

INVENTING TOMORROW



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to make world a better
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INVENTING TOMORROW

Fall/Winter 2009-10
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fall/winter 2009-10

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PHOTO BY DIEGO PONCE DE LEON BARIDO

FROM THE DEAN
STEVEN L. CROUCH

2010: Our future is here today

AS WE BEGIN 2010, I am reminded of the 1980s science fiction book and movie "2010: A Space Odyssey," a sequel to the hit "2001: A Space Odyssey." Looking back, we thought 2010 seemed so far in the future, and we could only dream of the technology featured.

While much of the technology from science fiction is still just a dream, a look around the Institute of Technology shows much of our research exceeds what we would have imagined 30 years ago. In 2010, our future is here today.

In a story in this magazine titled after the famous movie "2010: A Space Odyssey," we highlight our request to the 2010 Minnesota Legislature for funding to build a new Physics and Nanotechnology Building. The cutting-edge research featured is like a page ripped out of a 1980s science fiction book.

Biophysicists like Joachim Mueller are using lasers to track individual molecules within cells. Others like Vincent Noireaux are constructing models of living cells to study gene expression and related cellular activities. In nanotechnology labs, researchers like Steve Campbell have developed nano cantilevers to switch current on and off in batteries to cut power consumption so soldiers of the future won't need to carry heavy batteries to power their electronics used in battle.

If a new Physics and Nanotechnology Building is approved, these types of research could expand. The building would contain a Class 10 clean room for biomedical applications. This would enable researchers to culture human cells, bacteria, etc. next to a clean room for device fabrication. This combination of medicine and nanotechnology could revolutionize drug-delivery devices and other areas of medical research.

A new Physics and Nanotechnology Building is critical to our success in 2010 and many years ahead. It would make us more competitive and provide the basis for great technological discoveries of the future.

In another story entitled "Engineering Troubled Waters," our students are changing the current situation to make a better future for communities around the world. One group of students is working to develop a sustainable business that addresses the long-standing



Together,
we can make
the future
better than
we ever
imagined.



IT to become College of Science and Engineering

The University of Minnesota Board of Regents has approved a name change for the Institute of Technology to the College of Science and Engineering (COSE), effective July 1, 2010. The new name will more clearly describe the unique combination of science and engineering disciplines to prospective students and faculty, business partners, and research-granting agencies. Changing the name of the college has been thoroughly discussed for more than a year with input from alumni, students, and other stakeholders. Members of the Dean's Advisory Board have agreed to donate private funds to cover the costs of the name change. For more information, visit www.it.umn.edu.

problem of clean water in the slums of Mumbai, India.

Thousands of miles west of Mumbai, another group of students who are part of the University of Minnesota chapter of Engineers Without Borders is working with a community in Uganda to expand the water supply and upgrade the sanitation system. Students planned the project, worked with the community, and even dug the trenches for the water system's pipes and wiring. These students are not waiting for the future to come to them, they are making it happen now.

Our alumni are also creating a better future for our planet. The story entitled "Green Ventures," highlights business innovations by Institute of Technology alumni. Alumnus Eric Granstrom is using a new, more environment-friendly nanotechnology process to make transparent conductive films for solar panels, touch screens, plasma televisions, and e-paper. Alumnus Clayton McNeff has pioneered a new method for producing biofuels from waste oils, weeds, and even algae that could potentially replace much of the country's fossil fuel consumption. We also have alumni like Jim Johnson who owns one of the world's largest electric vehicle dealerships.

Scientists and engineers are critical to the future of our state, nation, and world. Our alumni and students hold the future in their hands to create new medical devices, discover the mysteries of the universe, and develop innovative products and systems to help people and make a better future. Together, we can make the future better than we ever imagined. ■

RECOMMENDED Extras | *on the Web*

Each day, more Institute of Technology faculty, students, and alumni are being featured in videos on the Web. We've listed some of the more recent offerings you may want to view. Just visit our Web site at www.it.umn.edu/inventing/videos and click on each of the links.

University's Solar House Public Tour



Solar Decathlon Project team leader, Shengyin Xu, takes you on a tour of the University of Minnesota's solar house, which won fifth place overall at the 2009 Solar Decathlon Competition held last October in Washington, D.C.

Researcher Develops Brain-scanning Process



Bin He, a University of Minnesota professor of biomedical engineering, has developed a technique that promises to play an important role in the treatment of epileptic seizures.

The Power Ranger: Massoud Amin



University of Minnesota electrical and computer engineering professor Massoud Amin wants to transform our country's energy system. Amin makes his proposal for how such an idea could be implemented.

Engineers Without Borders—Uganda



The University of Minnesota student chapter of Engineers Without Borders traveled to Uganda to bring potable water and ecological sanitation to Hope Integrated Academy. See cover story beginning on page 14.

Is the Internet Running Out of Space?



Institute of Technology mathematics professor, Andrew Odlyzko, says the Internet will easily accommodate increased user traffic because technology has improved greatly.

Motorcycles for Paraplegic Riders



Paraplegics can now ride a specially-equipped motorcycle developed by IT engineering students. Outfitted with wheels much like that of a jet, the motorcycle allows riders to come to a stop as the wheels come down.



JOIN US ON FACEBOOK AND FOLLOW US ON TWITTER

More than 500 University of Minnesota Institute of Technology alumni and friends are already connecting on the Institute of Technology's Facebook fan page. Become a fan today by visiting our home page at www.it.umn.edu and clicking on the Facebook icon located at the top right. Find out about the latest research and exciting events. Also follow us on Twitter at twitter.com/uminsttech for the latest news about the college. We welcome your feedback and suggestions about these social media tools.

University of Minnesota team places fifth overall in 2009 Solar Decathlon

THE UNIVERSITY OF MINNESOTA placed fifth overall with its first-time entry into the U.S. Department of Energy 2009 Solar Decathlon competition, the highest of any rookie team.

Named the ICON Solar House for the iconic shape of its gabled roof, the University's solar house won first place in two of the competition's individual categories: engineering and lighting design.

The 20 teams selected to participate in the competition, including teams from the United States, Canada, Germany, and Spain, were required to build and operate a modern, energy-efficient, livable home powered solely by the sun. Nearly 200 undergraduate and graduate students worked on the house that began to take shape in late 2009.

The competition, which culminated in a three-week showcase on the National Mall in Washington, D.C., required each team to operate the home they designed, built, and transported to the nation's capital. During the decathlon's showcase, teams opened their homes to the public and received points for their home's performance in

10 categories (consequently the "decathlon" name).

The judges were particularly impressed with the home's stringent energy budget—it took only 500 watts, the equivalent of five 100 watt bulbs, to power the lighting in the entire home.

According to Ann Johnson, civil engineering faculty member and Solar Decathlon project team leader, the team performed extremely well for a first-time entry.

"All the teams placing ahead of us had previously competed in the Decathlon, so to finish fifth on our first try is truly a monumental achievement," Johnson said.

Created in 2002 by the U.S. Department of Energy, the Solar Decathlon is a biennial competition designed to educate college students—and the public—about the benefits of energy-efficient homes and green building technologies.

TO TAKE A VIRTUAL TOUR of the solar house on the team's Web site, visit: http://www.solardecathlon.umn.edu/media/virtual_tour.html



For the past two years, nearly 200 University of Minnesota students worked to build this 800 square-foot home full of modern conveniences and entirely solar powered to compete in the 2009 Solar Decathlon, sponsored by the U.S. Department of Energy. The Minnesota team took home a first-place finish in two categories: the prestigious engineering category and in lighting design.

'Watchmen' video wins regional Emmy



"THE SCIENCE OF WATCHMEN" VIDEO, featuring University physics professor James Kakalios, recently received a regional Emmy Award from the National Academy of Television Arts and Sciences in the "Advanced Media: Arts/Entertainment" category. Produced by the University News Services team, the video has received more than 1.5 million views on YouTube, making it one of the most widely viewed videos in higher education.

Warner Bros. Pictures tapped Kakalios in 2007 for his science expertise on the popular comic book movie, "Watchmen." He appears on the Director's Cut Blu-ray in a featurette discussing the physics of Doctor Manhattan, one of the characters in the film. The University's "The Science of Watchmen" video looks at Kakalios' involvement with the film and the physics behind the movie's extraordinary characters.

"If anyone had asked me back in grad school if I could imagine winning an Emmy for a YouTube video, I would have answered, 'What's a YouTube?'" Kakalios said. "This award is a testament to the University News Service who conceived and created the video."

Kakalios is a recognized expert in condensed matter physics. Most students know him for his popular freshman seminar, "The Physics of Superheroes."

The Emmy Award honors exceptional work in a variety of categories including news, sports and documentary programming, as well as individual talent. The Upper Midwest region includes Minnesota, North Dakota, South Dakota, western Wisconsin, and most of Iowa.

U-led consortium will receive \$8M grant for wind energy research

A UNIVERSITY OF MINNESOTA-LED consortium of researchers will receive up to \$8 million from the U.S. Department of Energy (DOE) for wind energy development in the United States. The consortium was one of three nationwide to receive funding.

The grant, funded by the American Recovery and Reinvestment Act, will support research to improve both land-based and offshore wind generation.

The University's consortium is comprised of academic and industrial partners who are working to improve wind power efficiency and educate a generation of scientists and engineers to specialize in wind energy technology.

Fotis Sotiropoulos, director of the University's St. Anthony Falls Laboratory and a professor of civil engineering, is principal investigator on the project, along with other researchers in the Institute of Technology and the University of Minnesota Morris, Syracuse University, and Dakota County Technical College. Cost share for this project was provided in part by customers of Xcel Energy through a grant from the Renewable Development Fund.

"This project is a tremendous opportunity for the State of Minnesota," Sotiropoulos said. "It is about leading the way in educating the next generation of technicians and engineers who will fill the many new jobs in the emerging wind energy sector of our economy."



RICHARD WALKER

The University will work with several industrial partners to help reach the Department of Energy's nationwide goal of achieving 20 percent wind power by 2030.

Researchers map bottom of world

THE NATIONAL SCIENCE FOUNDATION-FUNDED Antarctic Geospatial Information Center (AGIC), based in the Institute of Technology's Department of Geology and Geophysics, is creating tailor-made maps that researchers and logistics experts in the U.S. Antarctic Program depend on daily.

Director Paul Morin, and his staff of 10, which includes undergraduate and graduate students, are producing the maps by using images from various satellites. Many are the first of their kind and of places where no human has yet tread. Researchers and logisticians use the maps to find interesting outcroppings of rocks, measure how far a glacier has receded, learn whether a boulder is blocking a path, and to show where crevasses are located.

"I've always been in scientific visualization, making pretty pictures with a computer," Morin said. "I realized there was a need for mapping in Antarctica and wrote a proposal to the NSF, which is the main funding agency for work on the ground there." In 2007, he won the National Science Foundation grant that established the AGIC.

Besides using satellite images, Morin also maps the rugged landscape the old-fashioned way: by going to Antarctica and surveying the terrain first-hand.



BRIAN DAVIS

Paul Morin, director of the Antarctic Geospatial Information Center, which is based in the Department of Geology and Geophysics, travels to Antarctica to survey terrain first-hand.

In Antarctica, Morin conducts his work in the McMurdo Dry Valleys region, a mountainous, rainless, 12,740-square-mile region. His field site lies 100 miles from McMurdo Station and is accessible only by helicopter, which is part of the reason researchers and logistics people make heavy use of the AGIC maps.

"We help with logistics and map-making for people in the most deserted spot in the world," said Brad Herried, a graduate student in geography, who has produced a number of the maps.

New study explores interactions between neighborhood walkability and air pollution

JULIAN MARSHALL, an assistant professor in the Institute of Technology's department of civil engineering, is among a group of researchers who compared neighborhoods' walkability (degree of ease for walking) with local levels of air pollution. They found that some neighborhoods might be good for walking, but have poor air quality.

The study, conducted for the city of Vancouver, British Columbia, is the first of its kind to compare the two environmental attributes, and suggests potential environmental health effects of neighborhood location, layout, and design for cities around the globe.

On average, the researchers found that downtown neighborhoods are more walkable and have high levels of some pollutants, while suburban locations are less walkable and have high levels of different pollutants. Neighborhoods that fare well for pollution and walkability tend to be a few miles

away from the downtown area. These "win-win" urban residential neighborhoods, which avoid the downtown and the suburban air pollution and exhibit good walkability, are rare, containing only about two percent of the population studied.

"Research has shown that exposure to air pollution adversely affects human health by triggering or exacerbating a number of health issues such as asthma and heart disease. Likewise, physical inactivity is linked to an array of negative health effects including heart disease and diabetes," said Marshall. "Neighborhood design can influence air pollution and walkability; more walkable neighborhoods may encourage higher daily activity levels."

The research was published recently in *Environmental Health Perspectives*, a peer-reviewed journal of the United States' National Institute of Environmental Health Sciences, part of the U.S. Department of Health and Human Services.

