

UNIVERSITY OF MINNESOTA

Gateway

to Research & Inventions



HARD SCIENCE

**Interdisciplinary research in
mathematics, materials science,
and a thing called the PowerWall**

A Publication of the Office of the Vice President for Research

Spring 2003

Gateway to Research and Inventions focuses on significant research and researchers in all disciplines, and on technology transfer at the University of Minnesota. It is published two times per year by the Office of the Vice President for Research at the University of Minnesota.

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This publication can be made available in alternate formats upon request to the editor. The publication is also available electronically at <http://www.ospa.umn.edu>.

On the Cover

Douglas Arnold of the Institute for Mathematics and its Applications

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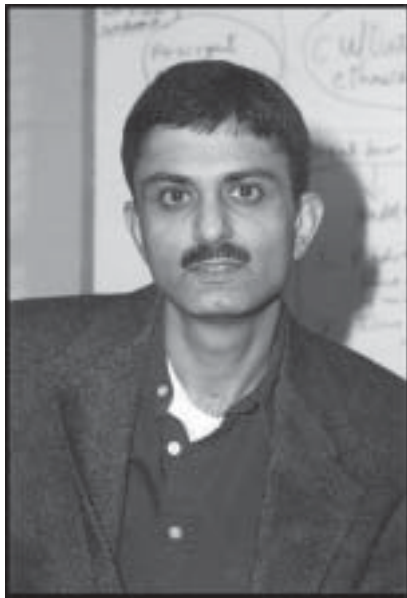
Award Winners

2003-05 McKnight Land-Grant Professors

The University of Minnesota Graduate School recently named 10 recipients of the 2003-05 McKnight Land-Grant Professorship. The purpose of the program is to strengthen the University's faculty for the future by advancing the careers of the most promising junior faculty. Winners receive a two-year appointment and two-year grant, and either a supplementary research grant or a year's leave to pursue research during the second year of the award.

The recipients are chosen for the significance of their research and the clarity with which it is conveyed to the nonspecialist; the degree to which past and present achievements demonstrate originality, imagination, and innovation; the potential for significant contribution to the discipline; the quality of the scholarly publication record; and the potential for attracting outstanding students. The professor, department, and focus of research are listed below.

Vinay Gidwani, geography. In the discourse on *globalization*, there



Vinay Gidwani

is a relative paucity of knowledge on the provincial and local impacts of globalization. Gidwani's research helps fill this gap by tracing the pathways and mechanisms through which globalization affects the lives of the rural poor in terms of their livelihood, security, economic well-being, political empowerment, and broadly, their social spaces of work, habitation, and everyday life. Gidwani will expand on his previous research to ground globalization by examining its

economic and political consequences for the most vulnerable segment of the working poor in India—rural to urban seasonal migrants from three historically marginalized and oppressed social groups. Gidwani's research should help to reshape our understanding of the economic and political operations of globalization regionally and locally and to yield new insights into labor circulation and subaltern politics in India.

William Gray, plant biology. Over the past 125 years, scientists have implicated the plant hormone *auxin* as a key regulator of virtually every aspect of plant growth and development. The mechanisms underlying this regulation, however, remain poorly understood. The long-term goal of Gray's research is to understand the molecular mechanisms of auxin action. This knowledge will provide new tools for modulating auxin response for agricultural and horticultural benefit. Additionally, since several of the genes identified in his studies on auxin are also present in vertebrates, Gray expects that the work will have significant implications on our current understanding of human development and disease.

Kathryn J. Kohnert, communication disorders. Approximately 14% of children in the U.S. speak a language other than English at home, and they begin the systematic learning of English as a second language (L2) at school age. While the majority of these children are typical language learners who will become proficient users of the L2, a subset have language disorders which are not the result of differences in their environments and for which language intervention is needed to ameliorate negative long term effects. At present, there is no clear way to separate normal differences from language disorders in these children. Kohnert will use recent findings in the literature on language disorders as a guideline for sorting out the apparent overlap between intact and impaired L2 learners. Insights from such research hold the potential to inform language assessment practices with bilingual children, as well as to inform basic theoretical beliefs on the nature of language and cognitive interactions.

