Office of the Vice President for Research

Winter 2008

SEARCH & DISCOVERY

RESEARCH AT MICHIGAN

BIG PLANS *for* SMALL TOOLS

UNIVERSITY OF MICHIGAN

CONTENTS

ON THE COVER

Top and back views of an integrated microsystem for data gathering. The system shown takes up less than one-half cubic centimeter when a battery is added. This system monitors pressure, temperature, and humidity, as well as a number of biological parameters. Credit: WIMS ERC

ONE OF THE COMPONENTS OF THE FIRST GENERATION MICRO GAS CHROMATOGRAPH DEVELOPED AT THE NSF ENGINEERING RESEARCH CENTER FOR WIRELESS INTEGRATED MICROSYSTEMS.

STEPHEN R. FORREST
VICE PRESIDENT FOR RESEARCH

WRITER
LEE KATTERMAN

MM&D 070695

STATE OF OPPORTUNITY

As one looks around Ann Arbor, it's fairly easy to see signs of what is classically termed a "boom town." The streets are lively, of course, as they always have been. But there is something more occurring that is lending a special vitality to this most interesting small city, even while much of the state is economically depressed.

An obvious sign is the construction projects at the University—more than $1 billion worth, including such major projects as the C.S. Mott Children's Hospital and Women's Hospital, the Kellogg Eye Center expansion, the Art Museum expansion and restoration, and the North Quad Residential and Academic Complex, to name a few. In fact, at almost every level, it is apparent that the University of Michigan is a vibrant, world-leading institution of higher learning that is thriving as never before. Our students improve every year, as do the faculty. Add to this President Coleman's recently announced proposal of an ambitious plan to hire 100 new young faculty over the next five years in multidisciplinary areas of research, and we can expect more and better impact from our research and teaching for many years to come.

Juxtapose the progress being made at the University with the condition of our region, and the contrast could not be starker. Michigan leads the U.S. in unemployment: 7.7 percent compared to the national average of 4.7 percent. The state is losing population, and many of those leaving are the young and highly educated who can provide the workforce for a revitalized knowledge-based economy. The cause of this problem lies in our traditional reliance upon manufacturing as our economic base. Yet, globalization has resulted in the diminishment of that base, with manufacturing now done increasingly off shore.

Since the University is doing well, our town is flourishing, and our reputation is better than ever in spite of the dire condition of the rest of the state, one would naturally expect that the U-M would continue business as usual. After all, we have followed that path in the past, and it has led to excellence across many disciplines.

However, I do not believe that such an approach, even if it might advance the University in the near term, will lead to a sustainable and stable future for the institution. Eventually the prospects of the region will encroach on our ability to attract the best students and the finest faculty from around the world. Equally important, we were founded as a public university with the mission to serve the people of the state of Michigan. While it would appear that the State itself is turning away from the university by continually reducing its support, this does not lessen our responsibility to provide a first-rate education to our students (most of whom come from Michigan) or to educate the knowledge workforce that will ultimately turn around the fortunes of an economy traditionally based on manufacturing.

Furthermore, the basis of our research competitiveness rests on the effectiveness of our engagement with industry. From Cambridge University in the UK, to Stanford, MIT, and UC-Berkeley, to name a few, the most competitive and influential universities worldwide are finding new ways to engage with industry in particular, and the non-academic world in general. The University of Michigan has no choice but to strengthen its engagement for no other reason than to remain among this group of the best universities in the world.

The state of Michigan and the Great Lakes region, once the powerhouse of manufacturing in the U.S. and the world, now presents a once-in-a-lifetime opportunity for the University of Michigan to rise to a new level of excellence through increased engagement. Certainly, in the Office of the Vice President for Research and many other units across the University, people are finding ways to seize this opportunity. The President's announcement for hiring a cadre of new young faculty is an excellent example of how to move boldly when everything around us suggests that more conservative steps are advisable. I would encourage everyone at our university to imagine, and to take advantage of the enormous possibilities offered in this time of change, and to use this change to energize our own thinking about our individual scholarly and research activities. Our successes offer an incredibly bright future to look forward to. And of course, failure is not an option.

—Stephen R. Forrest

BIG PLANS *for* SMALL TOOLS

The electronics revolution of the last 50 years has made so many changes to daily life that many of us don't even remember the full extent of what has happened. The invention of the transistor in 1947 started a revolution in data processing and communications that today influences all aspects of daily life. The "stereo console" (based on transistors rather than vacuum tubes) was a prized piece of technology in living rooms of the 1960s. That furniture-sized music player has now evolved into myriad solid-state devices, including the mp3 players of the last few years. More recently, new feature-packed devices have appeared, such as the iPhone. This high-tech wonder includes a cell phone, music and video player, and internet browser, controlled by one mechanical button and multiple sets of touch-screen controls that appear as needed.

A new branch of the electronics revolution—wireless microsystems—has also been making significant advances for the last couple decades in an effort to provide better and smaller devices for linking this electronics revolution to the non-electronic world. "This is a really hot topic worldwide," says Ken Wise, William Gould Dow Distinguished University Professor of Electrical Engineering and Computer Science, J. Reid and Polly Anderson Professor of Manufacturing Technology, and director of the Engineering Research Center for Wireless Integrated MicroSystems (WIMS ERC) at the University of Michigan.

"These wireless microsystems can be used to measure just about anything, any time," continues Wise. "They can gather information about global warming, pollution, and even help meet homeland security needs. Some of these new devices are so small that you can implant them in the body and use them to monitor internal systems for diagnostic and therapeutic applications."

Funded by the National Science Foundation, the WIMS Center, which is a collaboration of the U-M with Michigan State University and Michigan Technological University, has aimed its research at four general application areas since it was established in 2000: health care, the environment, homeland security, and energy systems. "Our

KEN WISE

research focus is on devices that merge sensing with low-power integrated circuits, wireless interfaces, and advanced power sources," adds Wise.