FACULTY HONORS

Professor **Roger Arndt** (civil engineering) and professor **Fotis Sotiropoulos** (civil engineering) have been elected Fellows of the American Physical Society.

Professor **Gary Balas** (aerospace engineering and mechanics) was named chair of the Aerospace Department Chairs Association through 2010.

Assistant professor **Kathrin Bringmann** (mathematics) has been awarded the 2009 SASTRA Ramanujan Prize. She also recently received the Alfried Krupp-Förderpreis for Young Professors award, which provides for about \$1.4 million in research funding over a five-year period.

Professor **Peter Carr** (chemistry) has received the Martin Medal by the Chromatographic Society, United Kingdom, in recognition of his contribution in promoting separation science globally.

Professor **Jonathan Chaplin** (bioproducts and biosystems engineering) has received the Charles E. Bowers Faculty Teaching Award for outstanding teaching at the undergraduate and graduate levels.

Assistant professor **Kevin Dorfman** (chemical engineering and materials science) has received a Defense Advanced Research Projects Agency (DARPA) Young Faculty Award for 2009, which will support his research on nanofluidic methods for manipulating and analyzing DNA.

Professor **Arthur Erdman** (mechanical engineering) and professor emeritus **Marvin Stein** (computer science and engineering) have received the 2009 President's Award for Outstanding Service recognizing exceptional service to the University.

Assistant professor **Christy Haynes** (chemistry) has been named a 2009 Camille and Henry Dreyfus Teacher-Scholar, recognizing her scientific accomplishments and her dedication to education in the chemical sciences.

Professors **Bin He** (biomedical engineering) and **Joe Konstan** (computer science and engineering) are recipients of the 2009 Distinguished McKnight University Professorship, which recognizes and rewards outstanding mid-career faculty.

Professor **Joachim Heberlein** (mechanical engineering) received the 2009 Plasma Chemistry

Award, the highest recognition awarded by the International Plasma Chemistry Society (IPCS).

Professor **Richard James** (aerospace engineering and mechanics) has received the Brown Engineering Alumni Medal given to Brown University Division of Engineering graduates who have established exceptional records of accomplishment in their engineering careers.

Professor **Yiannis Kaznessis** (chemical engineering and materials science) was named Outstanding Young Researcher for 2009 by the Computing and Systems Technology Division of the American Institute of Chemical Engineers.

Professor **David Kohlstedt** (geology and geo-physics) was recently elected a Fellow of the Mineralogical Society of America.

Professor and department head **Uwe Kortshagen** (mechanical engineering) was named an American Society of Mechanical Engineers Fellow for 2009.

Professor **Vipin Kumar** (computer science and engineering) was recently named the Alumnus of the Year by the University of Maryland's computer science department.

Assistant professor **Marta Lewicka** (mathematics), and assistant professor **Aaron Massari** (chemistry), and assistant professor **Marc Riedel** (electrical and computer engineering) have received a National Science Foundation's Faculty Early Career Development (CAREER) award. This competitive five-year award is the NSF's most prestigious program to support the early career development of promising young researchers.

Professor **Tim Lodge** (chemistry) has received the American Chemical Society Award in Polymer Chemistry recognizing his work in the field of polymer chemistry.

Professor **Ned Mohan** (electrical and computer engineering) has been awarded the 2010 Undergraduate Teaching Award from the Institute of Electrical and Electronics Engineers (IEEE).

Professor **David Odde** (biomedical engineering) received the George W. Taylor Award for Distinguished Research, which recognizes the outstanding research of a mid-career faculty member.

Assistant professor **Sang-Hyun Oh** (electrical and computer engineering) received the Doctoral New Investigator Award from the American Chemical Society's Petroleum Research Fund.

Professor Emeritus **Suhas Patankar** (mechanical engineering) received the Max Jakob Award, the highest honor in the field of heat transfer, for his pioneering contributions to Computational Fluid Dynamics and Heat Transfer.

Associate professor **R. Lee Penn** (chemistry) has received the George W. Taylor/ITAS Award for Distinguished Teaching for her contributions to undergraduate education.

Professor **John Riedl** (computer science and engineering) has been elected Fellow of the Association for Computing Machinery (ACM).

Professor **Alan E. Shapiro** (history of science and technology) received the George W. Taylor Award for Distinguished Service recognizing his outstanding service to the University and voluntary public service to governmental and other public groups.

Regents professor **Don Truhlar** (chemistry) and professor emeritus **Bryce Crawford** have been named Fellows of the American Chemical Society (ACS). Truhlar also recently received the 2009 Herschbach Medal for Excellence in Research in the Field of Collision Dynamics.

Tolman named Chair of Department of Chemistry

WILLIAM TOLMAN, a professor of chemistry, has been named chair of the University of Minnesota Institute of Technology's Department of Chemistry. Tolman succeeds professor Jeffrey Roberts who stepped down as chair to accept an appointment as dean of the College of Science at Purdue University.

A faculty member since 1990, Tolman is a renowned synthetic chemist whose work straddles the traditional boundaries separating chemistry's inorganic, biological, and organic specialty areas. His current research, funded primarily by the National Institute of Health and the National Science Foundation, focuses on using synthetic chemistry to understand copper sites in enzymes and new ways to develop biorenewable sources to replace petroleum-based plastics.

Online game gives insight into solving traffic gridlock

INSTITUTE OF TECHNOLOGY engineering faculty and staff in the Intelligent Transportation Systems (ITS) Institute have developed a new online game that gives players a turn at solving the problem of traffic gridlock into an exercise that's entertaining and informative.

"Gridlock Buster" is a game that incorporates tools and ideas that traffic control engineers use in their everyday work.

Players must work through a series of levels by controlling the traffic and ensuring that delays don't get out of hand—such as lines of backed-up traffic and frustrated drivers—in the simulated environment. Sound effects and animation simulate cars honking and drivers' fists shaking to illustrate the realistic results of backed-up traffic queues.

Based on work by civil engineering staff member Chen-Fu Liao, the ITS Institute's education systems engineer, the game provides a fun way for students to learn about the traffic engineering field.

"Kids are really into games, especially online games. We think creating a game like Gridlock Buster is a great way to engage them and get them interested in engineering and transportation," said Max Donath, director of the ITS Institute and mechanical engineering professor. "The best way to learn is by playing."

To try your hand at the game, visit:
www.its.umn.edu/GridlockBuster/



"Gridlock Buster" is an online game that lets you try your hand at solving traffic problems

IN memoriam

H. TED DAVIS, A UNIVERSITY OF MINNESOTA Regents professor of chemical engineering and materials science and former dean of the University's Institute of Technology, died suddenly on May 17 of complications from a heart attack. He was 71. For more than 45 years, Davis served the University of Minnesota and its students in various roles, most recently as director of the BioTechnology Institute.



- PAUL CARTWRIGHT, a long-time professor of electrical and computer engineering and former Institute of Technology assistant dean for student affairs, died of cancer on May 31, 2009. He was 93.
- STEVEN CASE, former professor of electrical and computer engineering and founder of CyberOptics, was killed in a plane crash on June 16 in Crystal, Minn. He was 60.
- MIRIAM EL-POUR, a professor of mathematics for 36 years, died on June 10. She was 81.
- LEON GREEN, professor emeritus of mathematics, died on Aug. 17. He was 83.
- CHIH-CHUN HSIAO, professor emeritus of aerospace engineering and mechanics, died on Aug. 7. He was 89.
- WILLIAM RANZ, a former long-time professor of chemical engineering, died on Oct. 20, 2009. He was 87.

U physicist probes earliest beginnings of universe

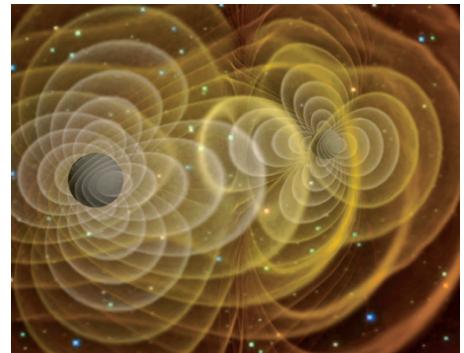
INSTITUTE OF TECHNOLOGY physicist Vuk Mandic is the lead author on new research findings that advance our understanding of the early evolution of the universe.

Mandic is co-chair of the Stochastic Working Group of the LIGO (Laser Interferometer Gravitational-Wave Observatory) Scientific Collaboration (LSC), a National Science Foundation collaboration of about 700 scientists worldwide. The research was recently published in *Nature*, an international weekly journal of science.

The research sets the most stringent limits yet on the amount of gravitational waves—or ripples in the fabric of space and time produced by violent events in the distant universe—that could have come from the Big Bang. The data taken from 2005 to 2007 has enabled scientists to narrow details of how the universe looked in its earliest moments.

The existence of gravitational waves was predicted by Albert Einstein in his general theory of relativity. The Big Bang is believed to have created a flood of gravitational waves that still fill the universe and carry information about the universe as it existed immediately after the Big Bang. If they can be found, they could carry information about the high-energy environment in which they were created.

The research also constrains models of cosmic strings, objects that are proposed to have been left over from the beginning of the universe and subsequently stretched to enormous lengths



Gravitational waves or "ripples in space-time" are helping physicists to narrow the possible physical environments in which the universe was born.

by the universe's expansion. The strings, some cosmologists say, can form loops that produce gravitational waves as they oscillate, decay, and eventually disappear.

"We now know a bit more about parameters that describe the evolution of the universe when it was less than one minute old," Mandic said. "We also know that if cosmic strings or superstrings exist, their properties must conform with the measurements we made—that is, their properties, such as string tension, are more constrained than before."

This is interesting, he added, "because such strings could also be so-called fundamental strings, appearing in string-theory models. So our measurement also offers a way of probing string-theory models, which is very rare today."

C. HENZE, NASA



2010: A space odyssey

The University seeks a new building to expand physics and nanotechnology research

WRITTEN BY DEANE MORRISON

PHOTOS BY PATRICK O'LEARY

Last year Steve Campbell, director of the University of Minnesota's Nanofabrication Center, showed a prospective faculty member the facilities that would be at his disposal if he took a job in the Institute of Technology.

He was a dream candidate: a senior researcher in his 40s, well established in the field of nanotechnology, with \$8 million in research funding from the U.S. Department of Defense to bestow on the institution that could reel him in. He toured the center, in the lower level of the Electrical Engineering and Computer Science Building.

When decision time came, "he went to a university that is building a new [nanotechnology] facility," Campbell said.

Talk to most University faculty in physics and

nanotechnology, and similar stories bubble up of big fish wriggling off the hook, lured by competitor institutions with well-equipped new facilities. It has become clear that the University, which boasts an outstanding record in physics and nanotechnology, must do more to stay in the game.

Only a strong and competitive physics department can maintain its level of achievement and its role as anchor and support for the other physical sciences and engineering, including nanotechnology. But the stakes go even higher, because while research in these fields may escape public notice, it holds incalculable value to society.

For example, recent Nobel Prizes have honored fundamental work from the 1960s and 1970s that led to the recent, dramatic miniaturization of hard disks;

Nanotechnology research is conducted in a clean room, where numbers of airborne particles are strictly controlled. If approved, a new physics and nanotechnology building would contain a Class 10 clean room for biomedical applications.



physicists' discoveries today, in areas from new technologies to the very nature of matter, will make an impact far beyond what can be foreseen.

But the demands of modern research are straining the University's physical capabilities, and without new space the Institute of Technology risks losing ground in areas that form the bedrock for advances in medicine, technology, and our understanding of the Universe.

As a first step to remedying the situation, the University will ask the 2010 Minnesota Legislature to fund two-thirds of a new \$80 million building to house experimentalists in physics and nanotechnology. Its amenities would include the ventilation and temperature control necessary for experiments in biophysics and solid-state physics, a Class 10 clean room for biomedical applications of physics and nanotechnology, and a high bay area for constructing the large detectors needed to reveal nature's ultimate secrets.

The proposed physics and nanotechnology building would be built on open space across Union Street from Akerman Hall. It would bring together faculty and staff who are already united on one point: Physics and nanotechnology must expand and modernize their facilities if they are to hold up their end of the University's research and teaching mission.