Erika Lee, history. Since its founding as a nation, the United States has admitted over 55 million immigrants from every continent in the world. America prides itself as being a nation of immigrants. Lee's research examines how the United States is also a gatekeeping nation that restricts, excludes, and tracks immigrants, often on the basis of race, ethnicity, religion, and other factors. Lee's research focuses on the transnational consequences of immigration restriction; a largely unexamined topic with significant implications, particularly following the events of September 11, 2001. In the 1880s, the U.S. became the first country to exclude immigrants on the basis of



Erika Lee

race and inspired a restrictionist shift in international immigration policy. Lee's work compares Chinese, Japanese, and Indian immigration and exclusion in the Americas. Linking together several interdisciplinary projects on migration, race, and globalization, it explains how the seemingly national issue of immigration policy is best understood in a transnational context.

Tian-Jun Li, mathematics. An n -manifold is a space that in small regions looks just like an n -dimensional Euclidean space. Points, curves, and surfaces are manifolds of dimensions 0, 1 and 2, respectively. The space in which we live is a 3-manifold, and the universe (space-time) is a 4-manifold. Symplectic structures on manifolds were discovered through Hamiltonian mechanics, and are now central in mathematics. Li's work is directed towards identifying possible shapes of 3- and 4-dimensional manifolds, especially those 4-manifolds with symplectic structures. The answer to this problem will have an impact on mathematics, theoretical physics, and cosmology.

Krishnan Mahesh, aerospace engineering and mechanics. Turbulence features prominently in a wide range of applications in nature and technology. Despite its considerable importance, the quantitative prediction of turbulent flows remains one of the unsolved problems in classical physics. Mahesh conducts research on the turbulent motion of fluids to develop the computational capability to reliably predict turbulent flows in complex, real-life applications, and to use numerical simulations to answer questions concerning the physics of turbulent flows. Mahesh is developing a novel numerical method flexible enough to handle real-life configurations and accurate enough to simulate turbulence. He is also using simulations to study pollutant dispersion, the mixing of fuel and oxidizer in engines, the nature of turbulence close to solid surfaces, and the possible influence of turbulence on the evolution of cacti.



Paul Mermelstein

Paul G. Mermelstein, neuroscience. Mermelstein's research focus is to understand the means by which synaptic inputs onto neurons can have long-term effects on cell excitability, leading to pronounced changes in both brain function and behavior. The underlying mechanisms responsible for such changes rely primarily upon alterations in gene expression. Mermelstein is particularly interested in elucidating the cellular re-

sponses responsible for learning and memory, but the research also impacts the fields of drug addiction, neuronal development, and hyperalgesia.

Fernando Porte-Agel, civil engineering. Porte-Agel's research interests are in land-atmosphere exchange processes, turbulence, and computational fluid dynamics. The main goal of his research is to better understand the physics underlying transport of momentum, heat, water vapor, and pollutants at different scales in the atmospheric boundary layer. Improved descriptions of those transport processes are developed and used in engineering and environmental applications (e.g. hydrologic, climate and pollution models). Most of his research projects involve a combination of experimental work (field measurements and wind tunnel experiments), modeling (large-eddy simulations), and theoretical development.

Natalia Tretyakova, medicinal chemistry. Tretyakova uses recent advances in biological mass spectrometry to study the sequence distribution of chemically modified DNA nucleobases (DNA adducts). DNA adducts form following exposure to genotoxic carcinogens and, if not repaired, may result in mutations and the initiation of cancer. Tretyakova is interested in how the DNA sequence affects nucleobase reactivity and in the relationship between DNA



Natalia Tretyakova

adduct formation and the induction of mutations in biologically relevant genes (K-ras, p53, etc.). The final goal of this research is to establish a link between cancer and specific types of DNA damage.

Byeong-Uk Yi, philosophy. The standard Fregean theory of logic set the framework for contemporary understanding of language and mind, and led to theoretical and technological breakthroughs (such as the development of digital computers). But the theory has serious difficulties in handling the logic of plural constructions of natural languages. Yi proposes to develop a post-Fregean framework that can accommodate plurals. He hopes the results will illuminate the subject matter of contemporary mathematics and lead to advances in computational linguistics, artificial intelligence, and cognitive psychology. ○

The *Beauty* of Mathematics

In the best of times, public policy decisions are difficult to make. Today, those decisions are much more complex and the results can have staggering consequences. For example, how should emergency coordinators for large metropolitan areas prepare to stop the spread of smallpox if it is released in a bioterrorist attack? There are thousands of variables and constraints involved in these life-altering decisions—epidemiological data, supply chain analysis, economies of scale, queuing theory, resource allocation, and much more.

