University of Minnesota

# INVENTING TOMORROW

PEOPLE AND IDEAS THAT SHAPE OUR WORLD | INSTITUTE OF TECHNOLOGY | SUMMER 2004

## HARVESTING HYDROGEN

Regents Professor Lanny Schmidt's pioneering hydrogen reactor has set the scientific world on fire

**ALSO INSIDE:**

MATERIALS RESEARCH

LIGHT RAIL

COOL GADGETS

**INVENTING TOMORROW**

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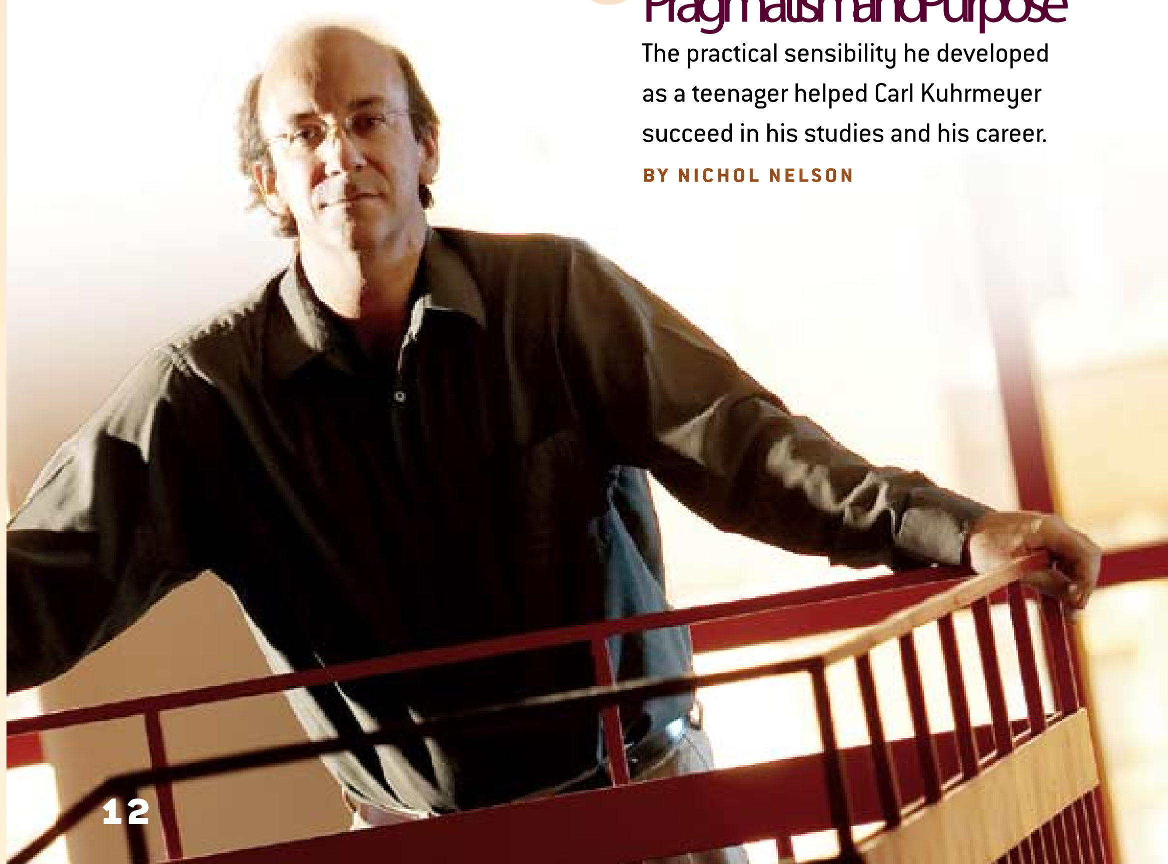

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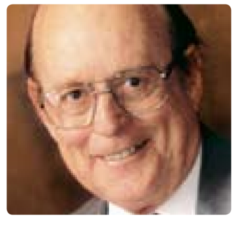
***ON THE COVER: Lanny Schmidt's groundbreaking ethanol reactor may fuel the hydrogen economy***
PHOTO BY JONATHAN CHAPMAN

# Purpose and posterity

**ZAAK KOLTHOFF,** the subject of this issue's "Retrospect," enjoyed the rare privilege of living long enough—nearly a century—to see the monumental impact of his work as a researcher and teacher. Thirty-two years ago this summer, the father of analytical chemistry—then in his late seventies—received the accolades of colleagues and former students present at the dedication ceremony for Kolthoff Hall.

Many of us may not be fated to share Kolthoff's longevity, but we can approach our work with the same diligence, creativity, discipline, and intellectual rigor he demonstrated. Like him, we assume the stance of the scientist, the mathematician, and the engineer: feet firmly rooted in the present and eyes fixed steadfastly on the future. Although as individuals we may never know the full impact of our contributions—the future outstrips us all—we understand the value of what we do.



We may never know the full impact of our contributions, but we understand the value of what we do

It's a theme that runs throughout the stories in this issue. The University leaders who hired Kolthoff recognized that his talents and work ethic would take him far, but back then no one could have predicted the full range of his accomplishments. In January we witnessed the successful landings of the twin Mars Exploration Rovers, the most recent example of NASA missions that have links to the University. In this issue you'll meet two IT professors whose research is aiding today's space program, and you'll also learn about the historical thread that connects a retired NASA engineer, his former University professor who came to the U.S. after World War II, and the Mars landings in January. Minnesota's involvement in the space program has deep roots.

Some of the most exciting research underway at the University focuses on fundamental knowledge and revolutionary technologies that will likely shape the future in ways we can't yet imagine. The interdisciplinary NSF Materials Research Science and Engineering Center (MRSEC) brings together University researchers and industrial scientists to advance the development of materials for new products and processes. Other researchers are working to create a future in which renewable energy sources reduce our dependence on fossil fuels. Regents Professor Lanny Schmidt, who just invented a reactor that extracts hydrogen from ethanol, is one of several IT faculty involved in the Initiative for Renewable Energy and the Environment.

We're actively investing in human potential, too. MRSEC's education and outreach program involves undergraduates in high-level research and helps high school and college teachers augment their science curriculum. Getting younger students enthused about science and engineering is the long-term goal of the IT Alumni Society's K-12 outreach committee, which launched a new strategic collaboration this year. In chemistry professor Xiaoyang Zhu's freshman seminar, students gain an appreciation for the science behind some amazing gadgets. Students who enroll in these programs—regardless of their eventual career choices—are more likely as citizens and voters to regard science and technology in a positive light.

The constancy of change is a familiar phenomenon to those of us who work in scientific and technological fields. Still, when colleagues leave our organization, we must adjust and accept that things will never be quite the same again. Phil Oswald and Kris Kosek, who served the college so well during their time here, have moved on to new career opportunities. We wish them the very best and thank them for all they have done on the college's behalf.

*H. Ted Davis*

REGENTS PROFESSOR H. TED DAVIS is dean of the Institute of Technology. You can reach him at 612-624-2006 or by email at info@it.umn.edu.

JONATHAN CHAPMAN (DAVIS); GETTY IMAGES (ILLUSTRATION)

PATRICK O'LEARY (2)





***SOUND BYTE:* "Minnesota cannot afford to squander its future by starving higher education."**
*—President Robert Bruininks, responding to the governor's 2004 budget*

## U launches national search for new IT dean

**After nine years as dean, H. Ted Davis will return to teaching and research this fall**

UNIVERSITY OFFICIALS have announced the formation of the search committee for the next IT dean. The committee, which held its first meeting May 5, has finalized a position description and developed an advertising strategy. National advertisements began running at the end of May.

Deadline for initial review of the applicant pool is July 12, although applications and nominations will continue to be accepted until the position is filled. The committee will work throughout the summer to develop a list of candidates and hopes to select a group of finalists by the middle of fall semester 2004.

IT dean H. Ted Davis announced in January that he would return to a faculty position fall semester 2004. Davis was appointed dean in November 1995 and is the third longest serving dean in IT's history and also the third longest serving among current deans on the Twin Cities campus.

Relevant information on the search, including progress reports, position description, and search committee roster, is available on the IT web site (www.it.umn.edu/news/dean).

**INSTITUTE OF TECHNOLOGY DEANS,** PAST AND PRESENT

| | |
|---|---|
| Samuel Lind | 1935–47 |
| Athelstan Spilhaus | 1949–67 |
| Warren Cheston | 1968–71 |
| Richard Swalin | 1971–77 |
| Roger Staehle | 1979–83 |
| Ettore Infante | 1984–91 |
| Francis Kulacki | 1993–95 |
| H. Ted Davis | 1995–2004 |

*List does not include interim deans.*

### CHEMICAL ENGINEERING GRAD PROGRAM TOPS *U.S. NEWS* RANKINGS

THE UNIVERSITY OF MINNESOTA, Massachusetts Institute of Technology, and the University of California at Berkeley rank first among the nation's graduate programs in chemical engineering, according to *U.S. News & World Report*'s annual survey of graduate schools and programs. All of IT's graduate programs in engineering ranked among the top 30, including mechanical (10), civil (12), electrical (14), materials (18), aerospace (18), computer (21), and biomedical (26). These specialty rankings are based on assessments by department heads in each field. For a complete list of rankings for each of IT's undergraduate and graduate programs, visit the IT web site at www.it.umn.edu.


Sohn

### Ceremony salutes class of 2004

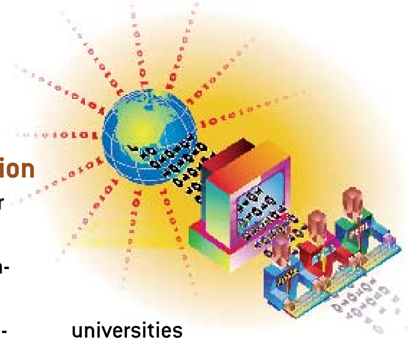
SUNG WON SOHN, executive vice president and chief economic officer of Wells Fargo, delivered the keynote address to more than 500 graduating IT seniors and 4,000 guests at the 2004 commencement ceremonies at Northrop Auditorium on Friday, May 7. The event also included an address by student commencement speaker Benji Mathews and presentation of awards. Among those honored were alumni Jorge Manuel Dengo-Obregon (Civil '43), who received an honorary doctor of laws, and C.A. "Sy" Syverton (Aero M.S. '48), who received an honorary doctor of science. (For a complete listing of honors and awards, turn to page 5.) Each year IT awards nearly 1,000 bachelor's degrees, 400 master's degrees, and 170 doctoral degrees.

# FOREIGN AFFAIRS

WHEN PHYSICS PROFESSOR Marvin Marshak accompanied 30 IT undergraduates to Switzerland last summer to study mechatronics at Zürich University of Applied Sciences, he was part of a University-wide effort to integrate study abroad into the curriculum. In today's global society, study abroad is no longer a luxury but a necessity, according to curriculum experts and higher education professionals who attended Internationalizing the Curriculum, a three-day study abroad conference held at the University in April.

IT students are taking the advice to heart. Study abroad opportunities in technical fields have increased dramatically, and so have enrollments in those programs. From fall 1997 through spring 2003, the number of IT students enrolled in study abroad programs jumped from 15 to 100.

"Study abroad gives our students the international experience to work effectively in industry, academia, and the public sector," says Susan Kubitschek, international programs director for IT's Office of Student Affairs. "This international perspective and the ability to communicate across cultures are essential skills for success in today's workplace."



## U team wins honors in world computer programming competition

A team of University computer science and engineering students received honorable mention in the world finals of the Association for Computing Machinery's International Collegiate Programming Competition (ICPC), held this spring in Prague, Czech Republic. University senior Vishal Shah, graduate student Stefan Atev, and recent graduate Elliot Olds constituted one of 73 teams that competed in the world finals for "the world's smartest trophy." First-place honors went to a team from St. Petersburg Institute of Fine Mechanics and Optics.

During the competition, three-person teams raced against the clock to solve 10 complex, real-world programming challenges that tested programming skill, creativity, and teamwork. During this year's contest, participants had the chance to become familiar with Linux and Eclipse, which provided the backbone for the contest's programming environment.

The ICPC is considered the world's most prestigious university competition in computer sciences and engineering. The regional competitions last fall drew participants representing 1,412 universities from 75 countries. Student participation in the contest has quadrupled since 1997, when IBM began sponsoring the event.

The University team was coached by Bobbie Othmer and Carl Sturtivant.

## Two IT students receive Fulbright Scholarships

Two IT doctoral students are among seven University students who received prestigious Fulbright Scholarships for 2004–05.

Ted Brekken, a doctoral student in electrical engineering whose research focuses on developing a method of controlling wind generators, will study Norway's wind farms at the Norwegian University of Science and Technology.

Fawna Korhonen, a doctoral student in geology, will conduct research in the Varpaisjärvi region of central Finland, focusing on magnetic minerals and their origins. She will also collaborate with geologists at the Geological Survey of Finland.

## IN MEMORIAM

WORLD-RENOWNED MATHEMATICIAN Boris Levitan, former adjunct professor at the University, died April 4 in Minneapolis. He was 89. In 1961 Levitan and a colleague received the Soviet Union's highest civilian honor, the Lenin Prize, for their work on the inverse scattering problem. Levitan came to the U.S. in 1992 and at age 77 joined the School of Mathematics.

PROFESSOR EMERITUS MATT WALTON, former director of the Minnesota Geological Survey (MGS), died February 26 in St. Paul. He was 88. As MGS director from 1973 to 1986, Walton initiated successful research programs focused on environmental issues and also started a program in the acquisition of high-resolution, low-level aeromagnetic data, which eventually provided aeromagnetic maps of the entire state.





# NEW VIEWS OF A NORTHERN NEIGHBOR

USING INFRARED images from NASA's Spitzer Space Telescope, astronomers from the University, the Harvard-Smithsonian Center for Astrophysics, and the University of Arizona have seen features of the M33 galaxy never before visible.

The work is the first in a planned series of observations of M33, a galaxy in the northern sky about three million light-years away from its nearby neighbor, the Milky Way.

Although smaller and dimmer than the Milky Way, M33 faces Earth more squarely, so more of its activity is visible. Astronomers are scrutinizing M33 for clues to how the Milky Way and other galaxies are born, live, and die. Astronomy professor Robert Gehrz is leading the team that will study M33 in detail over the next two and a half years.

Launched in 2003, the Spitzer Space Telescope operates at infrared wavelengths and can detect details invisible to the human eye and to telescopes that operate in visible light.

# Words of DISTINCTION

Seymour

JONATHAN CHAPMAN (MARSHAK); GETTY CREATIVE (ILLUSTRATION); NASA (SPITZER); PROGRAM FOR WOMEN (SEYMOUR)

WHY DO WOMEN REJECT majors and careers in mainstream science? University of Colorado researcher Elaine Seymour examines the reasons women are underrepresented in many scientific fields. She shared insights based on her research at events in April sponsored by IT's Program for Women. Seymour—coauthor of *Talking About Leaving: Why Undergraduates Leave the Sciences*—has studied the issue for more than 15 years. Her visit was part of the college's Distinguished Women Scientists and Engineers Speakers Program, which creates greater visibility for distinguished women in their respective fields.

In bringing these accomplished professionals to campus, the lecture series offers encouragement to IT's female students, postdoctoral associates, and faculty, says Associate Dean Roberta Humphreys, who directs the Program for Women. Guest lecturers include scholars who study the challenges facing women in science and engineering as well as prominent women in a variety of fields.

For a list of upcoming speakers and events in the series, see www.it.umn.edu/women.



# University, IT honor outstanding students, scholars, and alumni

EACH SPRING, IT and the University pause to savor the year's achievements and to honor the exceptional faculty, advisors, alumni, and students among us.

## UNIVERSITY AWARDS AND HONORS

Distinguished McKnight University Professor
- Graham Candler (aerospace eng. and mechanics)
- Guillermo Sapiro (electrical and computer eng.)

McKnight Land-Grant Professor
- Baoquan Chen (computer science and eng.)
- Heiko Jacobs (electrical and computer eng.)
- Kristopher McNeill (chemistry)
- Joachim Mueller (physics)

Award for Outstanding Contributions to Postbaccalaureate, Graduate, and Professional Education
- Mats Heimdahl (computer science and eng.)

Tate Award for Excellence in Undergraduate Advising
- Ann Pineles (Lower Division)

President's Award for Outstanding Service
- Sally Gregory Kohlstedt (geology and geophysics)

Distinguished Women Scholars Award
- Karin Musier-Forsyth (chemistry)

Honorary Doctorate
- Jorge Manuel Dengo-Obregon (Civil '43)
- C.A. "Sy" Syverson (Aero M.S. '48)

Outstanding Achievement Award
- Daniel Rich (Chemistry '64)
- Theofanis Theofanous (ChemE Ph.D. '69)

## COLLEGIATE AWARDS AND HONORS

IT Distinguished Professor
- Timothy Lodge (chemistry)
- Marvin Marshak (physics)

Taylor Award for Distinguished Research
- John Bischof (mechanical eng.)
- Georgios Giannakis (electrical and computer eng.)

Taylor Award for Distinguished Service
- Lawrence Rudnick (astronomy)

Taylor/ITAS Award for Distinguished Teaching
- Mark Distefano (chemistry)

Taylor Career Development Award
- Victor Barocas (biomedical engineering)

Charles E. Bowers Faculty Teaching Award
- John Dickey (astronomy)

John Bowers Teaching Assistant Award
- Meghan Kearney (mechanical eng.)