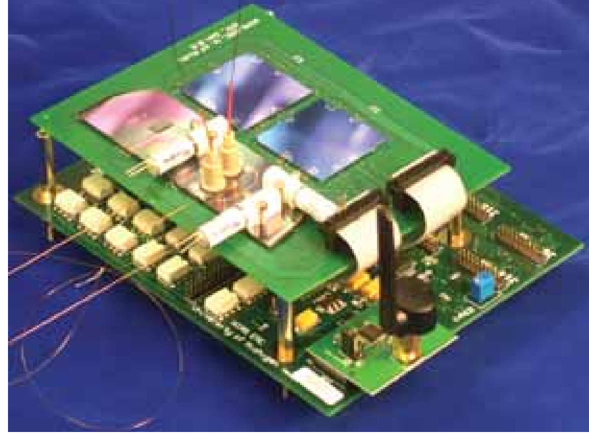
A good deal of progress has been made in the environmental sensor work of the WIMS ERC, which has concentrated on developing devices to interact with the chemical and physical world. "Environmental monitoring is an area with lots of promise," says Wise. With small enough sensors, there are all kinds of possible applications, such as distributing indoor air-quality monitors throughout a building, in a subway, or deep in a mine. The WIMS scientists and engineers can measure pressure, temperature, and humidity, along with air quality, all in one small package.

The centerpiece of the environmental sensing efforts, which is led by Professor Edward Zellers of the School of Public Health, is a self-contained miniature gas chromatography system capable of identifying different gases in a gaseous mixture at parts-per-billion concentrations or less in a few seconds to a few minutes. The target size for this device is that of a small calculator or wristwatch, in great contrast to the suitcase-size systems of today.

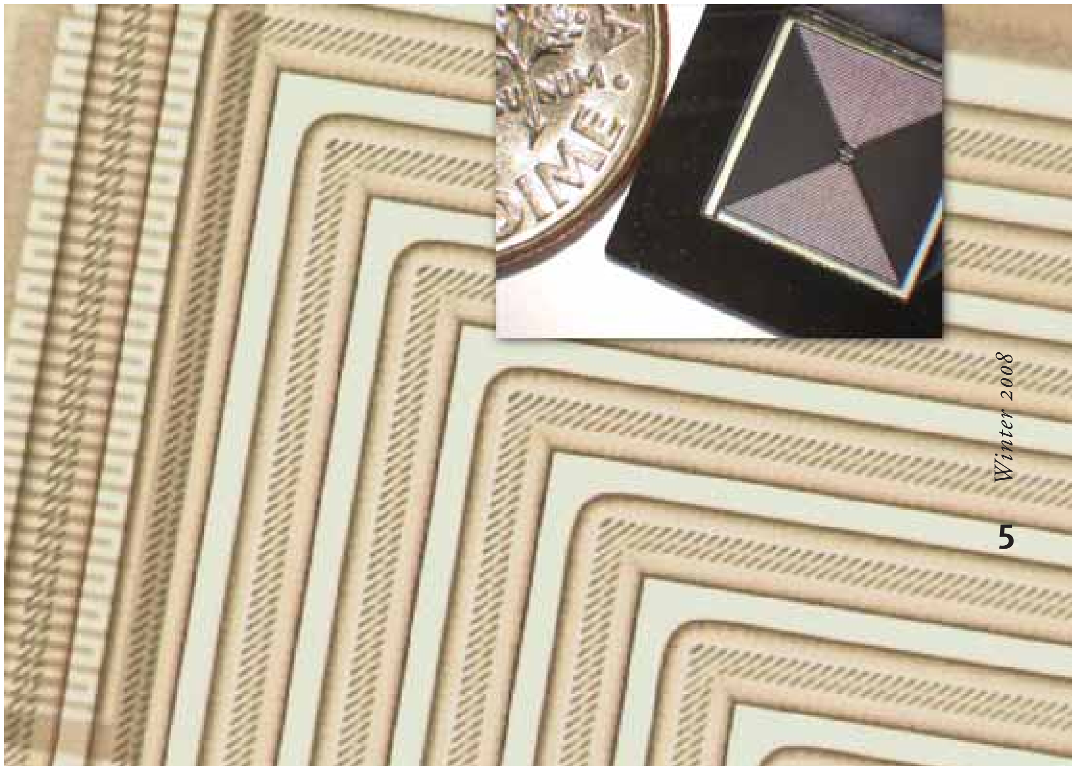
Gas chromatography is an analytical technique for separating different molecules in a complex sample that dates back to the middle of the last century. In the standard modern instrument, the sample of gas is injected in one end of a tube that is about a millimeter or so in diameter and many feet long. The tube is coated with a material to which the different molecules of the gaseous mixture adhere for different amounts of time as they pass through the tube. The different molecular components thus exit the end of the tube (column) at different times, and the time it takes for each component to pass through the tube can be used to identify it.

Building a micromechanical gas chromatograph (GC), however, is not simply a matter of shrinking all of the pieces of a standard laboratory instrument. "It's not easy since a GC has lots of parts including valves, preconcentrators, separation columns, detectors, and a pump," says Wise. "We still have a way to go on this, but we do have a working microGC the size of a handheld calculator, which is a world record in itself. The calculator size is fine for many applications, but pushing it to wristwatch size is an attempt to promote a paradigm shift. The use of MEMS [microelectromechanical systems] technology for this promises much smaller size, much lower operating power, much lower cost, and greatly increased speed of analysis."

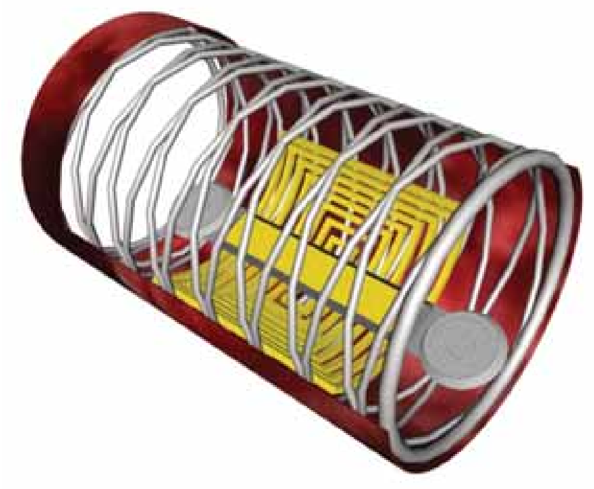
One step in reducing the size of the gas chromatograph has been to create the tubing of the separation column using the same technologies developed to make integrated circuits. WIMS Center researchers use precision lithography on 10 cm-diameter silicon wafers to batch fabricate dozens of 0.1 mm-diameter chromatography columns, each wound back-and-forth over the chip surface and up to a meter or more in length. "In gas chromatography, longer tubes can give better separation of mixtures," notes Wise.