If the unthinkable happens, should we try to immunize everyone, despite the logistical and economic constraints and the inevitable illnesses and deaths caused by the vaccine itself? Or should we try to cordon a ring of immunizations around the confirmed cases of exposure and risk the outbreak spreading beyond the ring?

According to an analysis presented at a recent workshop in the University's Institute for Mathematics and its Applications (IMA), mass vaccination looks like a better strategy, ultimately saving thousands of lives. Using complex mathematical formulas, researchers were able to provide analyses of potential infection, death, and cost rates in a hypothetical bioterrorist attack. It is this type of work that makes the IMA so valuable, and so unique.

Established in 1982 by the National Science Foundation (NSF), the IMA is one of the two senior national institutes for mathematics in the U.S. The NSF originally intended to create one national institute for mathematics, notes IMA director **Douglas Arnold**. However, the University's proposal was to create something different than the more traditional institutes found in Europe—the type the NSF envisioned replicating.

“Our concept was for an institute that would focus not only on math but also look for ways to advance other fields,” says former institute director **Willard Miller**. “We would bring together people from all over the world, and we would provide the facilities and atmosphere that would encourage interaction between mathematicians and other scientists.”

The NSF ultimately funded both a more traditional institute at California-Berkeley and the University of Minnesota's institute. Located on the east bank of the Twin Cities campus, the Institute continues to be supported primarily by the NSF's Division of Mathematical Sciences, although it also receives support from over 30 U.S. and international educational institutions and over 10 corporations. And the scientific interaction envisioned in Minnesota's proposal is a reality as the institute is host to roughly 1,000 visitors from various backgrounds each year.



Participants at an IMA Industrial Mathematical Modeling workshop. Graduate students work in teams of up to 6 students with a tutor from industry. The tutor helps guide the students in the modeling process, analysis, and computational work associated with a real-world industrial problem.

The IMA sponsors annual and summer programs, hot-topic workshops, tutorials, industrial problems seminars, public lectures, and Industrial Mathematics Modeling Workshops where graduate students work with industrial mentors. Each year revolves around annual thematic programs where people come together to discuss the latest applications and techniques on broad areas of research and to brainstorm about various issues related to the particular research area.

The 2002-03 thematic program, “Optimization,” included the workshop on biodefense. In a separate workshop on travel and transportation, one presentation used mathematical modeling to help optimize the complex world of airline ticket pricing. At any one time, major U.S. domestic carriers offer over four million fairs and change 100,000 fairs on a typical day. To do this, complicated algorithms must control approximately 500 million variables and constraints with the goal of selling every seat on every plane for the highest possible fare.

It is that combining of disparate variables and constraints that makes mathematical modeling so challenging and unique. “One of the beautiful things about mathematics is that it finds the commonality of things that seem very diverse,” Arnold says. For the airline industry, mathematical modeling of ticket prices yields potential benefits of \$15 billion per year—a beautiful thing indeed for the airlines.

This summer the Institute will host a 20th anniversary celebration and open house on June 5, which will include a public lecture titled, “Secrets of the Human Heart Revealed—by Mathematics and Computer Simulation.” For more information on the Institute, including future annual themes, go to www.ima.umn.edu. ○



“It’s not enough to create one beautiful image from the data. You need to create thousands of such images at a time” -- Paul Woodward, pictured in front of a Red Giant star projected on the PowerWall.

Welcome to the PowerWall

Walk down the main first floor hallway of the beautifully renovated Walter Library and one room seems out of place. Amid the cacophony of marble, sconces, and hand-painted plaster ceilings sits an unadorned room, quiet and dark. But get astronomy professor and **Paul Woodward** to rev-up the PowerWall, and suddenly that dark room is the jewel of the building.

Located in the Laboratory for Computational Science and Engineering (LCSE), a component of the University’s Digital Technology Center (DTC), the PowerWall is a high performance, high resolution visualization system for large scientific simulations. For sheer computing power and graphic display capabilities, it has no peer.

The 13 million pixels of the 7’ tall by 23’ wide PowerWall display allow researchers to see simulations or other data in un-

precedented detail, or to view multiple related views simultaneously so huge amounts of information can be seen at a glance. The large display area facilitates collaborations of small groups of researchers using the same data. All the collaborators can see the display clearly and without obstruction, and the rear-projection technology makes it possible to walk up to the display and point to features of interest, just as one would do while discussing work at a blackboard.

