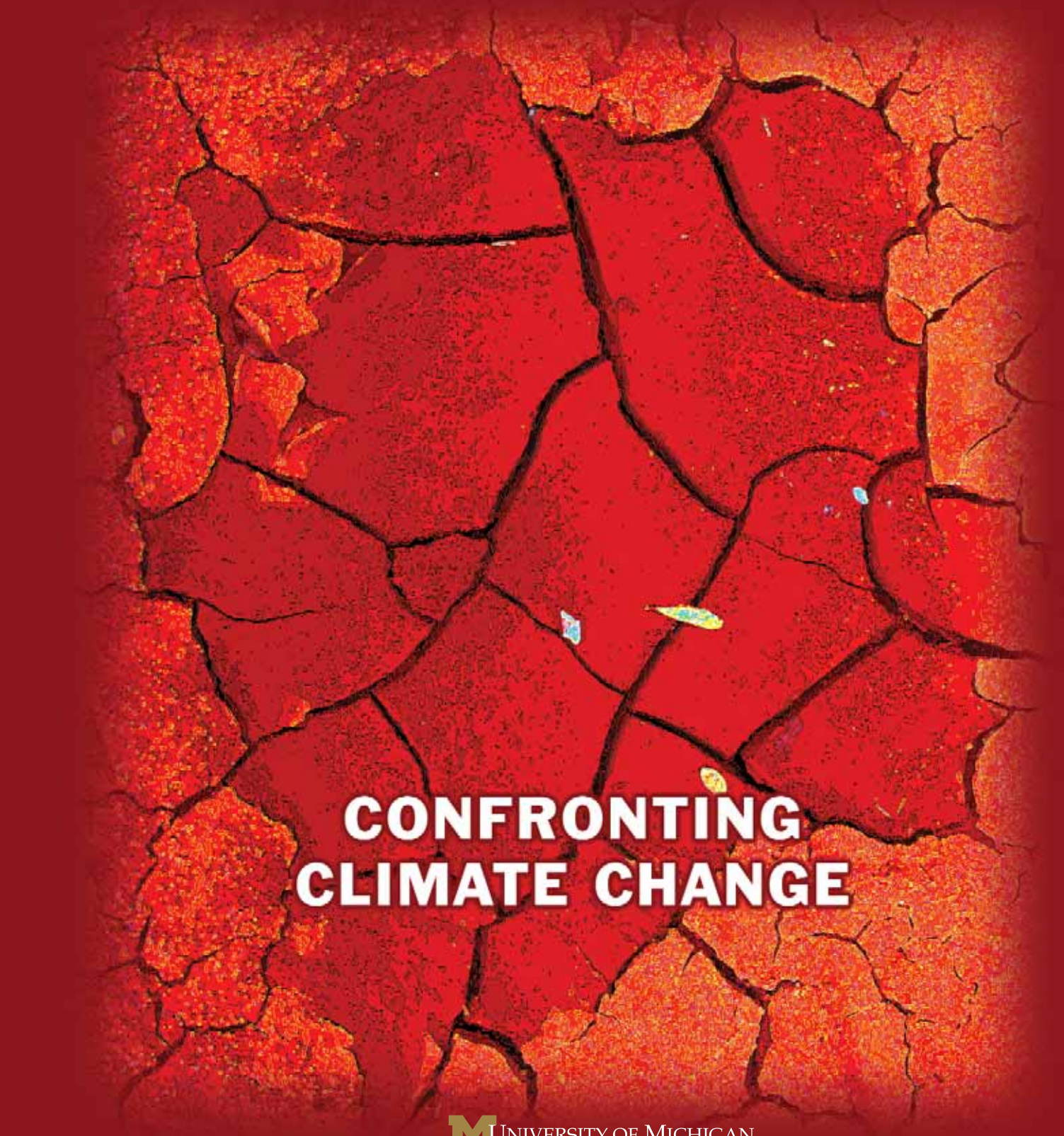
Office of the Vice President for Research

Spring 2007

SEARCH & DISCOVERY

RESEARCH AT MICHIGAN



CONFRONTING CLIMATE CHANGE

University of Michigan

CONTENTS

ON THE COVER

Global warming and the environmental changes that will ensue (and are already taking place) will put stresses on biological, social, political, and economic systems around the world.

STEPHEN R. FORREST
VICE PRESIDENT FOR RESEARCH

WRITERS
LINDA FITZGERALD
LEE KATTERMAN
ADRIENNE LOSH
ROBIN STEPHENSON
SUZANNE TAINTER
SARAH WALKLING

MM&D 070212

RESEARCH PERSPECTIVES

It is clear that universities contribute in numerous ways to modern society. For example, at this time every year, the University of Michigan graduates about 10,000 students who will become the future leaders of Michigan, the United States, and the world. Our students and faculty also conduct fundamental research in all areas of inquiry, from medicine and engineering, to social sciences, public policy, and the arts. This research has changed the way we perceive our world. In recent years, however, the University community has undergone a large-scale shift in how it views itself as an agent of change and how it must engage society to fulfill its mission of educating the public, and ensuring that the product of its intellectual resources benefit humanity. This focus on an *engaged university* does not, nor should it, displace our traditional roles in education research by more applied and "outward focused" areas of inquiry. All of these roles are extraordinarily important, and their coexistence at our university ensures that one always will gain strength from the others.

In this issue of *Search & Discovery,* we highlight U-M linkages to the world beyond its doors. In each article, an outstanding research program is described, and we can see the roots of these programs in the highest quality fundamental research. What distinguishes this work, and makes it a strong contributor to our mission as a public and engaged institution, is that in each case fundamental inquiry has taken that "extra step"—by affecting public policy, by changing our way of educating young people, and by creating a technology that finds its way into a practical application.

The lead article, "Confronting Climate Change," deals with global warming and how the U-M is involved in many international efforts to understand what is happening to our planet. Rosina Bierbaum, dean of the School of Natural Resources and Environment, is a leader in these efforts, having been deeply involved in the recent United Nations report on global responses to climate change. The close connection of climate change research by our faculty to the shaping of public policy exemplifies social engagement of the highest order. This research is vital to the health and perhaps survival of our planet as we know it.

Another article describes how Professor Sridhar Kota has developed a variety of micro-electro mechanical machines (called MEMs, which are micrometer-scale electronically driven mechanical devices) as well as applying this technology to the dynamic control of jet wing and helicopter rotor surfaces. In the past, work such as Professor Kota's would only be published in specialized scientific journals and then left for others to find applications. Today it is increasingly common for our faculty to be personally involved in applying their academic output directly to the realization of new products and processes. Sometimes, as in Professor Kota's case, that means forming a company that takes the university research into the marketplace.

A third example is found in the work of Professor Daphne Oyserman in the Psychology Department and School of Social Work. Professor Oyserman has looked at the limited academic success of minority students in Detroit and has developed a psychological model to help understand why this occurs. She has taken this work further by developing interventions to enhance student success, and has tested these interventions in the community. Her experiments are promising, and she hopes to see this effort through to wide adoption in schools.

If there ever was an opportune time for the University of Michigan to emphasize engagement with the outside community, it surely is now. From local economic disruptions such as the closing of the Pfizer R&D laboratory in Ann Arbor, to the nation's energy crisis, to the changing foundations of the regional economy from a manufacturing to a knowledge base, U-M is involved as never before as an active participant in affecting change. And why shouldn't we? As a public institution, it is our inherent mission to serve the public.

Furthermore, if there was ever a time to "pay back" the state of Michigan after being supported by its citizens for nearly 200 years, it is surely now. This does not conflict with our traditional missions of fundamental inquiry or in providing a spectacular education to all of our students, but rather supports it.

The Office of the Vice President for Research, along with the rest of the University of Michigan, is committed to supporting our engagement with industry, the community, and the larger society outside of our academic environment.

—Stephen R. Forrest

CONFRONTING CLIMATE CHANGE

U-M dean and colleagues analyze environmental changes facing the global community and outline strategies for mitigating the likely risks

As the 21st century unfolds, there may be no area of engagement where universities can have a greater impact than through involvement in the issues related to the warming trends on Earth. The consequences of the rise in temperature are already contributing to climate and ecological perturbations that may set in motion irreversible—or worse, catastrophic—changes for humankind.

DEAN ROSINA BIERBAUM

"The world is experiencing climate disruption now and the increases in droughts, floods, and sea level rise that will occur in the coming decades will cause enormous human suffering and economic losses," said Rosina Bierbaum, dean of the University of Michigan School of Natural Resources and Environment (SNRE).

"We imperil our children's and grandchildren's future if we fail to improve society's capacity to adapt to a changing climate," she continues. "We can manage water better, bolster disaster preparedness, increase surveillance for emerging diseases, make cities more resilient, move vulnerable populations and prepare for environmental refugees, design more drought-tolerant crops, use natural resources more sustainably, and enhance local capacity to cope with a suite of expected changes."

Bierbaum made these statements in late February in announcing the completion of a report entitled "Confronting Climate Change: Avoiding the Unmanageable, Managing the Unavoidable." The report, which provides an overview of the science of climate change, was delivered to the United Nations Commission on Sustainable Development and was sponsored by the United Nations Foundation and Sigma Xi, the Scientific Research Society. Bierbaum and Peter Raven, director of the Missouri Botanical Garden, co-chaired the Scientific Expert Group on Climate Change and Sustainable Development, a panel of 18 eminent scientists from 11 countries responsible for the report.

Bierbaum and her co-authors state their conclusion in stark terms: "Global climate change, driven largely by the combustion of fossil fuels and by deforestation, is a growing threat to human well-being in developing and industrialized nations alike. Significant harm from climate change is already occurring, and further damages are a certainty. The challenge now is to keep climate change from becoming a catastrophe."

This report proposes a two-pronged approach of mitigation and adaptation. Mitigation, or "avoiding the unmanageable," calls for limiting climate changes through measures such as significantly reducing carbon dioxide emissions. Adaptation, or "managing the unavoidable," involves taking steps such as changing agricultural practices to cope with climate changes that cannot be prevented.

Increases in atmospheric carbon dioxide concentration is known to be the largest contributor to rising temperatures. Fortunately, the authors point out, many technologies exist to reduce CO_2 emissions by "improving efficiency in the transportation sector through measures such as vehicle efficiency standards, fuel taxes, and registration fees or rebates that favor purchase of efficient and alternative fuel vehicles."

Another mitigation approach that policy makers can set in motion to address rising greenhouse gas concentrations is through changes in building codes aimed at more efficient commercial and residential buildings. Governments can provide incentives for property developers and landlords, such as low-cost financing for energy-efficiency investments, so that the properties they build and manage require less energy.

Nations must encourage greater use of non-corn biofuels in place of fossil fuels, and set policies to require all new coal-fueled power plants to be designed and built with the capacity to capture and sequester carbon dioxide in the coming decades. Increases in the domestic and international budgets to rapidly develop, demonstrate, and deploy new clean technologies are urgently needed. The federal government spends less than $3 billion each year on energy research.