Boxed in

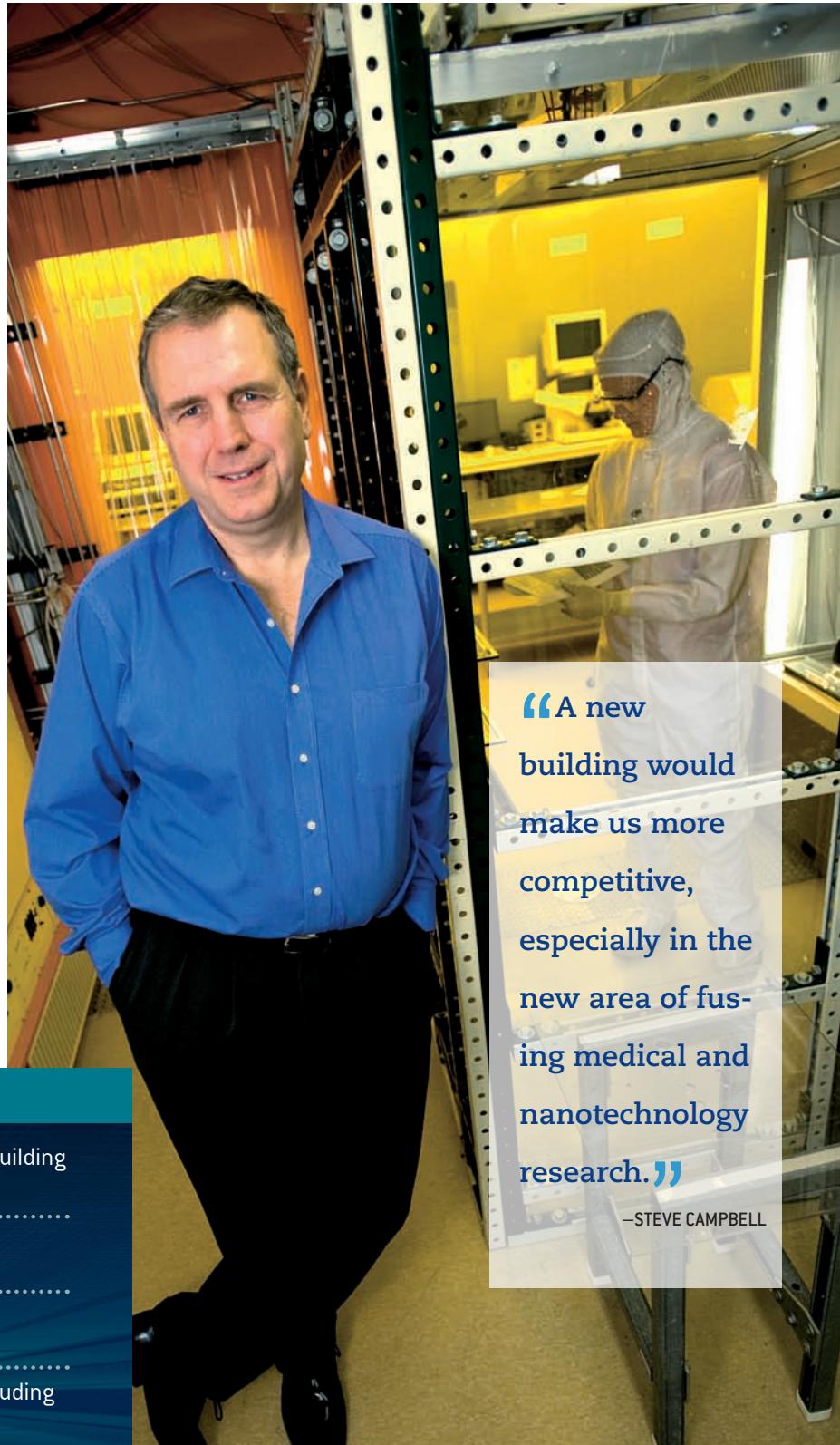
Built between 1927 and 1937, the Tate Laboratory of Physics set the bar for facilities housing research in physics and astronomy.

"It was featured in the American Journal of Physics as a model of how a modern physics building should be constructed," said physics professor Kenneth Heller.

BUILDING FEATURES

Plans for a new physics and nanotechnology building call for:

- 1 State-of-the-art, modular research labs
- 2 Laboratory support spaces
- 3 Nanotechnology: 15,545 square feet, including 5,000 square feet of clean room labs
- 4 Physics space: 43,200 square feet for labs, 14,702 square feet for offices
- 5 Faculty, post-doctorate, and graduate student offices



“A new building would make us more competitive, especially in the new area of fusing medical and nanotechnology research.”

—STEVE CAMPBELL

Steve Campbell, director of the University's Nanofabrication Center and a professor of electrical and computer engineering, says a new physics and nanotechnology building would enable the integration of biomedical applications into nanotechnology—specifically a wet biology lab where human cells can be cultured next to a clean room for device fabrication.

Tate served as home base for famous discoveries by University physicists. For instance, in finding the first evidence of heavy ions in cosmic rays, Phyllis Freier, Edward Ney, Frank Oppenheimer, and C.J. Waddington began a sterling tradition in balloon, rocket, and satellite-borne research that has thrived for 50 years.

Alfred O.C. Nier, who isolated the isotope of uranium that made nuclear power possible, and John H. Williams, who headed the Atomic Energy Commission, stand out as luminaries in the history of atomic power and the University's decades-long leadership in nuclear physics. The department also nurtured the careers of five physics Nobel Prize winners: Walter Brattain, Arthur Compton, Ernest Lawrence, John Van Vleck, and double winner John Bardeen.

Today, however, it is clear that Tate was designed for physics in another era, said former department head and Regents Professor Allen Goldman, a National Academy of Sciences member who has made fundamental discoveries in superconductivity. To renovate Tate, its heating, ventilation, and air conditioning "would have to be recreated," he says. But no one has found a way to keep its teaching and re-

search programs running during such a massive remodeling.

And the lack of space keeps the University from adding faculty in accordance with its size and caliber.

"Michigan has a smaller campus, but about 60 physics faculty," said Goldman. "Ohio State also has about 60. We have around 38."

"During this decade, we have made six offers to experimentalists that were accepted, and 15 that were declined," said Ron Poling, current head of the School of Physics and Astronomy. "According to our overall ranking, which is around 22, we should have a better success rate. The single biggest factor in our difficulty competing for these outstanding researchers is the lack of competitive experimental laboratories."

"We haven't lost any of our experimentalists to a raid yet, but if a new building isn't built, there may be people who decide it isn't worth staying here because there are better opportunities somewhere else," Goldman added.

Needed: one high bay

The space squeeze has created real difficulties for physics professor Kenneth Heller and other members of the high-energy physics group, who are engaged in two national, federally funded projects to study neutrinos. Both projects require gargantuan detectors to pick up the elusive subatomic particles, but without a high bay in Tate, the physicists must build prototypes a good mile away, in a building on busy University Avenue.

"There, the loading dock can't accommodate big trucks," lamented Heller. "Every time we have a delivery, we get a permit from the city, then close the street behind the building, bring in the truck and a crane, and have students carry material inside."

Besides that, they can't ship or receive items between mid-November and March or April because trucks can't perform the tricky task of edging up to the building in slippery conditions. But since they must build their next detector soon, they will rent and renovate space outside the University at a cost of about \$2.5 million.

Or consider physics professor Shaul Hanany, who uses high-altitude balloon-borne equipment to study microwave radiation (the Cosmic Microwave Background, or CMB) left over from the first 300,000 years after the Big Bang in a quest to understand how the Universe began. He is part of a major new experiment now gearing up to glean more clues from the CMB.

But despite the \$6.3 million he has received from NASA, "major portions of the experiment had to be built at Columbia University because they have a high bay and we don't," he said. Instead, money went

THE CASE FOR PHYSICS

1 A strong physics department is essential for a first-rate research university. Discoveries in physics form the basis for MRI scans, microwave ovens, laser optics, and numerous other innovations. Students of sciences such as biology, chemistry, and geology must complete required courses in physics.

2 University physics research generates more than \$10 million annually in federal grants. Last year the U won \$40 million to build a new neutrino physics facility in northern Minnesota, generating income, science—and jobs. A further \$15 million for the project goes to building the detection devices in the Twin Cities.

3 Every year about 3,000 undergraduates in the University's Institute of Technology; College of Biological Sciences; College of Food, Agricultural and Natural Resource Sciences; and other colleges must take introductory physics. The School of Physics and Astronomy graduated 41 physics majors, two M.S. students, and eight Ph.D. students in the 2008-09 academic year. As of fall 2009, it had 122 undergraduate students and 129 graduate students. Demand is expected to rise, putting pressure on the size of the physics faculty and increasing the need for modern research facilities.

“Having a high bay to conduct experiments at the University would have simplified our work immensely.”

—SHAUL HANANY



to quartering students in New York City for months at a time, and “tens of thousands of dollars would easily have been saved, and more of the money would have stayed at Minnesota” if the U of M had had a high bay.

“It would have simplified our work immensely,” Hanany said.

Noise and the hoods

Physics professor Paul Crowell, who studies optics and low-temperature physics, minces no words in describing his pet peeve with Tate: “Temperature regulation in this building is awful.” Sometimes, he says, “we’ve lost eight hours of data overnight because the temperature soared.”

In his work, he reflects lasers off precisely positioned mirrors. A temperature rise of just a half-degree Celsius can change the distance between mirrors enough to render his data useless.

Biophysicists Joachim Mueller and Vincent Noireaux face similar difficulties.

“To work with cells, we need good hoods to keep them sterile, and a good growing environment,” said associate professor Mueller, who uses lasers to track individual molecules within cells. “The sub-basement is the only renovated space we have that’s modern. Yet, temperature drifts in the room cause a

lot of problems with the lasers and the microscope optics.”

Assistant professor Noireaux, who constructs models of living cells from the ground up “because building things is a good way to understand them,” uses the synthetic cells to study gene expression and related cellular activities.

In the past two years, however, “we have had problems with dirty water in the pipes, and also with temperature control,” he says. A new building would not only fix these problems, but allow the biophysics group to share lab space and expand their numbers.

Crowell also requires a low-vibration environment and the means to get large equipment in and installed. But Tate’s freight elevator only operates between the sub-basement and the first floor loading dock area, stopping short of the sub-sub-basement, where Crowell has his lab.

“We had to get an optical table [for precision laser work] weighing a couple of tons into the sub-sub-basement by winching it down the stairs,” he recalled.

In many labs, ceilings are low and cluttered with ductwork. But Tate’s most often mentioned failing is the lack of research-grade ventilation and environmental controls.

Physics professor Shaoul Hanany (above) is part of the Observational Cosmology research group. The group is working to understand the early history of the Universe through measurements of the cosmic microwave background radiation, which was created shortly after the Big Bang. Vapor of liquid helium bilows from a cryostat machine—a container that holds detectors at temperatures close to absolute zero—which is used in Hanany’s research.

“We have had problems with dirty water in the pipes, and also with temperature control.”

—VINCENT NOIREAUX

“For the biophysicists, we had to spend \$300,000 to \$400,000 a piece on air handling, temperature control, and cleaning,” Goldman said.

Besides the poor ventilation, the sheer clutter puts off prospective faculty—especially in space that may become theirs.

“When we interview candidates, we can rarely show them the space they’ll occupy without it being full of stuff,” says Crowell. “I’ve had at least one visiting candidate comment, ‘Will this space really be available?’”

The effect on prospective graduate students may have even more profound repercussions.

“I think potential graduate students are more significantly influenced by the nature of the physical plant than the faculty are,” Goldman said. “If a student comes here and sees beat-up old offices [and jury-rigged labs], and visits somewhere else that has shiny new facilities, they’ll go there, all else being equal.

“The quality of graduate students influences the quality of instruction in introductory courses and essentially the quality of research, because most of the research here is done by them,” Goldman added.