Cartwright/ITAS Outstanding Student Service Award
- Joshua Colburn (computer science)

**A new freshman seminar explores the science behind 'cool gadgets' from the microscopic to the mundane**

BY JUDY WOODWARD


JONATHAN CHAPMAN

# Gee-Whizardry!

HALF A DOZEN FRESHMEN SIT IN A rough semicircle, their attention fixed on a PowerPoint presentation at the front of the classroom. The image on the screen before them resembles a Southwestern landscape with reddish-brown pueblo walls rising at abrupt angles from the desert floor. The cryptic caption reads "Arizona?"

At the lectern, Professor Xiaoyang Zhu of the chemistry department enjoys a quiet moment as his class scrutinizes the mysterious landscape for clues to its identity. What appears to be slides from Zhu's summer vacation, however, is actually the photographic evidence of a far more exotic journey.

Zhu is demonstrating the dazzling powers of the scanning tunneling microscope (STM), an ingenious device with a resolution so fine that it's possible to view individual atoms on the surface of materials. In a sort of miniaturized version of Braille, the STM sends a flow of electrons through an ultrafine probe to sample the "bumps" and "depressions" of a surface. In reality, "Arizona" is a view of the minute surface features of copper atoms on a copper base. The sheer looming cliffs of the desert landscape are actually tiny surface irregularities.

The STM offers a portal into the visual delights of nanotechnology, a world where landscapes are measured not in acres but in angstroms and where desirable resolutions are measured in minute fractions of an atom's width. It's a brave new world for the first-time viewers among the students, but Zhu has yet another wonder to unveil.

Not only can the STM reveal the natural beauty and harmony of atomic organization, but the device also can manipulate the arrangement of atoms to create a different image. Now the image on the screen changes to a collection of tiny fuchsia-colored beads organized—with the aid of the STM—into a primitive but identifiable human figure: "Carbon Monoxide Man," who's built of individual CO molecules on a platinum surface. Zhu estimates that it takes about two days to construct an image like it.

Given that rate of output, it's a good thing the STM is not simply a special-effects machine whose purpose is to produce cool-looking graphics, one atom at a time. After class Zhu explains the STM's deeper scientific significance: "Being able to manipulate matter, to build things one atom at a time, is a huge step forward," he says. "We always want to do things with control, and doing them on the atomic scale is the ultimate control."

Today's class, though, emphasizes the showier aspects of the STM's capabilities. That's because the STM is the centerpiece of the day in Zhu's freshman seminar, What's Inside That Cool Gadget. Designed to introduce students to the chemistry, physics, and materials that underlie some of the advanced technologies of daily life—everything from MP3 players to Air Jordan sneakers—Zhu's class is a weekly lesson in gee-whiz visual thrills for his seven first-year students.

Like all freshman seminars, Zhu's class is intended to introduce incoming students to some of the more interesting forays into the life of the mind. Led by senior faculty who are gifted teachers as well as distinguished researchers, the limited-enrollment, two-credit classes are designed to give new students a taste of the intellectual stimulation available at the University.

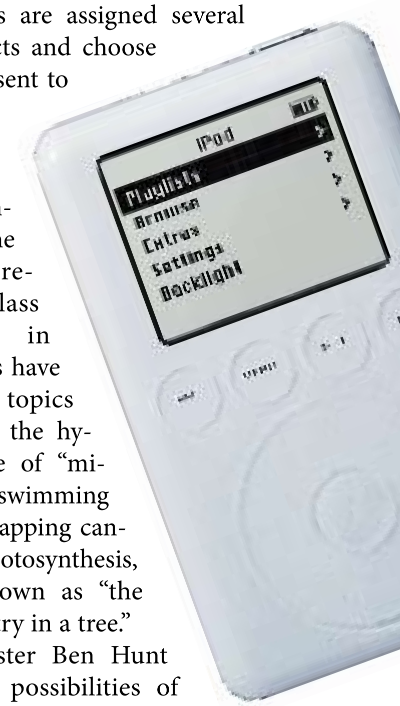
Zhu, whose research focuses on advanced materials science, says he uses the class to communicate his own excitement about the behind-the-scenes chemistry of advanced technology. "I want the students to appreciate the beautiful science," he says, "but I also want them to develop observational and analytical skills."

Zhu also has another motivation for teaching the class. His students come from General College, the Carlson School of Management, and the College of Liberal Arts as well as IT. For some participants, this seminar is one of the few times they will be exposed to pure science at the university level. "People take things for granted," Zhu explains. "Public support for science is not that high. [In some circles] 'chemical' is a bad word. People think 'toxic.' But in reality there's chemistry behind everything. People never think how wonderful the science behind things is."

Zhu did his undergraduate work at Fudan University in China and received his Ph.D. from the University of Texas in 1989. He was an Alexander von Humboldt Fellow at the Fritz-Haber Institute in Berlin and taught at Southern Illinois University before coming to the University in 1997. He says that the learning experience offered by freshman seminars at the University is very different from the way he was educated.

"I wish I'd had this kind of opportunity when I was an undergraduate," he says. "When I was in college, the course was completely rigid." In fact, when Zhu was an undergrad, students didn't always choose their majors; instead, majors were sometimes assigned by the institution. Students from other disciplines had no opportunity to sample the wonders of chemistry at Fudan University.

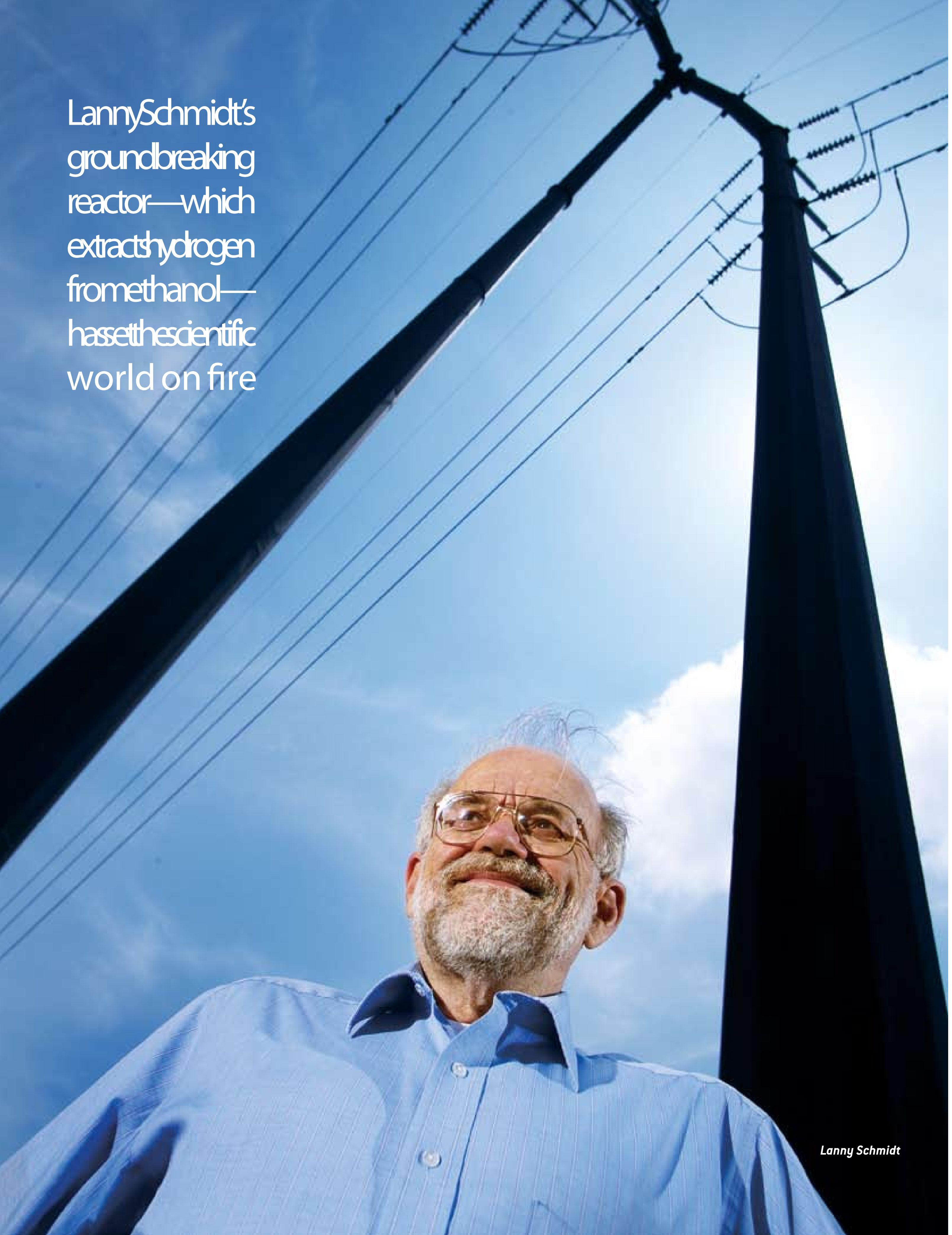
Nowadays, Zhu encourages the students in his freshman seminar to use their freedom to explore and develop ideas on their own. Students are assigned several writing projects and choose a topic to present to the rest of the class. Topics are limited only by the ingenuity of the individual researcher. Class participants in previous years have investigated topics ranging from the hypothetical use of "micro-machines swimming in the body, zapping cancer cells" to photosynthesis, otherwise known as "the biotech industry in a tree."




This semester Ben Hunt explored the possibilities of polymer photovoltaic cells. "You could paint your house with them," he explains, conjuring up the prospect of a new frontier in homemade electrical energy supplies. Partly as a result of this class, Hunt is considering a major in biochemistry. He says that Zhu's class is nothing

**WHIZARDRY** CONTINUES ON PAGE 26 ▶

**Lanny Schmidt's groundbreaking reactor—which extracts hydrogen from ethanol—has set the scientific world on fire**



*Lanny Schmidt*

# Harvesting HYDROGEN

**As a kid, Lanny Schmidt was a bit of a pyromaniac.** He loved making colored flames with his chemistry set, especially when the flames got away from him and caused an explosion. But times have changed. Schmidt, now a Regents Professor of Chemical Engineering and Materials Science, has just invented a reactor that extracts hydrogen from ethanol. He did it by taming a chemical reaction that used to explode, and in the process he has set the scientific world on fire.

BY DEANE MORRISON • PHOTOS BY JONATHAN CHAPMAN

Greg Deluga

## IREE promotes research and development of Minnesota's renewable energy resources

JUST AS TYPEWRITERS GAVE WAY TO computers, so our finite supply of fossil fuels will one day be replaced by cleaner, renewable energy. The University is helping this vision become reality through its Initiative for Renewable Energy and the Environment (IREE).

In 2003 the Minnesota legislature made $20 million available to the University from money Xcel Energy provides for alternative energy development. Later that year the University formed IREE, linking researchers from disparate fields to capitalize on Minnesota's wealth of biomass (plant material) and wind, along with solar energy.

"It's all about bringing together people inside and outside the University," says Jennifer Kuzma, interim associate director of IREE and associate director of the Center for Science, Technology, and Public Policy in the Humphrey Institute of Public Affairs. "Our core mission is promoting research and development in Minnesota based on renewable energy."

IT dean H. Ted Davis serves on IREE's executive committee, which is chaired by College of Biological Sciences dean Robert Elde. Richard Hemmingsen, associate director of government relations, is interim director of IREE.

The initiative has its work cut out for it. According to the U.S. Department of Energy, Minnesota now spends more than $10 billion a year on energy, and about 90 percent of that money leaves the state. Turning this situation around and enabling the state to produce its own energy will boost the economy, with the added benefit of reducing carbon dioxide emissions if the energy comes from renewable sources. Led by IT, the College of Biological Sciences, the College of Agricultural, Food and Environmental Sciences, and the Humphrey Institute of Public Affairs, IREE sponsors projects in four "cluster areas":

- Hydrogen. Besides the research by Lanny Schmidt (see accompanying article) and others on finding means to produce hydrogen from renewable sources, this cluster includes work on transportation, storage, and utilization of hydrogen.
- Bioenergy and bioproducts. Researchers in this area are harnessing the natural abilities of plants and microorganisms to turn biomass into energy or products, replacing traditional industrial processes with new ones that consume less energy and produce less pollution, including greenhouse gases.
- Conservation and efficient energy systems. Whether we use renewable or nonrenewable energy, efficient systems for generating and conserving energy are crucial. Studies of wind- and solar-based technologies fall into this category.
- Policy, economics, and ecosystems. Virtually every project intersects with work in this area, which examines the structural changes necessary to guide technologies and the economy toward renewable energy and healthy ecosystems.

So far, IREE has awarded more than $1 million for faculty projects. A list of projects is on the web at www.umn.edu/iree/funded_projects.html. ■

—Deane Morrison

FOR MORE INFORMATION see www.umn.edu/iree.





What got everybody's attention was that the reactor doesn't burn ethanol like ordinary combustion, which produces water and carbon dioxide. Instead of water it makes hydrogen gas, the long-awaited currency of the heralded "hydrogen economy." But hydrogen as a fuel doesn't represent much of an advance unless it comes from renewable sources like ethanol. At the moment, virtually no free hydrogen exists, except what is made from fossil fuels at a high cost. The Schmidt reactor offers the first real hope of making hydrogen cheaply enough to achieve a hydrogen economy, at least for certain energy uses.

"This work has attracted enormous interest in Minnesota because the state is a huge ethanol producer," says Schmidt. "The rural economy depends on it."

Ethanol is fermented from corn, which the Upper Midwest produces in abundance. The carbon dioxide generated by the reaction would not cause a net increase in the atmospheric level of the gas because the next year's crop would reabsorb the gas to make sugar and starch. As envisioned by Schmidt, the reactor would feed hydrogen gas into a fuel cell, where it would be burned to produce enough power to supply an average home. In fact, Schmidt sees homes in rural areas as the first beneficiaries of the new technology. Eventually, homeowners may be able to buy ethanol and use it to power small hydrogen fuel cells in their basements.

Ethanol is easy to transport and, as Schmidt puts it, "relatively nontoxic." It's already burned in car engines, but it would yield nearly three times as much power if its energy were channeled into hydrogen fuel cells instead.

"We can potentially capture 50 percent of the energy stored in sugar by the corn plant, whereas converting the sugar to ethanol and burning the ethanol in a car harvests only 20 percent of the energy in sugar," says Schmidt.

The difference is largely due to the fact that the last thing you would want to do is put water in your gas tank, says Gregg Deluga, a scientist in Schmidt's lab and a coinventor of the reactor. The fermentation reactions that produce ethanol take place in water, and removing every last drop of water from a batch of ethanol takes plenty of energy. But the Schmidt reactor doesn't require that water and ethanol be separated. In fact, the reaction strips hydrogen from molecules of water as well as from ethanol, yielding a hydrogen bonus.

The reactor is deceptively simple in design. At the top is an automotive fuel injector that vaporizes and mixes the ethanol-water fuel. The vaporized fuel is injected into a tube that contains a porous plug coated with the catalyst. As the fuel passes through the plug, the carbon in the ethanol is burned, but the hydrogen is not. What emerges is mostly carbon dioxide, burnt carbon, and hydrogen gas. The reaction takes only 5 to 50 milliseconds and produces none of the flames and soot that usually accompany ethanol combustion. The reactor needs a small amount of heat to get going, but once it does, it sustains the reaction at more than 700 degrees C.

In most ethanol-water fuel mixtures, one could get up to five molecules of hydrogen for each molecule of ethanol—three from ethanol, two from water. So far, the Schmidt team has harvested four hydrogen molecules per ethanol molecule.

"We're confident we can improve this technology to increase the yield of hydrogen and use it to power a workable fuel cell," says graduate student James Salge, another coinventor.

When word of the new reactor hit the pages of *Science* magazine, calls poured in from around the world. The team has been talking to everyone from corn farmers to ethanol producers. In March, Schmidt traveled to Sweden to talk about the reactor; at the same time, Deluga and Salge drove to the University's Southern Research and Outreach Center in Waseca, Minnesota, to meet with farmers. Companies like Honda, BOC, Delphi Automotive, and Caterpillar have expressed interest, but it was the media attention that really surprised the Schmidt team. Deluga ticks off a few places where he never thought he'd see a chemical engineering story:

"We were on the front page of the Cancun edition of *The Miami Herald*, and we were in the *Iran Daily*—that's the English-language newspaper of Tehran," he says. "James and I were both in the Mapleton [Minnesota] paper. James is from Mapleton, so now he's a hometown hero there. Also, [radio personality] Paul Harvey did about 30 seconds on the story."

The publicity seems to have solved one problem common to researchers everywhere: "Our parents—James's and my parents, that is—know what it is we do now," says Deluga.

"We have not gotten many negative comments. We've had surprisingly positive comments," says Schmidt.

As the saying goes, Schmidt has worked long and hard to become an overnight sensation. He began as a chemistry student at Wheaton College in Illinois and earned a Ph.D. in physical chemistry from the University of Chicago. When he came to the University of Minnesota in 1965, he studied the behavior of molecules on surfaces. He was a fundamental chemist then, but somewhere along the way he transformed himself into one of the "most applied" chemical engineers in his department.