THE FIRST GENERATION OF MINIATURIZED GAS CHROMATOGRAPH DEVELOPED BY WIMS SCIENTISTS, WHICH CAN FIT INTO THE PALM OF YOUR HAND.



A MEMS-BASED GAS CHROMATOGRAPHY (GC) COLUMN MADE FROM SILICON, PLACED NEXT TO A DIME. CLOSE-UP SHOWS THE INLET SECTION OF GC COLUMN. TOTAL LENGTH OF THE COLUMN IS ONE METER WITH A COLUMN CROSS-SECTION OF ABOUT 0.1 MM IN DIAMETER.



A "SMART" STENT CONTAINING MICRO-SCALE SENSORS AND WIRELESS TRANSMITTER TO DETECT ARTERIAL PRESSURE AND FLOW.

But to make good use of these ultrasmall tubes, the column temperature and flow rate must be both known and controlled with accuracy. Small heaters and temperature sensors are embedded on each separation column chip. Pressure sensors are formed as well during the same fabrication process. Both provide feedback to the heaters and the micropump to provide reliable conditions during separation.

The microGC may not end up with all of its parts integrated on a single silicon chip, however. One more likely grouping may be to integrate the sample "preconcentrator" (a component that collects the desired vapors until the sample size is large enough, and then is rapidly heated to release the sample into the column), the chromatography column itself, and a multi-element chemical detector, all on different chips that can be plugged into each other to form a tiny separation system. Another chip will hold the data processor that analyzes the detector output and the wireless communication interface needed to send the data to a local or global monitoring network.

While making the gas chromatograph offers many challenges, says Wise, "It turns out that some processes work much better if miniaturized. My rule of thumb is that as long as what you are measuring is much smaller than the device you are measuring it with, then it probably makes sense to miniaturize the sensing system. In the case of the microGC, tests separating mixtures of gases show that identification can take place much more rapidly than with a full-blown desktop GC—on the order of seconds as opposed to minutes," he says. The small size of the instrument also means that power requirements will be low—there is much less to heat and what there is can be heated much more rapidly.

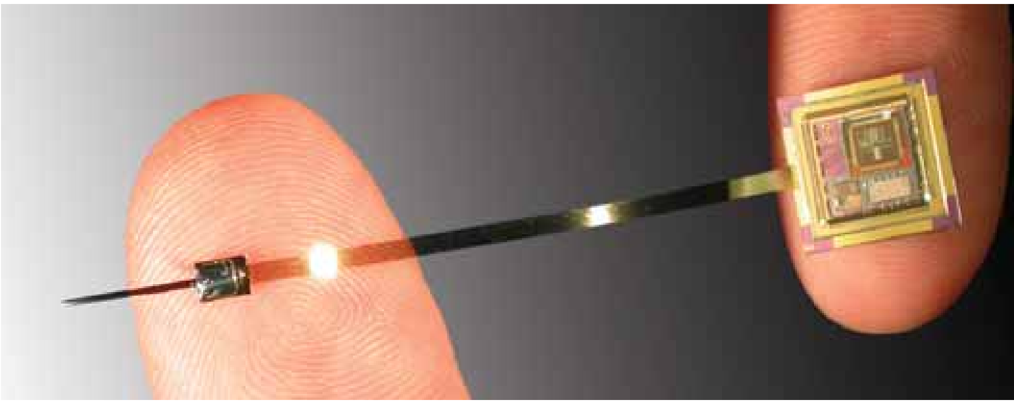
In another example, a microsystem for gathering, interpreting, and storing data on pressure, temperature, humidity, and biopotentials has been integrated on a device small enough to fit on the tip of a finger. Powered from a small off-the-shelf three-volt lithium battery, this microsystem can operate for more than 100 days at a sampling rate of one reading every 10 seconds.

"The present microsystem power consumption is low enough to enable long-term operation from small batteries," says Wise. Even at present, the entire device is smaller than 0.5cm^3, and the battery takes up most of this device size. As improvements are made and power needs drop, the overall size will continue to drop as well, notes Wise. "We are currently developing a wireless implantable microsystem for measuring intraocular pressure in the treatment of glaucoma. The device is smaller than a cubic millimeter and has much, much lower power needs," he adds.

Another area that has shown great promise is the application of wireless microsystems to neural interfaces, particularly to restore hearing to the profoundly deaf and in the use of deep brain stimulation to treat Parkinson's disease and related conditions. "The idea is to interface with the nervous system electronically," says Wise.

This work began in the 1950s by employing single wire microelectrodes with external signal processing technology. By the mid-60s, silicon etching technology was being used to make microchips containing multiple microelectrodes to record or stimulate many parts of a neural network simultaneously. But it wasn't until the mid-80s that the more precise etching used to make MEMS made it possible to imagine whole arrays of electrodes able to record from or stimulate virtually every neuron in a volume of tissue, thus eavesdropping on normal neural activity for diagnostic purposes or inserting signals for therapeutics. The size of multi-electrode probes has been dropping over the years, so that now some are as small as five micrometers (10^{-6} m) wide, or about one-twentieth the thickness of a sheet of paper. The goal is to make them essentially invisible to the tissue they are dwelling in.

The oldest form of neural prosthesis is the cochlear implant, which uses a bundle of wire electrodes inserted in the spiral cochlea of the inner ear to stimulate the auditory nerve and create the perception of sound, bypassing the hair cells that no longer function in the most common form of deafness. More than 120,000 cochlear prostheses have been implanted around the world, making it possible for even



A PROTOTYPE COCHLEAR IMPLANT. THE ELECTRODE ON THE LEFT HAS 32 SITES OF CONNECTION FOR STIMULATING AUDITORY NERVES. THE CHIP ON THE RIGHT CONTAINS THE PROCESSOR AND WIRELESS INTERFACE.

the profoundly deaf to hear well enough to use the telephone and interact with the hearing world. But much more is needed and may be possible.

"At Michigan, we have developed the first cochlear prosthesis to use thin-film lithographically-defined electrode arrays. They permit many times more stimulating sites than present commercial devices, and that should translate into improved sound quality and frequency range. We are also developing a wireless cortical microsystem to record signals from the motor cortex of the brain as the basis for systems that may someday restore at least limited motion to quadriplegics," says Wise. "Today, neural prostheses are working real miracles in helping people, and we expect even greater progress in the coming decade."

