calculate, and secret messages may be sent by quantum cryptography. Perhaps someday Polly will even be able to teleport from her black cell into a friendlier parallel universe, leaving us to wonder about the bizarre nature of our surroundings. ●

RETURN OF THE RAILS

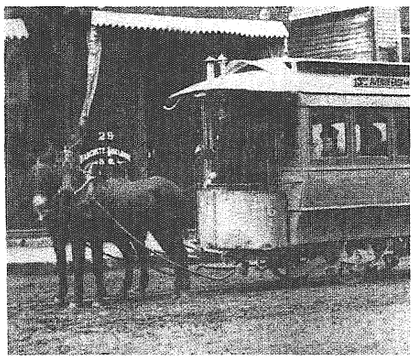
Examining the Twin Cities' streetcar tradition

BY RYAN GIERKE

The new light rail vehicles being built for Minneapolis will glide down the tracks at 55 mph, powered by two 375-horsepower electric motors. In contrast, the city's first light rail vehicles were one-horsepower, and clanked along the rails at six mph, and left a trail of manure. These changes did not occur overnight, but demonstrate over a century of advancements in streetcar technology.

Rail mass transit arrived in the Twin Cities in the form of horse cars. The first horse car line began service in 1875; it linked the University of Minnesota to a major rail depot and then continued on through downtown Minneapolis.

Horse car transit was not without its problems. In addition to their slow pace and dung trail, streetcars tired horses out quickly. It took six horses to power one streetcar for its 18-hour service period.



Horse-drawn rail cars were common around campus in the late 1870s. One line linked the University to downtown Minneapolis.

Horse car service continued for 12 years until the advent of cable cars. This new system had a long, constantly moving cable under the rails, which the car would grip to start moving and release to stop. It was invented to pull the vehicles up steep hills that horses couldn't take, but it also ran twice as fast and eliminated the problem of taking care of hundreds of horses. This system quickly made its way to St. Paul, but then disappeared even more quickly.

"The cable system was very expensive to install and, with rapid cable wear, even more expensive to maintain," explains Russell Olson, former employee of Twin City Transit System. Starting and stopping in traffic was especially difficult, because the cars had only one speed, dictated by the constant 12 mph cable. Olson is author of *The Electric Railways of Minnesota*, and now helps restore the electric streetcars that became the technology of choice after only three years of installing cable systems.

Twin City Rail Transit was one of the first rail companies to install an electric rail system after the technology was introduced in the 1880s. The first line built linked Minneapolis and St. Paul, and by 1890 all streetcar lines in both St. Paul and Minneapolis were electrified.

Electric streetcars were powered from an overhead trolley wire that was supported by a series of poles with arms protruding over the track. This wire was charged by generators spaced out along the track to supply electricity evenly over the entire line. The pantograph structure on top of the trolley pressed up against the wire and collected 650 watts for a direct current electric drive motor.

With the electric motors, "speed was much easier to control; the conductor could apply as much or as little electric power as desired," Olson says. In addition to allowing easier starting and stopping in traffic, the electric streetcar lines were much cheaper to construct and maintain than cable lines. Electric trolleys also had speeds between 22 and 42 mph.

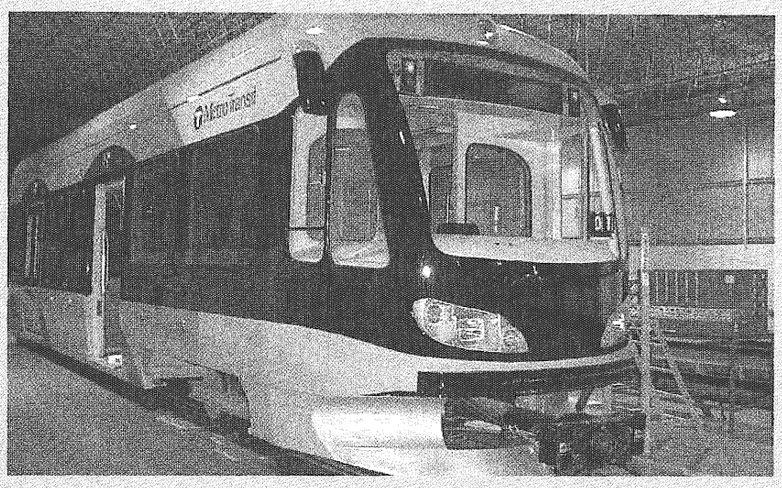
The electric streetcar appeared to be the ideal form of mass transit for the city. Electric streetcar lines continued to grow in length, importance and efficiency until the mid-1950s. However, at this time the popularity of motorcars brought streetcar patronage down steeply. People were drawn to automobiles because they offered much more freedom than the rail-bound streetcars. Many companies switched to buses to stay competitive and by 1954 streetcars had all but disappeared from most major U.S. cities.