"Right now Lanny is doing the best research of his career, and that's very unusual for somebody who's been doing so well for 35 years," says Distinguished McKnight University Professor Frank Bates, head of the chemical engineering and materials science department. "We're absolutely thrilled, and we're all jealous."

The engineering world has been taking note of him for a long time. In 1994, for example, Schmidt was elected to the National Academy of Engineering and received the Alexander von Humboldt Prize, Germany's highest research award for senior U.S. scientists and scholars.

For the last 20 years Schmidt has had about 10 students working with him at any given time. The work is tough and not for the easily discouraged. Deluga recounts how prototypes of the reactor used to blow up inside a hood on a weekly basis, but Schmidt kept pressing him to keep working on the design. Despite such rigors, Schmidt's students call him "Lanny" and have great fun with each other. The lab's signature success is probably its work with novel catalysts that transform organic molecules into useful products. The hydrogen reactor is only the latest project in that vein.

"We started 15 years ago, trying to turn natural gas into synthetic diesel fuel," says Deluga. "That process will go commercial someday."

Making diesel fuel involves, essentially, stringing molecules of methane (natural gas) together. Marilyn Huff, a former graduate student of Schmidt's, tried the process on ethane—a two-methane string—and

**HYDROGEN** CONTINUES ON PAGE 27 ▶

**Schmidt's reactor offers the first real hope of making hydrogen cheaply enough to achieve a hydrogen economy, at least for certain energy uses**

*Recent visitor Ivan Lee is among the dozens of researchers who have worked with Schmidt's group over the past 20 years. The lab is noted for its work with novel catalysts that transform organic molecules into useful products.*

## Materials are the backbone of civilization.

From the beginnings of human existence, materials have delimited the technologies, commodities, lifestyles, culture, and achievements of a given society. The earliest humans used whatever materials were at hand to make clothing, fashion tools, build shelter, and obtain food: stone, sticks, bones, animal hides, water, and the earth itself.

By any measure, the search for today's materials is more complicated than ever. No longer do people simply fell a tree and cut it into boards or smelt the ore dug from the earth. Today, we demand more from our materials: We want them to last longer, stretch farther, work faster, and take up less space. And in the high-tech world, we expect materials to accomplish things science fiction writers only dreamed of a generation ago.

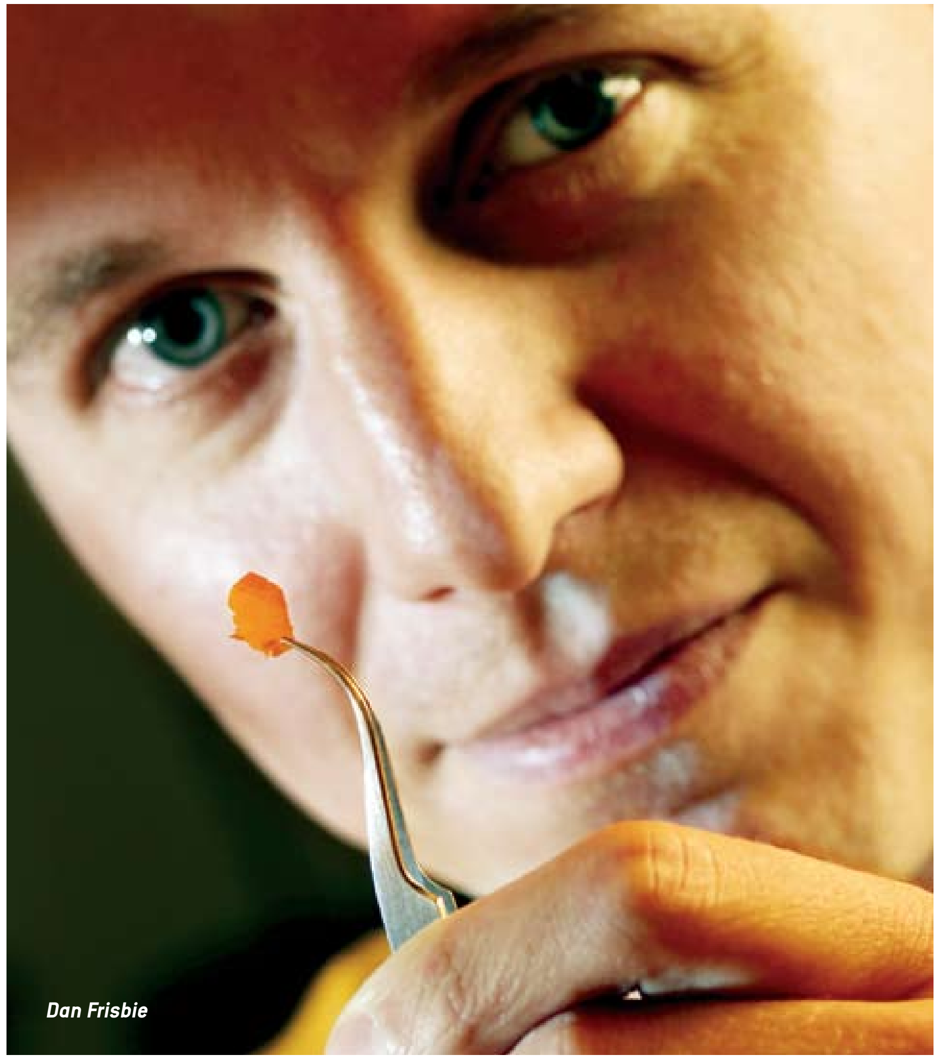
To fuel these advances, a network of interdisciplinary Materials Research Science and Engineering Centers (MRSECs) established by the National Science Foundation (NSF) supports innovative materials research at the University of Minnesota and 27 other colleges and universities across the U.S.

*Associate Professor David Norris uses glass marbles to illustrate his work with photonic crystals. His efforts—part of MRSEC's seed program—may make it possible to replace the large switching devices that direct telephone and Internet traffic with a tiny device no larger than a computer chip.*

# Material evidence

BY MARGARET KAETER • PHOTOS BY JONATHAN CHAPMAN

**IT's structure fosters collaboration across disciplinary boundaries, offering a unique environment for materials research**



Dan Frisbie

"Materials research stretches across the boundaries of scientific disciplines," says Distinguished McKnight University Professor Michael Ward, who directs the University's MRSEC. "It is vitally important to advances in many different areas."

According to Tom Weber, director of the NSF's Division of Materials Research, the MRSECs emphasize strong interaction among disciplines and relevance of their research to society and technology. "The centers do fundamental research, but they are linked much more explicitly to industry and other sectors," he says.

The ascendance of interdisciplinary research reflects the increasingly complicated nature of problems in science and technology. Through its MRSEC program the NSF underwrites studies whose scope and complexity would not be feasible under traditional funding of individual research projects. Unlike other NSF-funded research in academia, where institutional barriers often prevent researchers from working together on projects of mutual interest, MRSECs emphasize interdisciplinary collaboration. The University's organizational structure makes it a natural fit for the MRSEC program.

"The University offers a unique environment for materials research," says Ward. Most universities place their engineering programs in a separate college, creating organizational barriers that isolate engineers from physical scientists and mathematicians, who are traditionally part of a university's college of arts and sciences. IT—which combines engineering, the physical sciences, and mathematics in a single college—fosters collaboration across disciplinary boundaries.

"In IT, the interdisciplinary tradition already exists," says Ward. "MRSEC simply catalyzes it, promotes it even more."

Established in 1998, the University's center is among the largest MRSECs in the country, with $3.5 million in combined annual funding from the NSF, the University, and industry. The center supports three interdisciplinary research groups (IRGs), an ambitious outreach program, and various seed groups. These activities involve about 35 faculty and 40 graduate students and postdoctoral researchers from seven University departments.

The IRGs—MRSEC's "flagships"—bring together faculty with expertise in materials synthesis, theory, characterization, processing, and applications—the central tenets of materials research, says Ward. "They're the principal engines that drive MRSEC research at the University."

### MICROSTRUCTURED POLYMERS

Led by Distinguished McKnight University Professor Tim Lodge, researchers in the microstructured polymer group seek to understand and control the nano- and micro-structures that result from combining dissimilar polymer materials in new ways. Hoping to synthesize and design novel polymers with tailored properties, they are working to create microstructured polymer materials with controlled structural features one micron or smaller in size, using block copolymers (two or more chemically distinct polymers that are bonded together) as raw materials.

Lodge equates their work to the development of a modern Bronze Age technology that combines two different polymers to create a sophisticated polymer with superior qualities (just as a mixture of copper and tin yields the alloy bronze). Because dissimilar polymers resist mixing, scientists must trick them into bonding. (Dish soap offers a good analogy: A molecule that likes water is bonded to one that doesn't, and the result is an "amphiphilic" material that likes both.)

Lodge, a faculty member in the departments of chemistry and chemical engineering and materials science, received the 2004 Polymer Prize of the American Physical Society for outstanding contributions to the fundamental understanding of polymer chain diffusion and segmented chain dynamics.

Many companies are keenly interested in the group's research. "There are many commodity polymers, to the tune of billions of pounds a year, but many of them are not very sophisticated, and block copolymers are," says Lodge. "We don't work on making particular products, but the techniques we use and the materials we create could be used in novel biomedical materials or in optical and electronic parts needed for a roll-up plastic laptop screen. The products and the markets our work might impact are varied, but the underlying science is the same."

Marc Hillmyer, for example, is working to develop environmentally friendly polymers as alternatives to petrochemical-derived products. Hillmyer, an associate professor of chemistry, is studying the chemical and morphological properties of polylactide (PLA), a biocompatible and biodegradable material extracted from cornstarch and other renewable resources. Today it's used primarily as absorbable sutures in human surgeries, but Hillmyer wants to produce a better, more versatile PLA that can be incorporated into block copolymer materials.

The group's research draws on the expertise of faculty from chemical engineering and materials science, chemistry, and physics. "Collaboration is both fun and essential to real progress," says Lodge. "We need innovative, sophisticated synthetic chemistry to make the molecules. We need to measure them, characterize them, and examine the processing and engineering of the resulting materials. It takes a very broad set of skills to develop these polymers."

### CRYSTALLINE ORGANIC SEMICONDUCTORS

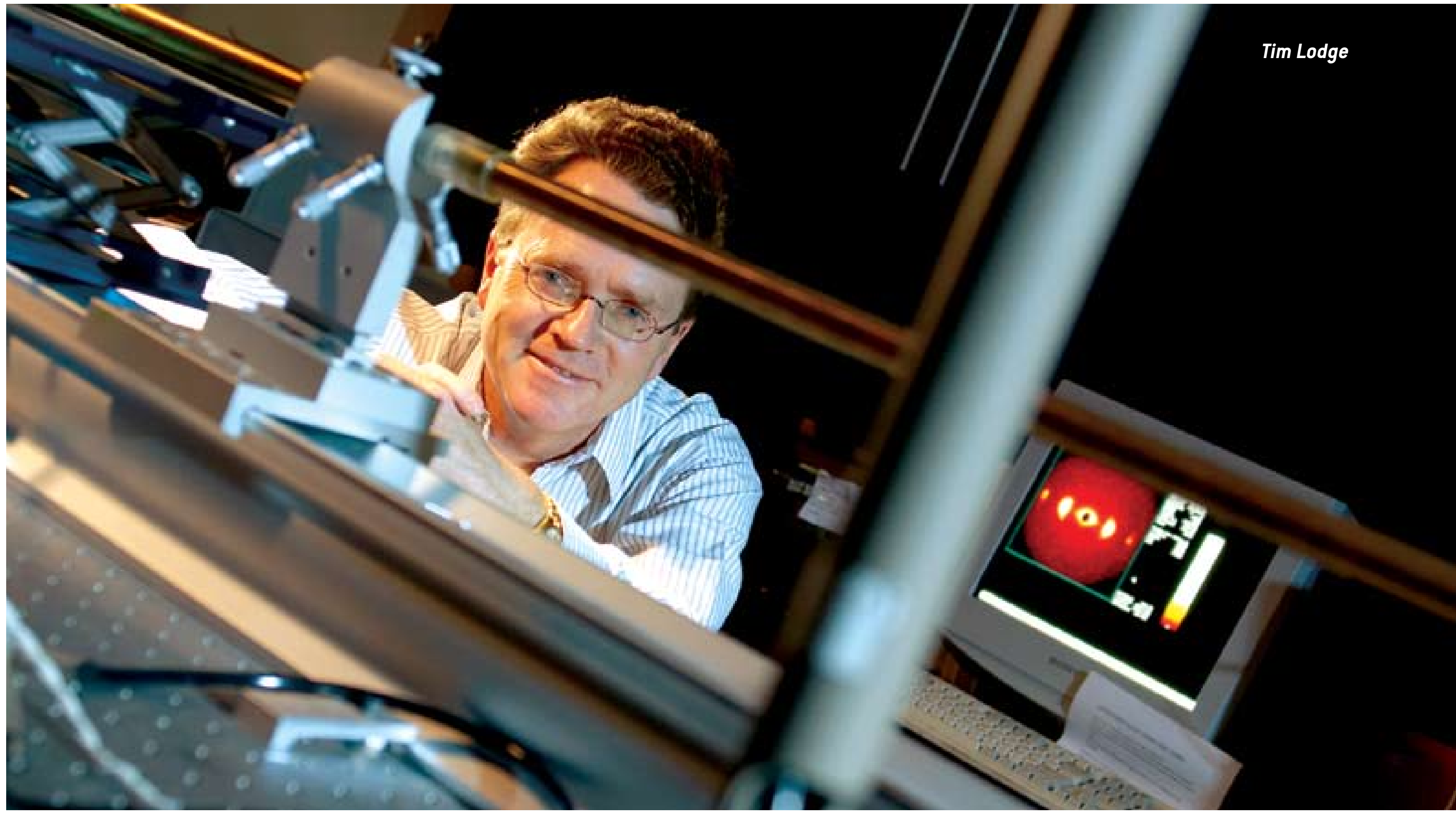
New developments in electronics research are preparing the way for a new generation of devices based on organic semiconductors—polymers that combine unique electronic properties with plastic's versatility, easy manufacture, and low cost. Now in its early stages, research in plastic electronics could someday produce a range of new products, from electronic paper and smart labels to low-cost solar cells, light-emitting clothing, and novel display technologies, such as flexible flat-panel displays.

"Organic semiconductors have similar electrical properties to silicon, but their thermal and mechanical properties are different," says Dan Frisbie, associate professor of chemical engineering and materials science, who leads the crystalline organic semiconductors IRG. For example,

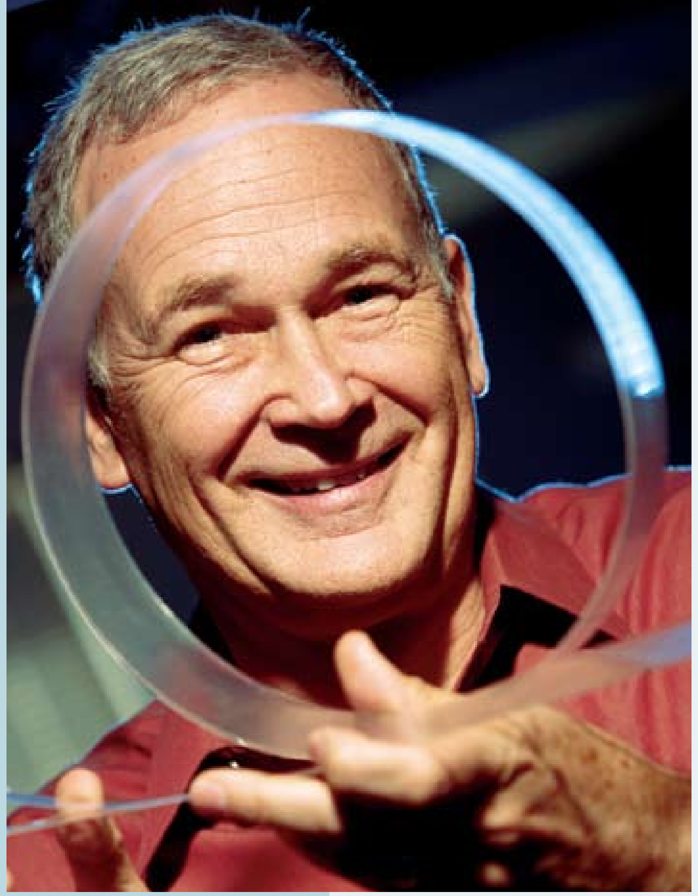
**Research in plastic electronics could someday produce a range of new products, from electronic paper and smart labels to low-cost solar cells, light-emitting clothing, and novel display technologies.**

because of their low melting points and solution solubility, many organic semiconductors can be coated onto conventional plastic substrates, something that is hard to achieve with silicon. This capability opens up potential opportunities for low-cost, high-speed printing of electrical circuitry on flexible sheets that can be used to make a range of products.

But first, researchers must learn how to make electrons move faster in organic semiconductors. In the competitive semiconductor technology environment, every extra bit of speed counts. "Our work in the IRG revolves around determining



Tim Lodge



# PRIME PARTNERSHIPS

**Increasingly, companies are turning to academia for the "building blocks of knowledge" they need to develop industrial applications.**

Scientific and technical articles comprise a growing number of citations in U.S. patents, which suggests that university research plays a greater role in the creation of products and services. Consequently, the NSF strongly encourages MRSEC programs to include an industrial component that promotes mutually beneficial partnerships between academia and the private sector.