"The challenge of halting climate change is one to which civilization must rise," the report authors urge. "Given what is currently known and suspected about how the impacts of climate change are likely to grow as the global-average surface temperature increases, we conclude that the goal of society's mitigation efforts should be to hold the increase [in average global temperature] to 2°C if possible and in no event more than 2.5°C" above preindustrial levels.

INDIA'S WORST DROUGHT IN 20 YEARS LEFT PEOPLE STRUGGLING TO FIND WATER.

Even if mitigation efforts are widely adopted and tremendously successful, the ongoing impacts of global and regional climate changes will need to be addressed to avert catastrophe. The reports states, "Managing the unavoidable changes in climate will be a challenge. International, national, and regional institutions are, in many senses, ill prepared to cope with current weather-related disasters, let alone potential problems such as an increasing number of refugees fleeing environmental damages spawned by climate change. Society will need to improve management of natural resources and preparedness/response strategies to cope with future climatic conditions that will be fundamentally different from those experienced for the last 100 years."

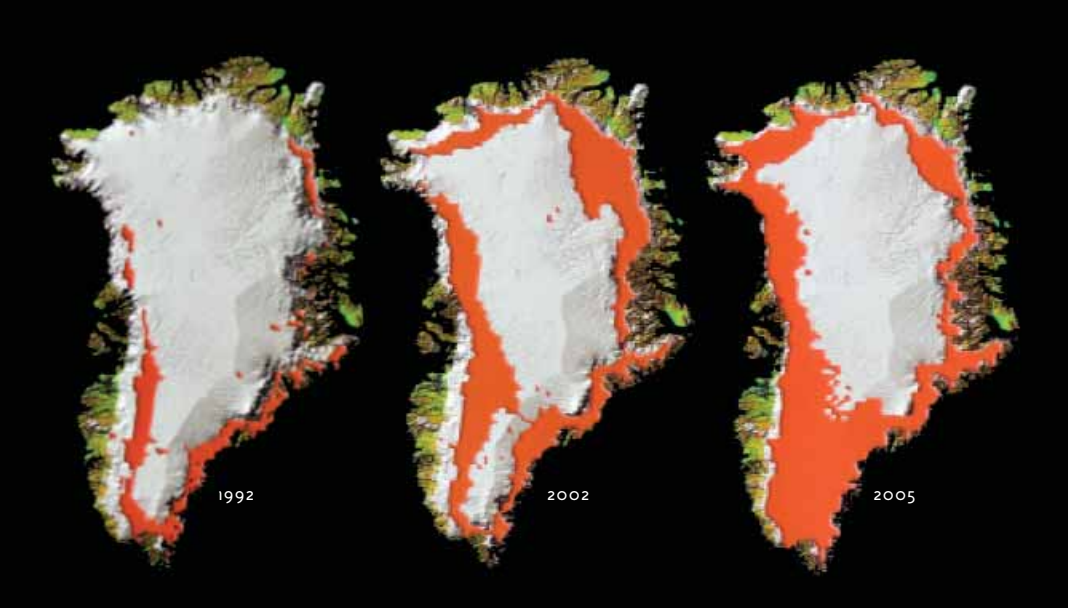
The panel advises international cooperation to address the adaptation needs of the poorest and most vulnerable nations, which will most likely face the greatest effects from climate change. As developing countries grow, it will be important to build "climate resilient cities," for instance. Collaboration efforts must be developed at all levels, from international to national to regional, that can better cope with weather-related disasters and an increasing number of "climate change refugees," those who must abandon home because the climate is no longer able to support a safe or economically viable existence. The panel identifies the United Nations and other multilateral institutions as crucial to such efforts, particularly in helping developing countries to finance and deploy new energy technologies, and educating all nations about opportunities to adopt mitigation and adaptation measures.

"Our report makes clear that the challenge before us is to reduce the risk of climate change resulting in intolerable global impacts," says Raven, panel co-chair, a Presidential Medal of Science recipient, and preeminent biodiversity expert. "Our recommendations are designed to

ARCHITECT AND DESIGNER WILLIAM MCDONOUGH, AT THE U-M ENERGY SYMPOSIUM IN FEBRUARY, TALKED ABOUT INNOVATIONS FOR CITIES AND BUILDINGS TO RESPOND TO CLIMATE CHANGE AND ENERGY NEEDS.

"Significant harm from climate change is already occurring, and further damages are a certainty. The challenge now is to keep climate change from becoming a catastrophe."

–REPORT BY SCIENTIFIC EXPERT GROUP ON CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT



GREENLAND ICE MELTING: IN 1992 SCIENTISTS MEASURED THE AMOUNT OF MELTING IN GREENLAND AS INDICATED BY RED AREAS ON THE MAP. TEN YEARS LATER, IN 2002, THE MELTING WAS MUCH WORSE. AND IN 2005, IT ACCELERATED DRAMATICALLY YET AGAIN. SOURCE: ACIA, 2004 AND CIRES, 2005.

help the international community get on a path to stabilizing atmospheric concentrations of greenhouse gases and managing the impacts of climate change. Unlike many reports from scientists, this report gives very clear recommendations for what the international community and nations themselves must do to mitigate and adapt to climate change."

Just prior to the release of this report, Bierbaum spoke about climate change and energy issues at the U-M symposium, "Energy Science, Technology, and Policy: Facing the Challenge." The meeting, held February 13–14, 2007, brought together influential people from government, industry, and academia to present their views on science, technology, and policy topics in the energy field. The Michigan Memorial Phoenix Energy Institute and the Office of the Vice President for Research organized the symposium, and DTE Energy sponsored it. (An overview of the meeting appear on page 18 of this issue. Webcasts of the presentations are available at www.mmpei.umich.edu.)

PANELISTS AT FEBRUARY 2007 U-M ENERGY SYMPOSIUM. FROM LEFT, KEITH TRENT, DUKE ENERGY; ROSINA BIERBAUM, U-M; NATHAN LEWIS, CALTECH; GARY WAS, U-M.

"We increasingly know that climate change interacts with everything else that we care about," said Bierbaum. "If we do not address these things simultaneously, we will very likely be inefficient and probably ineffective, and we might even exacerbate or create new problems," such as increasing ozone concentrations and smog formation to levels that exceed those the U.S. government now requires to prevent human health problems.

Bierbaum pointed out that because the science behind climate change analysis has become so much better, predictions coming from groups such as the Intergovernmental Panel on Climate Change (IPCC) now have a greater level of certainty. In the 2007 IPCC report, released only days before Bierbaum's symposium talk, the overarching conclusion about climate change is now between "90 and 99 percent probability that the increase in temperatures is due to humans," she noted, compared to the 1995 report, which declared that the "balance of evidence suggested a discernable human influence."

The increased certainty is due in part, she continued, because climate models have improved to the point where it is possible to show that only through combination of natural and human-caused processes can the global temperatures of the last 150 years be explained. "That ability to reproduce the historic temperatures gives us confidence that our models are incorporating the key parameters that are necessary to project into the future," said Bierbaum.

Scientists are also becoming more confident in what kinds of specific impacts will accompany global warming, said Bierbaum. "For ecologists, such as myself, a very scary thing is that the entire ocean is becoming acidified." The projected decline in pH and the changing balance of carbonate ions will make it difficult for marine creatures to make shells by the end of the century, "such that not just the corals, but also lobsters, shellfish, some plankton—will all potentially have trouble forming shells." This in turn may cause severe disruptions in the ocean food chain.

Studies of 17,000 species indicate that, on average, their normal range is "moving the equivalent of six kilometers a decade," said Bierbaum. "They are responding to the shifting climate map and either moving latitudinally northward or altitudinally higher."

For Bierbaum, one of the great challenges facing the United States is completing research quickly enough so that the nation can effectively mount both mitigation efforts and adapt to inevitable climate change and its spin-off effects. She notes that federal global change research budgets, as reported by the White House Office of Science and Technology Policy, show that the five-year average spending levels measured in inflation-adjusted dollars dropped from $8.3 billion in 1997-2001 to $8.1 billion for the period 2002–2007. "I would

CLIMATE CHANGE RESEARCH AT SNRE

At the School of Natural Resources and Environment, climate change research is a core area of emphasis. Ongoing work focuses on understanding the effects of global climate changes on human and natural systems, including impacts on disadvantaged communities, ecosystem health, water availability, land use patterns, microbial diversity, and biogeochemical cycles; and the transfer and use of information in decision-making under uncertainty.

Equally important is the study of how to reduce greenhouse gas emissions. Two of the School's Centers of Excellence deserve mention for their roles in climate change research. In the Center for Sustainable Systems (CSS), interdisciplinary and collaborative research is conducted to support the design, assessment, and management of systems that meet societal needs in a more sustainable manner. Studies focus on life-cycle analyses of transportation systems, manufacturing processes, infrastructure development, and alternative energy options, as well as modeling of greenhouse gas emissions and policy. CSS co-directors are professors Jonathan Bulkley and Gregory Keoleian.

The Erb Institute for Global Sustainable Enterprise, a partnership between the School of Natural Resources and Environment and the Stephen M. Ross School of Business, focuses on understanding the fundamental needs of a growing human population in an equitable manner within the means of nature. Erb Institute projects address questions such as how long-term trends in environment and development are reshaping nature-society interactions, and what kinds of incentive structures—including markets, rules, norms, and scientific information—can most effectively improve society's capacity to move toward more sustainable systems. The Erb Institute director is Professor Thomas Lyon.

SNRE—in conjunction with the College of Engineering, the School of Public Health, and the Ross School of Business—will host the first National Summit on Coping with Climate Change, May 8–10, 2007. In spite of uncertainties about the specific magnitude, timing, and spatial distributions of change, past and present trends in greenhouse gas concentrations in the atmosphere have committed the Earth to a trajectory of climatic change to which humanity will need to adapt. The summit will focus on four specific sectors, among many, that need to be addressed—public health, the energy industry, water quality, and fisheries. Leaders from industry, academia, government, and the nonprofit world will work to identify options available for various actors in U.S. society as they develop plans to anticipate and adapt to near- and long-term change. S&D

say these expenditures are really incommensurate with the task and with the challenge," she concluded.

"But am I optimistic? I am actually," says Bierbaum. "I think there's a dramatically changing landscape. We have an increasing amount of pressure coming from cities that are signing onto the Kyoto Protocol, from states that are doing things, from mainstream corporate America, from the investment community, from the international community, the drumbeat of science, and I'm really proud to say that Michigan is now reporting on greenhouse gas emissions in the state, in part because students at this University helped develop the first inventory. And the 'Evangelical Call to Action' last year—a very interesting statement—that the need to act now is urgent. This now means just about every major religion in the world has put out a statement that climate change is a moral challenge."

THIS CHART SHOWS THE NUMBER OF MAJOR WILD FIRES BY CONTINENT AND DECADE SINCE 1950.