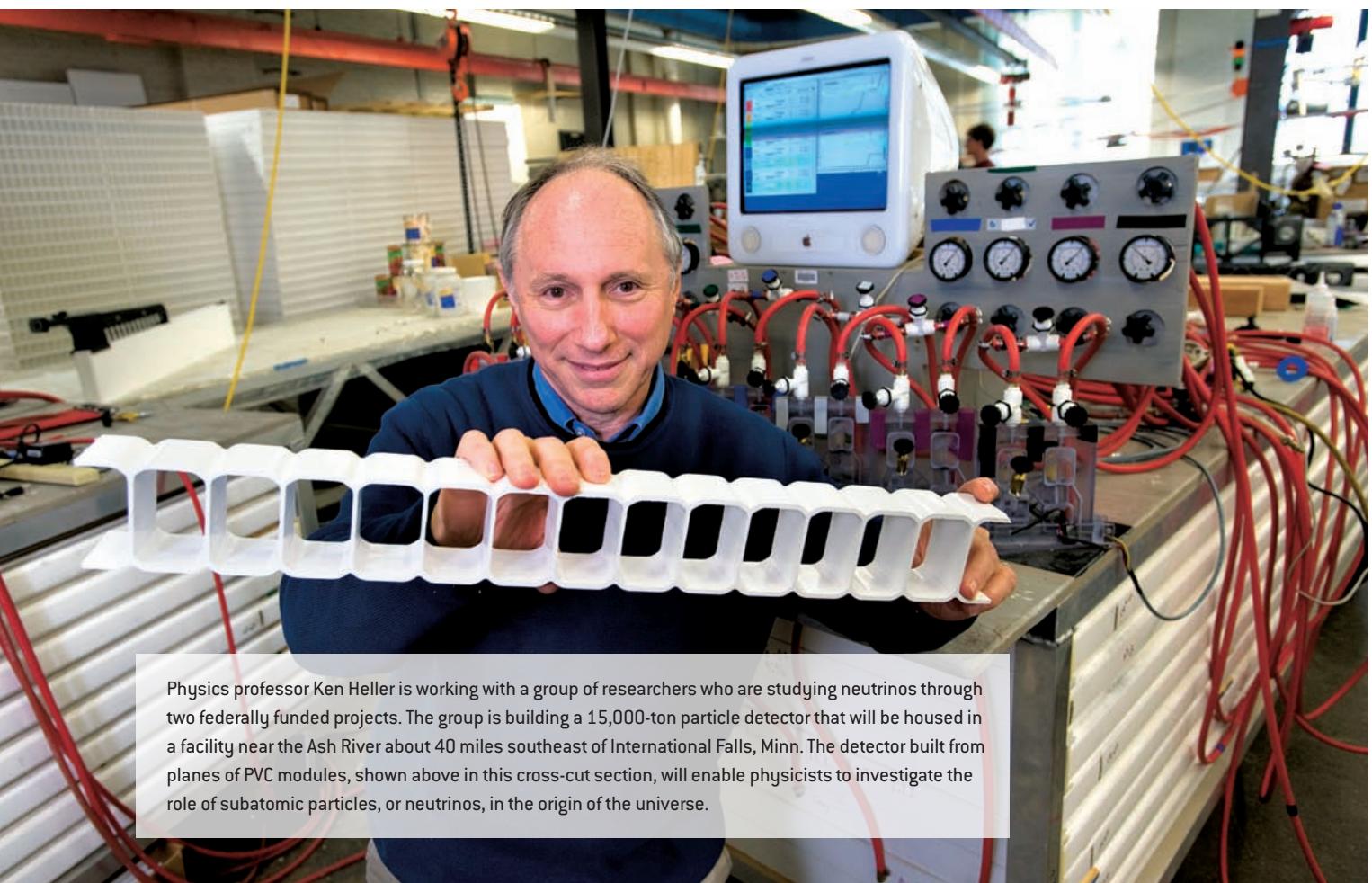
Small world, big payoffs

Soldiers of the future will go into battle carrying lots of electronics that weigh little—except for the power-hungry batteries.

Transistor-based batteries leak power after devices are turned off, and more powerful batteries mean heavier loads, Campbell said. But he and his colleagues have developed nano cantilevers to switch current on and off cleanly, with no leakage. They have already managed to cut power consumption 10-fold, but the nano cantilevers can work only about a quarter as fast as transistors.

“We can make features on the scale of 100 nanometers, but we need to go down to 10 nanometers,” Campbell explained. “We don’t have the equipment or an appropriately designed facility here, but the [proposed building] would allow that.”

Besides experimental physicists, the new Physics and Nanotechnology building would house the Nanofabrication Center and the fledgling Center for Nanotechnology Applications, which currently has no physical home. To appreciate the crunch, one need only look at the Nanofabrication Center. The center helps clients from universities and companies



Physics professor Ken Heller is working with a group of researchers who are studying neutrinos through two federally funded projects. The group is building a 15,000-ton particle detector that will be housed in a facility near the Ash River about 40 miles southeast of International Falls, Minn. The detector built from planes of PVC modules, shown above in this cross-cut section, will enable physicists to investigate the role of subatomic particles, or neutrinos, in the origin of the universe.

THE CASE FOR NANOTECHNOLOGY

- 1 Nanotechnology research is inherently interdisciplinary. At the U, three colleges and 17 departments are involved in nanotechnology projects.
- 2 Nanotechnology research contributes to energy conservation and production, smart fabrics, electronic noses, and printed electronics. For example, U researchers are discovering ways to print transistors on plastic sheets, paving the way for electronic paper and foldable display screens.
- 3 Between August 2008 and July 2009, the Nanofabrication Center (NFC) served the needs of 250 users in eight University of Minnesota departments, 28 other academic institutions, and 24 companies nationwide.
- 4 Together, the NFC, Characterization Facility, and Particle Technology Lab constitute one of 13 user facilities in the National Science Foundation-supported National Nanotechnology Infrastructure Network.

across the country construct nanotechnology-based devices. During the last two decades, the number of users who take advantage of its facility and expertise has quintupled.

"The University provides important nanotechnology research and facilities to serve both faculty and industry throughout the state and nation," said Lynne Osterman, executive director of MN Nano, a statewide, private-sector led coalition of advocates for nanotechnology.

But the need for new space has even more to do with the types of work a new building could accommodate, especially in the key areas of energy, information devices, and medicine. To successfully apply nanotechnology in those areas requires shoulder-to-shoulder collaboration between engineers and professionals from disciplines like biology, medicine, materials science, and physics.

"As we look toward integrating biomedical applications with what we do here, we have inadequate square footage and equipment, and we don't even have the facilities to put equipment in," Campbell said. "The most common example is that we need wet biology labs where you can culture human cells, bacteria, etc. next to a clean room for [device] fabrication."

The work done in wet labs can't be added to the clean room currently in the center. One reason is that a wet lab can be decontaminated by spraying

bleach, but that could never be done in a clean room, where numbers of airborne particles are strictly controlled.

If combined, however, medicine and nanotechnology hold enormous potential; for one thing, they could revolutionize drug-delivery devices. Consider a drug-coated stent: It sheds the drug very quickly when first implanted, but more and more slowly as the coating wears thin. But if the drug were in a container with pores of the right size, the rate at which it entered the bloodstream would be limited—i.e., stabilized—by the rate at which its molecules could pass through the pores.

About 120 University faculty perform an estimated \$20 million worth of nanotechnology research annually. Without the collaboration a new building would allow, the University will be severely hampered in competing for the large federal grants now available for nanotechnology, which ranks second only to

cancer as a top area of federally sponsored research.

"A new building would make us more competitive, especially in the new area of fusing medical and nanotechnology research," Campbell explained. "The University has applied for a National Science Foundation grant for nanoimaging that could, for example, detect very early cancers that are likely to form tumors. We also have submitted a grant application for therapeutics work, such as the drug-delivery system, to the National Institutes of Health (NIH). NIH currently has funded about five nano-cancer centers and is adding two more—and we want one."

The University of Minnesota was able to submit both applications because it brought biology and engineering people together in part through the University's Center for Nanostructure Applications, he points out.

Besides labs and offices for graduate students, postdoctoral researchers, and faculty, the envisioned building would have adequate space for research groups to meet and places where students can gather and help each other out.

"It's known that students do better when they can talk about things with each other," said physicist Heller.

If built, "it will be a beautiful building," he added. "It would satisfy our immediate needs. It's not the end of the story, but the beginning." ■

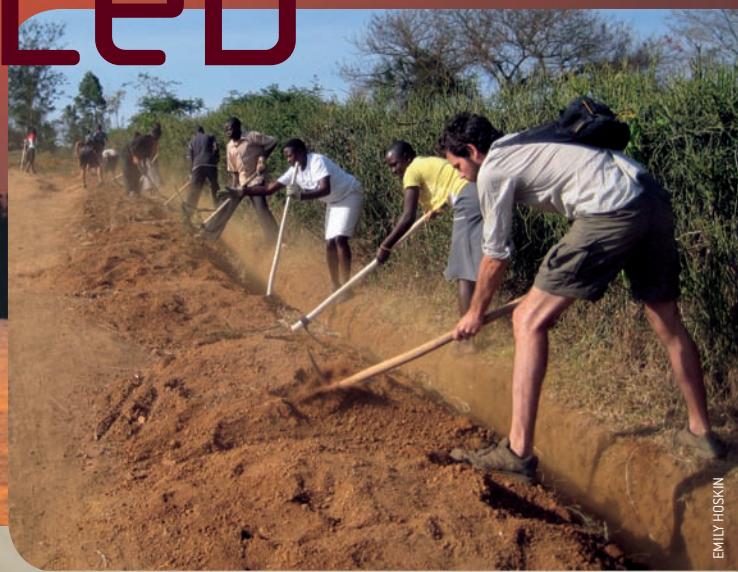
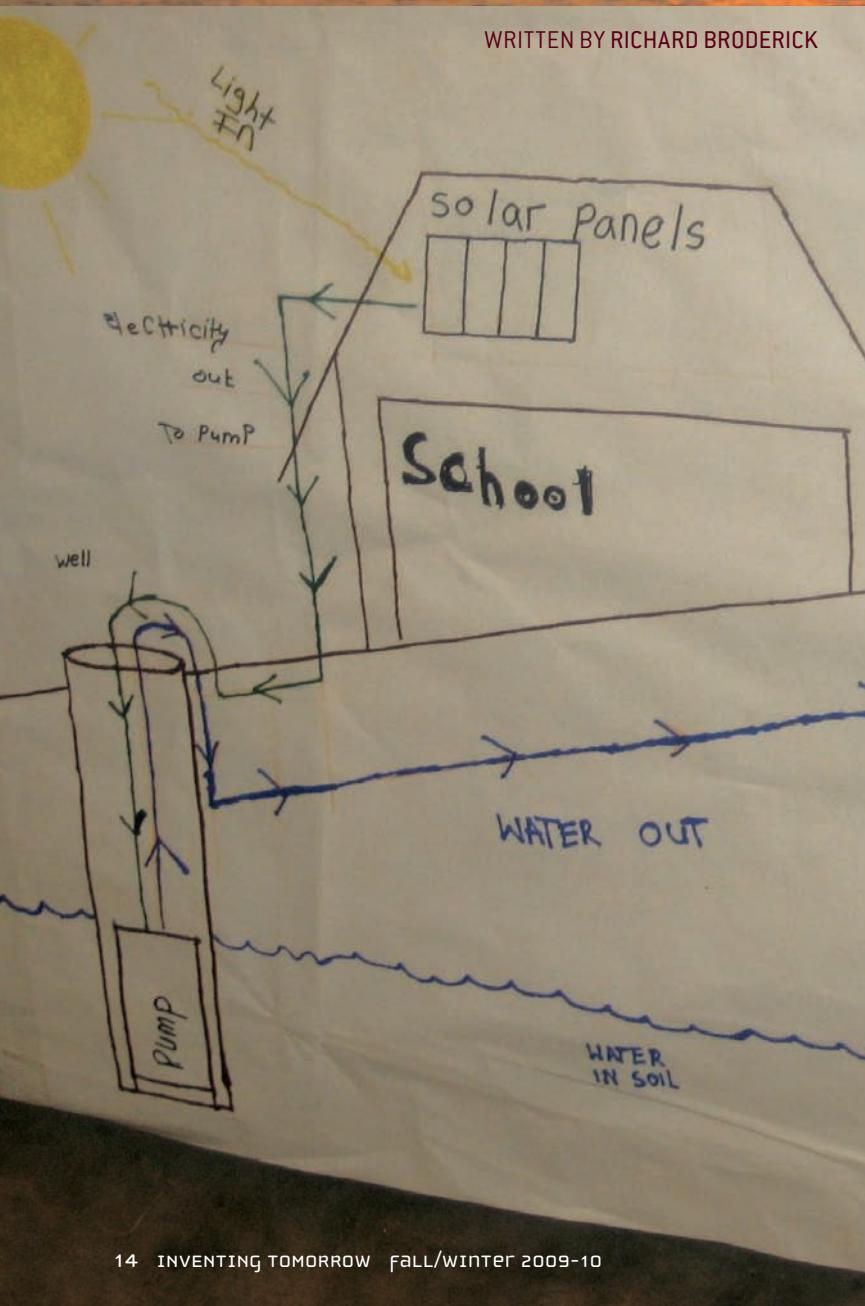
“We haven’t lost any of our experimentalists (physicists) to a raid yet, but if a new building isn’t built, there may be people who decide it isn’t worth staying here.”

—ALLAN GOLDMAN

Engineering TROUBLED Waters

INSTITUTE OF TECHNOLOGY STUDENTS
are addressing global societal
challenges, one community at a time

WRITTEN BY RICHARD BRODERICK



EMILY HOSKIN



MARK LUNDIGEN



ANNE COOK

Although Mumbai may be India's financial and entertainment capital, one cannot dismiss the fact that more than half of its 13 million people live in slums. Squalor and wretchedness definitely exist in India's largest city. The Academy Award winning film, "Slumdog Millionaire," offered viewers worldwide a small glimpse into the slum's swarming hive of poverty, inequality, and deprivation—but also a glimpse into the fervent everyday aspirations of its residents for a better tomorrow.

Now, one of those everyday aspirations—clean, affordable, and plentiful water for cooking, drinking, and cleaning—is being addressed for several thousand residents of the slums of Mumbai thanks to a multi-disciplinary project team called ReachOut Water Solutions comprised of University of Minnesota Institute of Technology students, Mark Lundgren, Brian Bell, Tony Schrempp, and College of Design student Karthikayan Kumar.