The University's Industrial Partnership for Research in Interfacial and Materials Engineering (IPRIME) serves as an entry portal for companies that want to participate in materials research programs with IT faculty and students. "Companies turn to IPRIME for the basic research—working principles and enabling technologies—that underlies their new products and services," says Chris Macosko, IPRIME director and professor of chemical engineering and materials science. "At the same time, the partnerships help us (University researchers) keep pace with industry's changing needs. We find out about possible applications of our work. And our students get a terrific firsthand look at the real world, they meet industrial scientists, and they learn about prospective employers."

IPRIME activities involve 45 faculty members and 70 to 80 graduate students from seven University departments, six of them in IT. Research studies vary annually according to industry's needs. About 40 companies provide $1.2 million in funding, mostly to support graduate students, with additional support coming from the University and MRSEC. Company researchers may also work directly in University labs as industrial fellows; more than 120 people have done so over the last 15 years. Research results are communicated in individual meetings with member companies and at the IPRIME annual meeting, to be held this year in early June.

**"IPRIME provides a ..."one-stop-shop" for companies interested in materials research."**

"IPRIME provides a coordinated, "one-stop-shop" for companies interested in materials research. "[It] eliminates a lot of searching, phone calling, and establishing a network," says Tommie Kelley, a research specialist at 3M's electronics and inorganics technology center in St. Paul. "It's like having yellow pages for research. It's been great to see an evolving MRSEC that parallels our research. The value to us is that we can suggest research that we would like to see but don't have the time or resources to pursue."

Another example is Cargill's effort to find new applications for soybean oil in plastics. Through the company's membership in IPRIME it quickly located experts in polymer science, and this year a research project in soy polyols has started at the University.

Some shared facilities that support IPRIME activities receive MRSEC funds to purchase equipment. A major example is the Characterization Facility, whose $10 million worth of instrumentation was funded in part by MRSEC. According to director Greg Haugstad, the facility serves 300 people a year, including researchers, students, and scientists representing more than 50 companies. ■

*—Margaret Kaeter*


*Companies can tap the rich vein of IPRIME resources, including the expertise of faculty researchers like Chris Macosko (above), and state-of-the-art instrumentation in the Characterization Facility, directed by Greg Haugstad (right).*



how fast the electrons (or their counterparts, "holes") move in these materials and how we can make them move faster," says Frisbie.

The IRG uses its expertise in synthetic chemistry and quantum chemistry calculations to design new organic semiconductors with higher charge velocities in the presence of an electric field.

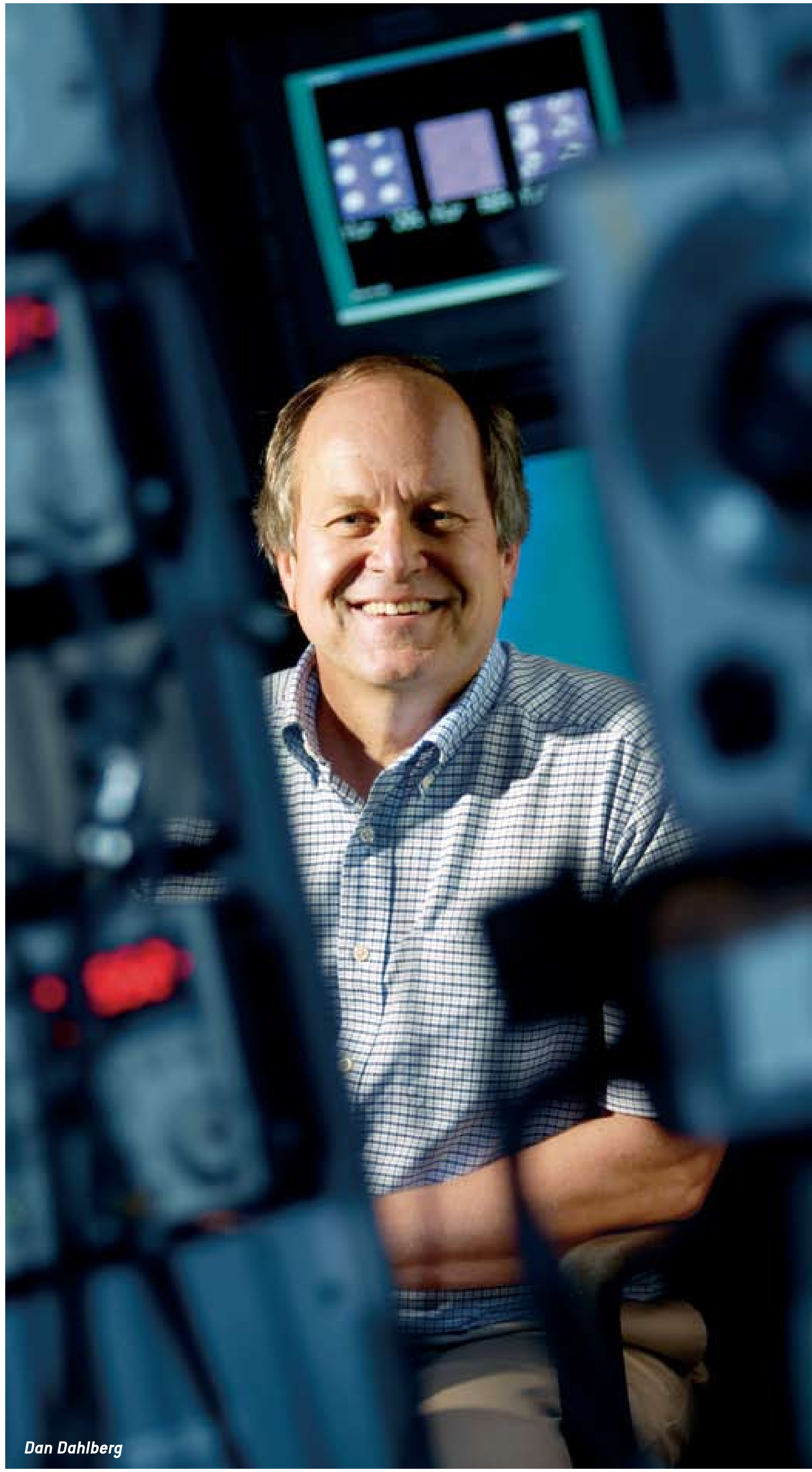
Besides studying the structure, carrier dynamics, and transport properties of these new materials, the group has an applied research goal of using organic semiconductors to create low-cost, thin-film transistors, a product highly valued by corporate partner 3M, which has an extensive program in organic electronics. The basic research in transistors is aimed at making product development much easier for the group's industrial partners.

According to Frisbie, the greatest advantage of the MRSEC organic semiconductors program is its team of researchers from diverse fields. "We have eight faculty: two from electrical engineering, two from chemical engineering and materials science, two from chemistry, one from physics, and one from Georgia Tech's chemistry department," he says. "There is no comprehensive program like this in the country that brings people together from multiple university departments to focus on making better organic semiconductors for plastic electronics."

## MAGNETIC HETEROSTRUCTURES

Over the last few decades magnetism has become the basis for many technologies that dominate modern life. The laws of magnetism control the amount of information that can be stored on a computer's disk drive, for example. If these principles could be changed, then the size of computers could shrink—perhaps to the size of a contact lens—and the speed of information processing would be accelerated to an amazing degree.

Under the leadership of IT Distinguished Professor Dan Dahlberg and Associate Professor Paul Crowell of the physics department, MRSEC's magnetic heterostructures group is investigating phenomena at the boundaries of magnetism: spin transport, magnetization dynamics, and exchange coupling. Materials research underlies the group's investigations.



Dan Dahlberg

# PASSING THE TORCH

> "The idea is to ensure technology and knowledge transfer via the students."

**Research isn't MRSEC's sole product. Each center also invests in human potential through education and outreach.**

At the University those efforts include programs for college faculty and undergraduates from other institutions, high school teachers, and the highly popular Physics Force performances designed for a general audience of all ages.

The University MRSEC's emphasis on faculty-student collaboration sets it apart from other programs, says Frank Snowden, the center's associate director and director of education and human resources.

"We were the first and one of the few now to have faculty-student programs," says Snowden, a professor of chemical engineering and materials science. "This [collaboration] is the anchor of the whole education and outreach program." MRSEC's research opportunities supplement the traditional science curriculum and increase participants' understanding of materials science and engineering, he adds.

Keenly aware that many smaller schools lack research facilities and programs, MRSEC created a 10-week summer outreach program for student-faculty teams from four-year institutions. The program's goal is to expose undergraduates to new opportunities, says Snowden.

"If students come here and participate in high-level research, they may be more inclined to pursue graduate school and a career in science and technology," he says.

MRSEC is also working with tribal colleges across the nation to encourage American Indian students to study materials science and engineering. The University's program, which was the first MRSEC in the nation to partner with tribal colleges, is seeking funding to create a two-year program in materials science with the College of Menominee Nation and to establish undergraduate internships.

Additional programs that promote diverse participation in science and engineering draw students and faculty from a network of 140 colleges nationwide, most of them concentrated in the Midwest: 22 four-year colleges, 13 tribal colleges, nine historically black colleges, and four schools that serve large Hispanic populations.

The center also offers a five-week program in which high-school teachers develop curricula for their classroom based on a topic related to materials science and engineering. Physics Force performances, supported in part by MRSEC funding, reach more than 30,000 Minnesota children a year.

"NSF sees [tomorrow's engineers and researchers] as the product of these programs," says Ward. "The idea is to ensure technology and knowledge transfer via the students. As the students go to industries that are interested in the research they did as graduate students, they take the new multidisciplinary knowledge with them." ■

*—Margaret Kaeter*

***An appreciative young audience peppers science teacher Jon Anderson (above) with questions during a performance by Physics Force: The Next Generation. Frank Snowden (right) oversees MRSEC's outreach and education programs.***




"To push the frontiers [of magnetism] you need pure material," explains Dahlberg. "You have to be able to see things on an atomic level, so you need perfect samples. We have people at the top of the research heap growing and developing new materials. Then others measure and understand the physics of the new materials, [and] still others model and design new materials."

Beth Stadler, assistant professor of electrical and computer engineering, works on microscopic wires with varying magnetic charges. Jim Chelikowsky, an IT distinguished professor in chemical engineering and materials science, is studying solid-state dynamics, essentially introducing a few ions of manganese to a semiconductor to make it slightly magnetic.

Magnetism dynamics in particular requires an integrated approach. "As we make computer chips for superconductors, we have to store the charge in smaller areas, called charge confinement," says Dahlberg. "However, we are looking at storing the information in the spin of electrons, which we use as a magnetic state. Eventually this could allow us to store a great deal more information in a much smaller place."

Saving time could be another benefit. Magnetic RAM, which is nonvolatile, eliminates the need for a boot period because it doesn't require power to maintain its state. Researchers are trying to learn more about how the electrons behave, how fast they switch, and how long the magnetic field persists.

Spin transport presents its own set of challenges. To lay the groundwork for new types of transistors, the group must learn how to transport magnetic information from one location to another, but the various materials involved resist the shift.

"The potential of electrons to carry magnetic information from one spot to another is not fully exploited because it's difficult to get spin to carry from magnetic material like iron to a semiconductor," says Crowell. "Also, the charge of an electron lasts forever so it goes everywhere the electron goes. However, the spin that holds the information doesn't last forever. It can last for just nanoseconds."

Storing the spin in the atoms' nuclei may provide a solution, but the problem requires a breadth of technical proficiency beyond the scope of one person's specialization. "That's the reason for programs like [MRSEC]," says Crowell.

## NEW FRONTIERS

By any measure, the University's MRSEC has already achieved remarkable success. Research initiated at the center has led to more than $10 million in additional funding from government and industry sources, and one project has already been spun off into its own NSF-funded program.

In 2002 the University was awarded $14.76 million to support six more years of MRSEC activity. More than 100 schools vied for the 13 MRSEC grants awarded.

The renewal is an endorsement of the University's eminence in materials research, says Ward. "The MRSEC enhances our existing strengths and elevates our visibility." Indeed, a recent *Science Watch* survey of materials research citations ranked Minnesota second worldwide.

With its strong foundation and innovative spirit, the University's MRSEC will enjoy a long and productive future, predicts Ward.

"The center is evolving all the time," he says. "We are constantly looking for new directions—searching for new frontiers of cutting-edge research." ■

FOR MORE INFORMATION see www.mrsec.umn.edu.

# SEEDING THE FUTURE

**MRSEC's seed program encourages new ventures by junior faculty who represent the center's future.**

> "The development of these technologies would not be possible without a collaboration."

The program supports research in emerging or high-risk areas, studies that promote long-term industrial collaborations, and projects that may bolster existing research clusters.

## PHOTONIC CRYSTALS

Photonic crystals, structures that can be designed to control and manipulate the propagation of light, hold enormous potential to improve optical devices, computing power, and a host of other applications in medicine and industry.

Basic building blocks of photonic crystals may make it possible to replace the large switching devices that direct telephone and Internet traffic with a tiny device no larger than a computer chip. "We make little glass marbles and trick them to organize in sheets," says David Norris, associate professor of chemical engineering and materials science, who is team leader for photonic crystals research. "Fill the spaces between the marbles with other materials and then use chemicals to etch away the marbles. Now you have spheres of air inside. If you picked the right material for the 'walls,' the light now scatters better and stronger than fiber optics and will go exactly where you want it to go. In fact, some colors will not even be allowed to exist."

Andreas Stein, associate professor of chemistry, predicts that photonic crystals will become highly efficient optical "transistors" of the future, when computers will use light instead of manipulating electrons. Photonic crystals also could be used to manipulate chemical reactions that require light. For example, a company currently has a patent on crystals that clean oil spills when light hits them. Wastewater treatment facilities might use them for a similar purpose.

As brilliantly colored as nature's opals, photonic crystals could be ground up to make nontoxic paints that don't fade. They have an unusual property that could revolutionize industrial pigments: When the "holes" in photonic crystals fill with water, the material changes color.

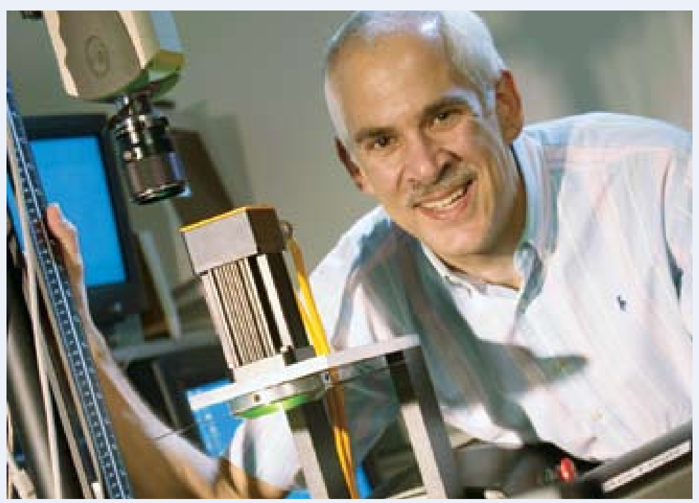
"For example, we can imagine a metallic green car on a rainy day that is red on a dry day," says Stein. "The army could use these properties for camouflage on vehicles. The yellow used on some fire trucks today is toxic, but these pigments wouldn't be. Likewise, red paints fade, but these are chemically stable."

## SILICON NANOPARTICLES

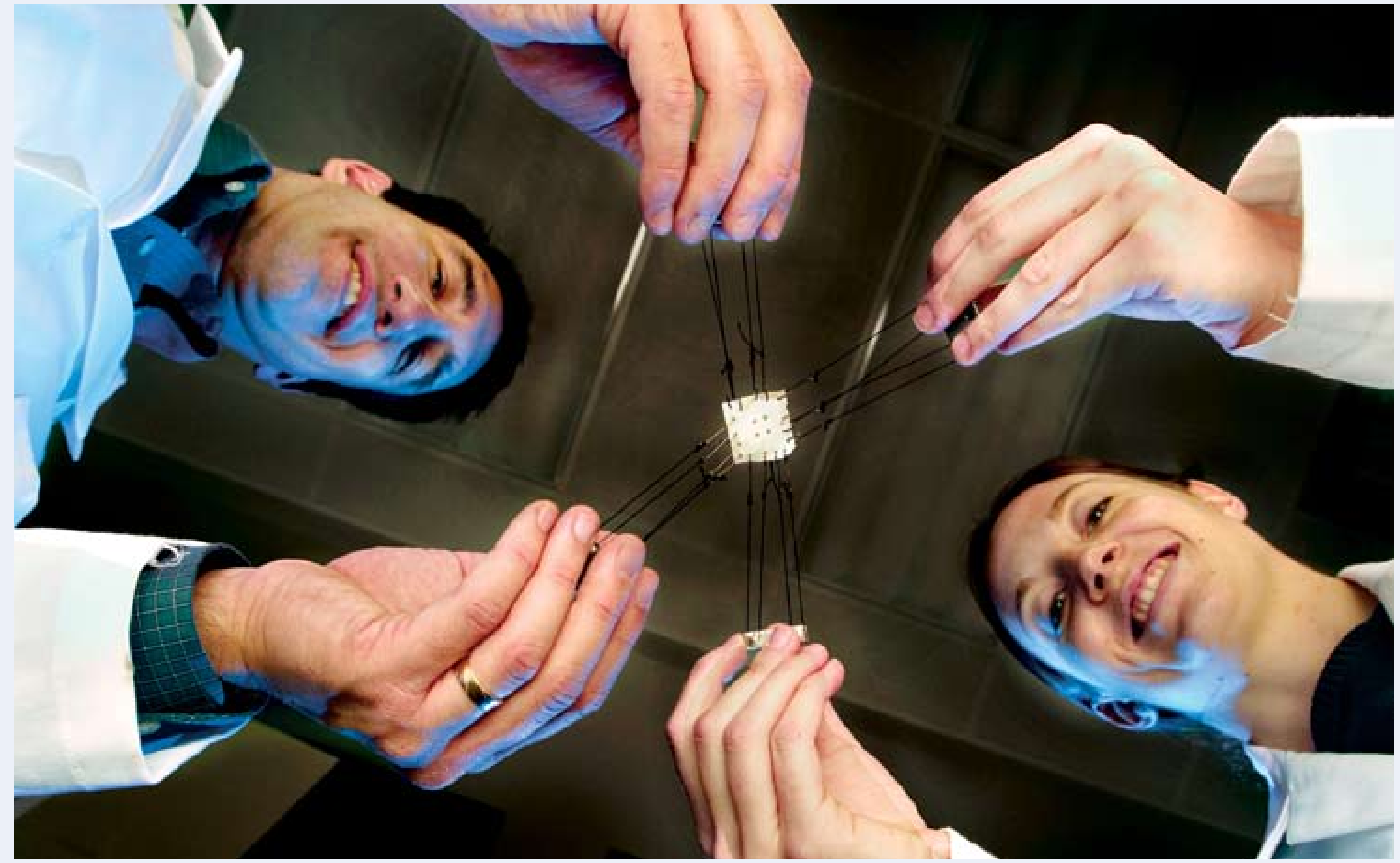
Steve Campbell's MRSEC group would like replace today's computer with a new generation of tiny electronic devices that won't be connected to a board by wires. Instead, a single-chip computer could be placed on a contact lens or be woven into clothing.