Nevertheless, as Bierbaum and Raven wrote in an April 6, 2007 editorial in *Science,* "Global climate has already changed noticeably. Heat waves; ice melt; shifting ranges of plants and animals; sea-level rise; and droughts, floods, and wildfires are increasing, as expected. Unless the world acts now, we will fail miserably to meet the UN Millennium Development Goals, fail to improve the fate of the poor, and fail to achieve global sustainability. The human race, now numbering 6.5 billion people, has never faced a greater challenge, and there is no time for further delay." S&D

Further Reading

Scientific Expert Group on Climate Change (SEG), 2007: Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable [Rosina M. Bierbaum, John P. Holdren, Michael C. MacCracken, Richard H. Moss, and Peter H. Raven (eds.)]. United Nations Commission on Sustainable Development, 144 pp. www.unfoundation.org/SEG.

Rosina M. Bierbaum and Peter H. Raven, 2007. "A Two-Pronged Climate Strategy," Science *316:17.*

SHAPE SHIFTERS

Compliant Systems Morph without Joints or Hinges

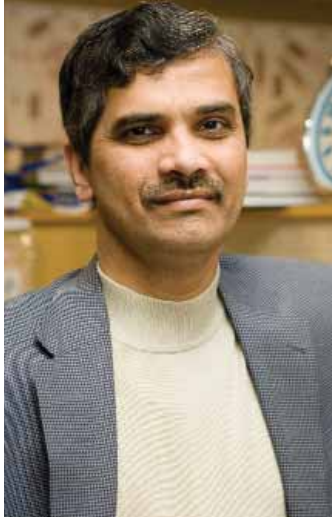
Ask Professor Sridhar Kota to talk about "compliant systems," and he just might pull out a plastic ring about three inches in diameter with some interlocking, looping beams inside. He presses two pairs of small pins in the outer ring, the beams deform without breaking, and the center opens to form a new ring. "This device is an iris, made from a single piece of plastic, but it could be made of anything elastic, such as a metal like titanium. It has no hinges and requires no assembly," says Kota.

"In traditional design, everything has to be strong and stiff," he continues. "Almost all engineered systems are assembled from a plethora of rigid discrete components, optimized for peak performance at a specific operating condition. But performance drops off as conditions move away from that specific condition, and so we end up with a compromise between performance and design complexity.

"In nature, we observe designs that are pliant and they adapt to maximize performance under all operating conditions and environmental fluctuations. A compliant mechanism aims to do just that—deform elastically without joints to produce a desired motion or force. "If you take advantage of elastic properties, you can get much more precise, efficient motion. Such a system all but eliminates problems due to wear, friction, or lubrication." In addition, cost-effective manufacturing processes can usually be developed for a no-assembly device.

Another simple one-piece mechanism, this one designed by Kota, is a windshield wiper assembly. The wiper is made by injection molding in one step, unlike its present-day counterpart, which is built from many parts. Preliminary studies of the no-assembly wiper indicates it would cost about one dollar less per assembly to manufacture with Kota's methodology compared to the wipers currently manufactured in China. There are 100 million wipers sold in the United States every year. Although assembly-intensive products like a windshield wiper are increasingly outsourced to countries with low labor rates, this new one-piece paradigm can lead to product designs that can be manufactured profitably in the U.S.

USING PROF. SRIDHAR KOTA'S TECHNIQUES, THIS ONE-PIECE WINDSHIELD WIPER CAN BE BOTH SIMPLER AND CHEAPER TO MANUFACTURE THAN THE WIPERS NOW IN USE.



PROFESSOR SRIDHAR KOTA

In the early 1990s, Kota became interested in building micro-electro mechanical systems (MEMS). These devices include extremely small mechanisms, sensors, and controllers that are integrated with electronics. Since MEMS are built on silicon chips, the single-piece, no-assembly feature of compliant systems is ideal.

The compliant design approach has enabled the development of high-performance MEMS actuators for two-dimensional and three-dimensional applications, notes Kota. "The resulting designs are easy to fabricate, last 10 billions cycles without failure, and offer high-power density systems." The University has also licensed this patented technology to a number of users.

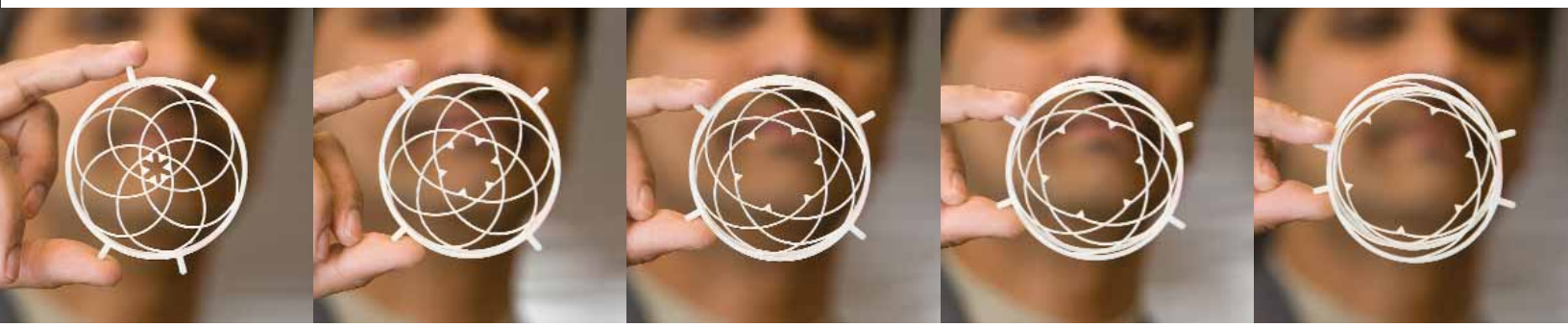
In order to design compliant mechanisms, Kota and his students have developed algorithms for determining optimal shapes and distribution of material. In addition, he has expanded their realm of application. "Compliant systems prompt you to come up with a whole new way of thinking of solutions to problems," he says. "I'm always asking myself: 'what kinds of objects need to undergo a change in shape during their use?'"

An area of great promise is related to flight. As any passenger sitting in a window seat behind the wings on a plane can attest, the wing shape changes several times during a flight—at take-off and landing and while turning, among other maneuvers. "I realized that aircraft wings have many different shapes that are optimum for different uses or situations," Kota says. Furthermore, the most efficient shape for take-off differs from that for landing, or flying fast and straight as opposed to making sharp turns.

These different needs have been addressed in modern aircraft with stiff flaps attached to a wing with a hinge controlled by motors inside the wing. Clearly, wing flaps have been a success, but they do not represent the ideal solution and are another example of a compromise solution. Hinged wing flaps provide varying lift as needed, but they also create drag that is undesirable in certain flight conditions.

Like the Wright Brothers

"It's been known from the very beginnings of aviation that significant maneuverability and stability can be achieved by small controlled deformations of flight surfaces, especially of a wing's leading and trailing edges," explains Kota. "The Wright brothers' original prototype flyer had a saddle that allowed Orville, the pilot, to adjust trim and the ends of the wood and fabric wings by changing his body position."

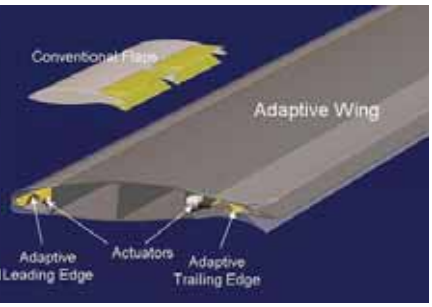


THIS IRIS IS CAST AS A SINGLE PIECE THAT OPENS AND CLOSES BY APPLYING FORCE TO THE SMALL EXTENSIONS ON THE OUTER RING.

The Wright brothers had intentionally designed their plane to be flexible, a design that succeeded thanks in part to very low aerodynamic pressures placed on their slow-flying aircraft.

The Air Force has looked into the development of an aircraft wing that changes shape by deformation without flaps and hinges, says Kota. During the 1980s, tests of just such a wing design, known as the "mission adaptive wing" (MAW), were conducted at Wright Patterson Air Force Base in Ohio. The wing from an F-111 was modified with fiberglass flex-panels able to withstand much greater stresses than the Wright brothers' plane experienced and could do more reshaping the leading and trailing wing edges than conventional flaps.

THE WHITE KNIGHT AIRCRAFT WAS USED FOR FLIGHT TESTS OF THE FLEXSYS ADAPTIVE WING (MOUNTED ON UNDERSIDE OF AIRCRAFT AND IN DRAWING BELOW).



This adaptive wing did demonstrate aerodynamic benefits over a conventional wing, but in the end, the version tested was simply impractical. Structurally, it was too heavy and complicated, says Kota. "Even in design situations when the goal is compliance for variable geometry, the traditional engineering approach is to use a plethora of rigid parts connected by joints," he says, "I take the approach of exploiting elasticity in my designs."

Kota's approach differed a good deal from the mission adaptive wing. Kota's wing uses jointless mechanisms to modify the leading and trailing edge of a wing as needed to improve its aerodynamics. One of the key strengths to the mission adaptive compliant wing (MACW), as he calls it, is the way it flexes at a variety of locations depending the shape needs of the moment rather than relying only on a variety of rigid members as found in the Air Forces' MAW design.

While he was confident in how compliant systems might benefit wing design, he is not an aerospace engineer, and he admits it took a little while for him to approach the Air Force with his ideas. When he did finally contact the Air Force Research Laboratory, he was a little surprised at the response. "From the beginning, they were more excited than I was," he recalls.

"The Air Force suggested that I apply for an SBIR, which I didn't know anything about at the time," says Kota. SBIR stands for small business innovation research, a federal program coordinated by the Small Business Administration. SBIR grants and contracts are awarded by many government agencies to help small U.S. businesses fund innovative research that will support the development of new products or processes.

Kota had started a company in 2001, FlexSys, Inc., to provide a platform for turning his research on compliant systems into products. FlexSys applied for and received SBIR funds from the Air Force, using them to launch the MACW program. After several years of work, tests completed in June 2006 in wind tunnels at Wright Patterson Air Force Base showed that the FlexSys compliant wing can both flex to provide aerodynamically advantageous contours, while also being able to withstand three times the load that an aircraft wing experiences in actual flight. The key design feature of the MACW is that the shape morphing wing flap weighs about the same as a conventional flap and needs about the same power to operate, but the MACW offers significant performance benefits.

FlexSys Inc.

Flight Tests Promising

Last fall a prototype wing section was affixed to the underside of a White Night Aircraft for four days of extensive flight tests in Mojave, California. In these tests, the wing hung below the jet's body where it could be observed and monitored during various maneuvers.

"Dr. Kota has achieved a long-sought milestone in aeronautics research—an efficient approach to seamless, variable geometry wings for superior aerodynamic performance," notes Donald Paul, chief scientist of the Air Vehicles Directorate, Air Force Research Laboratory.

The tests completed so far indicate that something like the FlexSys wing could improve flight efficiency and reduce fuel costs by 5 to 12 percent. Even retrofitting this technology into existing wings might reduce fuel costs by about 3 percent.