Automobiles continued to increase in popularity, choking roads and highways in major cities. When a plan to convert Hiawatha Avenue into a highway was presented in

Riding the rails

The first of 20 light rail vehicles under construction for the Twin Cities light rail system has already arrived in Minneapolis.

Seating capacity:	66
Total capacity:	187 (a Metro Transit bus holds 43)
Vehicles in service:	20 during rush hour
Max speed:	55 mph.
Overhead voltage:	750 V
Motor power:	140 kW
Vehicle length:	94 feet
Vehicle weight:	105,000 lbs



1975, many local residents protested and suggested a light rail transit system alternative, which was eventually approved. Light rail is merely a new name for modern electric streetcars, which never lost popularity in Europe and were making a comeback in America.

The Twin Cities have experienced the second largest congestion growth in the nation, and today the average commuter spends 54 hours a year in gridlock. Traffic congestion during rush hour increased 425 percent between 1990 and 2000.

Light Rail Technology

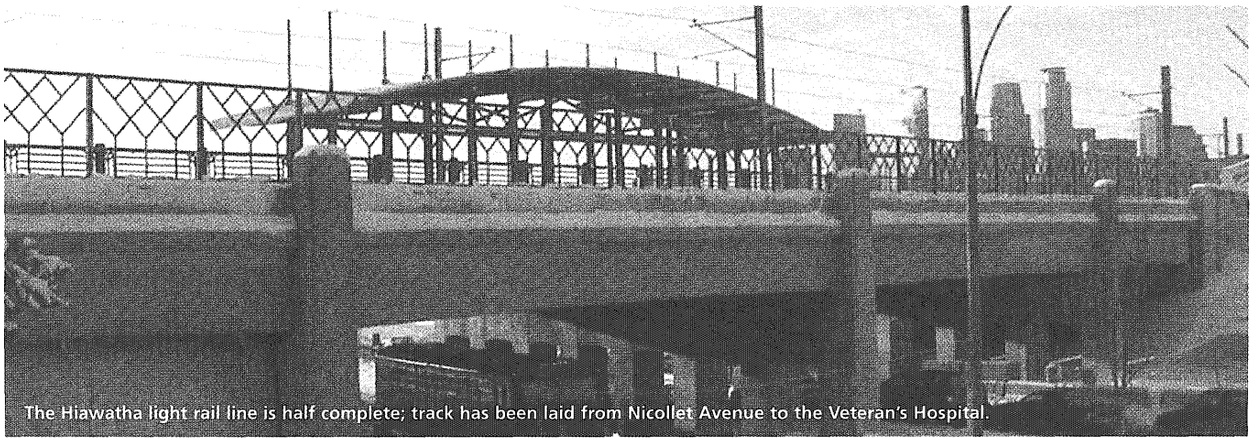
Light rail transit may solve much of the Twin Cities' traffic problems. At around $2 million per car and over $675.4 million for the entire project, no expense has been spared in providing the latest streetcar technology. The new technology improves the streetcar service in an attempt to coax car users into trading in their keys for a light rail ticket.

One of the main objections to public transportation is that it is slower, so the Minneapolis light rail system will be sped up by giving trains priority at traffic lights and using vehicles capable of 55 mph. But this higher speed requires changes from power lines all the way down.

The pantographs on old streetcars had to follow the drooping overhead wire and would begin to bounce off it when moving too fast. In order to straighten this line for continuous transmission at high speeds, modern light rail systems use a two-wire power line. The top catanary line is hung with the natural catanary curve and supports the trolley wire below, keeping this line absolutely straight for the pantograph. Both lines carry power from the 15 electric substations along the route.

Moving at speed of 55 mph would be pretty bumpy if not for the new light rail technology used for rail construction. The 60-foot sections of flexible steel track are now welded instead of bolted together, eliminating the gaps and inconsistencies in the old streetcar track. Once the track is placed and welded together it is ready for the "tapping and leveling" process, in which a machine "taps" different amounts of crushed gravel under the rails to make them perfectly level. This job was once done by human sight, but now the leveling sensor measures the exact grade of the track, achieving a much more even grade.