"Eventually we want to make a full transistor that would be just 10 nanometers in size, but it is our job to do the basic research first," says Campbell, a professor of electrical and computer engineering.

To that end, his group is exploring the unique electronic and optical properties of single silicon nanoparticles, which successfully convert energy but don't interact well with other materials.



*Professor Steve Campbell (above)envisions a single-chip computer that could be placed on a contact lens or woven into clothing. Professor Robert Tranquillo (right) is working to perfect artificial tissues.*



*Assistant Professor Mark Nicosia and Megan Kruse (Biomedical '04) display a model of a biaxial tester that characterizes the mechanical properties of esophageal tissue.*

Mechanical engineering professor Uwe Kortshagen is using plasma processes to synthesize the nanoparticles, which then are imbedded in growing cells or free-standing particles.

"We are looking to modify the properties of the films or materials we imbed them in, to make them more stable, for example," says Kortshagen. "The result could be a solid-state-like device or a nonvolatile memory device."

The silicon nanoparticles' stabilizing properties would prevent the energy waste associated with today's solar panels. "They are very good at energy conversion on solar cells," says Campbell. "They have mobility [and] efficiency, and they don't degrade."

The development of these technologies would not be possible without a collaboration, says Kortshagen. "My students would produce the film, and other professors' students would characterize it. We can't do the job without each other."

## TISSUE ENGINEERING

The development of an improved artificial heart valve—one that will be a permanent option for survival—continues to elude scientists, and Distinguished McKnight University Professor Robert Tranquillo's artificial tissues research cluster is determined to find out why.

"We are trying to understand how the underlying properties of tissue give rise to the properties of how it acts. If we want to create an artificial heart valve or artery, it's important that it functions like an artery or heart valve," says Tranquillo.

To discover how the "real thing" works, the team conducts experiments and develops computer models that demand the expertise of researchers from various departments.

Victor Barocas, assistant professor of biomedical engineering, has developed a first-generation microstructural-macroscopic model that simulates how tissue fibers will act when the tissue is stretched and relaxed. His model predicts that microstructure (i.e., tissue-fiber alignment) cannot be deduced simply from macroscopic strain. The model can be tested with data from a high-speed polarized light-imaging device, developed by Tranquillo's group, which can produce an image of the tissue's fiber alignment every 40 milliseconds.

"He models the macro-micro relationship," says Tranquillo. "That's why collaboration is important. I don't have that capability."

Mark Nicosia, assistant professor of biomedical engineering, studies basic mechanics and computer modeling to understand how heart valves open and close. "We have a state-of-the-art biaxial testing system," explains Tranquillo. "As a result, we can stretch tissue in two directions at once. It simulates how the tissue experiences stress in the body. Victor and Mark can use the data to refine their model of valve leaflet bending and use that model to predict valve function."

Tranquillo himself focuses on creating and characterizing artificial tissues by controlling how cells remodel a biopolymeric scaffold, which he and his colleagues use in their models. The three then combine their information to determine which qualities need to be incorporated into the next generation of artificial tissues.

"Right now we are trying to make sense out of the preliminary high-speed data," says Tranquillo. "Our initial reaction is that our artificial tissue doesn't relax stress primarily by realignment of the tissue fibers." ■

—Margaret Kaeter

# Minnesota goes to MARS

## Genuine made-in-Minnesota expertise contributed to the technological triumphs of NASA's Mars Exploration Rover expedition

BY JUDY WOODWARD

**WHEN THE TWIN MARS EXPLORATION** Rovers touched down on the Red Planet in January 2004, there was a bit of Minnesota in the payload. The Minnesota connection wasn't anything obvious, like a plush Goldy Gopher tucked in among the scientific equipment or a few bars of the "Rouser" encoded somewhere in the software; rather, it was genuine made-in-Minnesota expertise that contributed to the expedition's technological triumphs.

Each NASA mission has presented scientists and engineers with a host of demanding technological hurdles. For decades, University researchers and alumni have been involved in finding solutions to these problems and advancing the nation's space program.

One of the most daunting challenges facing the Mars team was the design of space vehicles that could withstand the physical stresses of entering the planet's atmosphere while traveling at speeds of about 15,000 miles per hour. Design engineers had to understand the precise nature of the atmospheric gases that would surround the vehicle as it entered the Martian atmosphere. To miscalculate was to risk incineration or disintegration of the scientific payload.

NASA/JPL/CORNELL

That's where the work of Professor Graham Candler of the Department of Aerospace Engineering and Mechanics comes in. He specializes in the development of numerical methods to calculate gas flows around spacecraft entering planetary atmospheres and to predict heating rates and aerodynamic forces. In a laboratory it's impossible to achieve the kind of chemical reactions that occur when the carbon dioxide-laden atmosphere of Mars is subjected to the extremely high temperatures produced by the space vehicle's entry.

Several of Candler's former graduate students have gone on to work for NASA and other aeronautical contractors, where they use numerical methods developed by Candler as the theoretical foundation for the engineering design of spacecraft.

Although Candler did not participate in direct design efforts for the twin Mars rovers, he is involved in other future space exploration projects. He's currently working on the design of thermal protection for the upcoming Mars Smart Lander launch. His research also is geared toward unmanned expeditions planned for Titan, which is one of Saturn's moons, and for the planet Neptune. "We're already working on the next mission that maybe will fly in 10 years," he says.

Other aerospace scientists may have harbored a boyhood fascination with rockets and space travel, but not Candler. "For me, it's much more [about] the technical understanding—how to design something that achieves that goal," he says. "I like working on tough problems."

**To miscalculate was to risk incineration or disintegration of the scientific payload**

A tough problem of a very different sort was solved by a three-man team that included electrical and computer engineering professor Guillermo Sapiro, an expert in mathematical image processing. In the mid-1990s Sapiro and two colleagues from Hewlett-Packard Laboratories in California, Marcelo Weinberger and Gadiel Seroussi, devised what they called the LOCO-I algorithm for high-resolution image compression. Their work allows scientists to transmit computerized images faster and without loss of data. Since January their technique has been used to transmit some of the high-quality images obtained by the Mars rovers.

*This image mosaic from the Mars Exploration Rover Spirit's panoramic camera shows the rover's destination toward the area nicknamed "Columbia Hills," on the right. The rover's heat shield can be seen on the left as a tiny bright dot in the distance, just under the horizon. This image was taken March 12–13, 2004, from the location the rover first reached on the crater's western rim.*

# LANDINGS **LEGEND**

**Helmut Heinrich**—German by birth, Minnesotan by adoption—was a towering figure in the development of scientific uses for parachutes

WHEN THE MARS ROVER LANDING CRAFT USED special parachutes to slow it enough to avoid setting it on fire during its high-speed entry into the Martian atmosphere, Minnesotan Clinton Eckstrom received the credit for the parachute design.

But as Eckstrom points out, another pioneer also deserves a nod of acknowledgement.

Helmut Heinrich—German by birth, Minnesotan by adoption—was a towering figure in the history of the scientific uses of parachutes (or "aerodynamic deceleration devices," as they are officially known).

A professor in the University's Department of Aerospace Engineering and Mechanics for almost a quarter of a century, Heinrich developed supersonic parachutes that contributed to the Apollo space landings in the 1970s as well as parachute systems that were used in the soft-landing technology of the Mars and Venus probes of his era.

Heinrich's personal life was as remarkable as his professional attainments. Born in Berlin, he received a doctorate in engineering at the Technische Hochschule in Stuttgart. During World War II, he became head of aerodynamics research at the Research Institute Graf Zeppelin, where he designed parachutes for the Luftwaffe.

According to family legend, as recounted by his son-in-law Paul Lane, a physics professor at St. Thomas University in St. Paul, by the end of the war Heinrich had fallen into disfavor with the SS as a result of less-than-diplomatic comments he made about the German war effort. "He went into hiding the last year of the war after burying his research papers in a trunk in a field," says Lane.

Those papers were to come in handy after the war. Distinguished German scientists like Heinrich were a prized commodity to the Allies, even as the strain of American-European wartime allegiances were already beginning to show.

"After the war ended, Heinrich was captured by the French," says Lane. "But the Americans wanted him more, so they took him at bayonet point from the French. When captured by the Americans, he was strongly advised to summarize what science he had done in World War II."

Weeks later Heinrich was spirited out of the ruins of Germany as part of Operation Paperclip, the clandestine U.S. military action that brought leading German scientists to America by force, including Wernher von Braun, who ultimately became the father of the space program. After a few months, members of Heinrich's family were able to join him at Wright-Patterson Air Force Base in Ohio, where they were held as semi-prisoners while Heinrich began to reconstruct his scientific work. Their status was eventually regularized, but Heinrich was never fully satisfied as a civilian employee of the U.S. Air Force. He much preferred the academic life, and in 1956 he accepted a position at the University of Minnesota.

Heinrich's knowledge of parachutes was encyclopedic. In addition to design efforts for the space program, says Lane, he also designed parachutes for use in skydiving.

Heinrich died of a heart attack in Houston on March 7, 1979, the day after he had received the highest honor of his profession, the newly created Aerodynamic Deceleration Systems Award from the American Institute of Aeronautics and Astronautics.

Visitors to the University's Science and Engineering Library can appreciate his legacy. The library houses the Helmut G. Heinrich Parachute Collection, a unique multimedia resource devoted to the study of aerodynamic deceleration. The collection is open to the public by appointment (612-625-3814). ■

—*Judy Woodward*

*The parachutes used in the Mars Exploration Rover mission trace their roots to research conducted by University professor Helmut Heinrich in the years following World War II.*

HEINRICH: UNIVERSITY ARCHIVES; PARACHUTE: NASA



IMAGES COURTESY NASA

Sapiro explains that the rover uses two image-transmission methods. The "lossy" technique is similar to the method that delivers a JPEG image to a home computer. To the naked eye it may look fine, says Sapiro, "but it's not actually preserving each bit of the image and all the original data."

In contrast, the "lossless" technique developed by Sapiro and his colleagues preserves all the available visual data, a capability that's critically important to the mission's scientific goals. "When you spend millions of dollars on a mission, you need all the data," he says.

Sapiro's delighted that his work is aiding the Mars Exploration Rover mission, but he's quick to point out that LOCO-I has many other applications in fields that require fast, high-quality image transmission. When it comes to scanning the world's great paintings for digital preservation, LOCO-I has been approved as the international standard for image compression.

Medicine is another field where high-quality images are vital. "Our technique is in the process of being declared the international standard for medical imaging," says Sapiro.

Like all U.S. space missions, the Mars probe began as an expression of national pride and technological know-how. In recent years, though, as NASA officials have collaborated with scientists from Europe and the former Soviet Union, space exploration has taken on a much more international flavor. Sapiro, Weinberger, and Seroussi studied science on three continents. They grew up in Uruguay, where they knew each other slightly, and then immigrated to Israel, where they studied at the prestigious Technion-Israel Institute of Technology. Eventually they came to California to conduct research together at Hewlett-Packard.

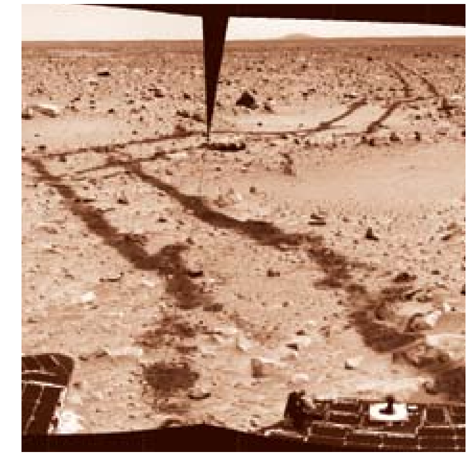
When the three men hold scientific discussions, they have the option of conversing in Spanish, Hebrew, or English, but boyhood habits die hard: "Normally we speak Spanish," confesses Sapiro.

In 1997 Sapiro left California to join the University faculty, but he continues his collaborations with Weinberger and Seroussi. Their latest project is in the field of image steganography (literally, "covered writing"), the technique of hiding information in plain view within an image.

Sapiro and Candler share more in common than the Mars expeditions. This year the two IT researchers were honored with the Distinguished McKnight University Professorship, an award given to the University's most outstanding mid-career faculty.

Some of the pacesetting technology associated with recent NASA missions, including the Mars expedition, emerged much earlier than many people realize. Retired NASA engineer Clinton Eckstrom (Aeronautical '61) designed what's known as a "heritage system." During the Mars program of the 1970s he developed a parachute that was used to slow down the space vehicles' payloads to subsonic velocity in order to help the craft penetrate the Martian atmosphere without destroying itself. His system was adapted, with only slight modifications, to the current Mars effort. It saves money and time to use existing technology like his, according to Eckstrom.

Parachutes have defined Eckstrom's professional life almost from the time he left his boyhood home on a farm in Minnesota's Watonwan County to enter the



*Mars Exploration Rover Spirit (below) and its twin, Opportunity, act as robot geologists during the mission. Mast-mounted cameras provide 360-degree, stereoscopic views of the terrain. The rover's robotic arm can place instruments directly up against rock and soil targets. A microscopic camera in the arm's mechanical "fist" functions like a geologist's handheld magnifying lens, while a rock abrasion tool, similar to a geologist's hammer, exposes the interior of rocks. Above, a pair of spliced images reveals the long, rocky path of nearly 787 feet that Spirit traveled during its first three months on Mars.*

University in 1956.

"The parachute expert Dr. H.G. Heinrich [see sidebar] came to the University the same year," he explains. "I ended up getting a job with him. Aeronautical engineering was a five-year program then, and I worked for him the entire five years."

After graduation and a stint at Wright-Patterson Air Force Base in Ohio, Eckstrom took a job with the G. T. Schjeldahl Company (now Sheldahl, Inc.) in Northfield, Minnesota, where

**Alumnus Clinton Eckstrom developed a parachute system in the 1970s that was modified only slightly for the 2004 mission**

he designed high-altitude parachutes for meteorological rockets.

"The parachutes were for rockets that went up 200,000 feet," he says. "The parachutes carried a weather measurement instrument called a 'sonde' down to 100,000 feet."

When NASA began testing parachutes for possible use in the Mars landings of 30 years ago, Eckstrom's design—the disk-gap-band parachute—was just what the space agency was looking for.