Now consider that about the half of the cost of running an airline goes to fuel. Statistics on fuel spending by the airline industry published by the Air Transportation Association indicate that during the first eight months of 2006, the U.S. air carriers spent $25.5 billion to buy 12.8 billion gallons of fuel. A 3 percent savings translates into more than $1.1 billion in reduced fuel costs (at 2006 prices, no less). When the adaptive wing technology is used in completely redesigned aircraft, the fuel savings should be several billion dollars per year.

Engineers from private industry as well as the Air Force and NASA observed the Mojave flight test. Now, discussions are underway about how to adapt this technology for commercial and military applications.

Helicopters Up Next

Even while he has worked on morphing wings, Kota has been exploring other applications of his approach. One that has Kota particularly enthused is the adaptation of helicopter rotors with flexible blade edges.

"As the rotor moves during forward flight, the airfoil orientation changes from one favoring lift to one that tends to stall," explains Kota. It's this changing orientation that causes the characteristic woofing sound that helicopters make. "A helicopter's blade undergoes these different conditions six or seven times a second. If I can morph the leading and trailing edges of the blade at this same rate, I might be able to reorient that rotor shape to make it more efficient."

As a rotor blade on present day helicopters slice forward through the air in the same direction as the direction of flight, air moves over and under the blade fairly efficiently and provides lift and forward motion. As that blade rotates in the opposite direction of flight, turbulence develops over the rotor blade, creating stall conditions. The rotor also undergoes detrimental vibrations and wear during this part of the rotation.

Kota's work has shown that by modifying the leading edge of the rotor as it rotates into the partial stall conditions, the air flowing over the rotor blade remains "attached," avoiding the loss of efficiency and speed caused by turbulence. As the blade rotates around again, the leading edge must be returned to its original shape to maintain proper air flow.

In a project funded by the Department of the Army, FlexSys designed and constructed a three-foot blade section with a controller to morph the leading edge once per revolution. Furthermore, the section was constructed with materials that can withstand the pressures and loads experienced by helicopters, yet still was able to flex and provide the conditions for smooth air flow.

"Our study indicates that a morphing rotor would be faster, quieter, and allow the helicopter to increase its payload by 10 percent, and perhaps as much as 25 percent," says Kota.

Another application that excites Kota is the redesign of wind turbines, which presents an opportunity similar to the helicopter rotor. "If we can morph the trailing edge of a turbine blade, you can get 30 percent more energy capture. This could lower the cost of energy production from wind by 20 percent while reducing fatigue loads by 80 percent." Kota is currently working on a collaboration with Sandia National Laboratories, a Department of Energy lab in Albuquerque, New Mexico. The compliant system improves the flow of air over the turbine blade, which ordinarily has some breakup as it reaches the trailing edge, causing turbulence and drag.

The potential for compliant systems is only limited by imagination, says Kota. The variable geometry devices that he works on offer multi-point optimal design, expanding the conditions under which a wing or helicopter or turbine or pump can operate efficiently with excellent performance and offering economically advantageous options compared to traditional configurations. "There are many exciting applications for compliant or variable geometry designs," says Kota. S&D

Further Reading

Kota, S. Lu, K-J., Kreiner, Z., Trease, B., Arenas, J., and Geiger, J., 2005. "Design and Application of Compliant Mechanisms for Surgical Tools," Journal of Biomechanical Engineering, *127:981-989.*

Lu, K.J. and Kota, S., 2003. "Design of Compliant Mechanisms for Morphing Structural Shapes," Journal of Intelligent Material Systems and Structures, *14:379-391.*

picture of success

Minority youths get better grades in school when they see links between school achievement, racial identity, and future accomplishment in life, U-M studies show.

Like their counterparts in the suburbs, teens from the poorest neighborhoods in urban Detroit value school and want to succeed in school. Yet fewer than half of urban teenagers graduate from high school on time.

U-M social scientist Daphna Oyserman was puzzled by this gap between actual academic attainment and high academic aspirations, and believed that low-income and minority teens could be helped to reduce this gap.

"Students clearly state that they want to succeed and their teachers are invested in teaching, yet there remains a gap between students' attainments and their hopes for the future," says Oyserman, professor of social work and psychology and research professor at the Institute for Social Research. "One possibility was that part of the gap was due to a discrepancy between students' wishes for success and their current effort in school."

Students did not seem to lack positive visions of themselves or hopes for adulthood. What seemed to be missing was the link between these positive future visions and everyday choices young teens make related to school. Success is built on endless repetition of relatively mundane tasks such as completing homework, getting enough sleep, setting and responding to the morning alarm clock, paying attention, and asking questions in class. Students who see future success as linked to these here-and-now activities, or are cued or reminded to engage in these activities, and who don't feel that these activities would be frowned on by important others, are likely to move toward their goals.

Oyserman wondered if perhaps these were the stumbling blocks that helped create the gap between aspiration and attainment. Perhaps students did not see these strategies as linked to their possible future selves. Perhaps they do not routinely encounter the cues to follow these strategies even if they knew about them.

Still, most teachers remind students to take home their homework and most students know that failing in school does not improve future chances. This suggested to Oyserman a third possibility—that students might know of but not engage in these useful strategies because they were unsure how others would react. Using these insights and her work on identity—plus a body of psychology research on how self-concept influences decisions and behavior—Oyserman proposed a model for why some students will work hard to stay in school while others fail to even show up for class.

According to Oyserman's theory of identity-based motivation, youths will be more likely to engage in persistent efforts in school if they can envision a goal of doing well and if concrete strategies to do well come to mind and are not seen as incongruent with important social identities.

With funding from the W.T. Grant Foundation and the National Institute of Mental Health, she collaborated with a number of Detroit public schools to test her ideas and develop an intervention program for Detroit eighth graders. The program, called School-to-Jobs, aims to bolster the specific psychological processes Oyserman thought could help students stay on track to school success, and help them to see success in school as part of their racial and social identities.

Putting Hopes and Dreams into Action

One task teenagers have is to think about the future, to imagine who they will be at a future time. These "possible selves" can be positive or negative images, explains Oyserman: "The 'clever' self who passed the algebra test, the 'fat' self who failed to lose weight, the 'fast' self who fell in with the 'wrong' crowd." Failure to obtain a hoped-for positive possible self may increase the risk for depression, she adds.

Most low-income youth have at least one possible self focused on school. However, few of these teens have in mind strategies for achieving that possible self, such as "set my alarm clock" or "go to class even if my friends skip." And it's not enough to stay after class for help once or do homework occasionally. It must be everyday behavior. The teens must avoid getting off-track with pregnancy, drug use, or involvement in crime.

This personal picture of the future must be plausible, too, to motivate the teen to bring to mind and use effective strategies to obtain the positive self and avoid the negative possible self.

Successful strategies for middle-class students may be linked automatically to the academic possible self because, explains Oyserman, "Parents, teachers, and parents of friends all converge to emphasize homework, persistence in the face of difficulty, tutoring, or staying after school if needed."

In urban low-income communities, youth may have difficulty connecting their possible selves to everyday behavior because they rarely encounter adults who trigger strategies for success. Furthermore, reports Oyserman, low-income youth may interpret their difficulty in self-regulating behavior as a signal to give up on the academically oriented possible self. Doubt creeps in about whether an academic future is genuine or whether people of the same race, economic level, or gender are actually meant to be successful at school.

"Low-income and minority youth are likely to experience at least three sources of difficulty—difficulty bringing to mind school-focused possible selves and linking them to strategies; difficulty maintaining the behaviors necessary to attain these possible selves; and difficulty integrating important school-focused possible selves with important social identities, such as being a boy or a girl and being African American or Latino," says Oyserman.

Context is Important

"Caring about school and using effective strategies for doing well in school have to feel like in-group things to do," Oyserman says. "Boys have to believe other boys want to do well in school and are willing to study in order to succeed; girls have to believe the same about other girls."

Possible selves do not develop in isolation. Youth need to be able to find connections between their possible selves and their racial and social identities. Social identities are aspects of self-concept based not in individual traits and goals, but on group-based traits and goals. Working class and racial identities are important social identities.

In various studies analyzing racial and cultural identity, Oyserman and colleagues have interviewed students and demonstrated the impact of racial identities on school success.

When a student's racial identity included a combined focus on both "in-group" and the larger society, this usually led to improved academic performance and higher emotional and behavioral engagement with school over time. Oyserman has found that African American students who felt good about doing well in school because it reflected positively on the Black community excelled, even if they viewed society as somewhat racist and against them. When focus is only on the in-group and not also linked to the broader society, individuals are less likely to reject anti-effort norms, are more at risk of feeling disengaged from school, and more at risk of declining grades, Oyserman says.

In a recent study on Detroit middle school students, feeling connected to one's racial-ethnic in-group and believing that doing well in school is an in-group characteristic promoted better school outcomes, Oyserman says. In addition, youths who reported high levels of racial-ethnic identity connectedness and awareness of racism in the beginning of eighth grade attained better grades through ninth grade. The positive effect of these components of racial identity on school grades are consistent for African American and Latino youth and for boys and girls.

"Caring about school and using effective strategies for doing well in school have to feel like in-group things to do. Boys have to believe other boys want to do well in school and are willing to study in order to succeed; girls have to believe the same about other girls."

"This is important because it suggests that interventions, which can bolster a youth's sense of connection to their racial/ethnic in-group and the belief that doing well in school is an in-group thing to do, can be equally helpful to African American and Latino youths," Oyserman said. "Girls are doing better in school than boys overall, but racial-ethnic identity can be beneficial for both boys and girls."

The most recent work in this area is published in the journal *Child Development* by Oyserman, Deborah Bybee (Michigan State University), and current and former students, Inna Altschul, Daniel Brickman, Marjorie Rhodes, Aaron Celious, Elizabeth Inez Johnson, and Kathy Terry.

Possible Selves and Current Behavior

The School-to-Jobs intervention was first tested in Detroit as an after-school program in a middle school. When shown to be successful, it was implemented in three Detroit middle schools. Twice a week for six weeks, in groups of about 12 students, the eighth graders were led through various activities to help them make connections between specific strategies, hard work in school, and racial identity. "The goal is for students to realize that difficulty in school assignments does not mean they can't complete the work," Oyserman says.

Students were randomly assigned to the intervention or to a control group that did not participate in the sessions. Parents joined their student for two final sessions focused on communication and interacting with adults in the community.

Following the intervention program, students were tracked for a two-year period, as they moved from three middle schools to more than 80 different high schools. The research team used school records, reports by the students, and teacher reports to measure changes in academic behavior and outcomes.

The effects of intervention emerged by the end of eighth grade and became more marked over time. Youths who participated in the intervention had a better attendance record, grade point average, and standardized test scores. High school teachers rated them as taking more initiative in the classroom and participating more, and as less likely to be disruptive or simply not participate. In addition, the students showed less risk of depression at the two-year follow-up.

The School-to-Jobs program was intentionally brief and inexpensive. To be practical, an intervention program has to be low-cost and manageable for school staff—whether teachers, social workers, or others—to carry out with reliability, Oyserman points out. Interventions that are lengthy and resource intensive are likely to be difficult for schools to maintain and sensitive to turnover in staff and students.