RAILS CONTINUES ON PAGE 13

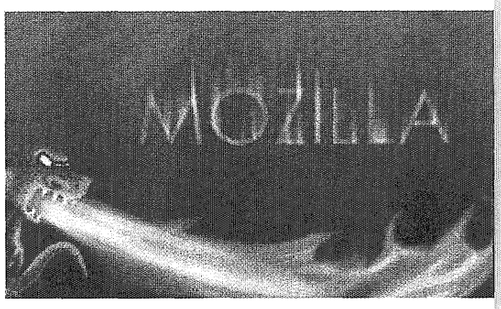


The Hiawatha light rail line is half complete; track has been laid from Nicollet Avenue to the Veteran's Hospital.

PHOTO BY ARIC BLODGETT

Browsing with Mozilla

BY NATE JOHNSON



The last time Internet Explorer crashed, did you ask yourself if there was a better program? Luckily, there is. Mozilla—one of the many free web browsers—can help relieve some of the stress associated with using crash-prone Internet Explorer. In the last year, Mozilla has enjoyed a much more mainstream spot in the Internet world through its increasing user-base and Netscape's decision to include Mozilla as the core of its browser.

Mozilla is an open-source alternative to the more common commercial browsers available today. This means that you are free to download it and modify it in any way, adding or subtracting features as you deem necessary. While this may be beyond the skills of most users, Mozilla has many other features that make it worth trying.

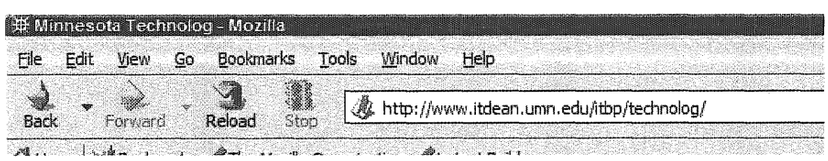
Skins

Much like the popular media player Winamp, Mozilla is capable of donning "skins" that change its appearance—sometimes rather drastically. Created by Mozilla enthusiasts, these skins are online, where they can be downloaded by anyone. Skins exist for every topic imaginable, from *Star Trek* to original artwork. Skin creators often spend many hours developing the skins and put out several versions before they look just like the creator intended.

Installing skins is easy. Once you click the link for a theme, Mozilla kicks in to download and install it. All you have to do is close Mozilla and reopen it for the skin to take effect. Switching between skins that have already been installed is just as easy. Simply click "View" on the toolbar, go down to "Apply Themes," and select the one you want.

The Password Manager

Ever feel like you have too many passwords to manage effectively? Ideally, you should use a different password for each log-on, but as your list of logons increases, it becomes more difficult to remember all that information. Mozilla provides a password manager to store all these passwords under the protection of a different, master password. This means that you only have to remember one password to get into all your web-based accounts, and each account can still have a different password. While using the password manager, your information is relatively safe, provided that someone doesn't get a hold of your computer.



A sample of the Mozilla navigation bar.

Tabbed Browsing

It's not uncommon for web surfers to use multiple browser windows while they are looking up information. Multiple windows make it easy to compare different sites quickly and efficiently, but before long it can crowd up your screen. Mozilla's answer is to use tabbed windows. One window can contain any number of pages, each of which can be easily reached by clicking the corresponding tab at the top of the window.

Pop-up Ad Control

Nowadays it seems like you can't go anywhere on the Internet without

generating a clutter of these annoying pop-up advertising windows. I use an ad control program that interfaces with Internet Explorer to block almost all pop-ups, but Mozilla has integrated a similar program into their browser. Mozilla's works as well, if not better, than the third-party ad control programs that I have used in the past. It is disabled by default, but can be turned on from the "Preferences" window: click on the "+" symbol next to Advanced, then click Scripts & Plugins. Uncheck the box that says "Open Unrequested Windows" and click OK.

Other Features

Mozilla also includes built-in chat and mail programs, a web page editor, address book, a download manager, an almost unlimited source of plugins available on the Internet, and many more features. Explaining everything Mozilla has to offer would require a full book, but the help file included with the program and the endless forums available on the Internet will help even the computer illiterate get a good grasp on everything Mozilla has to offer.