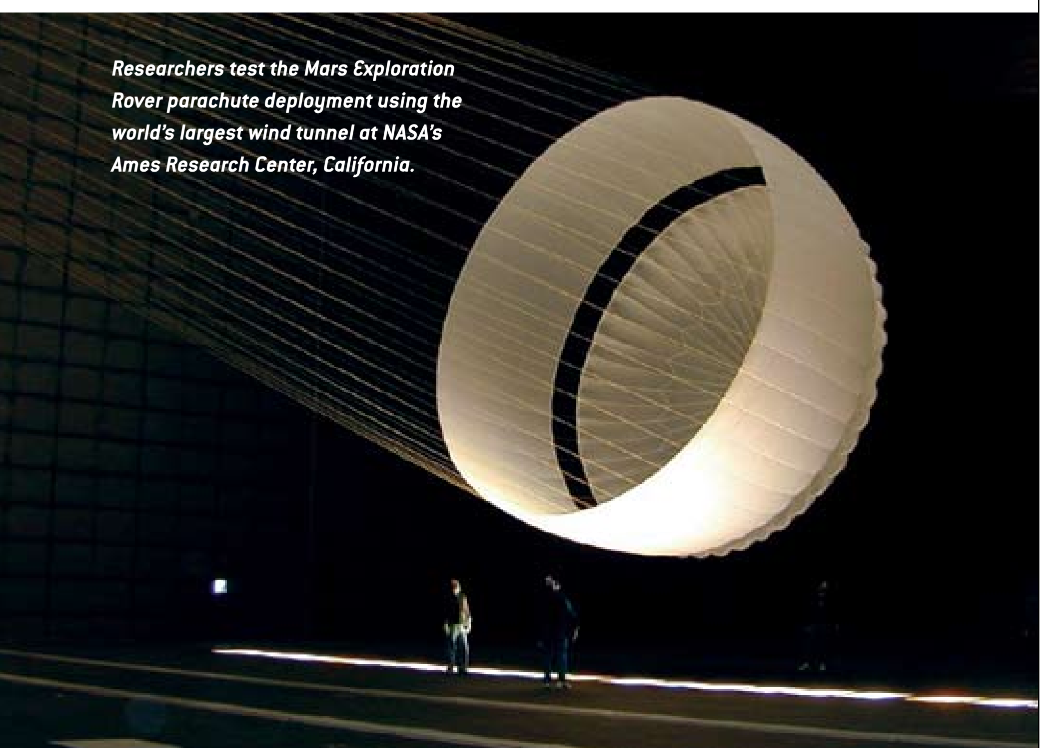
"When NASA began the sorting process in the late 1960s, this parachute tended to survive, while others were likely to tear up," he says.

Because his parachute was a prime candidate for the earlier Mars missions, Eckstrom decided to join the engineering team at NASA Langley in Hampton, Virginia. He retired 35 years later with the knowledge that his design had been instrumental to the success of several decades' worth of space exploration.

Now retired and living in Virginia, Eckstrom seems mildly astonished that the University recognizes his contribution to the Mars Rover expedition. "I'm surprised you were able to track me down," he says.

He may be surprised, but others who know of the University's contributions to space engineering are not. What's clear is that the efforts of people like Eckstrom, Sapiro, and Candler will continue to represent Minnesota as long as the nation embraces the challenge of conquering the frontiers of space. ■

FOR MORE INFORMATION see marsrovers.jpl.nasa.gov/home/index.html.



*Researchers test the Mars Exploration Rover parachute deployment using the world's largest wind tunnel at NASA's Ames Research Center, California.*

NASA

## WHIZARDRY

CONTINUED FROM PAGE 7

like high school: "Every week he draws us into a new avenue of stuff. We get a really broad view this way."

CLA student Micah McLellan credits Zhu's class for expanding his horizons. "I thought it would be just about the 'cool gadgets' themselves," he says. "Instead, I'm learning more advanced stuff than I expected. It helps me understand where [technology] is coming from, and I'm learning how much farther we have to go."

For CLA student Jeremy Marzofka, the course's highlight was a classroom demonstration of a micro-mirror device to illustrate microelectromechanical systems [MEMS], tiny machines that replace traditional mechanical technology. Marzofka was particularly impressed with the fragility of the ultraminiaturized mechanism.

"A piece of my hair could destroy the whole system," he reflects in awestruck tones as Zhu jokes from the front of the classroom, "Yes, you'll be getting a bill."

General College freshman Matt Bahnemann initially joined Zhu's class because he was hoping for a deeper understanding of the high-tech gadgets he sells in his off-campus job at Best Buy. So far he hasn't discovered any practical on-the-job applications of his knowledge, but that hasn't dampened his enthusiasm. "I want to study computer engineering," he says. "The class gives me the interest in looking further into the new technology that's coming out."

Zhu has mounted another PowerPoint image on the projection screen. This time the STM has arranged an elegant display of red-tinted iron atoms against a blue-green copper background. "I learned to write this when I was five," Zhu says as the picture resolves itself into two Chinese characters.

"Seeing Beauty in the Nano-World" is the theme that Zhu has chosen for today's lecture, and it's hard to imagine a better illustration for it than the graceful image the students see now. In simple, shapely nano-calligraphy, the characters depict the Chinese word for "atom." ■

FOR MORE INFORMATION see www.chem.umn.edu/groups/zhu.



## HYDROGEN

CONTINUED FROM PAGE 11

found she could make olefins, the building blocks of economically important polymers like polyethylene and polypropylene. Schmidt and his team have also succeeded in converting methane to "syngas," a mixture of hydrogen gas and carbon monoxide that can be used to make synthetic diesel fuel and a variety of industrial chemicals.

"We'd been working with fossil fuels until this molecule—ethanol—came along," says Schmidt. "The hydrogen economy became important during the last five years, and all these processes we've been talking about make hydrogen. Now we're trying to tune the process to maximize hydrogen output instead of olefins. This is fundamental research, and a lot of steps are still required to turn it into a viable technology."

Confident it can perfect the reactor, the team is studying the rhodium-ceria catalyst to find out exactly why it works so well and how it could be improved. But several speed bumps still lie on the reactor's road to becoming the linchpin of the hydrogen economy.

For one thing, it matters where the hydrogen comes from. If its source is a plant like corn or soybeans, then the real powerhouse is the sun. But if the U.S., let alone the world, were to switch to ethanol and biodiesel, farmers would have to supply much more corn or soybeans, and the effort of growing these crops would consume extra energy and may devour more pristine land. Also, corn requires high inputs of nitrogen fertilizer. Crops like switchgrass or hybrid poplar have been suggested as possible hydrogen sources that would exact a lesser environmental cost. Nevertheless, the question of how to supply hydrogen without despoiling the environment will probably not be answered soon. Wind power, although sporadic, can generate electricity to extract hydrogen from water and may ease the situation somewhat.

However hydrogen is generated, it's of little use without fuel cells to extract its energy. That technology is just now moving from infancy to the demonstration stage.

"Once fuel cells become popular, the hydrogen reactor technology will be a very competitive option," says Schmidt. But the combination of his reactor and fuel cells won't replace current technologies until a new infrastructure is ready.

"The hydrogen economy means cars and electricity powered by hydrogen," he says. "But hydrogen is hard to come by. You can't pipe it long distances. There are a few hydrogen fueling stations, but they strip hydrogen from methane on site. It's expensive, and because it uses fossil fuels it increases carbon dioxide emissions, so it's only a short-term solution until renewable hydrogen is available."

**Eventually, homeowners may be able to buy ethanol and use it to power small hydrogen fuel cells in their basements**

As engineers create a system of fuel cells and fueling stations for hydrogen-powered vehicles, they will need a steady supply of hydrogen. Currently, however, only fossil fuels can deliver it. Schmidt estimates it will take at least a decade for the system to develop enough to convert to renewable hydrogen fuels.

Schmidt is not waiting for the hydrogen economy to come to him. He is a co-principal investigator in a national project to build hydrogen fueling stations. Also, California's Electric Power Research Institute has submitted a proposal to Xcel Energy for a hydrogen fueling station on the University's Minneapolis campus. If it should come to fruition, Schmidt would certainly be a major player. Minneapolis may soon get in the game, too.

"The Minneapolis City Council is interested in hydrogen buses," says Schmidt. "We may get a demonstration model."

A fleet of 30 buses running on hydrogen fuel cells is being introduced this year in 10 European cities, according to Rolf Nordstrom, director of the Upper Midwest Hydrogen Initiative (UMHI), a

JONATHAN CHAPMAN

public-private entity working to make the region a leader in the conversion to hydrogen-based energy. In addition to his work with UMHI, Schmidt is a key member of the University's Initiative for Renewable Energy and the Environment [see sidebar on page 10].

At home, Schmidt loves to grow plants, especially orange and lemon trees, which he tends in a two-story glass enclosure. Besides producing delicious fruits, the trees symbolize the increasingly important role of plants in giving us tomorrow's energy and materials. ■

FOR MORE INFORMATION see www.cems.umn.edu/

JONATHAN CHAPMAN

# THE RIGHT TRACK

**IT alumni led the team of engineers who delivered Minnesota's first light-rail line on time and under budget**

BY TRISHA COLLOPY

2 WEEKS AFTER THE TWIN CITIES BUS strike ends in April, there's a quiet bubble of excitement on the Hiawatha light-rail line. Bells clang as the train slowly pulls up to the line's downtown Minneapolis stations. Train operators fill the car, "burning in" the new vehicle and logging training hours.

Sitting in one of the passenger seats, Jack Caroon, head of the Hiawatha Project Office, notices little details—the train lingers too long at the stations, which means the signal timing is off. On this day, crews also are repainting the rails on the Metrodome station, after winter weather caused the first coat to peel.

For the last six years, Caroon (Civil '74) has led one of the largest public works projects undertaken by the state—building the $715.3 million light-rail line. At the project's peak he directed a staff of 70 to 80 full-time employees and consultants in the Hiawatha Project Office and indirectly supervised the work of more than 350 contractors—everyone from engineers to electricians to welders.

Caroon also coordinated work between two lead agencies, the Minnesota Department of Transportation (MnDOT), which built the line, and the Metropolitan Council, the line's eventual owner.

At the outset, he and his staff faced some huge unknowns. It was the state's first light-rail project and its first time supervising a design-build project, in which one contractor handles every phase of the project.

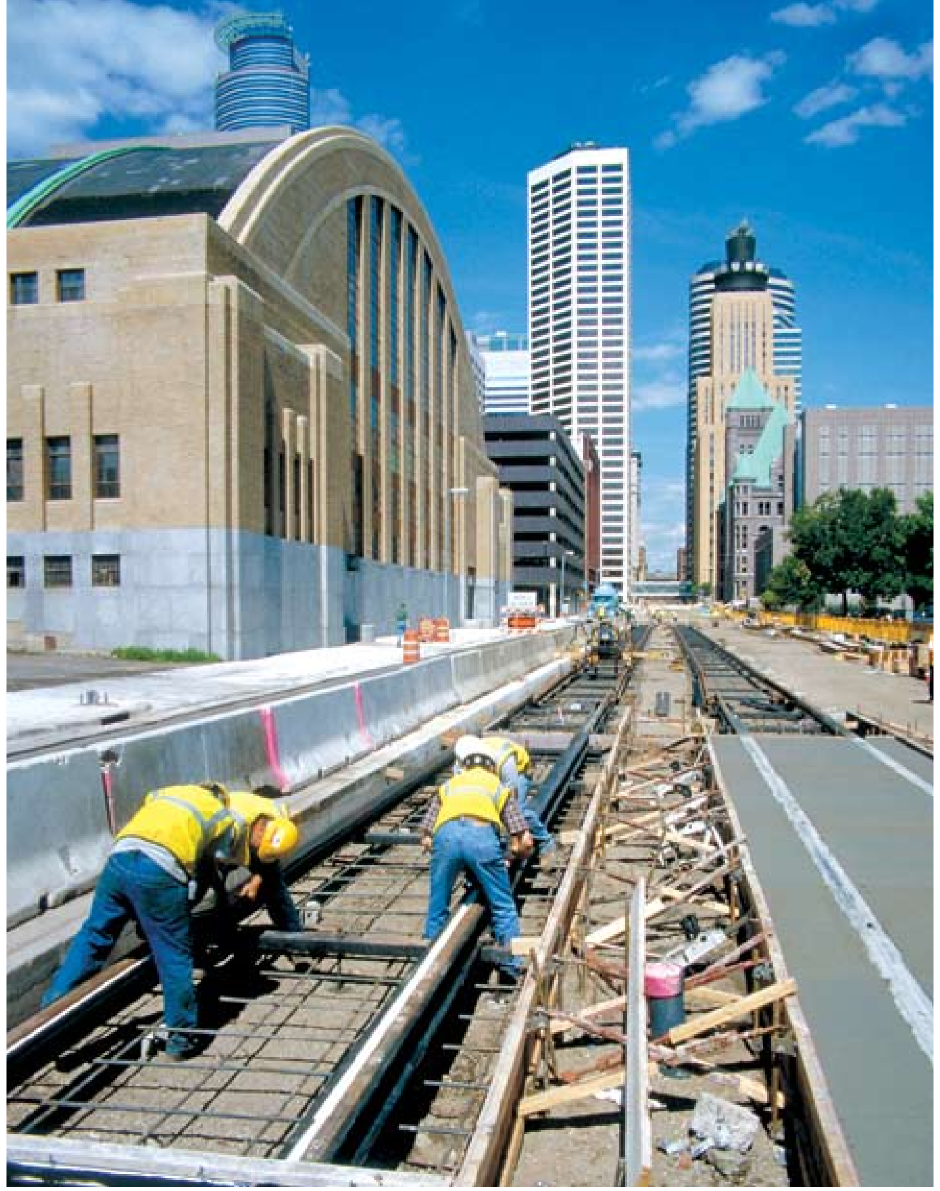
"Projects like this, from MnDOT's standpoint, are very complicated," Caroon says. "This is not your standard 'build a six-lane highway.'"

MnDOT veteran Vicki Barron (Civil '84, M.S.I.S. '03), the project's deputy manager, attended several early meetings before she joined the Hiawatha office.

"As an outsider looking in, I didn't think it was possible that we would ever get all the deadlines behind us," she says. Nevertheless, she and her colleagues—including a core group of University graduates—jumped at the chance to work on the region's first light-rail line.

## 'THE STARS LINED UP'

Politicians, urban planners, and rail advocates have kicked around the idea of a light-rail line in the Twin Cities for more than three decades. Past proposals have included light rail in the region's central corridor



*Workers lay track on South Fifth Street in downtown Minneapolis.*

along University Avenue or Interstate 94, a line along Interstate 35W, and commuter rail lines such as the proposed Northstar line, which would run from Minneapolis to St. Cloud.

Barron, who wrote her senior paper on the debate over light rail, remembers the public discussion over a 1985 environmental impact statement (EIS) that identified light rail as the preferred transit alternative in the Hiawatha corridor. For her and many other young transportation engineers at the time, light rail held huge promise as a solution to the region's growing traffic congestion.

But the Hiawatha EIS sat on the shelf for more than 10 years while legislators and local politicians debated light rail's costs and benefits. In 1996 a group of MnDOT engineers dusted off the 1985 EIS and began holding public hearings for a busway in the Hiawatha corridor.

"The goal was to have some kind of transit alternative in the corridor," says Joe Gladke (Civil '94, M.S. '03), who worked on the project along with Caroon. "We thought light rail was still 20 years away."

This time, however, political momentum had shifted in favor of light rail. Key officials in Minneapolis and Hennepin County backed a proposed line between downtown Minneapolis and the airport. More federal funding had recently become available for light-rail projects, and Minnesota's senior congressional representatives, James Oberstar and Martin Sabo, were in a good position to get a piece of the pie. In 1997 Congress approved $20 million to start building a series of transitways in the Twin Cities. The next year state legislators approved $40 million for preliminary engineering of a light-rail line in the Hiawatha corridor.

"All the stars started lining up, politically and financially," says Gladke. Almost overnight the project jumped from a $44 million busway to a $400 million light-rail line. But securing preliminary funding was just the first hurdle.

"We had a window of time to get the project underway to get federal dollars. The push was to get construction underway fast to hit the envelope," says Caroon, who began running the Hiawatha Project Office in June 1998.

MnDOT scrambled to update the EIS for the new light-rail proposal. In order to meet the federal funding deadline, the state legislature allowed MnDOT to bid the light-rail line as a design-build project. MnDOT engineers had to get up to speed on the requirements for design-build contracts, which have a different set of rules than traditional design-bid-build contracts, in which one company designs and oversees compliance on a project and a second company, usually a construction firm, builds it.

The agency's veteran highway engineers also had to learn an entirely new set of guidelines for light rail. In the project's early days, Caroon crisscrossed the country, visiting light-rail projects in Portland (Oregon), Denver, Baltimore, and Dallas, where he spent a week working in the city's light-rail office. Gladke took a rail operations class at the University of Wisconsin. He would later travel to Pueblo, Colorado, to inspect the steelyard building the project's rail girders.

## STICKING POINTS

When Barron joined the project in May 1999, engineers were struggling to hammer out an alignment for the light-rail line and put together design specifications so the project could go out on bid. One of the thorniest issues was routing the line around Fort Snelling through multiple parcels of federal property, including land owned by the Veterans Administration, the National Guard, the General Services Administration, and others. Some buildings were protected by the state's historic preservation office. Environmentalists and other activists wanted to make sure the construction didn't disturb sensitive land near Minnehaha Falls.

"That was a nightmare," says Caroon, who spent more than a year bringing all the parties to the table. "Imagine working with seven different federal agencies and getting them to agree on an alignment."

Because the state has no right of eminent domain on federal property, MnDOT had to negotiate a trade for each segment of federal land. In one instance, the proposed route ran through a dilapidated army building used mostly for storage. Instead of negotiating a price for the land, the army required MnDOT to build an addition to a newer office building nearby.

"Those were hard lessons," says Caroon. "We learned that the simple answer is not always the one that succeeds."

Adding to the project's political complexity, the Federal Transit Administration (FTA) demanded a key change early in the project's chronology: MnDOT could design the line and supervise construction, but the Metropolitan Council would hold the purse strings as the pass-through agency for federal dollars. Both sides had to sort out who would be the lead agency and what roles each would take. A third agency, the Metropolitan Airports Commission, supervised construction of the rail tunnels at the airport.

As the project sped towards groundbreaking, other issues surfaced. Xcel Energy filed a lawsuit over the costs of relocating its power lines in downtown Minneapolis, a lawsuit that could have added millions of dollars to the cost of the project. A federal judge later ruled against Xcel.