The ReachOut Water Solutions team won the first-ever Acara Challenge, sponsored by the Acara Institute, a non-profit organization based in Minnesota that helps to address global societal challenges through sustainable business solutions. The challenge laid down by the Institute—whose founders come from both business and academic backgrounds—was a daunting one: develop a plan for a sustainable business that addressed this year's subject: How to provide clean water to the slums of Mumbai.

Last May, the winning team traveled to Mumbai for two weeks where they partnered with four students from the Indian Institute of Technology-Bombay, as well as representatives from Mumbai's municipal corporation and a number of community organizations operating in the slums. There they learned first-hand of the challenges in water provision by visiting a variety of slum communities.

According to team member and civil engineering graduate student Mark Lundgren, some residents get water from a "chaotic system" of pipes running—sometimes through open channels of sewage—from a municipal water line to individual homes. In the poorest slums, people have to walk to collect overpriced water from private vendors. But in other slums, the team found well-organized and engineered systems, made possible by community organizations leveraging local technical and financial resources.



Putting plans into action

Using water from the city's public utility, ReachOut Water Solutions' Slum Water Program is based on a public service delivery framework addressing water quantity, quality, access and management to serve two types of Mumbai customers: 1500 community residents who receive the water for free and 200 pay-per-use customers. Eventually, however,

the system could be expanded to provide potable water to hundreds of thousands of Mumbai residents.

Toward that end, the Slum Water Program combines source water storage with ultraviolet water treatment and a novel delivery system to supply 50 liters of water to community participants and 10 liters of water to pay-per-use customers every day.

"It was the first time I had ever been in India," said Lundgren. "It was overwhelming. The city is so loud, so busy and so chaotic, but it was a great experience."

The ReachOut Water Solutions team (left) is comprised of Institute of Technology students Mark Lundgren, Brian Bell, Tony Schrempp, and College of Design student Karthikayan Kumar. The team traveled to Mumbai to develop a plan for providing clean water to residents who live in the Mumbai slums.

Nearly 55 percent of Mumbai's population lives in slums as shown below. The highly polluted water (below) acts as a drainage system.



MARK LUNDGREN



“The slums have a real range of economic classes—not just the desperately poor, but people doing pretty well and capable of creating and operating strong organizations.”

—MARK LUNDGREN

(Above) Residents of the Mumbai slums receive water from a “chaotic system” of pipes. Sometimes the pipes run through open channels of sewage. In the poorest slums, individuals must walk to collect overpriced water from private vendors.

Even in the midst of the disorder, ReachOut Water Solutions worked extensively in eight different slum neighborhoods, collaborating with established community organizations that were already engaged in running successful sanitation programs in coordination with the municipality. “These programs were being run by residents,” observes Lundgren. “One thing that surprised us was that the slums have a real range of economic classes—not just the desper-

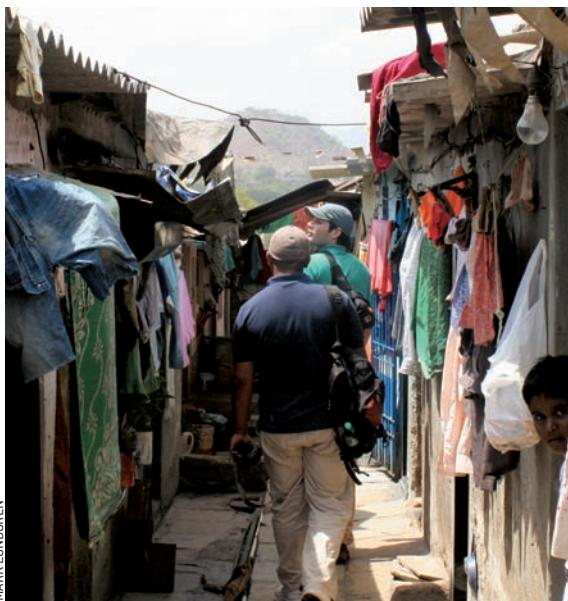
ately poor, but people doing pretty well and capable of creating and operating strong organizations like classes and festivals in addition to sanitation programs.”

ReachOut Water Solutions was created as part of a new Institute of Technology class called “Design for Sustainable Development.” After the Acara Institute announced its Mumbai challenge, the class was adapted to respond specifically to it.

“The course was built around the Acara Challenge,” explains John Gulliver, professor of civil engineering who taught the class. “We had three teams, each with four members. Each team was required to put together a sustainable business plan that would be reviewed by a panel of judges drawn from industry, higher education, and non-profit organizations.”

During the months leading up to the judging, outside experts came to each class session and made presentations on topics ranging from sanitation to venture capitalism. After the presentations, the three teams would work separately to apply what they had learned in class to their final proposals. “The process was wide open,” explains Gulliver. The winning team received \$25,000 to underwrite its expenses.

“I can’t say enough about how valuable the class was for my learning experience,” Lundgren said. “It was totally different from any other class experience I’ve ever had. Not only were we asked to do



(Right) ReachOut Water Solutions Project Team members, Karthikayan Kumar and Brian Bell, navigate the narrow pathways that wind through homes in the Mumbai slums.

MARK LUNDGREN

something real world, success meant learning team-building and financial skills and combining them with engineering."

As to his future with the organization he helped to create with his teammates, Lundgren said, "We're going to operate as a non-profit organization," adding that he hopes to continue to work with ReachOut even after he completes his master's degree program. "One of our goals is to be financially independent, and not rely long-term on grants," he said. "There are about 4.4 million people living in the slums of Mumbai—many of them now can access water only a couple of hours a day. We want to be in a position that, when communities within the slum come to us, we will be able to provide more water at a lower cost than they are currently paying, and use that revenue to repay our capital costs and build more systems."

Relieving thirst in Uganda

Several thousand miles west of Mumbai and a world away in terms of urbanization and culture, another team of Institute of Technology students has been engaged in a long-term project to provide clean, plentiful water to residents in the rural village of Mulobere, Uganda.

The project, an initiative of the University's chapter of Engineers Without Borders (EWB), centers on expanding the water supply and upgrading the sanitation system at the Hope Integrated Academy, a school and community center operated by the Uganda Rural Fund. The academy currently supports about 180 students, as well as adults from the local community, by providing a secondary school, after school programs, women's empowerment projects, micro-finance projects, and community health education. Nearly 500 people use the center each day.

The academy is growing really fast," said Brian Bell, former EWB president and a team leader in the Uganda project. Bell was also in Mumbai this past spring as a member of the winning Acara challenge team. In May, he completed an undergraduate degree in civil engineering and is pursuing a master's degree in sustainable international development at Utrecht University in the Netherlands.

About the only thing rural Uganda has in common with Mumbai's slums is



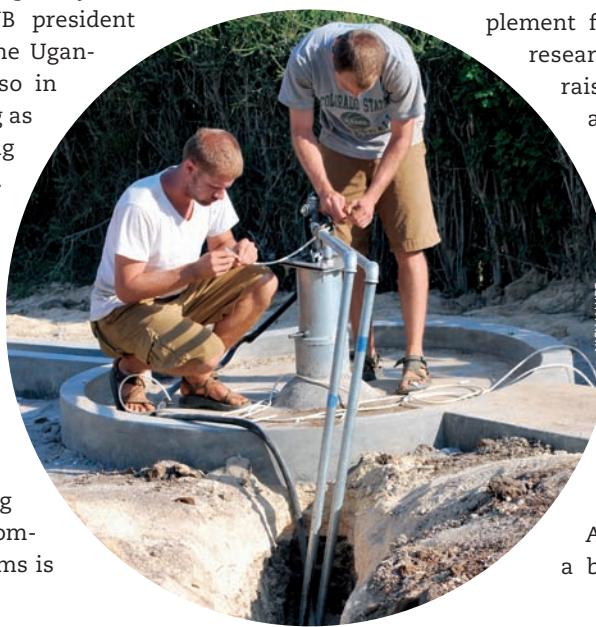
the climate—both are hot. Otherwise, the school is located in a semi-arid zone where the primary livelihood is from subsistence farming. This year's EWB project builds upon a rainwater harvesting system designed and implemented by a team of Institute of Technology students in 2007 and 2008. The harvesting system makes it possible for Hope Integrated Academy to store up to 96,000 liters of water—enough to see the academy through Uganda's dry season.

"I was part of the team that came to Uganda last year," Bell explains. "After that, I became extremely interested in infrastructure projects in developing countries." It was that interest, in turn, that led Bell to apply to Gulliver's Acara Challenge class. Out of 26 applicants, 12 were accepted into the class.

In June, Bell and 13 other University students traveled to the academy in Uganda to implement further improvements after researching, designing, and fund-raising for the trip during the academic year. There, the students worked with the school and community to conduct a topographical survey, and install a deep groundwater well, a submersible pump with solar panels, an elevated storage tank, and distribution taps.

The team also improved the academy's sanitation and composting systems. Additionally, it constructed a bio-sand filter to clean wa-

(Above) Meeting with Anand Jagtap, left, from the Brihan Mumbai Municipal Corporation Office of Municipal Waste and Sewage Disposal is the ReachOut Water Solutions Team (left to right) Brian Bell, Tony Schrempp, and Karthikayan Kumar, in maroon T-shirts. They met to learn about the Slum Sanitation Program sites and reviewed contracts and building plans for the team's proposed project.



NICK HAUPT

(Left) Steve Hankey and Eric Hettler prepare wiring for the water pump before dropping it into the bore hole.

[Right] Students Nick Haupt, Steve Hankey and Eric Hettler work with a Ugandan solar power and well expert, to prepare a bore hole for the submersible pump installation.

[Below] Amber Koskey, Adam Both, Diego Ponce de Leon Barido, Katerina Georgiou, and Emily Hoskins shown in front of the completed dry composting sanitation building.

ter from a local swamp, a drip irrigation system designed to improve the yield from the academy's gardens, and distributed more than 1,000 mosquito nets for malaria prevention.

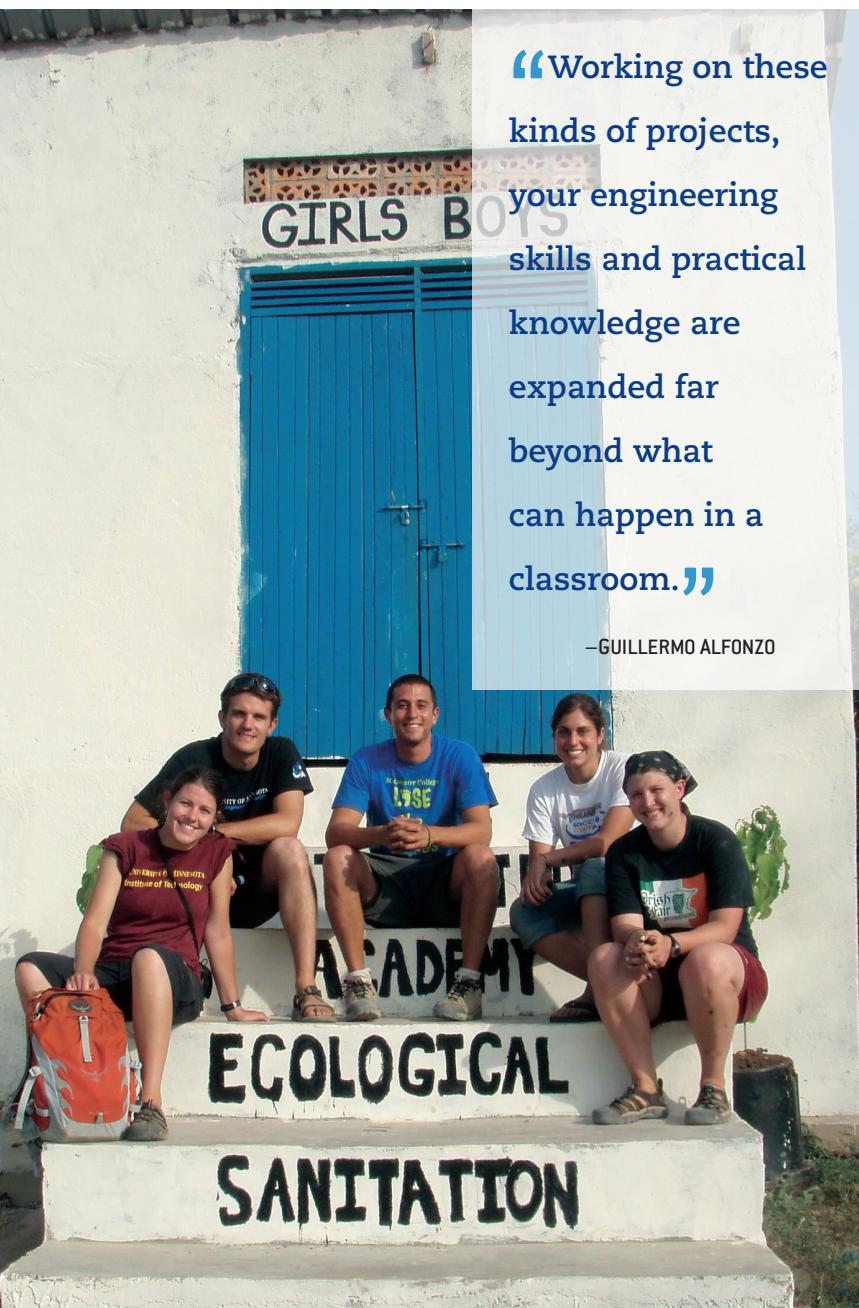
As is typical with EWB projects, team members engage in a lot of pre-implementation design work and onsite multi-tasking. For example, Greta Schmalle, a senior majoring in geological engineering with a special focus on groundwater issues, had a number of responsibilities, not all of them directly related to engineering. Among other things, she had to choose a reliable, low-energy pump suitable to the conditions at the school months before implementation.