In evaluating the intervention, Oyserman and her colleagues found support for their conceptual model of the program's influence on improved academic outcomes and mental well being. In concert with social identity and the feeling of thinking about one's self, called meta-cognitive experience, the intervention worked directly on the student's "possible selves."

While Oyserman has been able to replicate the success of the intervention program and validate her conceptual model, she would now like other research groups to see how well it can be generalized to other schools and places. The most recent report on this research is published in the *Journal of Personality and Social Psychology* by Oyserman, Bybee and Terry. Current research focused on translating the success of the program to younger students involves collaboration with current U-M doctoral students Leah James and Mesmin Destin.

"The most important finding from the research is that even in areas typically defined as high risk due to poverty and other social indicators, youth want to succeed and can do so more readily if they remain focused on school, undeterred by failure or by concerns that maybe school is not for them," Oyserman says. "What we need are programs to help children in high-risk contexts hold onto this kind of belief. Research to date suggests that this can happen as part of school-based programs. Future research is needed to better integrate these efforts with the current school reform goals described in the No Child Left Behind legislation. The identity-based motivation model can be effective in thinking about younger children entering the school years." S&D

Further Reading

Daphna Oyserman, Deborah Bybee and Kathy Terry, 2006. "Possible Selves and Academic Outcomes: How and When Possible Selves Impel Action," Journal of Personality and Social Psychology, *91:188-204.*

Daphna Oyserman, Daniel Brickman, Deborah Bybee and Aaron Celious, 2006. "Fitting In Matters: Markers in In-Group Belonging and Academic Outcomes," Psychological Science, *17:854-861.*

LAB CULTURE

An inside look at the people—and the mission—that power the laboratory of Dr. Arul Chinnaiyan

Ask biochemist and Assistant Professor Sooryanarayana Varambally when his workday typically begins, and he'll break out in a dazzling but slightly sheepish smile. "Often three, sometimes four o'clock in the morning," he admits. Along with approximately 40 other researchers employed in the lab of Dr. Arul Chinnaiyan, Varambally uses DNA microarrays to study gene expression and identify biomarkers in prostate cancer as well as cancers of the breast, colon, and lung. He sought out a position in Chinnaiyan's lab in 2000 after completing two years of post-doctoral study in Paris.

What accounts for such remarkable dedication on his part? "Many things," Varambally explains, the smile still firmly in place. "The cutting-edge work we do. The talent of my colleagues. The resources available to us. The freedom to follow through on a project. The opportunity to publish. And the fact that Arul tends to look at the big picture, always focusing on how our work can have a positive impact on patient care."

Varambally isn't alone in his enthusiasm for the lab. In fact, that same sense of commitment and excitement is shared by nearly all of his research colleagues, among them Daniel Rhodes, who joined Chinnaiyan in 2000 on his way to earning an M.D./Ph.D. at Michigan. A specialist in bioinformatics, Rhodes—who estimates that he logs anywhere from 70 to 80 hours in a typical week—appreciates the trust that Chinnaiyan places in his staff. "Arul knows how to dig out people's potential," he says. "He also knows how to align people with projects. Here you can go as far as your ability will take you. A graduate student can become group leader. That's what drives the lab, and that's what pushes us to work so hard."

Rhodes himself is a case in point. In 2003, he was instrumental in helping Chinnaiyan launch the Oncomine™ cancer profiling database. By collecting highly disparate gene expression data sets generated by labs around the world, then standardizing the data and placing it on a single, integrated platform, Rhodes and Chinnaiyan found that they could provide "regular biologists" with usable, readily accessible, high-throughput data.

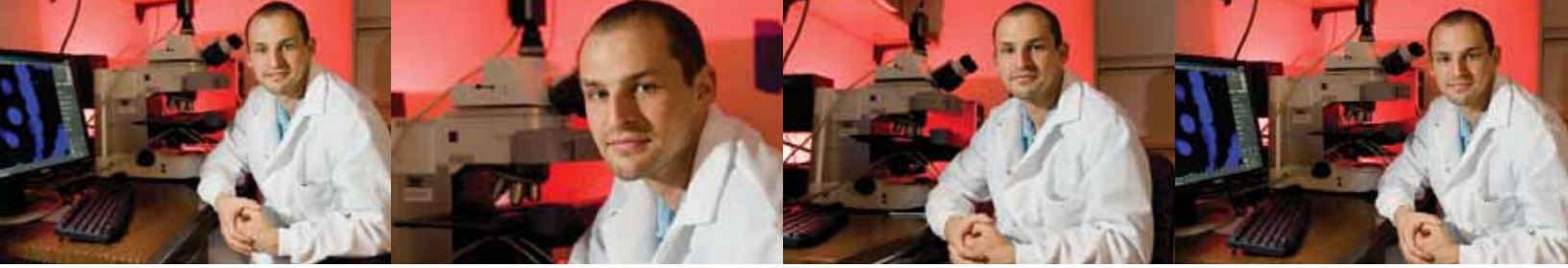
The Oncomine™ database is freely available to all academic researchers at www.oncomine.org and currently serves more than 10,000 registered users. In March 2006, a commercial version of the database was launched through a start-up—Compendia Bioscience Inc.—to meet the needs of pharmaceutical companies and other for-profit ventures. In addition to his work as a research investigator, Rhodes serves as chief scientific officer of Compendia, consulting with commercial clients to enhance database services. The company was recently awarded a $1.2 million grant from the 21st Century Jobs Fund, a competition sponsored by the State of Michigan.

For M.D./Ph.D. candidate Scott Tomlins, the deciding factor in pursuing a spot in the lab was the opportunity to publish and—just perhaps—pattern his own career after Chinnaiyan's meteoric rise from M.D./Ph.D. student to U-M faculty member. "Arul had the most successful career of any Ph.D. student I've ever known," he says. "It makes sense that he's going to continue his success as an independent investigator, and I wanted to be a part of that." Tomlins continues to be impressed with the lab's overall strategy, which he describes as "taking a global perspective, figuring out what's important, finding a target, and then drilling down by focusing on one key component."

ABOVE SOORYANARAYANA VARAMBALLY, RESEARCH ASSISTANT PROFESSOR. **RIGHT** PROF. ARUL CHINNAIYAN.

Earlier this year, Tomlins achieved a major milestone when he and Chinnaiyan co-authored a ground-breaking paper that appeared in the October 28 issue of *Science* magazine. Based on research conducted in collaboration with Harvard's Brigham and Women's Hospital, their article chronicled the discovery of recurring chromosomal abnormalities that lead

XUHONG CAO IS MANAGER OF THE CHINNAIYAN LABORATORY.



SCOTT TOMLINS (ABOVE) AND DANIEL RHODES (BELOW) ARE GRADUATE STUDENTS IN THE MEDICAL SCIENTIST TRAINING PROGRAM AND MEMBERS OF THE CHINNAIYAN LAB.

to a gene fusion found in a majority of prostate cancer tissue samples. According to Chinnaiyan, this finding represents a "paradigm-shift" for all epithelial tumors—including cancers of the lung, breast, colon, ovary, liver, and prostate. As he notes, "The data in our study provides tantalizing evidence that gene fusion is the causative agent."

As project manager for the entire lab, research associate Xuhong Cao has a unique understanding of the organizational dynamics at work. From her perspective, it's all about giving researchers a sense of ownership. "The people who work here feel that this is their lab," she explains. "That's why they devote themselves to it." But, she goes on to note, another important factor is the unusually broad expertise of the research team, which allows for a systemic approach to projects. "Unlike many other labs," Cao observes, "we excel in both biology and bioinformatics. We have approximately ten individuals engaged in dry lab activities—primarily computational data mining. The remaining 30 or so are biologists involved in wet lab experimentation. This leads to interesting collaborations among researchers and makes a huge difference to our overall success."

Chinnaiyan himself agrees that taking the broad view is one of the distinguishing characteristics of his lab. As he points out, "What we're trying to do is globally capture cancer progression. We're not focused merely on gene expression but on all the different molecular alterations that occur in cancer. So we're looking at genomics, transcriptomics, proteomics, metabalomics. In this way, we get a real systems perspective, a global view of the molecular transitions that occur in cancer progression. It's this big picture that allows us to pick out the best clinical biomarkers and identify molecular targets. Thanks to our dual expertise in biology and bioinformatics, we have the ability not only to make speculations and predictions, but to follow up and validate with experiments. And the process often moves in the other direction as well."

Chinnaiyan's lab has attracted attention—and admiration—from members of the wider University community, among them Dr. David Casimir, a patent attorney working with U-M's Office of Technology Transfer. A molecular biologist by training, Casimir has helped Chinnaiyan and his research team prepare numerous patent applications. "If I were back in graduate school, I'd bend over backwards to work in Dr. Chinnaiyan's laboratory," he says. "The lab has everything I looked for when I was a graduate student: cutting-edge science that exerts a direct impact on human health, in a high-energy, fast-paced environment, with a nearly endless set of interesting projects to work on."

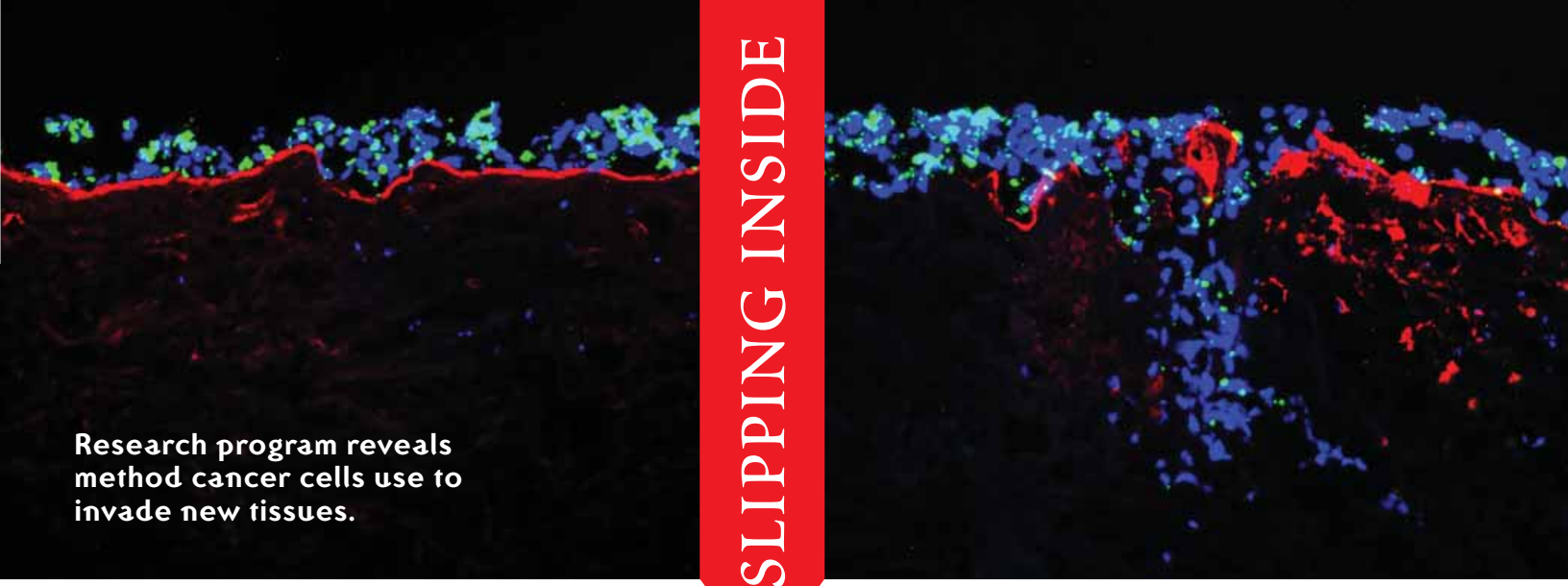
In January of 2007, Chinnaiyan will become director of the new Michigan Center for Translational Pathology. This will be in addition to his positions as director of Pathology Research Informatics and director of Cancer Bioinformatics.