But the PowerWall does not consist solely of a high resolution display system; it is also a supercomputing system. A Unisys Orion-130 machine with 32 Intel Itanium-2 processors and 64 GB of memory, together with PC clusters and storage area networks, provide the principal engines for data analysis, image rendering, and movie animation. With a Gigabit Ethernet link to the University’s OC-12 Internet-2 connection, massive data sets can be streamed onto the 4.8 terabyte (each terabyte is over one thousand billion bytes) LCSE storage area network. And as machines in the Walter student computer lab are outfitted with new disks, new graphics engines, and new Gigabit Ethernet connectivity, they will be able to hold over 25 terabytes of data and to render it into PowerWall movies at night, when the students are not using the lab.

In the LCSE, faculty use the equipment in their research to visually represent intensive scientific computations. “We use the equipment as the ‘electronic brain’ that connects networks of data to draw images of the phenomena we are studying,” says

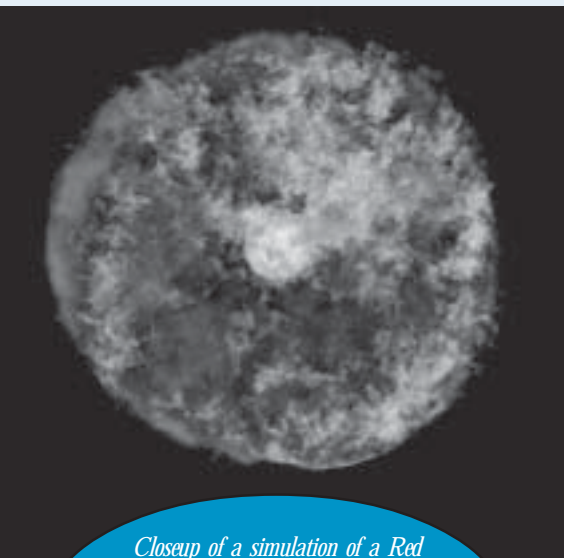
LCSE director Woodward. “This might be pictures of giant stars, thunderstorms on earth, or the movement of river sediments. We are able to visualize digitized data and manipulate it to look at it in different ways.”

One of the keys to the PowerWall is its ability to create smooth motion animation across the entire PowerWall viewing area. “It’s not enough to create one beautiful image from the data. You need to create thousands of such images at a time. We use hundreds of computers working in concert to generate this data, so it is natural to use dozens of machines to make a movie of the simulated fluid flow,” says Woodward.

Continuing Alliance

Digital technology was one of five key areas named by former president Mark Yudof in 1997 as essential to strengthening the University and advancing the state’s economy. As part of the initiative, the University established the Digital Technology Center, an interdisciplinary facility that fosters computer-aided research. The DTC also forms alliances with business, industry, government, and other educational institutions to help secure Minnesota’s leadership in digital and information technologies.

Continuing the alliance, Unisys recently donated two new supercomputers to the DTC, one of which is being used with the PowerWall. “Industry contributes the hardware and we contribute performance testing and demonstrations with real applications of interest to a broad community,” says Woodward. ○



Closeup of a simulation of a Red Giant star and its stellar envelope. A typical Red Giant envelope extends from the sun as far out as the orbit of Jupiter.

MRSEC, a University Diamond, or Some Other Material, in the Rough

The University's Materials Research Science and Engineering Center (MRSEC) is an innovative program that fosters a creative, interdisciplinary approach to materials research. Established in 1998, MRSEC's research encompasses a wide variety of topics including biodegradable polymers and other polymer vesicles used as drug delivery devices; electronic paper; sensors that could be incorporated into textiles, wall coverings, or windows; new materials for hard drives and other memory storage devices; crystals for optical computing; artificial heart valves; and nanoparticle transistors. With faculty, graduate students, and postdocs from seven departments, the Center is the largest public university MRSEC in the country.

Funded by the National Science Foundation (NSF), the University, and by industry, MRSEC supports various seed groups to

promote further scientific exploration and advancement. The Center also collaborates with a broad complement of roughly 25 businesses through the Industrial Partnership for Research in Interfacial and Materials Engineering (IPRIME). NSF recently awarded MRSEC a \$14.8 million program renewal grant and a \$538,000 award for its Education and Human Resources (E & HR) initiative.