The Verdict

Mozilla is definitely worth looking at. It is very stable and the interface is very intuitive. Netscape users will find it very familiar because Netscape and Mozilla are built on the same core. (The only difference is that Netscape uses an older version of Mozilla.) In the time that I spent using Mozilla, it crashed only once. Importing bookmarks from Internet Explorer couldn't have been easier. So, if you're looking for a different browser, give Mozilla a shot. ●

FOR MORE INFO: The latest versions of Mozilla are available for download from www.mozilla.org. Version 1.2.1, the most stable to date, was released in early December, 2002. Version 1.3, a newer but less stable version, is available for testing. This version is for those who really want to get involved in the development process.

RAILS CONTINUED FROM PAGE 11

Since light rail vehicles move at a faster average speed, they require a better braking system for safety and comfort. Those being made for Minneapolis have four breaking systems for different situations. Regenerative braking uses the train's momentum to create electricity, and is used for breaking at high speeds. Disc breaks automatically kick in at speeds of less than three mph to bring the train to an easy halt. It also has magnetic breaks in case of emergency and a system that sprays sand at the wheels if they begin slip on the tracks.

Streetcars of the past used a single breaking system in which compressed air pressed steel plates up against the steel wheels. This was crude but effective at the lower streetcar speeds. According to Olson, "good conductors could stop on a dime without passengers feeling a thing." The light rail vehicles will not require the same operator skill—perhaps part of the reason the old streetcars have a certain magic for Olson and others that high-tech rail systems cannot replace.

But most passengers will be thankful that the light rail vehicles have also replaced the passenger skill that was once necessary. Awkward jumps and steep stairs from the station to the streetcars are now a thing of the past. The low-floor design of the vehicles eliminates the need for stairs and makes them wheelchair-accessible. A hydraulic leveling system keeps the vehicle floor within 3/8-inch of the platform height as passengers get off and on.

Hoping that the comfort and safety afforded by these technologies will do the trick in luring commuters from their cars, future expansion has already been planned into the Hiawatha Maintenance Facility. This building houses the computer control center for the entire light rail system, which has been designed for possible future lines.

Confidence vs. Controversy

But with just over a year until the first section of the line opens, conflict over light rail's potential and costliness continues. Kathy Tinglestad, a Minnesota House representative, believes that light rail is not cost-effective because state expenses on the project are too high to justify a system that may only be used by a small amount of people.

"It'll be cheaper to give people a cab ride from downtown Minneapolis to the airport than it will be to operate this light-rail line," says Gov. Tim Pawlenty.

But light rail's supporters say the light rail system is designed to aid strategic areas of traffic congestion, not automatically solve all transportation problems in the Twin Cities. Its main purpose is to provide a safe, clean alternative to automobiles. Light rail's daily patronage is expected to reach 24,800 by 2020, so working together with bus systems, light rail may be the answer to the Twin Cities' growing traffic problem

"The Twin Cities metro region needs a balanced approach to resolving the growing congestion problem," says to Karen Booth, communications spokesperson at Hiawatha Project Office. "It's a 'roads only' mentality that will ever get us out of the crunch. We cannot simply build our way out of this problem with more pavement. Neither is LRT the only other piece of the solution. We must have a balance of roads, light rail, commuter rail, buses and bus rapid transit ways."

Supporters hope to not only curtail ballooning traffic congestion, but also stop urban decay and revitalize parts of the city with development by stations. Olson says that area along old streetcar lines were places of rapid growth and development because rail lines brought a permanent stream of passengers, business and life.

If the Hiawatha line is as much a success as is hypothesized, additional lines may be constructed. A Central LRT corridor would travel between downtown Minneapolis and downtown St. Paul. Another planned line may use the transit line between the Minneapolis and St. Paul University campuses. History has a funny way of repeating itself: this transitway was a streetcar line during the heyday of trolleys. ●

Appetite for DIVERSE IT

BY ABDUL BASIT

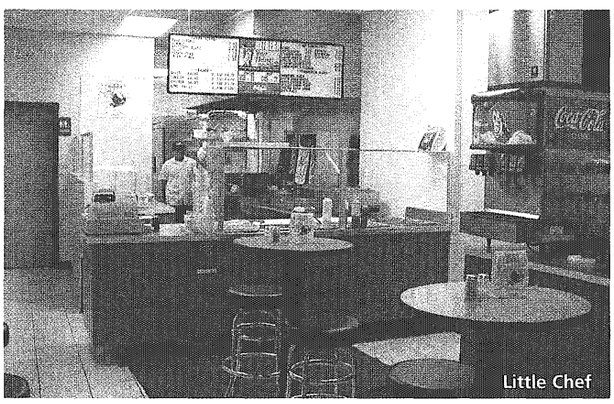
The University is home to students from more than 50 countries, and the restaurants in the surrounding community display almost as much diversity. With Middle Eastern gyros, spicy Indian curry, Vietnamese noodles, casual African food and much more, the campus offers many temptations for trying something new.