According to Chinnaiyan, the Center will be grown strategically. "I'd like to keep my lab at essentially the same size and make it the core of the Center," he says. "Then, of course, we'll recruit faculty with complementary expertise. The mission of the center will be similar to that of the lab—to translate early discoveries into clinical applications. I believe that, as scientists, we haven't made a real contribution unless our work has impacted patient care. This will remain the core objective. Of course," he concedes, "it's almost impossible to accomplish that without commercial representation, especially when it comes to diagnostics. But the scientific and academic mission of the center will always take priority over entrepreneurial considerations."

And what are his goals for himself during the coming transition? He grins as he answers. "I'll be looking for ways to compartmentalize the administrative components as much as possible," he acknowledges. "Trying to find time to think about scientific problems. Because, really, that's what I enjoy most." S&D

Further Reading

Rhodes DR, Kalyana-Sundaram S, Mahavisno V, Varambally R, Yu J, Briggs BB, Barrette TR, Anstet MJ, Kincead-Beal C, Kulkarni P, Varambally S, Ghosh D, Chinnaiyan AM, 2007. "Oncomine 3.0: genes, pathways, and networks in a collection of 18,000 cancer gene expression profiles." Neoplasia. *2:166-80.*



SLIPPING INSIDE

Research program reveals method cancer cells use to invade new tissues.

While the diagnosis of cancer often creates feelings of dread, anyone familiar with the disease knows that when the word "metastasis" is mentioned, panic and hopelessness pervade.

Today, almost 90 percent of deaths from cancer are the result of metastases, cancer cells' most deadly characteristic—their ability to invade tissues and appear throughout the body. When cancers are discovered and treated before they spread, the likelihood of cure is much greater.

The recent announcements from public figures such as Elizabeth Edwards and Tony Snow that their cancers had returned and metastasized further emphasize the grim reality of what cancer patients face after cancer cells seed different areas of the body and begin to grow. Though further treatments are possible, managing recurrent disease is widely accepted as being an uphill battle.

If an original tumor attacks breast or colon tissue, how does it years later, after treatment, appear in the bone or liver?

Findings from the laboratory of Stephen Weiss at the University of Michigan published in *Genes and Development* in September 2006 provide important insights into the processes that control cancer cell metastasis and the molecular mechanisms that allow their pernicious spread.

"We asked how cancer cells cut their way through tissues in order to move away from their primary site of growth," said Weiss, Life Sciences Institute research professor and the division chief of Molecular Medicine and Genetics in the U-M Medical School. "They use what we call *proteases,* a type of molecular scissors. However, as there are so many different types of these scissors encoded by the human genome, we wanted to focus our attention on finding the subset used by cancers."

In all forms of cancer, a hallmark of malignancy is the tumor's ability to penetrate the basement membrane, a specialized form of connective tissue that lines the internal and external surfaces of the body. The tumor cells appear to use a surprisingly small number of proteases to cut their way through the basement membrane, and all of the other intervening tissues, to allow cancer cells access to blood vessels and lymphatics, which act as conduits for the spread of malignant cells to distant sites in the body.

Of the more than 500 enzymes that could be used by cells as molecular scissors, the Weiss team found that three proteases, termed MT1-MMP, MT2-MMP, and MT3-MMP, are the most likely candidates that regulate cancer cell invasion.

ABOVE IMAGE SHOWS CANCER CELLS INVADING HUMAN TISSUE (METASTASES) BY ENTERING A HOLE IN THE TISSUE'S BASEMENT MEMBRANE.

"These closely related proteases allow cancer cells to start eating through basement membranes and the surrounding tissues," says Weiss. "This is the critical step that initiates the malignant process and allows the rapid spread of cancer cells to sites throughout the body."

PROFESSOR STEPHEN WEISS

By identifying this set of proteases and the molecular events that control their expression, Weiss and his colleagues have provided the first proof that a small set of genes and proteins may underlie the cancer cell metastatic process. While their work is still at an early stage, Weiss and co-workers are attempting to develop new inhibitors of these proteases to begin testing their importance in animal models of human cancer. S&D

Further Reading

Kevin Hotary, Xiao-Yan Li, Edward Allen, Susan L. Stevens and Stephen J. Weiss, 2006. "A cancer cell metalloprotease triad regulate the basement membrane transmigration program." Genes & Development. *20: 2673-2666.*

THE ENERGY CHALLENGE

Complex problem, complex resolutions

In February and April of this year, the Intergovernmental Panel on Climate Change (IPCC) released two more reports saying that global warming is occurring in large part due to human activity. With global warming on the rise and oil reserves dwindling, the need for secure, clean, and affordable energy sources is crucial.

Leaders from academia, industry, and government came together at U-M to explore the breadth and depth of energy

U-M ENERGY SYMPOSIUM SPEAKERS LISTEN TO A QUESTION FROM THE AUDIENCE DURING A PANEL DISCUSSION.

issues during the symposium titled, Energy Science, Technology, and Policy: Facing the Challenge. The February 13–14 symposium was attended by over 450 participants.

Samuel W. Bodman, U.S. secretary of energy, delivered the keynote address. He recognized the formation of the Michigan Memorial Phoenix Energy Institute (MMPEI) and discussed the Department of Energy's new initiatives with plug-in hybrid electric vehicles and the production of cellulosic ethanol.

"I notice that the students at America's leading research universities are voting with their feet—and energy is the leader, the focus of the day," Bodman remarked. "So it is entirely appropriate that this Institute has been built on the work of the earlier Phoenix Project, but in a way that brings the energy challenge up to date, as something that captures the interest and imagination of today's students and tomorrow's scientists and engineers."

U-M faculty from the College of Engineering, the School of Natural Resources and Environment, and the Ross School of Business were joined by faculty from the California Institute of Technology, University of California-Davis, MIT, and Michigan State University to deliver a series of presentations about today's most pressing energy issues and their work toward solutions.

Topics included new sources of bio-fuels, innovations in solar technology, the cost-benefit of nuclear power generation, the influence of government policy on energy markets, and the impact of our energy use on transportation systems and the global environment. Speakers also participated in panel discussions after each session.

Industry was represented by executives from DTE Energy (symposium sponsor), Dow Chemical, Duke Energy, the Ford Motor Company, and General Motors, who discussed their respective corporate development and research programs on fuel diversity and innovation, the energy business model, and automotive technology and design.

The range of speakers and topics revealed there is no silver bullet solution to the energy crisis. Instead, a collective strategy of pursuing energy efficiency, influencing consumer behavior, research and development in renewable and alternative fuels and policy changes create long-term opportunity for change.

Gary S. Was, professor of nuclear engineering and director of the MMPEI, kicked off the event by discussing the University's approach to the energy challenge. The MMPEI, established in September 2006, develops, coordinates, and promotes energy research and education across the University.

SAMUEL BODMAN, U.S. SECRETARY OF ENERGY, DELIVERED THE ENERGY SYMPOSIUM KEYNOTE (ABOVE) AND TOURED U–M LABORATORIES (BELOW) DURING HIS FEBRUARY VISIT TO CAMPUS.

"The enthusiastic turnout of faculty, students, community leaders, and colleagues from the region and beyond is an indication of support for the Institute's endeavor to lead the nation to a secure, affordable, and sustainable energy future," Was said. "The entire campus is energized by this event, and we are committed to making a difference—the Michigan Difference."

Recordings of the symposium talks and panel discussions can be accessed on the MMPEI website at www.mmpei.umich.edu. The symposium proceedings will be published later this year. S&D

PLANS GET ROLLING FOR ANN ARBOR AFTER PFIZER

On January 22, 2007, Ann Arbor and the state of Michigan received a "punch in the gut," as characterized by Michigan Governor Jennifer Granholm. That was when the pharmaceutical giant Pfizer announced plans to close its entire Ann Arbor research facility. The closure will be complete by the end of 2008 and result in the loss of 2,100 jobs, although Pfizer will move some of the people now in Ann Arbor to other sites as part of a company-wide reorganization aimed at consolidating operations.

The announcement was a surprise and shock to the entire community and state. The University immediately pledged to work with the City of Ann Arbor, State of Michigan, Ann Arbor SPARK, and others in the community to address the job loss. At a news conference at the Michigan Union on the day of the announcement, Gov. Granholm joined U-M President Mary Sue Coleman, Ann Arbor Mayor John Hieftje, and other elected officials in promising an "aggressive strategy" to keep workers here and avoid a "brain drain" of highly educated people.

"We are determined to send a message to all of the employees of Pfizer that we want you to stay," said Granholm.

The potential cost to Ann Arbor is great. However, notes Stephen R. Forrest, University of Michigan vice president for research, this action on the part of Pfizer also provides an opportunity for the University and City to pursue new ventures in an effort to retain some of the intellectual power currently working for Pfizer in Ann Arbor. The facility and the land it is on also presents opportunities, and several community taskforces have been organized to make plans for a post-Pfizer period.

Within a week of Pfizer's announcement, Gov. Jennifer Granholm and Ann Arbor area leaders announced the formation of the Strategic Working Action Teams (SWAT) to aid displaced workers from the company's Ann Arbor campus and to help guide the community response. Business formation and acceleration resources were set up through Ann Arbor SPARK, an economic development and marketing organization for the greater Ann Arbor region. A Web log has been established along with a Web section for updated Pfizer news and employment, and business start-up opportunities at www.annarborspark.org. And the Michigan Department of Labor and Economic Growth has committed $1 million to assist dislocated workers.

Ann Arbor SPARK and its community partners also are working on funding for start-up businesses through the Michigan Pre-Seed Capital Fund and equipment through the Michigan Innovation Equipment Depot. The action teams and their partners will also be working with regional universities and Pfizer to identify business and entrepreneurial opportunities.