Researchers at the WIMS Center are also building a "smart stent." Stents are short tubes that are inserted into arteries to keep to keep them open in the face of plaque buildup. The significance of this new stent is that it has sensors embedded in it to detect blood flow and pressure. "You can wave an RF [radio frequency] wand over the area where the stent is placed, which provides enough power for the stent to send readings back to a nearby receiver," says Wise, "so there is no need to implant a battery." These stents would make it possible to check for re-stenosis (continued plaque buildup) whenever desired.

One key resource that makes WIMS research possible is the Solid State Electronics Laboratory (SSEL) and the related Michigan Nanofabrication Facility (MNF) on the College of Engineering campus. The SSEL has a very broad research program in all aspects of solid-state devices and technologies, and the MNF provides advanced research facilities and capabilities in micro and nano technologies to U-M researchers. (See sidebar.)

"I don't think the State of Michigan fully realizes the important assets it has in the SSEL and the MNF," says Wise. These resources are used by Michigan faculty and students, but more and more private companies are forming partnerships with the WIMS Center and other College of Engineering projects that give them access to the know-how and facilities.

"In the next 50 years, wireless microsystems are going to have an impact similar to what the integrated circuit and microcomputers have had over the last 50 years," says Wise. "It's an exciting time to work in this area of research." S&D

Further Reading

D.F. Lemmerhirt and K.D. Wise, *"Chip-Scale Integration of Data-Gathering Microsystems,"* Proceedings of the IEEE, *Vol. 94, pp. 1138-1158, June 2006.*

K.D. Wise, D.J. Anderson, J.F. Hetke, D.R. Kipke and K. Najafi, "Wireless Implantable Microsystems: High-density electronic Interfaces to the Nervous System," Proceedings of the IEEE, *Vol. 92, pp. 76-97, January 2004.*

FABRICATION FACILITY CRUCIAL TO WIMS, OTHERS

ADDITIONAL CLEAN ROOM SPACE, SHOWN HERE, IS A KEY PART OF THE MICHIGAN NANOFABRICATION FACILITY RENOVATION AND EXPANSION THAT IS NEARING COMPLETION.

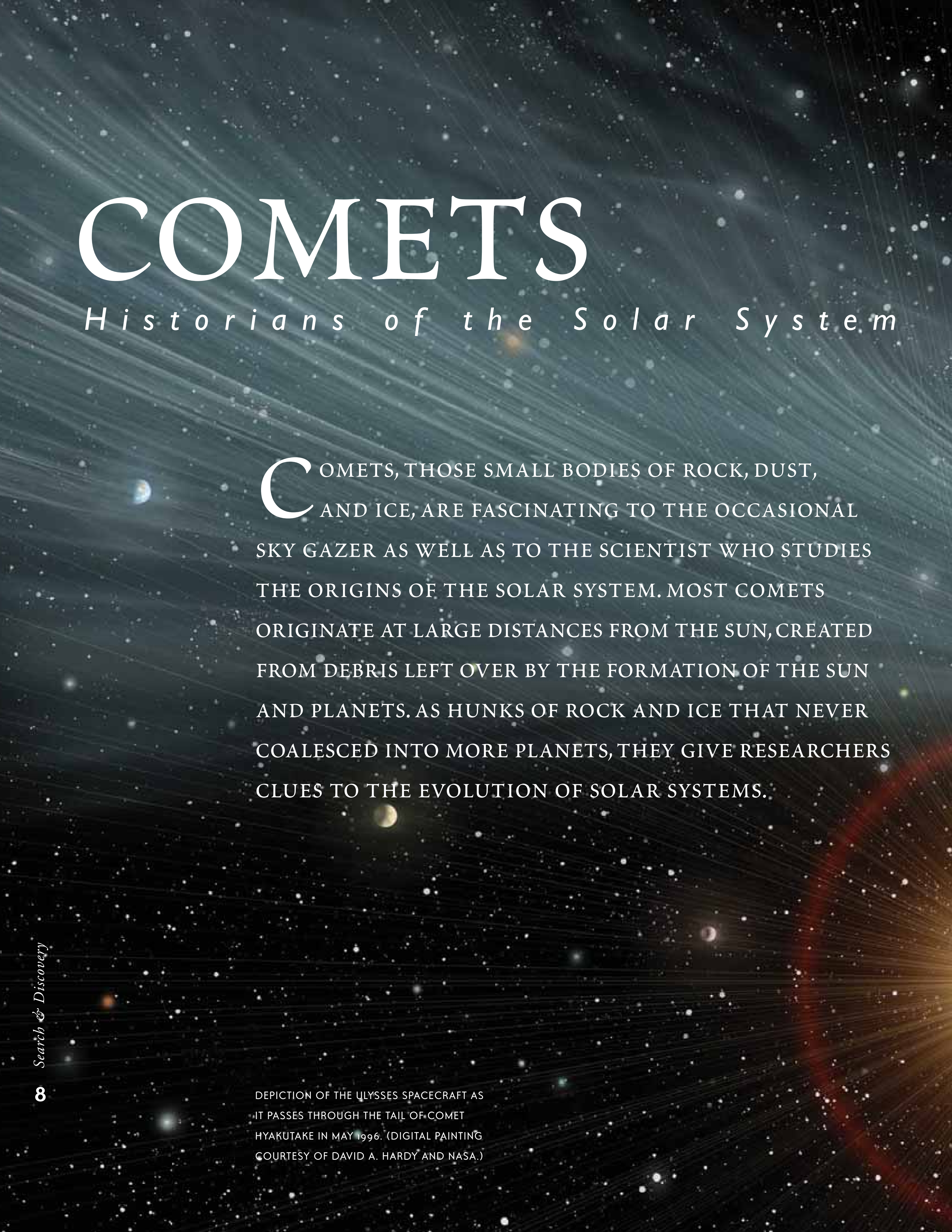
The University of Michigan boasts many important facilities that support top-quality faculty research. One of those having the greatest impact is the Michigan Nanofabrication Facility (MNF), operated by the College of Engineering as a resource to the entire campus and beyond. This Facility supports activities in the Engineering Research Center for Wireless Integrated MicroSystems (WIMS ERC) in applications ranging from health care and environmental quality to homeland security, and also supports cutting-edge research in nanotechnology, new materials and nanostructures, and state-of-the-art optoelectronics. The MNF is playing a catalytic role in helping to grow high-tech industry in Michigan through both academic and private-sector research. In 2007, nearly two dozen companies, both large and small, made use of the Facility for research and prototype development.