MnDOT also faced a legal challenge over the first company chosen to manage design and construction. That company's contract was eventually terminated, and a private partnership, Minnesota Transit Constructors (MnTC), was awarded the design-build contract in August 2000.

Four months later, on January 17, 2001, a crowd of more than 700 gathered for the project's chilly groundbreaking on the site of a future maintenance shop and yard near Franklin Avenue.

For Caroon, Barron, and others who had already put in hundreds of hours on the project, it was a watershed moment. They had hammered out an alignment and met key deadlines for state and federal money. The cost of the Hiawatha line was climbing—it would eventually reach $715 million—but so were local, state, and federal commitments to pay for the project.

Now the clock began running for a new group—the private designers and construction crews who would transform preliminary designs into a working light-rail line. The accelerated timetable of a design-build project meant that construction could start on one segment while design work continued on another.

## HAMMERING OUT DETAILS

Although the MnDOT team had completed enough of the design to put the project out for bid, hundreds of large and small details still had to be worked out. One of the engineers charged with that task was Michelle Boltjes (Civil '01), who found herself wrestling with curb cuts and street design for the light-rail line in downtown Minneapolis.

"We had some really tight constraints," says Boltjes, who worked on segments of the project for Professional Engineering Services as an undergraduate and later for Parsons Transportation Group, a MnTC partner. The streets had to drain away from the embedded track but had to be level so cars could drive over them "without going bumpety-bump," she says. "It would all work if you could sink the road down," she says. "But in downtown you can't really sink the roads because you have so many utilities, underground vaults, and parking garages underneath."

She also had to figure out how to get the train around corners within the tight constraints of downtown and where to dig holes for the overhead electrical lines without drilling into underground parking garages or utility lines.

When construction started on the project, public interest—and input—grew. Attendance at the regular project updates swelled. One of the most controversial

**RIGHT TRACK** CONTINUES ON PAGE 35 ▶

*Jack Caroon steered the Hiawatha light-rail project through a maze of complex challenges.*


HIAWATHA PROJECT OFFICE

JONATHAN CHAPMAN

Carl and Janet Kuhrmeyer

JONATHAN CHAPMAN (KUHRMEYERS); AD COURTESY 3M

**The practical sensibility he developed as a teenager helped Carl Kuhrmeyer succeed in his studies and his career**

BY NICHOL NELSON

# Pragmatism and purpose

FOR MOST AMERICAN KIDS TODAY, HIGH SCHOOL is a blur of letter jackets, SATs, and unrequited crushes. But for teenagers in the early 1940s, high school was little more than a buffer between them and the frightening events unfolding in the real world. When Carl Kuhrmeyer entered St. Paul's Harding High School in 1941, World War II was just beginning, and he knew that when he graduated, the odds were great that he'd be on the front lines of the biggest conflict the world had ever seen.

"Everyone I knew was going into the war—friends, neighbors, relatives," he says. "They were drafting people as old as 45, and I knew when I turned 18 I was going to be eligible."

More than a half century later, Kuhrmeyer remembers the war years vividly. The pragmatism he developed as a teenager helped him graduate from the University after the war and pursue a career at 3M, where he rose quickly through the ranks to become the company's youngest-ever vice president. In an effort to give back to his community, he recently created a $2.1 million charitable remainder trust to the University to establish a chair in biomedical engineering.

But back in high school Kuhrmeyer couldn't be sure what his future held. He tried to push thoughts of war aside, taking as many math and physics courses as possible to prepare for his dream career, engineering. "I always liked school," he says. "I knew that math and science were important." His teachers encouraged him to pursue a degree in mechanical engineering, but his studies were overshadowed by a grim reality.

A number of his peers were signing up for military service, even before graduation. During Kuhrmeyer's senior year, one of his best friends joined the marines. "He went through basic training in January [1945], got sent to Iwo Jima, and was dead by March," Kuhrmeyer says. "I used to walk with him to school every day."

But Kuhrmeyer's luck held out. He didn't turn 17 until May of that year, and by mid-August the war was over.

He was working at his part-time job in a foundry when he heard about the Allied victory. "Everybody was overjoyed," he says. "At the end of that day, I went downtown to Wabasha and 7th, where all the streetcars merged. There were thousands of people there, yelling and clapping and having a good time. That was a big day."

A month later Kuhrmeyer entered the University. "I always wanted to go to the U of M—I didn't even apply anywhere else," he says. "I was a Minnesota boy, and at the time the University was the only place in the state where you could get an engineering degree."

He enrolled at a momentous time in the University's history, when veterans returning from the war flooded the campus. Many of them had married before entering the military and were eager to get an education so they could join the workforce.

"There were people all over the place," recalls Kuhrmeyer. "The University built lots of temporary classrooms, and registration was a mess."


*Early in his career at 3M, Kuhrmeyer helped develop the Thermo-Fax dry-copy machine.*

He says the registration queue was so long that sometimes he'd get up at 5 a.m. just to get a place in line.

To save money Kuhrmeyer lived with his mother for the first three years of school and then moved into the Zeta Psi house. When he joined the fraternity as a freshman, he was the chapter's youngest member; most of his fraternity brothers were veterans who were there on the G.I. Bill. Kuhrmeyer says they helped him see the world from a larger perspective.

"They were in their twenties, and I'd just turned 17," he says. "They had some real-life experience, coming out of the military," he says.

During his freshman year Kuhrmeyer decided to focus on mechanical engineering. "I liked mechanical the best because it was the broadest field," he says. "You can choose from such a wide range of areas: heating, machine design, industrial engineering. I liked having that choice."

When he graduated in 1949, Kuhrmeyer worked briefly as a design engineer with an architectural firm. In 1951 he joined the new-products division of 3M as a product development engineer. "I thought that the company had tremendous potential, but people really didn't know an awful lot about 3M at that time," he says. "Most of them thought all we did was make sandpaper and Scotch tape. I had an opportunity to work on new things right away, which was pretty exciting."

He was placed on a project developing the Thermo-Fax, a dry-copy machine that didn't need any liquid to reproduce documents. The machine was a huge technological advancement at the time because all other copying methods used wet, messy components or required toner powders. When the Thermo-Fax copy machine was introduced in 1955, Kuhrmeyer moved into other manufacturing positions and in 1968 became division vice president at age 40.

Richard Lidstad, former vice president of human resources at 3M, worked with Kuhrmeyer for almost 40 years and has high praise for his leadership. "He's an engineer from head to toe," Lidstad says. "He thinks like an engineer—very straightforward and very disciplined, with a clear communication style."

Kuhrmeyer also made a point of checking with people personally to make sure projects were moving on track, and as a result his programs were quite successful, says Lidstad.

Kuhrmeyer's responsibilities became more wide-ranging as he moved up through the company. He was elected to 3M's board of directors in 1973 and traveled around the world to oversee the company's operations. Occaisonally, he was accompanied on his travels by his wife, Janet, a registered nurse whom he married in 1953 after meeting her at their St. Paul church. (The couple has three married children and seven grandsons.) At 3M he also served as

"People are still dying [from cancer] every day, and we want to help change that," says Kuhrmeyer, whose $2.1 million gift to the University will support biomedical engineering research.

a group vice president and retired in 1993 as vice president of administration.

Kuhrmeyer's achievements aren't limited to the business world. During his tenure at 3M he took on a staggering amount of volunteer work in the community. In 1987 he became involved with one of his favorite activities, the St. Paul Winter Carnival, as a member of its board of directors. He served as board chairman in 1991, when the nonprofit festival began planning for the gigantic challenge of constructing a towering ice castle on Harriet Island the following year.

"I think that the carnival is a rallying point for the whole community during the wintertime, when there isn't a whole lot of other things to do in Minnesota," he says. He also served on the board of the St. Paul Area Chamber of Commerce and was the board's chairman in 1993.

"It wasn't easy," he says of the huge time commitment, adding that he learned a lot about time management during his years at the University. "That's where I really learned discipline," he says. "You have to be organized to go through the University. No one's watching over your shoulder saying you have to go to class and study. If you aren't organized, you're not going to make it. There are all kinds of opportunities there, but you have to learn to take advantage of them."

His University experience also inspired Kuhrmeyer to get involved with Campaign Minnesota. He and other volunteers organized a fundraising drive within 3M that helped raise money to build the new mechanical engineering facilities on campus.

"There are a lot of people at 3M from the University, so we were pleasantly surprised at the response we got," he says. To his delight, many of his peers who weren't mechanical engineering alumni contributed to the effort.

"People realize that facilities are important," Kuhrmeyer asserts. "It's not just classrooms—you have to have good labs, or you just can't learn."

Not content to raise money for a new building, the Kuhrmeyers believe in supporting research that can lead to new advances in medicine.

"As a mechanical engineer working in biomedical research, I've already benefited tremendously from Kuhrmeyer's generosity and vision," says Professor John Bischof, whose laboratory was funded in part by a gift from the Kuhrmeyers. "I know he's very supportive of the University, and he's remained active as an alumnus and advisor. He has always had a particular vision that mechanical engineers can play a significant role in the evolving and exciting field of biomedical engineering."

Kuhrmeyer, a cancer survivor, says he hopes the money will help engineering and medicine work together to eventually find a cure for the deadly disease.

"With Janet's background in nursing and my interest in engineering, we're excited about [the gift's] potential," he says. "There are an awful lot of people doing a lot of things about cancer, but it's still an unknown. People are still dying every day, and we want to help change that." ■

JONATHAN CHAPMAN



## RIGHT TRACK

CONTINUED FROM PAGE 31

issues was the design of a flyover bridge for Lake Street. As the project's cost grew, MnDOT engineers switched to a less expensive alternative, a structure that rested on a filled-earth berm. When nearby residents and business owners learned of the change, they complained that the berm would separate the light-rail line from the neighborhood. Public hearings led to a redesigned, open structure that added as much as $4.5 million to the project's cost.

Another key change, the location of the Mall of America station, was still unresolved as late as mid-2003. Crews had already finished laying several miles of rail when mall officials approved a rerouted line that would bring passengers directly to a transit center in the mall. That change added 0.4 miles to the light-rail line and $39.9 million to the cost.

"We had looked at 23 different options for how it could potentially tie in," Gladke says of the early designs. "We weren't really happy with the ultimate selection, but we had to move ahead with the plan. [Mall owners] never thought this project was going to become a reality. Once they saw where the station would end up across the street, they wanted to get it in the mall."

The Hiawatha Project Office was able to shift $30 million in federal dollars from another Metro Transit fund to help cover the cost and to include land donated by the mall in the $9.9 million balance.

### 'THE TRAIN'S COMING'

In summer 2003, residents along the Hiawatha light-rail line saw a strange sight: three engineers clinging to a go-cart as it raced up and down the line. Kap Phanthavong (Civil '00), a project engineer for EVS Engineering who had logged considerable time on the line's electrical systems, was one of its passengers.

The go-cart attracted lots of attention. "People would yell, 'What is that thing?' I'd scream back, 'Due to budget cuts, this is the new LRT,'" Phanthavong says.

He and a crew rode the go-cart for a month, testing clearance for the trains up and down the line. The following March, he found himself on a real rail car—literally. He spent three weeks riding on the top of the train, monitoring a camera that watched the sweep of the wires from the rail car to the overhead catenary poles that supply its electricity.



*A fan of light rail since her days as a University undergraduate, deputy project manager Vicki Barron jumped at the chance to join fellow alumnus Jack Caroon on the Hiawatha project.*

JONATHAN CHAPMAN

Andy Inserra, a civil engineering junior who sits on the Hiawatha LRT Community Advisory Committee, attended several public hearings held that spring. Residents living along the line packed meetings to discuss everything from exhaust at a bus terminal near 46th Street to the noise of train horns at night. (It turned out the culprit was a freight-rail operator.)

"We had all these subcommittees for studying the horns, neighbors beefing like crazy, people trying to get resolutions passed," says Inserra, an avid rail fan who is also president of the University's Railroad Club. "Someone finally called over to [the freight line's] shops and said, 'Have you guys been doing any of that?'"

Despite the gripes, enthusiasm for the project was growing.

"A lot of people are really excited about light rail, which helps," Inserra says. "They say, 'Sure we've got a backhoe sitting in our front yard, but it's going to be great because I can walk to the train station.'"

### END OF THE LINE

On his weekly drive up and down the Hiawatha line in late April, Caroon sees light-rail trains shuttling back and forth as operators break in the new vehicles. He sees workers tweaking signals and putting the finishing touches on stations. On the line's final segment, in Bloomington, crews are still pouring concrete and laying rail.

After six years on the project, Caroon has a simple approach to dealing with surprises: Get people talking. When workers discovered Indian mounds along a segment of the line in Bloomington, he quickly had the state archaeologist and the contractor out on site "eyeball to eyeball," physically marking the space and discussing solutions.

As the project winds down, Caroon and his colleagues can point to some major victories: They have delivered the light-rail line on time and under budget.

"A lot of people said you couldn't build this project for less than $1 billion," Caroon says. "We're still under that."

Beyond the numbers is one final, tangible milestone—a working light-rail line. Engineers involved in the project will see the trains running for decades to come, whisking passengers to and from the airport, the Mall of America, and downtown Minneapolis smoothly, quietly, and seamlessly.

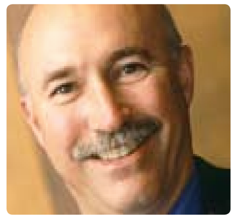
"Every time I see that train run up and down Hiawatha, I can't get the grin off my face," Barron says. ■

FOR MORE INFORMATION see www.dot.state.mn.us/

# Philosophy and a farewell

WILL ROGERS ONCE SAID, "Even if you are on the right track, you'll get run over if you just sit there." Perhaps his philosophy is taught early in IT's required curriculum; the accomplishments of many IT alumni mirror the famous humorist's sage counsel. Never content with the status quo, they're creative and visionary individuals who seize opportunities to shape the future of science and technology.

Rogers's prescription is good advice for anyone—but particularly so for universities, colleges, and development officers. IT definitely is on the right track. During his tenure, Dean H. Ted Davis has brought financial stability to IT, cultivated a strong sense of collegiality, and emphasized the critical importance of interdisciplinary research, the college's hallmark. With an eye to the future, our outstanding faculty, staff, and students are working together to ensure IT's place in the vanguard of emerging technologies, innovative education, and service to the community.



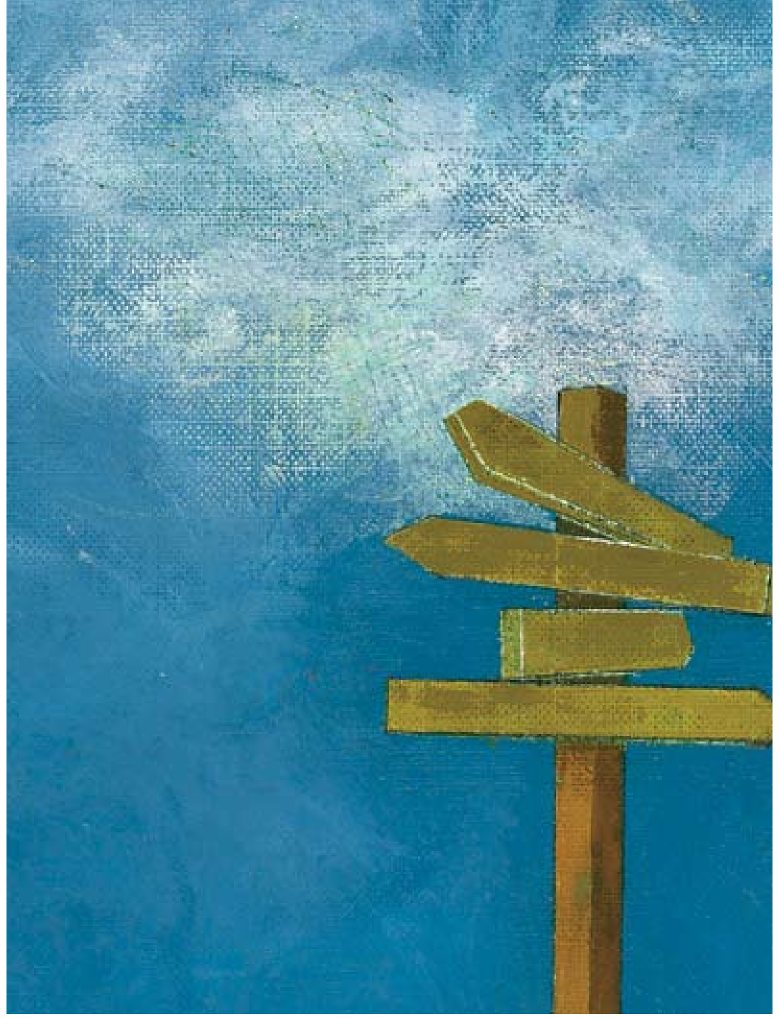
Proud as we are of IT's accomplishments, complacency is not an option, for we must keep moving down the path toward greater success

During the past four years, I've had the privilege of serving IT as the college's director of development. The Office of Development has achieved great success, primarily through the efforts of our alumni, friends, my development teammates, and faculty leaders who have built strong relationships with alumni and friends.

Proud as we are of IT's accomplishments, complacency is not an option, for we must keep moving down the path toward greater success. New initiatives in renewable energy and biotechnology are generating much excitement in the college and the University. The development team is working to build stronger relationships among IT and a number of corporations, and already we have more ongoing relationships with individual alumni and friends than ever before. Clearly, IT isn't just "sitting there."