Nano-particles and Biodegradable polymers

MRSEC member **David Norris** was part of a team that recently developed nanoparticles (also called quantum dots) that are 10,000

times smaller than a grain of sand and that glow almost indefinitely. By wrapping these particles in a layer of soap, they found that they were completely compatible with living organisms and therefore of use in detailed study of biological events. For example, the authors demonstrated that by injecting glowing particles into an individual cell of a frog embryo, it is possible to see which part of the tadpole develops from this cell, allowing scientists to learn how cells differentiate during embryo development. Nanoparticles should be useful for studying a variety of important problems, such as the efficacy of new drug treatments for cancer and diabetes.

Marc Hillmyer works with a MRSEC group conducting research on biodegradable plastics, specifically polylactide (PLA). According to Hillmyer the process goes something like this: corn to corn starch to sugar to lactic acid (via a fermentation process)

to lactide (the starting material for polylactide) to the final product (polylactide). Some potential applications of PLA include food packaging like candy wrappers, disposable tableware like plastic knives, forks, and spoons, and fiber applications for clothing and carpet. "We hope to develop next generation environmentally-friendly plastics that can compete with traditionally petrochemically-derived materials such as polyethylene and polypropylene," says Hillmyer. "In five or ten years, some of the things we uncover could be useful for next-generation materials."

Educational & Human Resources Outreach

MRSEC's E & HR programs complement its research by extending the understanding of materials science beyond campus. By drawing-in students, teachers, and faculty from a network of over 175 four-year colleges (including tribal and historically-black colleges and universities and Hispanic serving institutions) for research and summer internships opportunities, MRSEC exposes young science and engineering students to the field of materials research. Students and their faculty mentors come to the Center to gain experience at a research university. Native American students have made-up 14 percent of participants in the summer internship feeder program, and over 30 companies have collaborated in research and student training.

In addition, the Center adds to the University's support for the *Physics Force*, an outreach program for K-12 students using high school physics teachers and faculty from the University to demonstrate various principles of science. "The kids' reactions are always positive," says Nancy Bresnahan, Hopkins physics teacher and Physics Force member. "At the very least, kids see a diverse group of people demonstrating physics and having fun. We are trying to break stereotypes with the hope that kids may realize that there is a place for them in the sciences." Physics Force is nationally recognized and has performed before more than 25,000 people in Minnesota, at Disney's Epcot Center in Florida, and on television in Germany and on *Newton's Apple*.

"I think MRSEC and our outreach programs provide the best public service from the University in the technological area," says **Mike Ward**, chemical engineering and materials science professor and MRSEC director. ○



Participant in 2002 summer Research Experiences for Undergraduates program, one of MRSEC's E & HR outreach programs which provide active research experiences to undergraduates.



A Physics Force demonstration

Transitions to Adulthood

Doug Hartmann and Jeylan Mortimer of the University's Life Course Center (LCC) are part of a team conducting a study of people's subjective transition to adulthood. Funded by the MacArthur Foundation Research Network, researchers are conducting a series of interviews with participants, who were high school freshmen in St. Paul in 1988 and are now nearing their 30th birthdays, to examine their multifaceted understandings and experiences of adulthood.

Little is known about the perceptions and reactions of young people themselves as they move through the multiple transitions of young adulthood—leaving home, entering or leaving school, finding employment, getting married, cohabitating, and childbearing.

The researchers are focusing on developing commitments to work, relations with the family of origin, marriage and parenthood, economic self-sufficiency, and multiple forms of civic and public participation. The study also addresses what being an adult means to the young people themselves. This research builds on and extends a long-term study of work and adolescent development initiated in the LCC in 1987.

The Life Course Center, part of the Department of Sociology on the Minneapolis campus, was founded in 1986 to support scholarly inquiry related to all stages of life, from birth to death. ○

Expanding the Circle for American Indian Youth

University of Minnesota researcher **Jean Ness** of the Institute on Community Integration is part of one of the first efforts in the U.S. to merge American Indian cultural traditions with educational services. Since late 1999, her work with the *Expanding the Circle* project has helped American Indian students with disabilities and those who are at-risk prepare for the transition from secondary to postsecondary education.

Working with a grant from the U.S. Department of Education's Office of Special Education and Rehabilitative Services, the project is a collaboration of the Institute and the Fond du Lac Tribal and Community College, and its impact is being felt on seven American Indian reservations in Minnesota: Bois Forte, Red Lake, White Earth, Leech Lake, Mille Lacs, Fond du Lac, and Grand Portage.