A major renovation and expansion of the MNF is now nearing completion. A new MNF addition includes four floors crammed with infrastructure to support ultra-clean air handling, temperature and humidity control, clean water, and effluent management. It adds approximately 10,000 square feet, housing a cleanroom, chemical storage, and support space. Portions of the existing MNF, which first opened in 1986, have also been renovated to house a new chemical processing laboratory, a new entry area, and additional laboratory space. The cost of the two-and-a-half-year construction project totals $40 million, with an additional $25 million being invested for equipment and other facility upgrades. A full range of characterization tools are available in the MNF as well as full-time staff to provide training and technical support. The MNF is currently one of thirteen nodes on the NSF-funded National Nanofabrication Infrastructure Network and is serving as a major asset to academic and private-sector users alike. It represents a continued commitment to excellence in an area that will play a key role in improving quality of life in the 21st century. S&D

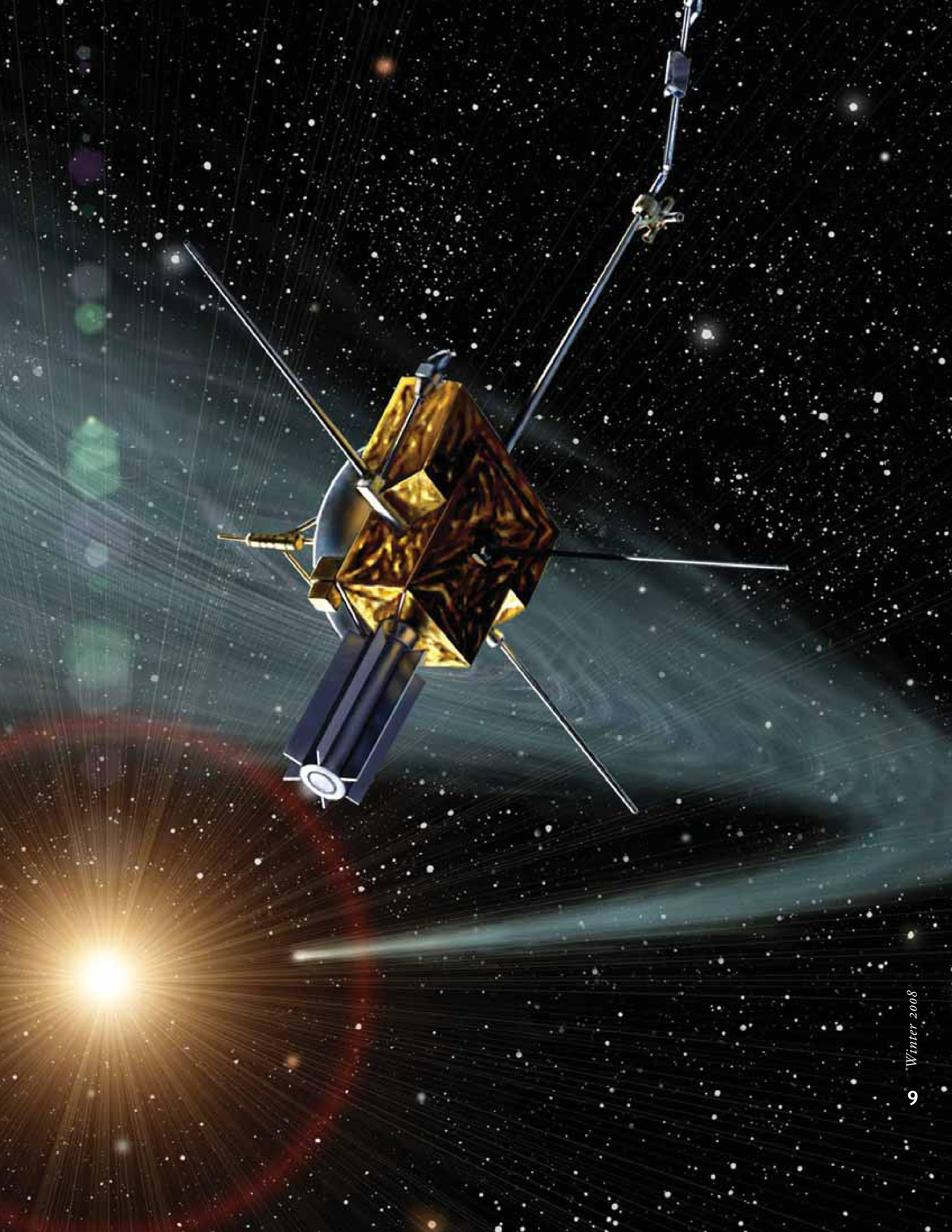
COMETS

Historians of the Solar System

Comets, those small bodies of rock, dust, and ice, are fascinating to the occasional sky gazer as well as to the scientist who studies the origins of the solar system. Most comets originate at large distances from the sun, created from debris left over by the formation of the sun and planets. As hunks of rock and ice that never coalesced into more planets, they give researchers clues to the evolution of solar systems.



Depiction of the Ulysses spacecraft as it passes through the tail of comet Hyakutake in May 1996. (Digital painting courtesy of David A. Hardy and NASA.)



JANUARY 2007 IMAGE OF THE COMET MCNAUGHT TAKEN IN SOUTH AFRICA. COPYRIGHT 2007 NEELS RAATH.

Comets travel great distances, too, as they orbit the Sun, but also return to the far edges where they originated. This brings comets close enough to Earth that they can be seen in the sky, sometimes without the aid of telescopes. This also gives scientists the opportunity to study "up close" the composition of the comet and its tail of dust and charged particles.

So a chance encounter earlier this year between spacecraft *Ulysses* and Comet McNaught's tail has scientists in the University of Michigan's College of Engineering marveling at a stroke of luck and the surprising data they obtained.

Ulysses, a NASA/European Space Agency spacecraft launched from the Space Shuttle *Discovery* on October 6, 1990, is on a mission to study the Sun from angles outside the plane of the planetary orbits. One of the instruments *Ulysses* carries was built and is operated by U-M scientists. In February 2007, the satellite flew by coincidence through the tail of Comet McNaught at a point some 160 million miles from the comet's core.