"Since we didn't have any groundwater data, that wasn't easy to do," she admits. Also, whatever pump the team chose had to be available in Uganda.



“Working on these kinds of projects, your engineering skills and practical knowledge are expanded far beyond what can happen in a classroom.”

—GUILLERMO ALFONZO



"Before doing that, we had to determine whether we wanted a hand-pump, a solar-powered pump, or one that ran off the electrical grid," Schmalle said. In the end, the team settled on a German-manufactured, solar-powered pump that is low-maintenance and very reliable.

Once in Uganda, Schmalle was also involved in laying out and actually digging trenches for the water system's pipes and wiring. She tested the solar panel that powers the pump, helped to construct the bio-sand filter, and was a part of a team that assessed community health issues.

"I was in on every stage of engineering and construction on this project," she said. "Hopefully it will have a great deal of impact on the school and the community."

"Any time Africa is portrayed in the media, the reports tend to focus on crises, corruption, and violence," observes Eric Hettler, a graduate student in civil engineering, who was part of this past summer's EWB Uganda team. "This gave me a chance to see how people actually live and what they want to do with their lives. It was an incredible experience that changed my perspective on the rest of the world."

The Uganda project is one of three current EWB initiatives located overseas involving Institute of Technology students. This past spring, six students traveled to Haiti for the assessment phase of a project that will involve integrating plastics recycling, indoor sanitation, and a biogas digester to provide essential waste removal, sanitation, and energy services to the residents of one of the largest slums in Cap-Haitien, on the northern coast of Haiti. This past summer, another team of six Institute of Technology students traveled to a rural community in Guatemala, which followed two earlier assessment trips to study and develop a viable solution to the village's water supply



problems. As in the Uganda phase 1 project, the EWB Guatemala team devised and installed a rainwater harvesting system capable of collecting 130,000 liters of potable water—enough to provide drinking water for an entire year.

"Working on these kinds of projects, your engineering skills and practical knowledge are expanded far beyond what can happen in a classroom," said Guillermo Alfonzo, past president of the University's chapter of EWB and a graduate student in chemical engineering and material science. "EWB has been a great way to develop my communication and leadership skills. I can't think of any other organization that provides students with such a high level of responsibility and that has such a great impact on communities thousands of miles away from Minnesota." ■



[Left to right] Kathryn Hope, Katerina Georgiou, Emily Hoskins and Greta Schmalle help with dinner preparations. Meals, which were generally made by members of the Ugandan community for the students, typically consisted of guacamole, chicken, tomatoes, rice, matooke [stew], and chapatti [fried flat bread].



EMILY HOSKINS

Hope Integrated Academy, a school and community center operated by the Uganda Rural Fund, supports students and adults from the local community, by providing a secondary school, after-school programs, women's empowerment projects, micro-finance projects, and community health education.



Lifting the 5,000 liter groundwater storage tank into place is (left to right) Scott Andrews, a URF volunteer, Emily Hoskins, Nick Haupt, Nathan Cantley, and Steve Hankey. The tank was placed on an elevated masonry pad that was constructed by a local mason in about three days.

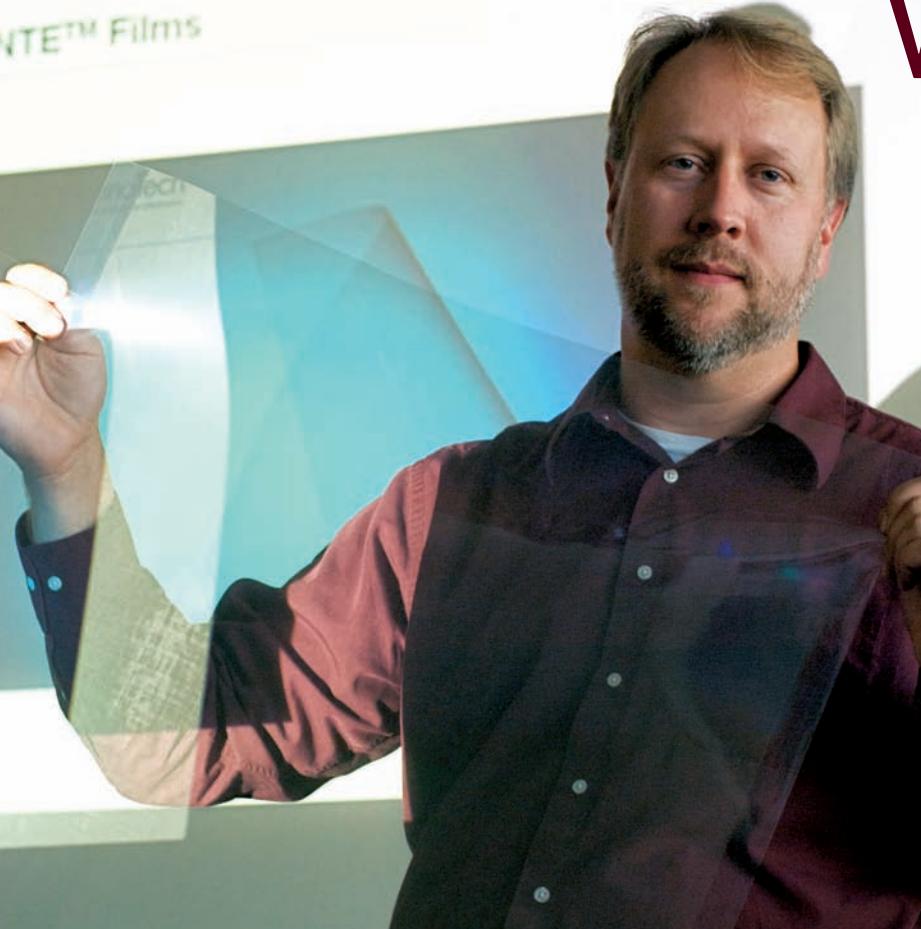


WRITTEN BY KERMIT PATTISON

PHOTOS BY RICHARD ANDERSON AND
PETER LEWINSOHN

Green Ventures

INSTITUTE OF TECHNOLOGY
ALUMNI ARE WORKING
TOWARD A GREENER FUTURE
WITH INNOVATIVE PRODUCTS
AND TECHNOLOGIES



Eric Granstrom [MatSci Ph.D. '99, MBA '04] has pioneered a process that is cleaner for the environment in making transparent conductive films for solar panels, touch screens, plasma televisions, e-paper, and electromagnetic interference filters.



RICHARD ANDERSON

Eric Granstrom leans over a microscope in his lab and peers at an image of a greener future.

Before him lies a tiny piece of transparent polymer laced with a fine matrix of silver nano particles. The conductive mesh is too small to be seen with the naked eye, yet Granstrom and his colleagues at Cima NanoTech envision many applications for this innovative technology—solar panels, touch screens, plasma displays, and more.

Here in a technology park just east of the University of Minnesota's Minneapolis campus, this start-up company has developed a novel process for making transparent conductive mesh with natural processes—ones that don't produce massive streams of waste or deplete rare earths as existing technologies do. Better yet, Granstrom says they can do it for less than half the price of competing technologies.

"It's green and has benefits that float right to the customer's bottom line," he said. "It's not just green in a nebulous sense, but it's also green in a tangible, dollars, bottom-line sense."

This is just one example of how the University of Minnesota's Institute of Technology alumni are venturing toward a greener future. What follows is more about Granstrom and two other alumni who are using their expertise to pursue cleaner technologies, innovate new methods of making biofuels, and promote electric cars.

The Matrix

Granstrom (MatSci Ph.D. '99, MBA '04) is vice president of research and development and general manager of Cima NanoTech. The St. Paul-based company is pioneering cleaner methods to make transparent conductive films for solar panels, touch screens, plasma televisions, e-paper, and electromagnetic interference filters. The company relies on an innovation they refer to as the Self Aligning Nano Technology for Electronics, or SANTE™ process, which takes

advantage of natural forces to make these products with less environmental impact.

In the SANTE process, silver nanoparticles are suspended in an emulsion of water and oil. This substance is spread onto a polyester film substrate, and within 10 to 60 seconds, water droplets grow in size, and then ultimately dry, leaving behind a controlled matrix of silver wires like an old skeleton decorating where the emulsion droplets had been. These particles are so small that 1,000 of them aligned end-to-end are only as thick as a human hair. The microscopic mesh is conductive, transparent, and so flexible, given its porous, nano-structure that it can be stretched by up to 30 percent. The process can also be adapted to use other substrates like glass or silicon or other metals like gold.

According to Granstrom, the SANTE process is less expensive and more environmentally friendly than existing techniques of photolithography (which uses hazardous chemicals and produces truckloads of waste) and indium tin oxide (which has a limited supply, is expensive, brittle, and is non-recyclable).

"We just put the silver down, let Mother Nature push it into the right spot and then we're done," Granstrom said. "In an environmental sense, it's a much nicer process. It shows up in the pocketbook of our customers as an extraordinarily cheaper process as well."

The technology has many potential applications—and one of the greenest is on solar panels. Photovoltaic cells need a mesh that is both transparent and conductive; it must admit sunlight and allow electricity to flow to external contacts. "When we use a green process to make the customer's solar cells more powerful, the net impact is much greener yet," Granstrom said. Cima NanoTech launched its first commercial products in 2009 and foresees an array of future applications.

Granstrom personally has never strayed far from the University of Minnesota. In his teens, he participated in the University of Minnesota Talented Youth Mathematics Program. While earning his undergraduate and master's degrees at Carleton College, he did three internships in the Institute of Technology in mechanical engineering, physics, and chemical engineering. Granstrom returned to the University to earn a doctorate degree in materials science and engineering (he also earned an MBA from the University's Carlson School of Management).

Today, he works two miles from his former haunts at Cima NanoTech's global headquarters, which is housed at the University Enterprise Laboratories in St. Paul (the company also has research and development and production facilities in Israel, manufacturing in Japan, and the CEO is based in Singapore).

His bookshelf is lined with textbooks from his grad school days and he frequently draws on many aspects of his graduate education, including metallurgy, polymers, electronic materials, semiconductor physics, or chemical engineering.

"There's not a part of my education that I'm not using here," Granstrom said. "I have to use the litany of everything I had in materials science."

"A Ph.D., particularly one in materials science, doesn't ground you in just your own specialty area," he said. "It gives you the background to dive into a breadth of projects."

Better Biofuels

Clayton McNeff (Ph.D. Chem '96) wants to turn stinkweed and pond scum into energy.

McNeff is part of a team of innovators who have pioneered a new method for producing biofuels from waste oils, weeds, and even algae.

"This is something the world desperately needs," McNeff said. "It can create a green sustainable economy here in the United States. This technology can enable the replacement of all fossil fuels in a worldwide basis."

McNeff grew up around the family business, the SarTec Corporation, which produces products for the agricultural, livestock, and golf course industries. He learned the fundamentals of running a business and spent summers working in the SarTec lab.

After earning his undergraduate degree at Augsburg College, McNeff came to the University of Minnesota for a Ph.D. in analytical chemistry and studied separation science under chemistry professor Peter Carr.

McNeff and Carr saw the commercial potential of their research and founded a company called ZirChrom Separations, Inc. to manufacture zirconia-based columns, which are used for high performance liquid chromatography (a technique for analyzing mixtures of compounds). These pencil-sized columns are used heavily in the pharmaceutical industry and later served as the catalytic reactor for a new process in making biofuels.

In 2006, one of McNeff's former professors at Augsburg informed him about a student who had discovered that zirconia could be used as a catalyst to make biodiesel. McNeff and his colleagues saw potential in the new application and began attacking the problem.



Silver nanoparticles are suspended in an emulsion of water and oil in Cima Nano-Tech's Self Aligning Nano Technology for Electronics, or SANTE™ process.