To reach the students, the project prepared a cadre of American Indian outreach trainers to provide ongoing training and support services for secondary case managers and postsecondary staff in secondary schools on or near reservations and in tribal colleges. Eventually, the training should build school capacity to help students complete secondary school and succeed with postsecondary education.

According to Ness, the outreach trainers provide a strong, trusted base for the project: "The trainers are typically American Indian staff who work at local high schools as home/school liaisons. They are well known in the Indian community, and they offer support to the students and their parents, families, and communities to help bridge the gap in understanding and the cultural divide that often occur in public schools."

Part of the trainers' work has been to prepare people from American Indian communities to implement the *Expanding the Circle Summer Transition Program* for American Indian students. Through summer 2003, over 230 secondary students will have participated in the program through activities such as college site visits, cultural activities related to career and col-



lege preparation, self-advocacy and awareness activities, and learning styles exercises.

In addition, training has been underway to implement the newly published curriculum, *Expanding the Circle—Respecting the Past, Preparing for the Future: A Transition Curriculum for American Indian Youth*. This curriculum will be used by the reservation schools and tribal colleges and is also being distributed nationally.

Through *Expanding the Circle*, Ness hopes that "more American Indian students will complete high school and attend college with appropriate goals based on their interests, values, and aptitudes." To do this, it must lay the foundation for broader changes. "We hope for systemic change in the schools and regions in which we have worked so that programs with staff trained in transition will continue, grow, and become long-term programs that support American Indian students in transition," says Ness. ○

Jean Ness



Bringing Business to Ukraine

The Center for Nations in Transition (CNT) in the University's Humphrey Institute of Public Affairs is leading efforts to train the next generation of free enterprise business leaders in Ukraine. Along with seven other American and Polish universities, the University trains professors and instructors from approximately 30 Ukrainian business education

institutions on how to design and deliver effective business and management education programs at the undergraduate, MBA, and specialized executive training and certificate post-diploma levels.

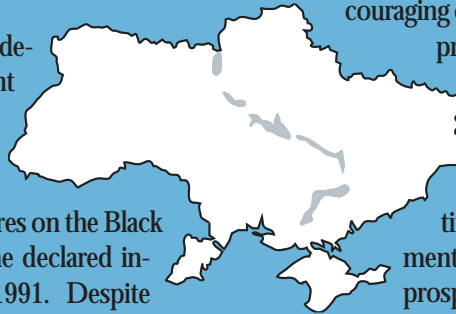
Bordering eastern and western cultures on the Black Sea between Russia and Poland, Ukraine declared independence from the Soviet Union in 1991. Despite being the home of Europe's major heavy industrial and mining complex, Ukraine still lacks contemporary business knowledge and proper management practices.

"In a country where free enterprise has only existed for 12 years, the effects of business education can be monumental," says project director **Zbigniew Bochniarz**. "Our educational program includes everything from creating specialized MBA and entrepreneur programs to assisting in creating Ukrainian-specific business textbooks. Professors and instructors are developing skills required

to deliver the type of training and education that Ukraine desperately needs to compete in a global economy."

The CNT was formally established in 1994, but the institute out of which CNT was formed has been involved in Central and Eastern Europe (CEE) since 1987. The CNT is devoted to encouraging environmentally sound restructuring of industry and promoting sustainable development in CEE countries as they undergo transition from central planning systems to market based economies. The CNT responds to the complex political, economic, and environmental issues of the region, and provides timely assistance to strengthen the intricate and monumental transition process in the region, thus improving prospects for lasting peace and stability there.

The CNT has raised over \$36 million in grants, including \$9.5 million from the United States Agency for International Development for the current Ukraine project. Over 2000 faculty and academic leaders have taken part in CNT Projects; over 1,000 in Ukraine alone. The CNT's model of participatory planning and implementation and sharing of information has helped researchers, educators, governments, and business people build the crucial social capital essential for global security—trust and understanding of each other. ○