George Gloeckler, research professor in the Department of Atmospheric, Oceanic and Space Sciences, is the lead scientist for the Solar Wind Ion Composition Spectrometer (SWICS) that is aboard *Ulysses.* SWICS was built to detect and identify components of the "solar wind." The solar wind is a stream of charged particles—electrons and positive ions. This *plasma* is the result of the Sun's million-degree heat, which ejects particles from its upper atmosphere, and consists mostly of electrons and protons with sufficient energy that they are able to escape the Sun's gravity. One familiar phenomena related to the solar wind is the Northern Lights, caused by collisions of the charged particles in the wind with atoms and molecules of the Earth's upper atmosphere.

During this unexpected intersection of *Ulysses* and McNaught, SWICS measured the composition and speed of the comet tail and solar wind. Not only did the U-M instrument send back readings of unexpected ions in the comet tail, it found that the tail had a major impact on the surrounding solar wind. Instrument readings showed there was a "complex chemistry" involved, says Gloeckler.

For the first time, the researchers detected in the tail of a comet a type of charged oxygen atom, represented O^{3+} for an atom of oxygen with a positive charge with five electrons instead of the usual eight. This discovery suggests that the solar wind ions, originally missing most of their electrons, plucked some electrons from oxygen atoms when they passed through McNaught's tail, says Michael Combi, Distinguished Research Professor in the Department of Atmospheric, Oceanic and Space Sciences.

SWICS also found that even at 160 million miles from the comet's nucleus, the tail had slowed the solar wind to half its normal speed. The solar wind would usually be traveling at about 435 miles per second at that distance from the Sun, but inside the comet's ion tail, it was less than 249 miles per second.

"This was very surprising to me," Combi says. "Way past the orbit of Mars, the solar wind felt the disturbance of this little comet. It will be a serious challenge for us theoreticians and computer modelers to figure out the physics to explain this observation."

In 1996, *Ulysses* passed through the tail of comet Hyakutake. Measurements taken at the time indicated that the comet's tail didn't slow the solar wind at all.

The interaction between comets' tails and the solar wind has been studied for decades. A comet's ion tail always points away from the Sun, whether the body is traveling toward or away from the Sun along the comet's elliptical orbit. It was this finding about the orientation of a comet's tail that eventually led in 1958 to the discovery of solar wind. The magnetism and velocity of the solar wind are so strong, it pushes the comet's tail away from the Sun no matter in what direction the comet is traveling.

Solar wind is blamed for the lack of an atmosphere on Mars and for geomagnetic storms that can cut out power on Earth. It is a major component of space weather, which scientists study because it affects satellites and humans in space.

As for what these observations say about the origins of the solar system, scientists don't know just yet.

"The composition of comets tells us about conditions approximately 4.5 billion years ago when the solar system was formed," says Gloeckler. "Here we got a direct sample of this ancient material which gives us the best information on cometary composition. We're still in the process of figuring out what it tells us."

Another U-M collaborator on this project, Thomas Zurbuchen, associate professor in the Department of Atmospheric, Oceanic and Space Sciences, likens *Ulysses'* encounter with comet McNaught to putting your hand in the waters of Lake Michigan and pulling out a fish.

"That's a pretty unlikely thing," Zurbuchen says. "The benefits of such an observation are important. They constrain the interactions of such comets with the Sun, including how the comets lose mass. They also examine the question of how a sudden injection of neutral and cold material interacts with hot solar-like plasmas. That occurs in other places of the universe and we were able to study it right here."

Pre-life Molecules in Comets

Comets offer other insights into the solar system. Studies of comets are thought to provide a "fossil" record of the conditions that existed within the gas cloud that collapsed to form the solar system a little more than 4.6 billion years ago. And because comets are created in the cold, dark, outer reaches of the solar system, they are believed to be the least chemically altered during the formation of the Sun and its planets.

In the gas cloud that led to our solar system, it is thought that nitrogen was there in its molecular form of N_2, so it follows that comets should contain molecular nitrogen as well. But molecular nitrogen hasn't been detected in comets and meteorites, which has puzzled scientists for years.

Recently, researchers from the U-M Department of Astronomy and the Harvard-Smithsonian Center for Astrophysics found evidence of *atomic* nitrogen in interstellar gas clouds, that is, single atoms of nitrogen. This finding substantially changes the understanding of chemistry in space, explains Sébastien Maret, U-M research fellow in astronomy, and Edwin Bergin, U-M professor of astronomy.

The presence of atomic nitrogen and the lack of molecular nitrogen in the interstellar clouds offers an explanation for the form of nitrogen found in comets, since these gas clouds are the source of microscopic solid particles that eventually form comets.

Also of great interest is that the presence of atomic nitrogen suggests that pre-life molecules may be present in comets, a discovery that gives a clue about the early conditions that gave rise to biological life. The nitrogen-bearing molecules in comets that crashed into Earth millions of years ago may have provided a sort of "pre-biotic jump start" to form the complex molecules that eventually led to life here, says Bergin.

"A lot of complex and simple biotic molecules have nitrogen, and it's much easier to make complex molecules from atomic nitrogen," Bergin explains. "All DNA bases have atomic nitrogen in them. Amino acids also have atomic nitrogen in them. If you have nitrogen in its simplest form, the atomic form, it's much more reactive and can more easily form complex prebiotic organics in space." These complex organic molecules could have been incorporated into comets and were delivered to the Earth.

"What we're seeing in space is telling us something about how you make molecules that led to us," Bergin says. S&D

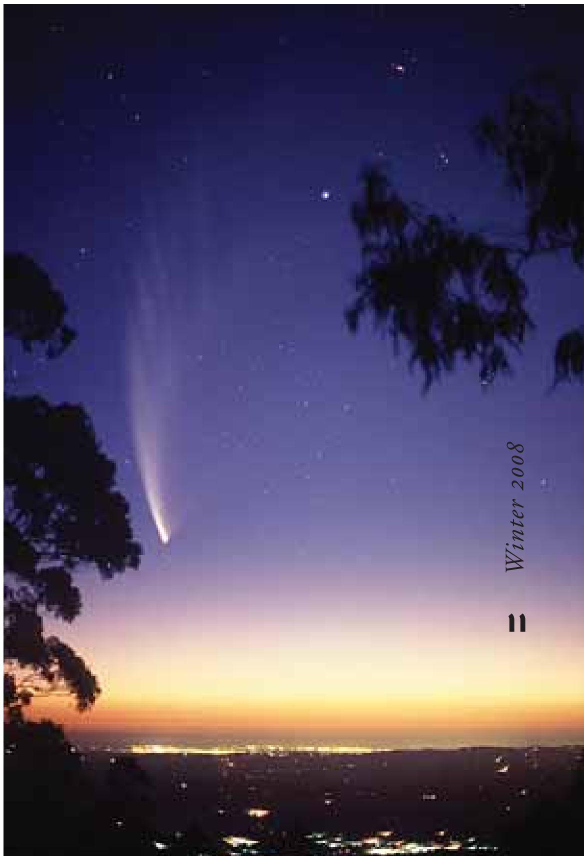
ABOVE: ARTISTS CONCEPT OF THE ULYSSES SPACECRAFT ENTERING ORBIT AROUND THE SUN. COURTESY OF EUROPEAN SPACE AGENCY.