Since January, several job fairs have been held aimed at helping match Pfizer employees with job opportunities in the area. Ann Arbor SPARK organized "career-change boot camps" for Pfizer employees who wanted help analyzing their choices as they considered what to do with their buyout payments. These boot camps covered topics such as starting a business, how to explore a career change, and specific sessions for careers in the health care and information technology fields.

In March, the University announced the establishment a $3 million fund that departments can use to help recruit Pfizer scientists to new research positions. The Provost's office will make $1 million per year available in one-time funds. Units that nominate individuals for this support will be expected to provide a substantial match to the Provost's funds, resulting in significantly more than the $3 million in University funding for this effort. Coleman says the extra money could help in special cases, such as instances where U-M wants to lure a particularly talented researcher or spouse, or a gifted faculty member.

While the fund could help create an additional 20 new research positions, Coleman stresses that U-M regularly has hundreds of openings that can also be filled by various Pfizer staff at all levels. Nominations for candidates to support will be made by individual schools and colleges and will go to the Office of the Vice President for Research, which will work with the Provost's office to determine allocation amounts.

The U-M School of Education held in late February a lunch presentation about the masters in arts with certification program. The one-year program is designed for non-education majors trained in one field who wish to obtain teacher certification and a master's degree, and change to a new career teaching. Traditional programs can take two or more years to receive the same credentials. The intensive summer-to-summer approach accelerates the process by coordinating coursework with extensive field experience in school settings. Some of the Pfizer employees who attended the presentation expressed interest in enrolling in the program as soon as this summer.

In early April, Pfizer disclosed additional details of its plans. Starting in June and continuing through the end of the summer, some current employees will be offered transfers to other Pfizer sites. Others will receive severance packages. According to Mike Finney, president and CEO of Ann Arbor SPARK, there are 19 groups of Pfizer employees who have expressed interest in starting companies. By September, Pfizer expects that a majority of its Ann Arbor employees will be gone, and the next chapter in the community's efforts to cope will begin to unfold. S&D

DISTINGUISHED INNOVATOR AWARDEE ON ENTREPRENEURSHIP

On March 21, 2007, Professor Mohammed Islam received the first Distinguished University Innovator Award, presented by the Office of the Vice President for Research. This prestigious honor recognizes the noteworthy demonstration of a transformational innovation, the movement of an innovation to market-readiness, or the creation of the new means for transferring innovations from the research lab into the private sector.

"Professor Islam has made great strides in developing breakthrough technology and then creating and fostering the formation of new companies to bring this technology to the market," says Stephen R. Forrest, vice president for research. "His efforts represent the kind of connections between research, innovation, and technology transfer that I wish to recognize and promote with this award."

Professor Islam, a member of the faculty in the Department of Electrical Engineering and Computer Science, was cited for his development of Raman fiber optic amplifiers for long-haul telecommunications and subsequent demonstration of this technology's competitiveness compared to the existing norm for the industry. When he introduced his technology, skeptics said it would not be reliable, yet Professor Islam has proven them wrong in the lab and through the success of his startup company, Xtera Communications, which has survived and grown in the fiercely competitive telecom equipment market.

In Islam's lecture at the award ceremony, he spoke about his experiences launching start-up companies and highlighted some of what he learned about entrepreneurship—including things he wished he knew before he started.

"It's tough doing non-automotive start-ups in Michigan," noted Islam. For one thing, it is not easy to assemble an experienced management team in a non-automotive. "And it's difficult to recruit people to move into Michigan with its image as a Rust Belt state."

The Midwest culture tends to be risk averse, he added. And lastly, venture capitalists like to have the start-ups they support close at hand, and the majority of the venture capital is located along the coasts, so they are less likely to want a supported company in the middle of the country. Islam did eventually need to move Xtera Communications to Texas in order to enlarge the company.

After coming to the University of Michigan, Islam actually moved back to private industry for a few years at a time, "but I always came back to the University," he said. "Part of the reason for that is because we always return to that which we love. The other reason is that universities are the perfect breeding ground for breakthrough technologies." He gives a lot of credit for that environment to the students and their energy and enthusiasm.

Islam also had a message for those interested in transferring an invention from the University into private development. First, he noted, "Either everybody wins or nobody wins. There is no other answer. And as an entrepreneur, you have to be sure that the University wins on its metrics." He urges those who spin off companies to contract research back into the University, which will benefit both parties.

"Now it takes two hands to clap," he continued. "So there are some responsibilities on the University's side." To illustrate that responsibility, he cited John Hennessy, president of Stanford University, and how that institution handled the spin-off of Yahoo, which was created by two Stanford graduate students.

"It becomes very difficult to impose licensing terms, and I think in many cases, people who have attempted to do that have messed up the technology transfer process, and they've destroyed what they really had, the real entity that they had," according to Hennessy. "It was better for us to find a way for them to transfer that technology and get out and get running with it, and leave with a good relationship with the university."

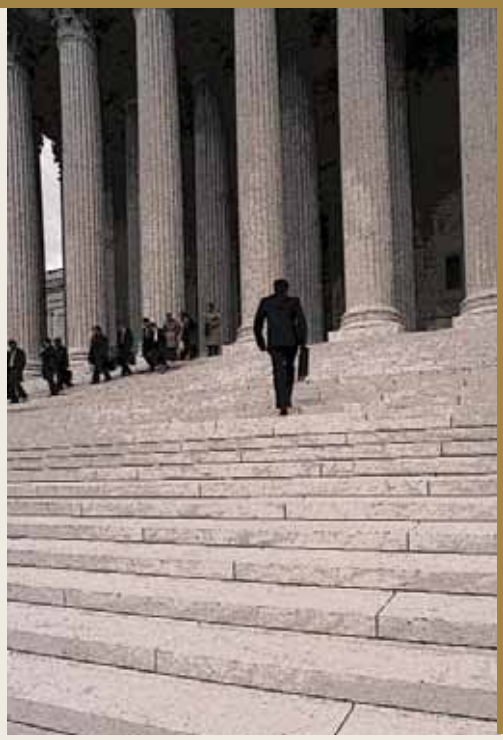
Then Islam added that some observers concluded that Stanford probably got more in the way of donations, enhanced reputation, and student enrollment by essentially releasing Yahoo without a tight licensing arrangement than it would have by trying to structure a contract to tap the eventual financial success of the company.

Islam closed his talk with a pitch to faculty and students to be involved in technology transfer. "There is a compelling reason to do this," he said. "And that's in support of the United States' research infrastructure." With the decline of the industrial research lab, there is a gap between the research done by universities and the product development done by industry.

"And that is the opportunity for start-ups," he said. "If you take on a start-up, what you are helping to do is take university concepts a step closer to where industry might pick them up."

Get students involved, too, for Islam pointed out that the really successful companies that came out of Stanford were started by students. Universities need to give students the tools to become entrepreneurs, and good things will happen. S&D

VIEW FROM WASHINGTON, DC



Tight Federal Budgets May Limit Research

The annual federal budget fight began at the start of 2007. Since the release of the President's Fiscal Year 2008 (FY08) Budget Request in February—the first since the Democrats took control of Congress in November—the White House and Congress have been locked in a battle over tax cuts and funding levels for every agency in the federal government. Research agencies, such as the National Institutes of Health (NIH) and National Aeronautics and Space Administration (NASA), will be impacted by this debate.

Each year, on the first Monday in February, the President sends Congress a budget request for the coming fiscal year. This request outlines in detail what the President believes overall federal fiscal policy should be and outlines priorities for federal programs ranging from defense to education, health, and science.

Upon receiving the request, both the House and the Senate each write separate budget resolutions. Compared to the President's request, these are documents that set out spending guidelines in broad functional categories, such as national defense, energy and science, space, and technology. Later, the two bodies iron out the differences between the two documents and produce one final budget resolution. Pinpointing exact funding levels for federal programs falls to the appropriations committees after agreement is reached on the resolution.

Innovation and Development Highlighted by President's Request

This year, the White House FY08 budget request of $2.9 trillion holds non-security discretionary spending growth to one percent. Of this total, the Administration allocates $142.9 billion, a 1.4 percent increase over the FY07 level, for federal research and development. These additional dollars, however, largely go to development of Department of Defense weapons systems and NASA spacecraft. Total support for basic and applied research actually falls 2 percent under the President's budget proposal. This means continuation of recent troubling trends for some research areas, such as NIH funding, but spells out good news for agencies such as the National Science Foundation (NSF) and the Department of Energy (DOE) Office of Science.

Under the President's proposal, the NIH —which has seen its budget flatten in recent years—drops by $529 million, or 1.2 percent, to $28.1 billion. Part of the reason for this decrease is a transfer of $300 million from the NIH to the Global Fund for HIV/AIDS program.

Other significant Administration cuts are aimed at NASA and the Department of Defense. In both agencies, development continues to trump basic research. Development of the new NASA Crew Exploration Vehicle and Crew Launch Vehicle receives a 10 percent increase over FY07 for a total of $3.1 billion. International Space Station construction is allocated $2.2 billion, a $503 million increase over last year. These programs consume much of the new money proposed for NASA. Therefore, Earth-Sun science, Earth observing, astronomy, and robotic missions receive a modest 2.4 percent increase while aeronautic research is cut by 20 percent. Life and physical sciences receive a $183 million budget, less than half of last year's funding.

At the Pentagon, weapons development increases by 5.5 percent to an all-time high of $68.1 billion, while basic defense research falls 9 percent and applied research plummets by 18 percent. Most of these cuts reflect the annual elimination of Congressional earmarks from the President's Budget Request. Even after this is taken into account, the Administration still asks for just 0.4 percent more for basic research than it did in FY07. In the case of applied research, the request is 2.7 percent less last year.

In contrast to other federal research programs, the NSF and the DOE Office of Science are slated to receive significant increases for the second year in a row. NSF research and development increases 8.3 percent over last year to $6.4 billion. The Office of Science budget increases by 16 percent to $4.1 billion. These two agencies receive unique attention as being key research programs to strengthening U.S. innovation and competitiveness, according to the National Academies report, "Rising Above the Gathering Storm."

Congress Provides Solid Funding for Science

As is traditionally the case when the Democratic and Republican parties split control of Congress and the White House, the Congressional leadership has considered the Administration's budget request to be "dead on arrival." Consequently, the House and Senate have each passed their own $2.9 trillion budget resolutions with priorities that differ greatly from the President's proposal. Of significant importance to research universities are additions made by both the House and Senate for health research.

Given the broad nature of these resolutions, details are hard to come by as to the future of the NIH. However, it appears that it will fare better. In the Senate resolution, $2.2 billion has been added to the health function. Senators Harkin (D-IA) and Specter (R-PA), who wrote the amendment to add this money, specified the amount for the NIH. The House also includes an additional $2.27 billion to its own health function. House Budget Committee staff have said that there will be "plenty of money for NIH." Significantly, House Appropriations Chairman David Obey (D-WI), who has referred to the President's budget proposal for the NIH as a "step backwards," has promised to increase FY08 appropriations for this agency.