I've evaluated each restaurant on a 10-point scale. My scoring is by no means a science—but then neither is gastronomy! The main consideration in scoring was quality, freshness, and taste of the food, but scores were adjusted for creativity of the cuisine, ambiance, price, and service.

LITTLE CHEF

Greek/Mediterranean
Rating: 7.9
307 Oak Street SE
612-378-0095
Typical meal: $6-8
Hours: 11 a.m.-10 p.m.
Recommended: Chicken Gyro, Falafel

Little Chef is one of the newest arrivals on campus, having just moved into a space between Chipotle and Oak Street Cinema at the end of fall semester. The theme is Middle Eastern fast food. Every thing from the pita bread to the yogurt is made fresh daily, a fact that becomes abundantly clear when you bite one of their gyros or sandwiches. The menu includes chicken and beef gyros, kabob, shwarma, falafel, humus, and five salad options. Being a deli, it seats only 12 guests. The interior is decorated with pictures of Middle Eastern cities. They have daily combo specials, and a lunchtime deal of $5 makes it pretty reasonable for a deli.



Little Chef

VILLAGE WOK

East Asian/Chinese
Rating: 7.4
610 Washington Avenue SE
612-331-9041
Typical meal: $4-8
Hours: 11 a.m. -1:45 a.m.
Recommended: Sweet and sour chicken, chicken corn crème soup

Located across Washington Avenue from the Radisson Hotel, the Village Wok offers tasty Chinese food in a no-frills atmosphere. The Wok is packed at all hours in the day and night—probably the most ringing endorsement any restaurant can get. This may be more due to the reasonable prices than the food; their $4.75 lunch special makes an especially good deal. Their hours are also a plus for students staying late on campus. Village Wok's specialty is Cantonese seafood, which is typically expensive but priced just right on the Village Wok's long menu of seafood specials. The restaurant floor is packed a little close, and with 70 guests to serve at a time, the service is sometimes less than impressive. Overall, it serves well as an inexpensive Chinese eatery.

JEWEL OF INDIA

South Asian/Indian
Rating: 7.2
1427 Washington Avenue S.
612-339-0002
Typical meal: $8-15
Hours : Monday-Friday, 11:30 a.m.-3 p.m., 5 p.m.-10 p.m.; Saturday-Sunday, 11:30 a.m.-10 p.m.
Recommended: Tandoori chicken

Jewel of India is one of the few good restaurants on the West

Bank campus. Don't let the unimpressive facade turn you away. Inside, the paintings on the walls of this family-oriented restaurant give a clean picture of Indian culture. The restaurant offers seating for 30 guests on the main level and two additional levels set aside for big event reservations. (It also has its own parking lot.) It is a modest, tidy restaurant with excellent service and traditional Indian music that blends in very well with the food. The menu, with over 50 food varieties, has more temptation for meat lovers than vegetarians. It is busy at lunchtime, thanks to the fantastic lunch buffet for $6.99. The food is otherwise rather expensive but good in quality and taste; the curry dishes are neither too spicy nor too wimpy, but have a distinctive Indian aroma. Once you are out of the restaurant, you will definitely praise the food—but you might not appreciate the smell of your clothes.

BONA

East Asian/Vietnamese
Rating: 6.9
802 Washington Avenue SE
612-331-5011
Hours: Saturday-Thursday, 11 a.m.-9 p.m.; Friday, 11 a.m.-10 p.m.
Typical meal: $5-8
Recommended: Shrimp lomein, hot and sour soup

Bona was voted the best Vietnamese restaurant by the Star Tribune—a great endorsement considering the number of Vietnamese eateries all over the Twin Cities. And the food does indeed taste good. The restaurant's décor is different than the Village Wok's, especially in the bright lighting, but it can only seat 40 at a time and has very few servers. The lunch special is a draw at $4.35 for a selection of up to 20 dishes similar to those in the normal menu.