BELOW: JANUARY 2007 IMAGE OF COMET MCNAUGHT TAKEN IN AUSTRALIA ABOUT 30 MINUTES AFTER SUNSET. COPYRIGHT 2007 ALAN YIM.

Further Reading

M. Neugebauer, et. al., "Encounter of the Ulysses *Spacecraft with the Ion Tail of Comet McNaught,"* Astrophysics Journal, *Vol. 667, pp. 1262-1266, Oct. 1, 2007.*

S. Maret, E.A. Vergin & C. J. Lada, "A low fraction of nitrogen in molecular form in a dark cloud," Nature, *Vol. 442, pp. 425-427, July 27, 2006.*



ADVANCING INNOVATION

Enhancing U-M Relationships with Industry

FIRST ROW: STEPHEN R. FORREST, UNIVERSITY OF MICHIGAN; SANDY K. BARUAH, U.S. DEPT. OF COMMERCE; CONFERENCE PARTICIPANT; DERRICK M. KUZAK, FORD MOTOR CO. **SECOND ROW:** CHARLES W. VEST, NATIONAL ACADEMY OF ENGINEERING; RICK SNYDER, ARDESTA AND GATEWAY COMPUTERS; J. IAN GRAY, MICHIGAN STATE UNIVERSITY. **THIRD ROW:** MARK A. MURRAY, MEIJER, INC.; CONFERENCE PARTICIPANT; JOHN C. AUSTIN, THE BROOKINGS INSTITUTION.

Innovation and collaboration have been important values at the University of Michigan for many years. Still, two campus committees that were asked to analyze University–industry partnerships concluded that additional steps can be taken to further enhance the campus culture. In particular, changes in the global economy require that the U-M broaden its already strong connections with industry in order to build a better future for the state and nation. Doing so, they say, will increase the ability of research knowledge to be applied to major societal needs, spur regional economic development and new jobs, give students valuable learning experiences, and help the University procure resources and expertise.

The committees—one comprised of faculty and the second of administrators—were asked by Vice President for Research Stephen Forrest to develop steps the University can take in order to rejuvenate and strengthen University connections with industry. The plans include many suggestions, from ways to make industry engagement a visible and central element of University life to improving coordination across the campus of these kinds of partnerships. The committees presented ideas to encourage faculty to engage in entrepreneurial activities and new companies, and to revise research policies to make industry-sponsored projects more appealing and efficient for faculty. And, importantly, the report recommended that the entire campus must become more cognizant of the time pressures facing industry and act accordingly in setting up relationships.

The report also called for the creation of a center that would serve as a highly visible point of focus for existing and new relationships between campus units and industry partners. By coordinating the U-M's industry relationships from a single physical location, the University can leverage its efforts to raise awareness among potential partners, provide a simpler means of access to campus research and faculty expertise, and work more efficiently with regional and state economic-development efforts.

Over the past ten years U-M has raised its investments in an economic-development role, doubling its resources in support of technology transfer and moving into the top tier of universities in commercializing university research. In addition, while industry-sponsored research makes up only a small percentage of the U-M's total research spending, U-M has remained in the top group of universities receiving industrial funding.

These efforts provide a platform for the University to become a state and national leader in improving economic prosperity. As a result of the work by the two committees, the University has set three broad goals for the next few years: increase understanding of industry goals by the University community, encourage a culture of innovation within the University, and coordinate and enhance our partnerships with industry.

In acknowledging the need to pursue a new initiative, Forrest also noted that all of these efforts will continue to be a work in progress. "As we move along this path toward improving our interactions with the industrial community, we will find that some of these recommendations are more effective than others at enhancing our partnerships," says Forrest. "We also anticipate finding completely unexpected new means for achieving these same goals that are not currently envisioned. Hence, this process should be considered as one of continued evolution and adaptation."

Since the committee reports were delivered to the Office of the Vice President for Research (OVPR) last spring, several strategies are already underway. For instance, many internal procedures and practices have been reevaluated and adjusted to make them more amenable to the goal of greater collaboration with industry. Here are examples of these changes:

- The indirect cost rate for industry agreements was reduced to the federal rate beginning last July 1, when the indirect cost rate for research was reduced to 52 percent from 56 percent.
- The Colleges of Engineering and of Literature, Science, and the Arts and the School of Information, in collaboration with OVPR, will now provide cost sharing for graduate student research assistants and for equipment on projects that qualify based on annual expenditures.

HOW DOES A STATE OR REGION, WITH ITS ECONOMIC FOCUS ON MANUFACTURING, TRANSFORM ITSELF INTO A KNOWLEDGE ECONOMY THAT REMAINS CONNECTED TO ITS TRADITIONAL BASE?

- The provost and the vice presidents for research, development, and government relations are collaborating with schools and colleges to establish a Business Engagement Center to complement unit efforts to reach out to industry, foster new relationships and projects, and provide "connections" between faculty and business partners.

PRESIDENTS OF THE UNIVERSITY RESEARCH CORRIDOR INSTITUTIONS: MARY SUE COLEMAN (U-M), LOU ANNA K. SIMON (MSU), IRVIN D. REID (WSU).

- Steps are being taken wherever possible to streamline processes associated with industry agreements. Central research administration offices and the schools and colleges are implementing policies to reduce the processing time for agreements related to projects with industry.
- In FY 2008, there will be two additional positions in the Office of Technology Transfer (OTT) and one additional position in the Division of Research Development and Administration (DRDA) to expedite processing of awards and to negotiate agreements. As licensing and project activity with industry increases further, new staff will be added.
- New "gap funds" from the central administration share of IP revenue will be available to move research more rapidly toward commercialization of promising research results.
- Regental policy has been modified to reflect new goals and practices. Faculty are now eligible for the traditional inventor share of royalties/equity payments to U-M, even when the inventor has a role as a consultant, is part of management, or has an ownership or equity position with the company.