I apply Rogers's maxim to my personal life as well as my professional goals. I am leaving IT to join the University of Missouri-Columbia as associate vice chancellor for development. Although this new track offers me (and my family) wonderful opportunities, the change also means that I must leave behind a great college, its alumni, and a group of professionals whom I consider friends as well as teammates. Development officers Jennifer Clarke, David Hoffman, Tom Kinsey, and Jennifer Pogatchnik are truly wonderful people. They bring passion, integrity, and dedication to their work, serving IT departments as well as alumni and friends who want to connect to the University, especially through philanthropy. I've also worked closely with Kris Kosek, former alumni relations director, and with the communications team, headed by Paul Sorenson. Their insights and talents have contributed significantly to our success.

I am grateful to have had the opportunity to know you and to serve the college. I will miss being affiliated with this great institution and such fine people, but I leave knowing that the college is on the right track. Thanks for all that you do on behalf of the Institute of Technology.



PHIL OSWALD was IT's director of development from 2000 to 2004. You can reach his interim successor, Tom Kinsey, at 612-625-4509 or tkinsey@it.umn.edu.

JONATHAN CHAPMAN (OSWALD); GETTY IMAGES (ILLUSTRATION)

GETTY IMAGES (ILLUSTRATION); JONATHAN CHAPMAN (STAFF)



**Fierce competition for high-tech workers means that scholarships and fellowships are more important than ever**

# Leveraging Minnesota's future

AGAINST A BACKDROP of more double-digit tuition increases, the University and IT are redoubling their fundraising efforts for scholarship and fellowship support. On May 14 University president Robert Bruininks announced the multiyear University of Minnesota Scholarship Drive, which seeks to raise $150 million and increase by 50 percent the number of students receiving privately funded scholarships, from 4,500 to 6,750.

"It's the most ambitious scholarship drive in University history, and it includes a wonderful opportunity that doubles the benefit to students," says Tom Kinsey, IT's interim director of development. "Income from endowed scholarship gifts will be matched by funds from the new President's Scholarship Match."

Bruininks made the announcement to the board of regents the same day he presented a proposal to raise tuition and fees for the coming year by an average 14 percent. Undergraduate students on the Twin Cities campus will pay an estimated $7,500 in tuition and fees this fall. That figure represents a 52 percent increase over the past four years, due to significant reductions in state funding. Minnesota trails other Big Ten institutions and private colleges in the number and size of merit scholarships it can offer incoming freshmen. The University offers merit scholarships to 14 percent of entering freshmen, placing it last among Big Ten schools.

IT dean H. Ted Davis sees an even more troubling prospect looming behind these statistics. "At a time when the U.S. is fighting to retain its world leadership in science and engineering, we're not producing enough highly skilled workers," he says. "Minnesota is competing with other states for the same high-tech labor force. It's critically important that IT be able to offer scholarships and fellowships that attract talented students because the majority of our students choose to stay in Minnesota after they get their degrees."

A recent report by the National Science Board (NSB) casts some doubt on the nation's ability to maintain its leadership in science and technology. If current trends continue, the number of U.S. citizens qualified for science and engineering jobs will remain level, "at best," according to *Science and Engineering (S&E) Indicators 2004*, a biennial report issued by the NSB. Furthermore, the U.S. cannot continue to rely on foreign citizens to fill the gap, either because of limits to entry or because of intense foreign competition.

*S&E Indicators* is considered the nation's most authoritative report on national and international trends in education, the labor force, academia, and the global marketplace. According to the 2004 report, the U.S. now ranks 17th among nations surveyed in the proportion of its 18- to 24-year-olds earning degrees in the natural sciences and engineering. In 1975 the U.S. ranked third.

The report also features a state-by-state analysis of key science and engineering indicators. In 2000, Minnesota was among the states with the highest percentage of businesses in high-tech industries, ranking in the top quartile. However, the state slipped to the second quartile in the number of science and engineering bachelor's degrees conferred per 1,000 students ages 18 to 24. Minnesota placed in the lowest quartile of states whose higher education programs in science and engineering emphasize graduate education.

"Minnesota must work harder to attract more young people to careers in science and engineering," says Davis. "Scholarships and fellowships are an extremely important step toward achieving this goal."

## Kinsey named interim director

**VETERAN FUNDRAISER Tom Kinsey will serve as IT's interim director of development during the search for a permanent successor to Phil Oswald, who left the University in March to become associate vice chancellor for development at the University of Missouri-Columbia. Kinsey joined IT's development team in September 2001. Previously he was a development officer at the University Foundation.**

## DEVELOPMENT OFFICE

**Development Team**

IT's experienced professional development officers can help you determine your best options for supporting the college. They can give you information about IT programs with funding needs that match your interests as well as information about ways of giving that best fit your financial situation.

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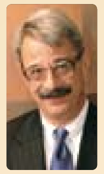

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## TO MAKE A GIFT

To support a project you've read about in *Inventing Tomorrow* or to designate a gift for any purpose, you may contact a development officer directly or call 800-587-3884 for more information.

# Teaming up to inspire kids


HOW CAN WE ATTRACT outstanding students to the University of Minnesota? ITAS is determined to do its part by encouraging young students to develop an interest in science and technology. Key to this long-term effort is getting IT alumni involved in K-12 activities and bringing together resources from business, education, and the University.

Led by Jerry Sosinske (EE '78), our K-12 outreach committee embarked this year on a creative, strategic collaboration with FIRST Lego League (FLL), an international program that engages kids in hands-on science and technology projects and sports-like competitions organized around a theme. Teams of students in grades 4 through 12 designed, built, and programmed robots for last fall's nationwide challenge, "Mission Mars." In Minnesota alone, FLL had about 250 teams and sponsored about 12 sports-style tournaments.

IT alumni can really make a difference in how young people perceive themselves and their abilities

Aided by a grant from 3M, ITAS subsidized new teams coached by our alumni. Minnesota FLL leader Fred Rose (EE M.S. '83) and his staff helped alumni get involved as coaches, mentors, and judges. Another ITAS collaborator, The Works—a hands-on technology museum and activity center in Edina—sponsored practice sessions. ITAS also cosponsored the FLL state high school tournament at Coffman Memorial Union. The enthusiastic response of our alumni was very gratifying.

Equally rewarding was the chance to see FLL teams in action. One of the most inspirational success stories involved a "team" with true grit—a lone 6th-grade girl from North Minneapolis. Over an eight-week period other members of her team dropped out. The night before the tournament, her group's robot just didn't come together. The following day the girl showed up alone, so intimidated she didn't want to leave the van to go inside.

Her first round was a disaster. She was devastated, but her coaches persuaded her to keep trying. Before the second round she modified and reprogrammed her robot, and by the third round her performance rivaled that of her competitors. This achievement wasn't good enough to qualify her for the state tournament, but she received the "Against All Odds" trophy and congratulations from coaches, officials, parents, and students. She was so elated by her personal victory that during lunch she talked almost nonstop—about quantum mechanics and the theory of relativity.

As one FLL coach noted, these students have so much talent, and if someone can keep them engaged, challenged, and encouraged, they are going to do great things. IT alumni who get involved in K-12 outreach activities like FLL can really make a difference in how young people perceive themselves and their abilities. With that kind of support, someday these talented kids may be included among our alumni.

FLL is just one example of the wonderful ITAS programs that flourished under the leadership of Kris Kosek, who served as director of alumni relations since 1998. In April, Kris accepted a career opportunity with the Carlson School of Management, where she is director of alumni services and outreach. On behalf of the ITAS board of directors and ITAS members worldwide, I extend best wishes and a sincere thank-you to Kris for all her support and accomplishments. I also offer a warm welcome to her successor, Sara Beyer, and look forward to the continued success of ITAS.

*Jim Clausen*

JIM CLAUSEN (AEM '63, M.S. '65) is president of the IT Alumni Society. You can reach him at 612-626-8282 or by email at itas@it.umn.edu.

JONATHAN CHAPMAN (CLAUSEN); GETTY IMAGES (ILLUSTRATION)

JONATHAN CHAPMAN (McQUEARY, BEYER)

## CAMPUS SCULPTURE HONORS ALUMNUS HOFF LU, "FATHER OF NUCLEAR ENERGY IN CHINA"

**A SCULPTURE OF CHINESE nuclear physicist Hoff Lu (M.S. '38, Ph.D. '41) was unveiled on campus June 17, commemorating the 90th anniversary of his birth. During his time in Minnesota, Lu studied under the direction of pioneering physicist Alfred O.C. Nier. Lu—respected in the scientific community for his integrity and revered in China as a great patriot—was called a "scientific sage" and the "father of nuclear energy in China." He continued research until his death in 1997. In addition to the sculpture, which will be displayed in the Tate Laboratory of Physics, a graduate fellowship has been permanently established in Lu's honor.**

*Lu*

## Beyer named alumni relations director

### Kosek moves to Carlson School

*Beyer*

IT STAFF MEMBER Sara Beyer has succeeded Kristine Kosek as IT's director of alumni relations. Kosek, who had held the post since 1998, left the college in April to become director of alumni services and outreach for the Carlson School of Management.

During Kosek's tenure as director of alumni relations, the IT Alumni Society (ITAS) increased its ranks to nearly 7,000 members worldwide. Under her leadership ITAS received numerous UMAA awards for its programs and sustained excellence.

"We're very grateful to Kris for her hard work and dedication," says IT dean H. Ted Davis. "She's done a great job helping our alumni reconnect to IT and fostering our relationship to the greater community."

Beyer, who received her bachelor's degree from the University this spring, has worked in the dean's office for the past two years as an administrator. She and her assistant, Liz Stadther, have worked closely with Kosek to ensure a smooth transition for alumni programs.

"I am thrilled to be working with the dedicated volunteers in the IT Alumni Society and the UMAA," says Beyer. "I look forward to building on the success of award-winning ITAS programs like the S&T Banquet and the mentor program. Together we'll work toward enhancing and expanding our programs and services to alumni and the community."

## Reflecting on security, scholarships at S&T Banquet

A CROWD OF 550 EXECUTIVES, alumni, faculty, and friends gathered April 14 at the Hilton Minneapolis for the 2004 Science & Technology Banquet, IT's premier alumni event. The banquet raised $20,000 for the ITAS Scholarship Fund. Charles McQueary, Under Secretary for Science and Technology, U.S. Department of Homeland Security, headlined the event, which also featured remarks by University president Robert Bruininks, IT dean H. Ted Davis, and IT Alumni Society president Jim Clausen.

## IT ALUMNI SOCIETY


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# Chemistry and charisma

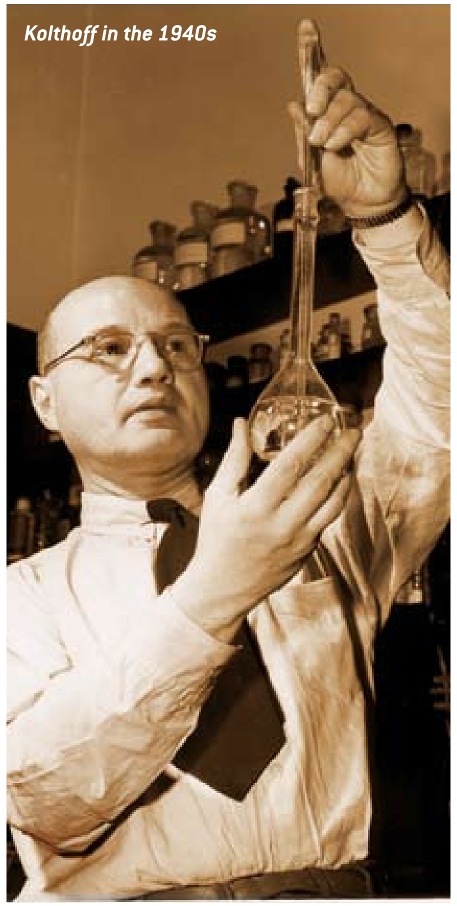
**Widely regarded as the father of analytical chemistry, Izaak Kolthoff elevated the largely empirical field to a modern scientific discipline**

WHEN THE UNIVERSITY OF Minnesota established the School of Chemistry in 1896 and offered a single course in analytical chemistry, Izaak Maurits Kolthoff was a two-year-old toddler exploring the world of his family's home in Almelo, The Netherlands. By the time of Kolthoff's death nearly a century later, the world-renowned University professor was widely regarded as the father of analytical chemistry who had elevated the largely empirical field to a modern scientific discipline that encompassed both theoretical principles and experimental results.

Kolthoff was present on June 2, 1972, at the dedication ceremony for the new chemistry research and teaching facility named in his honor. He listened as David Hume, professor of analytical chemistry at Massachusetts Institute of Technology and his former graduate student, recounted his teacher's brilliant career and declared: "We are honoring our alma mater by placing his name on our building."

Although the day's testimonials befitted a retirement celebration, Kolthoff, then 78 years old and only nominally retired, would continue his research for nearly two more decades. Over the course of his career he wrote or cowrote more than 900 papers as well as numerous textbooks. With P.J. Elving and others, he coedited the monumental multi-volume *Treatise on Analytical Chemistry*, the field's principal reference source. His influential *Textbook of Quantitative Inorganic Analysis* (Kolthoff and Sandell, now by Kolthoff, Sandell, Meehan, and Bruckenstein), first published in 1936, remains a landmark text in undergraduate chemistry education.

Born on February 11, 1894, Kolthoff was the youngest of three children born to Moses and Rosetta Kolthoff. Known to nearly everyone by his childhood nickname, "Piet," he developed a strong interest in chemistry as a high school student taking his first course in the subject. He commandeered part of the kitchen for a laboratory and dismayed his family by conducting experiments using hydrogen sulfide.


*Kolthoff in the 1940s*

After graduating in 1911, he entered the University of Utrecht as a pharmacy student because he lacked competency in Latin and Greek, prerequisites for admission to studies in the pure sciences. The pharmacy curriculum included a great deal of analytical chemistry (then a largely empirical field), and Kolthoff's teacher, Professor Nicholas Schoorl, placed an unusual emphasis on general principles of chemistry. Kolthoff received his *apotheker* diploma and published his first paper in 1915, after which he continued to take courses at Utrecht in physical and colloidal chemistry.

In 1918 the University of Utrecht dropped the requirements for Latin and Greek and granted Kolthoff a Ph.D. in chemistry. By then the prodigious young researcher had already published more than 30 papers on subjects other than his doctoral research, and during the next nine years his phenomenal productivity at the University of Utrecht attracted international attention, including an invitation to lecture in the U.S. and Canada.

In 1927 he accepted an offer from the University of Minnesota for a one-year term as a professor in the School of Chemistry, an appointment that quickly became permanent. In 1930 he became head of the school's analytical chemistry division, a post he held until his nominal retirement in 1962.

A dedicated but demanding teacher, Kolthoff set rigorous standards for his graduate students, many of whom later enjoyed illustrious careers in academia and produced new generations of talented students. By the time Kolthoff died in 1993, his academic descendants numbered more than 1,000. Of all the many honors and awards he received, Kolthoff is said to have cherished most an award from the American Chemical Society for excellence in teaching.

A freethinker and humanitarian, Kolthoff considered himself to be a world citizen. During the late 1930s he and University agricultural biochemist Ross Gortner, assisted by the Rockefeller Foundation, helped relocate to the U.S. a number of European scientists who were being persecuted by the Nazis.

UNIVERSITY ARCHIVES (2)

During World War II, Kolthoff contributed to the war effort as part of a government research team that developed improved techniques for producing synthetic rubber.

After the war he dedicated himself to many humanitarian efforts, supported the control of nuclear weapons, and held political stances that evoked the wrath of U.S. Senator Joseph McCarthy during the early 1950s. During the McCarthy era he was accused of belonging to 31 subversive organizations, but the charge was never substantiated.

Kolthoff never married but enjoyed an active social and cultural life. For many years he lived in a small apartment in the Faculty Club in Coffman Memorial Union, where he entertained visitors from all over the world. Despite physical limitations and two sporting accidents, he maintained an active lifestyle well into his seventies.

At the dedication ceremony in June 1972, the prolific Kolthoff paused long enough to savor the tribute offered up by Hume: "To say that he placed his mark on the profession of analytical chemistry is a great understatement. He changed it radically. More than any other person, he transformed analytical chemistry from a rather unimaginative, conservative art to a dynamic, innovative science. He swept the profession along with him, and I'm happy to say, passed the momentum on to his students."

> "More than any other person, Kolthoff transformed analytical chemistry from a rather unimaginative, conservative art to a dynamic, innovative science."
>
> —MIT PROFESSOR **DAVID HUME,** A FORMER STUDENT OF KOLTHOFF, AT THE DEDICATION OF KOLTHOFF HALL IN 1972

And then, with the day of tribute behind him, Izaak Kolthoff went back to work. ■

*—Carolyn Wavrin*


*Kolthoff remained active long after his retirement in 1962.*

# 100 YEARS OF CHEMISTRY

**Chemistry Centennial Celebration**
October 8–9, 2004

Join us this fall for festivities celebrating 100 years of chemistry at the University of Minnesota. Special events include faculty and alumni poster sessions, departmental tours, speakers, dinner, and a party.

**FOR MORE INFORMATION**
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*Chemistry laboratory in 1932*


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