SHUANG CHENG

East Asian/Chinese
Rating: 7.7
1320 4th Street SE
612-378-0208
Hours: Monday-Thursday, 11 a.m.-10 p.m.; Friday-Saturday, 11 a.m.-11 p.m.; Sunday, 4 p.m.-10 p.m.
Typical meal: $4-9
Recommended: Sesame chicken

Shuang Cheng is a full-service Chinese restaurant. It is a little different than other Chinese eat-outs around, with better lighting, more seating (almost 70), bigger serving staff, and—above all—a better kitchen. They have a reputation for high quality ingredients, but the taste is about average. The menu features more than 100 dishes, both vegetarian and non-vegetarian. The interior is decorated with paintings portraying Chinese culture. The rushed servers may not make you feel welcome, but their sesame chicken is worth a visit. Lunch specials for $3.75 also make it the best deal on the campus at that time.

PHOTOS BY ARIC BLODGETT


Bona

LORING PASTA BAR

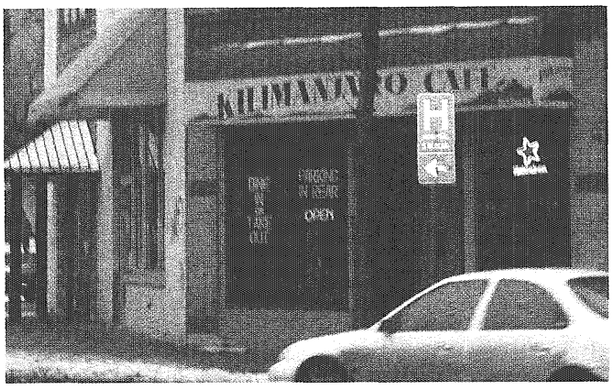
European/Pasta
Rating: 6.7
327 14th Avenue. SE.
612-987-3444
Typical meal: $12-14
Hours: Monday-Saturday, 11:30 a.m.-1 a.m.;
Sunday, 4:30 p.m.-1 a.m.
Recommended: Pasta

With its Bohemian glamour, the Loring Pasta Bar has mastered a kind of elegant sophistication. It is not easy to run a restaurant with great food and service. It would easily win any prize on campus for exterior decoration, and the eclectic mix of Bohemian wood and rock art make its interior more striking. Beyond its (delicious) namesake pasta, there is still much to enjoy at the Loring. One of the most praised meals is Salade Sauvage featuring pears, walnuts and blue cheese. This salad, the Loring's fresh, crusty French bread, and a cold glass of pinot grigio made a fantastic and elegant light lunch for under $10. Quality musical performances also helps fill its 220 seats. Local musicians have evening contracts with the bar, mainly presenting Salsa, Tango, Reggae dances, live piano, and guitar performances, so it's no surprise that the pasta is incredibly popular for dinner. Although a little pricey for students, the Loring is a classy place for a special occasion.

NOODLES & COMPANY

Pasta
Rating: 7.1
233 Cedar Avenue S.
612-659-7777
Hours: 11 a.m.-9 p.m.
Typical meal: $6-8
Recommended: Japanese Pan Noodle, Wisconsin Mac n Cheese

Known for its Japanese Pan Noodles, Noodles & Company offers the most variety in noodles of any place around the U. But if you want to try something new and are unsure about the



choices, rest assured that menu of 10 noodles, four salads, and two soups will not overwhelm you. Their East Asian motel look together with the slow music gives it a warm feeling to accompany the warm noodles in your bowl. They have a small parking lot and are able to seat 50 at a time. The quality and taste of the noodles is the best I have tried.

KILIMANJARO CAFE

East African
Rating: 7.0
324 Cedar Avenue S.
612-333-2211
Hours: 11 a.m.-Midnight
Typical meal: $8 - 10
Recommended Dishes: Injero

Located a block from the Carlson School on the West Bank, this is one of three African restaurants next to campus. It seats only 40 and might well be unknown to most students, despite its impressive food. Be prepared to eat with your hands since most dishes are served with flat bread on large platters without silverware. The 45-dish menu lists many choices for vegetarians as well as meat lovers, including sandwiches and platters. The interior features African art, with paintings, lighting, and hanging beads modeling a typical east African home. The staff is friendly, and the cafe also educates its guests about the African culture through its selection of African music. With its medium prices, the restaurant is good choice for students on campus. □

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