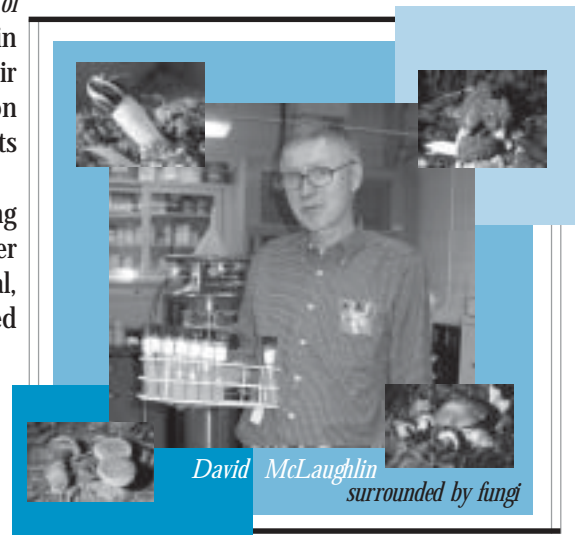
Meet Your Long Lost Relatives—Fungi!

We've called them scum, lifesavers, and even hors d'oeuvres, but only since 1995 has anyone called them relatives. That was the year scientists determined that mushrooms, yeast, mildews, and other fungi are more closely related to animals than to plants. Now, researchers at Minnesota, Duke, Oregon State, and Clark universities are attempting to sort out relationships among this diverse group of organisms, to which the world owes several antibiotics, beer, wine, cheese, and bread, among other things.

The research is part of the National Science Foundation's *Assembling the Tree of Life* program, which seeks to determine exact evolutionary relationships within several of its branches. Fungi's branch is critical for many reasons, including their associations with the roots of plants. About 90 percent of all plants depend on fungi to more efficiently absorb water and nutrients, and without fungi, few plants would grow.

The study may point researchers to species of fungi that, by virtue of being related to medically or commercially important species, may produce drugs or other useful products. "Some fungi are crucial for life, but others cause many medical, plant, and animal diseases, and it's important to learn which ones are closely related so we can choose the correct model organism to study the troublemakers," says **David McLaughlin**, professor of plant biology in the College of Biological Sciences.

The best guess is that only 5-10 percent out of what may be 1.5 million species of fungi worldwide are known. That means plenty of work for McLaughlin and others on their branch of the tree. ○



David McLaughlin
surrounded by fungi



University Start-Up Demonstrates its Jetson-like Solution to Gridlock

Taxi 2000 CEO Ed Anderson (right) with a prototype of a SkyWeb Express vehicle.

Taxi 2000, a University start-up company, unveiled a functional prototype of a SkyWeb Express vehicle and guideway section at a recent product launch ceremony. SkyWeb Express is an example of Personal Rapid Transit (PRT). PRT is a network of small, lightweight, electric-powered vehicles riding on raised rails. The small vehicle design allows each rider to have a private ride, or in the case of SkyWeb Express, share the cabin with two family members or friends—picture how George Jetson got to work.

According to Taxi 2000 officials, this system offers almost as much flexibility as an automobile and may be the only public transportation system capable of enticing large numbers of drivers away from their cars. Currently, conventional transit systems in the Twin Cities attracts three percent usage. **Ed Anderson**, designer of SkyWeb Express, CEO of Taxi 2000, and former University of Minnesota professor, estimates this PRT would attract at least 30 percent usage.

“There are several features that give SkyWeb Express its incredible flexibility,” says Anderson. “First, its vehicles are guided by an automated control system. Second, its stations are offline, which means vehicles can stop at stations without blocking traffic behind them. And third, the privacy of its rides ensures that riders never have to stop to let strangers get on or off.”

SkyWeb Express would provide nonstop service to your destination in a private, climate-controlled vehicle with little or no waiting. According to Anderson, benefits for communities installing SkyWeb Express include low-cost (possibly even profitable) operation, 1/640th land use compared to freeways, no need for public money, and energy efficiency. Construction of SkyWeb Express would cost roughly \$9 million per mile compared to \$40

million for light rail.

The product launch is the result of over 20 years of work and research by Anderson and others. In addition, Taxi 2000 generated nearly \$1million from 68 individual investors to take SkyWeb Express from an intriguing computer simulation to a fully functional prototype running on 60 feet of track at their headquarters in Fridley.

City planners from Sweden, Korea, Chicago, and Cincinnati, among others, have shown interest in SkyWeb Express. But before the system can be built commercially, Taxi 2000 plans to build a half-mile track with one station and three vehicles to test safety and reliability. Possible test sites include the State Fair grounds and the Blaine Sports Facility complex. ○



Interior of SkyWeb Express vehicle

University Research and Products on Display

People from Minnesota, across the country, and around the world are touched by products and research developed at the University of Minnesota. That's one reason the University recently hosted two events to showcase that work.