Clayton McNeff and his colleagues invented the Mcgyan Process in which they are able to use lower-quality plant oils to make biofuel.



"What ensued was a full research program with thousands and thousands of experiments and many long nights," McNeff recalls. "It was very similar to what I had done in my Ph.D. research at the University of Minnesota, systematically attacking the problem. As we kept pushing forward, we realized this was something that was novel and revolutionary in terms of making biofuels."

They named the new technique the "McGyan Process" (a combination of the names of the three inventors). It uses an heterogeneous metal oxide-based catalyst reactor that creates biodiesel from plant oils and animal fats that previously had been unusable. McNeef believes this breakthrough may transform the biofuel industry.

The old technique of producing biofuels relies on a process developed in the 1930s and requires food-grade feedstock. In contrast, the McGyan process can use lower-quality plant oils and waste tallow—which don't compete with food—to make biodiesel.

One exciting potential source of energy is algae, which can double its biomass in a few hours. Although this remains in the research stage, McNeef is confident the McGyan process could someday provide enough biodiesel to meet the current United States demand of 63 million gallons with a 70-square-mile area of algae production. Another potential source is stinkweed, otherwise known as Pennyroyal, which

McNeef said could produce about 100 gallons of biodiesel per acre.

Even better, the production process is greener. According to McNeef, it produces low emissions, less waste, and has a smaller physical footprint than conventional biofuel plants. It also doesn't produce any soap byproducts or use water and hazardous chemicals.

This past summer, the project took a big step forward with the opening of the new Ever Cat Fuels production plant in Isanti, which will produce four million gallons of biodiesel per year using the McGyan process. The team also has set up a licensing company to spread the technology as widely as possible. McNeef foresees other applications such as fragrances and flavors for foods and perfumes.

"Biodiesel," he said, "is just the beginning."

Driving Change

Jim Johnson (AgEng '66) wants to change the world one vehicle at a time.

Putting his agricultural engineering degree to a novel use, Johnson started out selling tractors and wound up owning one of the largest electric vehicle dealerships in the world—MC Electric Vehicles based in Seattle, Wash.

"It's a major paradigm shift—like going from adding machines to computers," he said. "We need to stop

Clayton McNeef (Ph.D. Chem '96) is part of team that has created a new method for producing biofuels from waste oils, weeds, and even algae.

“This technology can enable the replacement of all fossil fuels in a worldwide basis.”

—CLAYTON MCNEFF



PETER LEWINSON

burning oil because it just doesn't make sense, so it's logical to shift to these plug-in electric vehicles."

After growing up on a farm in Lindstrom, Minn., Johnson knew he didn't want a farming career. At the University's Institute of Technology, he earned a degree in agricultural engineering (a combination of civil engineering, mechanical engineering and machinery courses).

After graduation, he took a job with Caterpillar, the giant machinery company. A few years later, he joined a Caterpillar distributor in the Pacific Northwest to see the business take off with the construction of the Alaskan Pipeline. Business boomed, yet the environmental depredation disturbed Johnson.

He rose to the company's top and earned a graduate degree in business, yet he longed to start his own business after realizing he wasn't excited about building dams, freeways, and pipelines.

In 1978, Johnson finally pursued his dream. He bought a two-acre site in Seattle and started selling lighter machinery. Although his business has remained in the same location, Johnson has constantly reinvented it in response to economic and technological trends.

In 2003, he planned to retire to Hawaii, but saw a new opportunity in electric vehicles.

"The business had meaning," he said. "It gave me a gut feeling—this is something we need to do to preserve our earth."

Johnson bought 30 electric vehicles and began selling them to customers that included a senior housing complex with golf courses. The original vehicles were 48 volt with wet lead acid batteries and DC motors.

He eventually expanded into electric cars, trucks, scooters, motorcycles, and all-terrain vehicles, which are classified as NEV (neighborhood electric vehicles) and street legal. They are limited to 35

mph, run on up to 96 volts, and have AC drives. In all, he has sold more than 500 vehicles and carries nearly a dozen lines, which he believes makes him the largest dealer in the United States and perhaps the world.

Now with multiple locations in the Pacific Northwest, last year MC Electric Vehicles sold 300 vehicles and achieved \$3 million in sales. Johnson anticipates more growth in the face of rising oil prices and looming carbon cap regulations.

According to Johnson, an electric car charged at off-peak hours can be driven for about one-half cent per mile. Washington State also offers electric vehicle incentives, such as sales tax exemption. State agencies provide free electric car plug-ins and so do many local establishments.

The City of Seattle recently installed more than 2,500 electric charge outlets for battery powered car users. "The money savings and other benefits from not buying gas is reinforced with our Federal government now offering up to \$7,500 in tax credits for buying an all-electric vehicle," Johnson said.

Johnson continues to pursue the latest in electric vehicle technology. He and another Institute of Technology alumnus, John Hansen (EE '64), recently traveled to China to look at zinc fuel cells as a possible energy source. He expects to have a highway-speed, all-electric vehicle next year that uses lithium ion cobalt batteries.

Johnson has shelved his retirement plans and continues to spread the gospel about electric cars.

"Every time a customer leaves here, we congratulate them for making a difference," he said. "We not only improve the environment, we protect our customer's value in their vehicle, with no sales tax and a tax credit."

"This is a tremendously exciting time as new technologies emerge," he added. ■

Jim Johnson (AgEng '66) owns one of the world's largest electric vehicle dealerships, which is based in Seattle, Wash.

**“We need
to stop
burning oil
because it
just doesn’t
make sense,
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to shift to
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in electric
vehicles.”**

—JIM JOHNSON

ALUMNI Report

Ken Floren

ITAS president

Volunteer offerings expand for alumni

I ACCEPTED THE REQUEST to be the 2009-10 president of the Institute of Technology Alumni Society (ITAS) because I believe in our goals. During my four years on the board, I have discovered a delightful and diverse group of people who also share these goals, which are to:

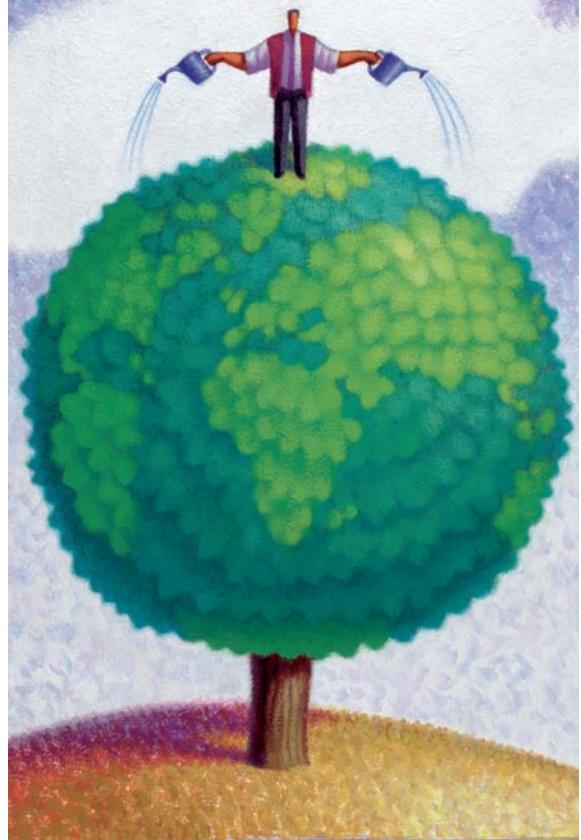
- Increase alumni engagement within the Institute of Technology and the University of Minnesota communities.
- Support Institute of Technology students and enrich their University experience to create lifelong affinity for the Institute as well as their individual college disciplines.
- Increase the interest of K-12 students in science, technology, engineering, and math. The Institute of Technology has a significant growth objective and it can be accomplished as the number of highly interested incoming students grows.
- Encourage industry partnerships with the Institute of Technology.

One of our new initiatives—an expanded volunteer program—will begin in January.

We have a number of programs established to achieve our goals, which are planned and executed through our strong partnership with the administrative staff of the Institute of Technology.

One of our new initiatives—an expanded volunteer program—will begin in January. We will have an Institute of Technology volunteer Web page that will display an updated list of volunteer opportunities. It will contain an online form that alumni and friends can complete to indicate their areas of interest. Those who sign up will be contacted with additional information. ITAS or Institute of Technology staff will work with volunteers to ensure they have the training and support needed for their particular activities.

My strong support of the program is based on my own experience as a volunteer. There are some alumni who decide they can make time for regular volunteer activities—joining the ITAS Board, for example. There are many more of us who cannot make time regularly but can and would do spot or event



volunteering if we could quickly see what is needed. This is the biggest value I see in the expanded volunteer offerings.

Initial opportunities include assisting students in a variety of ways such as conducting informational and mock interviews, participating on career panels, speaking at career planning classes, and providing support to student organizations to help them succeed with their projects.

Other options include helping with legislative advocacy, alumni event assistance, and participating on reunion committees. The admissions office looks for alumni to talk to students who have been accepted to tell them about our college and the University as they make their final decision about where to attend. ITAS and IT support K-12 activities such as the FIRST Robotics and FIRST Lego League tournaments and the annual Tech Fest at The Works technical museum for kids. Volunteer opportunities are updated as needs change.

Volunteers have always played a substantial role within the Institute of Technology and its departments. The opportunities are many and varied, and time commitments range from a few hours to a few years. ITAS and the Institute of Technology are grateful for their support. I hope there is an opportunity that will interest you.

Visit the Web site at www.it.umn.edu/volunteer if you have an interest in volunteering. Also, feel free to contact me at 651-338-7790 or Liz Stadther, alumni relations coordinator, at stadt001@umn.edu or 612-626-1802. ■

IT Class of '60 reunion May 6-7

SAVE THE DATE to reconnect with your fellow classmates when the Institute of Technology Class of 1960 celebrates its 50-year reunion on May 6-7, 2010. Members of the Golden Medallion Society, which includes the Class of 1960 and earlier classes, are also invited to attend.

A variety of events are currently being planned including tours, panel discussions, lectures, and more. As part of the activities, the class of 1960 will be invited to join the academic procession during the 2010 Institute of Technology commencement ceremony.

Watch for further information in your mailbox, and on our Web site at www.it.umn.edu/alumni

Golden Medallion Fund established

The Class of 1959 recently established the Institute of Technology Golden Medallion Scholarship Endowment to provide scholarships for deserving incoming science and engineering students.

The initial goal is to raise \$25,000. Funds that reach that level will be eligible for the President's Scholarship Match program, which will double the impact of the gift.

"A University of Minnesota degree continues to provide opportunities for thousands of young people from all walks of life," said Jean McCallum (CivE '59), 1959 IT Golden Medallion Scholarship Endowment chairwoman. "Join us in this endeavor to assist tomorrow's scientists and engineers who are preparing to take on the future challenges our world faces."

Gifts may be made by check, credit card or pledge. For more information, please contact Anastacia Davis by phone at 612-625-4509 or via email at: aqdavis@umn.edu.

Students meet mentors at IT's Mentor Program orientation



RHONDA ZURN

Adam Krzmarick, a junior majoring in mechanical engineering, discusses future career goals with his mentor, Ronald Frazzini (Ph.D. '06), at the Institute of Technology's Mentor Orientation Program held at McNamara Alumni Center in November. More than 280 students and alumni attended the event. Since its inception in 1991, the award-winning program has matched thousands of science and engineering students with professionals in technical fields who have volunteered to help students as they transition from the academic environment to the professional world.

2009—The Ultimate Homecoming



RHONDA ZURN

Institute of Technology alumnus Thomas Muilenberg (ChemE '92) and his wife, Shellee, were among more than 800 alumni, family, and friends who showed their maroon and gold spirit at the 2009 Homecoming celebration held at the University Recreation Center on Oct. 9. Hosted by Institute of Technology Dean Steven L. Crouch and members of the Institute of Technology Alumni Society, the casual, fun-filled picnic barbecue featured children's activities and a performance of "Energy & U," followed by the Homecoming parade, pep fest, and fireworks at the new TCF Bank Stadium.

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IT students eager to tackle world issues

NOW, MORE THAN EVER BEFORE, our state and nation require well-trained scientists and engineers to solve the world's most pressing problems.

The Institute of Technology has made a commitment to increase the number of graduates and to ensure they are career-ready and prepared to take on these challenges.

Through the combination of a rigorous curriculum, research opportunities, learning abroad, internships and co-ops, as well as student design projects, our students are ready and eager to tackle such concerns as energy security, national security, environmental hazards, failing infrastructure, and more.

To give you an idea of how one of our students is preparing for the future, I share with you Lauren Butler's story. She is a senior honors student majoring in mechanical engineering and dance, and also serves as this year's president of the University of Minnesota chapter of Engineers Without Borders (EWB). Like so many of our students, Lauren has set her sights on making a difference in the world by using her engineering degree.