It is unclear how most basic science programs will fare under the Congressional budget resolutions. The NSF and the Office of Science are expected to receive increases similar to those advocated by the White House. The House resolution funds the general science, space, and technology programs at $27.6 billion, while the Senate provides $27.5 billion. The Senate budget resolution originally provided only $26.5 billion for these programs. However, Senators Bingaman (D-NM) and Alexander (R-TN) introduced an amendment that added $1 billion to this budget function with the understanding that over $390 million goes to the NSF, more than $600 million to the Office of Science, and $11 million to the National Institute of Standards and Technology.

In the coming months, Washington will work to reach an agreement on the FY08 budget guidelines. The appropriations process then will turn the budget recommendations into actual dollar allocations for each federal agency. As strong advocates for science, the Michigan delegation will continue to represent the concerns and interests of the University of Michigan community through negotiations that are likely to last until the last days of the year. S&D

—SARAH WALKLING, DIRECTOR OF FEDERAL RELATIONS FOR RESEARCH, AND ASSISTANT DIRECTOR OF THE U-M WASHINGTON DC OFFICE

RESEARCH NOTES

Cited More, Safe Forever: Deep Blue makes it possible

The University of Michigan Library has established a free service—Deep Blue—designed to securely store scholarly and creative works. According to its creators, Deep Blue provides many advantages to the Michigan scholarly community:

- **Visibility.** Work accessible via Deep Blue should be easier to locate online (in Google Scholar, for example), which should lead to it being cited more readily. The Library reports that a recent study shows that work available through databases like Deep Blue is cited 25 percent to 250 percent more than it would be if it was only available through subscription-based services.
- **Permanence.** Deep Blue uses special technology that assures the stability of a work's online location, making the citation to it as reliable as a scholarly journal, while as accessible as any website.
- **Comprehensiveness.** Deep Blue supports a variety of formats, and it will accept not only finished work, but related materials (including data, images, audio and video files, etc.) to provide context and promote further scholarship.
- **Safe storage.** Deep Blue ensures that works only have to be deposited once. From then on the Library takes care of backups, compatibility, and format issues. There are some technical limitations to the formats the Library can support indefinitely, but it is committed to preserving the integrity of all material exactly as it was deposited.
- **Control over access.** Deep Blue allows the person submitting material to limit who can view various aspects of the work for a given time, if necessary. This is difficult to do on a personal website without hiding the work completely.
- **Context.** Deep Blue provides context in two additional ways. First, U-M is a destination for the best researchers and scholars, and Deep Blue places a scholarly work in the larger context of the U-M environment, side-by-side with the scholarly and artistic contributions of colleagues and students. Second, as other universities, institutions, and organizations begin to provide this service for their work as well, the Library will collaborate with them to create discipline-specific services.

Deep Blue is designed to meet not only today's publishing demands but also new ones as they evolve. Find it online at deepblue.lib.umich.edu.

Russian Academy of Sciences Honors U-M Geologist

In March, Professor Rod Ewing, chair of the Department of Geological Sciences in LSA, was in Moscow to receive the Lomonosov Gold Medal of the Russian Academy of Sciences. The Lomonosov Gold Medal, named after Russian scientist and polymath Mikhail Lomonosov, is the highest award of the Russian Academy of Sciences. Each year, a Russian and a non-Russian receive the award for outstanding achievements in the natural sciences and humanities. Professor Nikolay Laverov, vice-president of the Russian Academy of Sciences, was the Russian recipient with Ewing.

Ewing and Laverov have played a significant role in fundamental research in support of the nuclear fuel cycle and nuclear waste management. Ewing's research has focused on developing an understanding of radiation effects in solids and the discovery of radiation-resistant materials that can be used to safely dispose of actinides, such as plutonium. Ewing is the Donald R. Peacor Collegiate Professor in the Department of Geological Sciences and also is a professor in the

Ancient Funerary Marker Installed at U-M Botanical Gardens

On April 2, a 12th-century limestone cenotaph was moved from storage in a pole barn to the Matthaei Botanical Gardens' conservatory. The cenotaph, or funerary marker most likely designed as a memorial to an important person, came from Syria. Arabic calligraphy excerpts from the Holy Qur'an's Verse of the Throne cover the cenotaph. Although the cenotaph deserves further study, U-M students and scholars have translated the Verse of the Throne inscription girding the lower stones where kufic script, the oldest form of Arabic calligraphy, incorporated complex floral motifs. Assembly of the marker, which consisted of 15 pieces, took several hours of manual and machine-assisted labor. The marker was a 1960 gift to the U-M Museum of Art. It was in storage until 1992, when it was moved to the grounds of U-M's Inglis House. While it awaits a permanent installation in the expanded art museum, the cleaned and restored piece will be on display at the gardens April 2–June 29, where it will find an environment resembling that of Syria near many plants from the Near East, including oleander, laurel, olive, and papyrus.

Departments of Materials Science and Engineering and Nuclear Engineering and Radiological Sciences.

More than twenty of the previous recipients are Nobel laureates. Previous recipients include Hans Bethe, John Kenneth Galbraith, James Watson, Linus Pauling, and Aleksandr Solzhenitsyn. The most recent award to a non-Russian in the geosciences was to Frank Press in 1997. Frank Press is a former president of the U.S. National Academy of Sciences.

Research Administrators Receive Awards

Three U-M research administrators are recipients of OVPR Staff Awards for 2007. Patricia Fink and Peggy Westrick received the Distinguished Research Administrator Award, which honors individual staff members from any unit at the University who have demonstrated over a number of years distinguished service exemplifying the goals of professional research administration. Kathleen Welch received the OVPR Exceptional Service Award, given to recognize research administrators from OVPR units who have risen to meet a particular challenge in an exceptional way, that goes beyond the ordinary fulfillment of their duties.

Patricia Fink is proposal and contracts manager for the Institute for Social Research, where she directs a small staff that processes nearly 250 grant submissions to more than 90 agencies each year.

Peggy Westrick is research process senior manager in the Dean's office of the College of Literature, Science, and the Arts. Her duties require her to understand the needs of faculty from every discipline in LSA, which processes about 800 proposals per year.

Kathleen Welch is statistician senior in the Center for Statistical Consultation and Research (CSCAR). She provides user support to the research community for many statistical software packages on several platforms, and is an instructor for CSCAR workshops. S&D

Five Chosen for Guggenheim Fellowships

The John Simon Guggenheim Memorial Foundation announced in April the 189 winners of its 2007 fellowships. Five of the recipients are members of the University of Michigan faculty:

- **Michael P. Flynn,** associate professor, Department of Electrical Engineering and Computer Science. Project: The fundamental limits of analog-to-digital conversion.
- **Enrique García Santo-Tomás,** associate professor of Spanish. Project: Fictions by war veterans in early modern Spanish literature, 1550–1680.
- **Arthur Lupia,** Hal R. Varian Collegiate Professor of Political Science. Project: Political knowledge and the practice of civic education.
- **Roberto D. Merlin,** professor of physics and of electrical engineering and computer science. Project: Sub-nanometer imaging with sub-picosecond resolution.
- **Piotr Michalowski,** George G. Cameron Professor of Ancient Near Eastern Civilizations. Project: The cyclical birth and rebirth of early Mesopotamian literature.

This year's Guggenheim Fellows include writers; visual and performing artists; humanities scholars; and physical, biological, and social scientists selected from almost 2,800 applicants for awards totaling $7.6-million. S&D

OFFICE OF
THE VICE PRESIDENT
FOR RESEARCH

4080 Fleming Building
503 Thompson Street
Ann Arbor, MI 48109-1340

UNIVERSITY OF MICHIGAN

FIRST-CLASS MAIL
U.S. POSTAGE
PAID
ANN ARBOR, MI
PERMIT NO. 144

CONTACTS

Stephen R. Forrest
Vice President for Research
734/764-1185, stevefor@umich.edu

James A. Shayman
Associate Vice President
734/763-1290, jshayman@umich.edu

Steven L. Ceccio
Associate Vice President
734/763-1290, ceccio@umich.edu

Pamela J. Smock
Associate Vice President
734/763-1290, pjsmock@umich.edu

Marvin G. Parnes
Associate Vice President and Executive Director for Research Administration
734/936-3933, mgparnes@umich.edu

Judith A. Nowack
Associate Vice President
734/763-1289, jnowack@umich.edu

Sarah K. Walkling
Director of Federal Relations for Research & Assistant Director, U-M Washington Office
734/764-1185; 202/554-0578,

Curt W. Smitka
Director, Budget & Administration
734/936-2681, cwsmitka@umich.edu

RESEARCH UNITS

Biophysics Research Division (BRD)
Duncan G. Steel, Chair
734/764-5257, dsr@umich.edu

Center for Human Growth and Development (CHGD)
Daniel P. Keating, Director
734/764-2443, keatingd@umich.edu

Institute for Research on Women and Gender (IRWG)
Carol J. Boyd, Director
734/615-6468, caroboyd@umich.edu

Magnetic Resonance Imaging Facility (fMRI)
John Jonides, Co-Director
734/764-0192, jjonides@umich.edu
Douglas C. Noll, Co-Director
734/764-9194, dnoll@umich.edu

Michigan Memorial Phoenix Energy Institute
Gary S. Was, Director
734/763-7401, gsw@umich.edu

U-M Transportation Research Institute (UMTRI)
Peter F. Sweatman, Director
734/764-6505, sweatman@umich.edu

ADMINISTRATIVE/ SERVICE UNITS

Business and Industrial Assistance Division (BIAD)
Marian J. Krzyzowski, Director
734/998-6201, mjsk@umich.edu

Center for Statistical Consultation and Research (CSCAR)
Edward D. Rothman, Director
734/763-2052, erothman@umich.edu

Division of Research Development and Administration (DRDA)
Marvin G. Parnes, Executive Director
734/936-3933, mgparnes@umich.edu

Institutional Review Boards (IRBs)—Behav-Sci and Health
Pamela J. Smock, Director
734/763-1290, pjsmock@umich.edu
IRB office: 734/936-0933, irbhsbs@umich.edu

Michigan Memorial Phoenix Project
Steven L. Ceccio, Director
734/763-1290, ceccio@umich.edu

Office of Human Research Compliance Review (OHRCR)
Ronald F. Maio, Director
734/647-0489, ronmaio@umich.edu

Office of Technology Transfer (OTT)
Kenneth J. Nisbet, Executive Director
734/763-0614, knisbet@umich.edu

Unit for Laboratory Animal Medicine (ULAM)
Howard G. Rush, Director
734/764-0277, hgrush@umich.edu

Women in Science and Engineering (WISE)
Cinda-Sue Davis, Director
734/647-7012, 734/615-4455, csdavis@umich.edu

INCUBATOR UNITS

Core Technology Alliance (CTA) of the Michigan Life Sciences Corridor
John C. Greenfield, Executive Director
734/615-5045, john.greenfield@vai.org

Imagining America
Julie Ellison, Director
734/615-8370, imaginingamerica@umich.edu

U-M Substance Abuse Research Center (UMSARC)
Margaret E. Gnegy, Director
734/998-6500, pgnegy@umich.edu