On February 27, the University hosted a daylong event at the McNamara Alumni Center. The purpose of the event was to highlight the innovative work of University researchers and the University's partnerships with investment, business, and private sector leaders. It's these partnerships that transfer University discoveries and technologies to the marketplace, creating new products and services.

According to President **Robert Bruininks**, "Investment in the University's research and technology transfer is critically important to Minnesota's future. Although it involves private industry, commercializing technology is an important part of our role of advancing knowledge and serving as a partner for the public good."

Fifty exhibitors participated in the event by displaying product information derived from technology licensed from the University and from current research projects. Exhibits ranged from samples of Honeycrisp apples and wine made from University-developed grape varieties to semiconductor chips for wireless networks and an artificial mouth. Exhibitors included University start-up companies like Apprise Technologies, MR Instruments, Discovery Genomics, and Bermat.

"This was an excellent way for the University to showcase their partnerships

with outside industry and what it takes to take a discovery and turn it into a useful product," says Dr. Robert Stenbom, an exhibitor from Boehringer Ingelheim. Boehringer currently licenses a vaccine for Mystery Swine disease from the University. "The ability to network with other exhibitors as well as the attendees was very valuable."

Over 700 people toured the exhibits and heard presentations by University administrators, faculty, and private sector investment partners during the day.

State Capitol Exhibit

The University also set aside a couple of weeks recently to remind legislators just how important the school is to the people of Minnesota and the world. From Sunday, March 30, through Saturday, April 12, Minnesota lawmakers and visitors to the Capitol saw examples of the far-reaching impact and contributions of University re-



Capitol exhibit

search as they walked along the Capitol's north corridor. This was the first time the University put together this kind of presentation for lawmakers.

"The Capitol is a very busy place this time of year, and we thought it was time for everyone passing through those halls to see all the great contributions that have come out of the University," says **Sandra Gardebring**, vice president for university relations.



McNamara event

Large-scale information panels and research products in four display cases highlighted ways University research has led to breakthroughs in medicine, agriculture, and technology, among other areas. Legislators and visitors had the chance to see products of University research, including a flight data recorder or "black box," an early model of the cardiac pacemaker, a retractable seat belt, taconite pellets, turf varieties grown at the University and used on golf courses like Pebble Beach, and the world's most expensive incense called *agarwood*, valued at \$12,000 per pound (the process to cultivate agarwood was discovered at the University).

This unique display came on the heels of other advocacy activities at the Capitol, including University faculty members visiting legislators to tell them about their work and hundreds of students speaking about why they chose to pursue their education at the University. ○

Follow-up: Earthquakes in Minnesota?

In our fourth quarter 2001 publication we highlighted the University's plan to build a Multi-Axial Subassemblage Testing (MAST) facility for earthquake-engineering research. Funded by a \$6.4 million grant from the National Science Foundation and a matching grant of \$4.8 million from the University, the project is now well on its way. The building shell is finished on the Minneapolis campus, ready for the equipment that will help structural engineering at the University have an impact far beyond faculty research.

Tests at the lab will help engineers retrofit existing buildings and design new structures to meet stringent international seismic codes. The MAST laboratory's unique system will allow researchers to impose more realistic loading conditions on test structures than current systems. Eight large jacks can apply forces or de-

formations vertically and in two horizontal directions.

The jacks can also apply rotations and twist the test structure to simulate overturning or bending. According to **Catherine French**, lead investigator for the project, no other testing facility can so closely simulate earthquake forces. This is important because "in the real world, wind and earthquakes don't load the structure in one direction," French said.

The U's MAST facility will become part of the nationwide Network for Earthquake Engineering Simulation (NEES), a network of 12 facilities conducting research on structural components of buildings. The Internet will link these facilities, allowing researchers from around the world to obtain data from, or participate in, experiments at any other NEES facility. The goal of the network



The new MAST facility building

is to allow earthquake-engineering researchers to work on integrated physical models, databases, and model-based simulations rather than performing isolated physical experiments.

The facility will begin operation in the fall of 2004. To read the original article, go to

www.ospa.umn.edu/researchrefmat&pubs/publications/gateway.

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