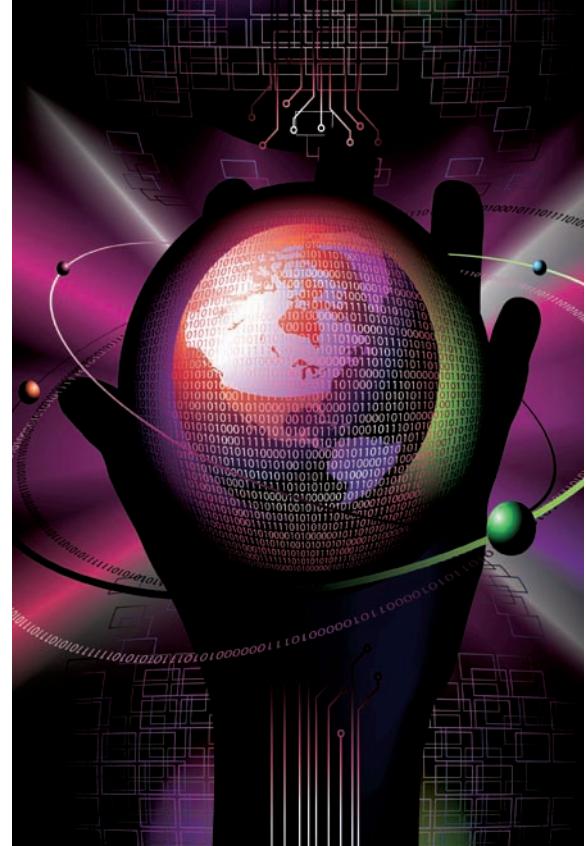
Lauren joined EWB to "contribute to improving the quality of life for people around the world and to experience new cultures. Through my involvement, I am actually receiving a lot that I didn't expect when I originally joined. I get to experience project management, participate in the design process, and learn many technical and practical skills," she said.

Lauren also received a scholarship that makes it possible for her to participate in EWB, of which she says: "Receiving a scholarship allows me to dedicate my time toward EWB. There are students who don't have time to get involved on top of classes and multiple jobs. While holding a job is invaluable, so is the EWB experience; I am deeply grateful that during the semester I am able to focus on classes and also dedicate time to working with developing communities in Haiti, Uganda, and Guatemala."

Like Lauren, many Institute of Technology students take advantage of opportunities outside of their major course requirements, which gives them



Many Institute of Technology students take advantage of opportunities outside of their major course requirements.



hands-on experience and teaches them how to work in a global environment.

Since becoming Institute of Technology dean in 2005, Steve Crouch has made it a priority to enhance the undergraduate student experience and to increase the number of graduates we produce.

To ensure that our students are able to take advantage of the many opportunities that are available in the Institute of Technology, he has assembled a team of professional advisors who will guide students in course selection, internship and learning abroad opportunities, and more.

Additionally, Dean Crouch has set a high priority on raising private funds to renovate the first floor of an ever-aging Lind Hall. When remodeled, it will serve as an Institute of Technology student center where students can meet their advisors, study together, interact in student organizations, receive student support services, and create a community.

Dean Crouch has raised money for undergraduate scholarships so that students have access to the high quality education provided in the Institute of Technology. For many students, scholarships make a significant difference in their college experience. They can concentrate on their studies and participate in programs such as EWB where they learn how to become the scientists and engineers of the future.

Your generous and continued support of scholarships, the Lind Hall renovation, and programs like EWB, helps to make all of this possible.

If you would like to learn more about supporting these and other programs, please feel free to contact Kim Dockter via email at: Dockter@umn.edu or by phone at 612-626-9385. ■

IT receives gift to establish chair in renewable energy

THE INSTITUTE OF TECHNOLOGY has received a gift from mechanical engineering alumnus Ron Christenson (ME '72) to establish the Ronald L. and Janet A. Christenson Chair in Renewable Energy. The endowment will support outstanding faculty involved in renewable energy research and education.

Eray Aydil, a professor of chemical engineering and materials science, and Jane Davidson, a professor of mechanical engineering, will be the first faculty members to hold the chair. Both faculty members have conducted pioneering research in the field of renewable energy.

Christenson, who recently retired from Cargill as a corporate vice president and the company's chief technology officer, was also an Institute of Technology Advisory Board member. He started working at the company as an undergraduate student at the University of Minnesota.

He and his wife established the chair because of the pivotal role science and technology can play in the United States' future success. "Renewable energy is one of the more important challenges facing science and technology today," he said.



Janet and Ron Christenson

CE celebrates centennial year



CHARLES PLAIN

Edward Silberman (CivE '35) and Lu Vorpal were honored guests at the Department of Civil Engineering centennial celebration held in October. Nearly 200 alumni and guests attended the festivities which featured a keynote address on sustainability by alumnus George Bugliarello (M.S. CivE '54), president emeritus and professor at New York's Polytechnic University; presentations on the Solar Decathlon 2009 and I-35W bridge construction projects; a history of the department by Professor Emeritus Charles Fairhurst; and dinner at the University's Campus Club.

U alumni tour Arizona telescope



ROB HUBBARD

University alumni Stanley Hubbard (B.A.'55) and family (above) and T. Denny Sanford (B.A. '58) (right) recently toured the Large Binocular Telescope (LBT) Observatory, located near Tucson, Ariz. A \$5 million gift from Hubbard Broadcasting Inc. to the University's Department of Astronomy makes it possible for the University to share viewing time on the LBT through a consortium of universities and research institutes. The LBT is the most-technologically advanced ground-based optical telescope in the world.



KIM DOCKTER

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The Institute of Technology's experienced development team can help you determine your best options for supporting the college.



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Over the years, the Department of Civil Engineering's innovative research helped to create the communities we live in today

100 years of building better communities

AS ONE OF THE FIRST THREE ENGINEERING majors at the University of Minnesota, civil engineering has stood on a solid foundation of growth and achievement, serving society and improving communities throughout Minnesota and beyond. This year marks the centennial celebration for the Department of Civil Engineering.

"Civil engineering has been a part of the University from its beginning," said Department Head Roberto Ballarini. "For 100 years, the department has focused its teaching and research activities on raising the quality of life of Minnesotans through technological advances in the State's infrastructure."

The Early Years

The Civil Engineering department was created out of a need to address the country's booming urban expansion during the late 1800s. The University's Board of Regents had seen how rapidly cities on the East Coast were developing and knew the Midwest would need civil engineers to oversee urban development. In 1871, they voted to form a department within the School of Mechanical Arts.

Early coursework focused on surveying, stone cutting, and railroad engineering in order to bring basic services to Minnesota's rolling prairies. The

UNIVERSITY OF MINNESOTA ARCHIVES



first Bachelor of Civil Engineering degrees were awarded in 1875.

Over the following decades, the department steadily grew and differentiated into three areas: structural engineering, municipal and sanitary engineering, and railway engineering. In 1909, the Regents voted to combine the programs and reestablish the modern day Department of Civil Engineering. Francis C. Shenehon was the department's first head and served from 1910-1917.

By 1925, the school graduated its first two female civil engineers, Esther Knudsen and Ursulla Quinn.

The department achieved international recognition in 1938 when the groundbreaking St. Anthony Falls Laboratory (SAFL) opened. Established as a traditional hydraulics laboratory, SAFL was dedicated to basic and applied research in hydraulic structures and engineering. The lab was designed and built under the direction of Lorenz Straub, who served as SAFL's director and head of civil engineering from 1945-1963.

A Place to Call Home

Despite being one of the University's founding engineering majors, civil engineering did not have a home of its own until 1983 when the current civil engineering building opened. Dubbed an "underground skyscraper," it was the first building ever built to the record depth of 110 feet below surface. The building also made use of numerous new energy efficiency technologies for heating and lighting.

Championed by then department head Charles Fairhurst, the design was based on the research of the department's own Underground Space Center. It received the American Society of Civil Engineer's Outstanding Civil Engineering Achievement of 1983,

Francis C. Shenehon

Before becoming the first head of the Department of Civil Engineering, Francis C. Shenehon (1861-1939) served as Chief Civilian Engineer of the United States Lake Survey from 1906-1909. During this period, he directed the resurvey of the Great Lakes and revolutionized hydrographic methods for navigating waterways. His Tension Wire Sweep invention, enabling surveyors to find depths and obstructions in lake and river bottoms, played a significant role in developing the Great Lakes water transportation system.

UNIVERSITY OF MINNESOTA ARCHIVES



UNIVERSITY OF MINNESOTA ARCHIVES

THEN

(Far left) An undergraduate class in land survey methods from the early 1900s learns how to assemble a plat and define property lines, work that was crucial to early urban development. (Left) The Civil Engineering building, built to a record depth of 110 feet, received the American Society of Civil Engineers outstanding achievement award for 1983, recognizing an exemplary civil engineering project.

beating out other marvels such as Disney's EPCOT park.

Research and Innovations Today

"Researchers from all around the world visit this department to collaborate with our talented faculty and to use our unique laboratories," Ballarini said.

Some of the largest water control structures in the world—including the Guri Dam in Venezuela, and the Mangla Dam in Pakistan—have been studied in models at the SAFL. Pioneering research on the thermal properties of soil was conducted here, and the first wastewater treatment plant in Minnesota—Pig's Eye Water Treatment Plant—was designed by one of the department's professors.

Innovation continues to thrive in the department, specifically with new facilities. In 2005, the Multi-Axial Subassemblage Testing (MAST) Laboratory opened, where researchers twist and jolt structures to see how they will perform during an actual earthquake. At the Minnesota Traffic Observatory, engineers keep a high-tech eye on Twin Cities' roadways analyzing data to test and evaluate new ways of managing transportation. The National Center for Earth-surface Dynamics, established in 2002, is a partnership of research and educational institutions, government agencies, and industry aimed at pursuing predictive earth-surface science by integrating physical, biological, and social sciences.

The department is committed to expanding research beyond traditional areas to solve society's greatest technical challenges—especially new ones.

"People typically think civil engineers only work on bridges, roads, and buildings," said Ballarini. "Many of our faculty are involved in multidisciplinary research such as micro and nano tech-

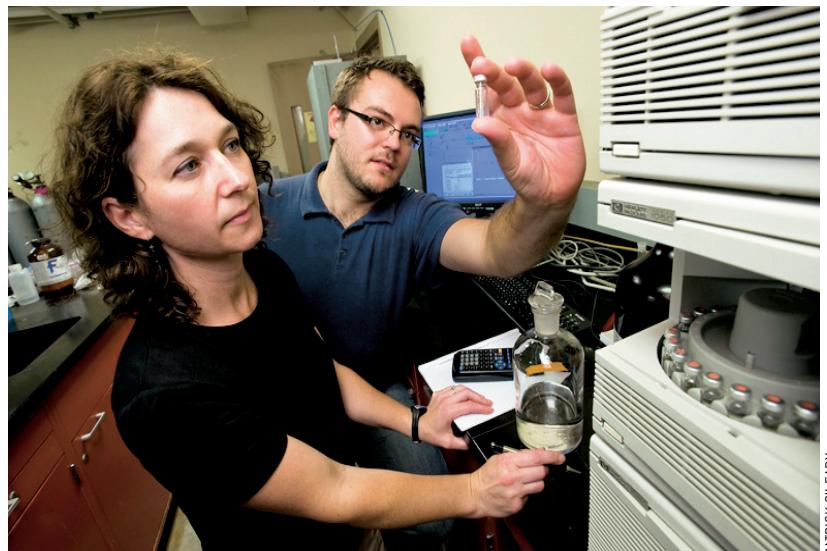
nology, medical imaging, environmental sciences, sustainability and public health."

In the world of nanotechnology, department faculty and students are working to enhance building materials and medical devices one atom at a time. They're also addressing the environmental crisis by developing methods to heal damaged ecosystems and limit pollution that threatens our planet. And as society searches for energy alternatives to oil, the department's research groups are investigating the potential of wind, water, and solar power.

The department's continued responsiveness to modern problems embodies the very impetus for its creation more than 100 years ago. In 1871, the University created a department of civil engineering to help build the communities we live in today. Now the department is ensuring society's well-being by improving them for tomorrow. ■ BY CHARLES PLAIN

NOW

Today, the Department of Civil Engineering continues to solve society's greatest challenges. In a groundbreaking study, civil engineering associate professor Paige Novak and graduate student Mark Lundgren have discovered that certain industries may be a significant source of plant-based estrogens, called phytoestrogens, in surface water.



PATRICK O'LEARY

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Why is math called the “queen of sciences?”



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Math is elegant and powerful



"In mathematics, we formulate conjectures and discover principles attesting to the world's order, beauty, and harmony. What is specific to math is that we achieve this through rigorous deduction! One who practices math will know to distinguish between objective statements and guesses or assumptions. Therefore, mathematics may provide the firm ground to our empirical understanding of the physical phenomena," said Marta Lewicka, assistant professor of mathematics.

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