Furthermore, the Office of the Vice President for Research is making it a priority to recognize faculty engaged in research partnerships with industry. Through the newly instituted Distinguished University Innovator Award, the Celebrate Invention event, and other venues, OVPR is striving to encourage and support research activities that involve invention, entrepreneurialism, and innovation, which are essential to Michigan's competitive position in the academic community.

In October, the University hosted two events aimed at broadening the discussion about innovation and culture change across campus and with the private sector. On October 3, a Partnership Forum brought together a panel of industry representatives with members of the University community to discuss how we can develop a more industry-friendly environment on campus. Panelists included Dwight Carlson (Coherix Corp.), Jan Garfinkle (Arboretum Ventures), Ed Jenkins (Ethicon Endo-Surgery, Inc.), Kirk Lignell (Whirlpool Corporation), Ed Krause (Ford Motor Co.), and Robert Sarisky (Centocor R&D Inc.). The moderator was Keith Cooley of the Michigan Department of Labor and Economic Growth. The entire forum is available for online viewing from www.research.umich.edu/events/PartnerForum.html.

THE U-M REGULARLY SPONSORS EVENTS TO PERMIT UNIVERSITY FACULTY AND STAFF TO NETWORK WITH THE PRIVATE SECTOR AS ONE ELEMENT OF ITS INNOVATION STRATEGY.

About ten days later, the University Research Corridor (URC) sponsored a two-day conference on "The Roles of Engaged Universities in Economic Transformation." The conference organizers believe that universities can and should play an important role in creating a knowledge-based economy, which they see as the best hope for long-term economic recovery by states, like Michigan, that were built upon manufacturing as the core industry. The conference attempted to address several questions:

How does a state or region that has had its economic focus on manufacturing transform itself into one based on a knowledge economy that maintains a complementarity to its traditional base? What elements define the significant role of research universities (and of higher education in general) of the state or region in effecting and being engaged in such a transition? What incisive collaborative steps must be taken as part of state or regional initiatives and university strategies to catalyze this transition?

In putting on the conference, the University Research Corridor (a year-old collaboration of the University of Michigan, Michigan State University, and Wayne State University) wished to help create strategies that manufacturing states can adopt to assist their transformation into more prosperous and sustainable economies. Speakers on the first day of the conference included Charles Vest (president, National Academy of Engineering and former MIT president), congressmen John Dingell and Vernon Ehlers, John Austin (director, Great Lakes Initiative, Brookings Institution), Sandy Baruah (assistant U.S. secretary of commerce), Derrick Kuzak (group VP for Global Product Development, Ford Motor Co.), Mark Murray (president, Meijer, Inc.), Richard Snyder (co-founder, CEO of Ardesta LLC; Chairman, Gateway Computers), Vivek Wadhwa (Duke University and Harvard Law School), and the three URC presidents: Mary Sue Coleman (U-M), Lou Anna Simon (MSU), and Irvin Reid (WSU).

A major theme for many speakers was the belief that universities can *create* opportunity for a region. How? By working with, but not trying to be, industry; by using its "convening power" to bring different communities together; and by contributing to and elevating K-12 education, to name a few proposals. Other speakers pointed out that the Great Lakes region has assets in its universities, but also in the Great Lakes as a freshwater source and for the amenities it offers. A major area that needs to be addressed is public attitudes—about education and universities, about what the future job market will require of workers, and of the lack of an entrepreneurial or risk-taking mindset in many citizens.

The second day of the conference asked participants to break into small discussion groups to develop actions that universities and their partners might undertake to improve the economic standing of the Great Lakes region. A summary of the workshop recommendations is being prepared and should be available in the early part of 2008, when it will be given to the three URC members for further analysis and action.

In spite of the needs and problems facing the Midwest, the overall tone was upbeat. "I would say that the future of Michigan is bright," noted Stephen Forrest. "This is a great time to invest in this state and in this region, because when things are looking the worst, the opportunities for advantage are the greatest. But it's going to require, as I like to say, all hands on deck." S&D

MICHAEL FINNEY, INNOVATION LEADER

In October of 2005, Michael Finney became the CEO and President of Ann Arbor SPARK, a economic development organization that had been recently established by a consortium representing the educational institutions, such as the University of Michigan, as well as the governmental, non-profit and private sectors in the Ann Arbor area. Finney returned to Michigan after spending three years in Rochester, New York, where he led the Greater Rochester Enterprise, the public/private economic development arm of the greater Rochester area.

SPARK was officially launched in May of 2005 by a coalition that included the U-M, Washtenaw County, Eastern Michigan University, Pfizer Corp., and others, to accelerate the creation of technology companies and jobs in the Ann Arbor region. In July 2006, SPARK merged with the Washtenaw Development Council to help unify the region's economic development efforts. Last May, the IT Zone also merged with Ann Arbor SPARK.

Search & Discovery had an opportunity to meet with Finney and learn more about Ann Arbor SPARK and its relationship with the University of Michigan.

S&D: *Please start by telling us a little about SPARK.*

FINNEY: Essentially, SPARK views its role as being a resource to businesses of all types—from the very earliest stage start-ups, where literally you have an innovator with an idea and perhaps some IP [intellectual property], all the way through companies that are at a growth stage, and on through companies that are large and established.

In each case we can offer a variety of services. At the earliest stage, and the stage that's probably most interesting to faculty within a university setting, is the ability to work with us on commercializing innovations that they're working on. So once you have some IP that has commercial value, we can then provide financial resources as well as other talent resources to help move that idea forward. We will assist in licensing of the IP, we'll help with options, we'll help with legal work involving freedom to operate, we'll help with putting business plans together, and the list goes on and on. For start-ups and for fast-growth companies, we're entirely focused on innovation-based companies only.

S&D: *Do you ever turn away start-ups?*

FINNEY: Yes, we do. This year, as an example, we will look at 350–400 business plans. We might get involved in up to a fifth of them, perhaps 70 or 75 over the year, where we actively provide business development assistance. The others are typically too early, bad ideas, someone else's idea—there's a variety of reasons that we turn them down.

But all in all, we have a lot of touches with companies, and we've had a pretty good track record of being successful with those that we engage. By way of example, in 2006 we looked at about 150 business plans for the whole year and engaged about 23. Of those 23, 21 of them are still active. A couple of them are doing reasonably well. A number of them are still searching for money, talent, and other things, but the good news is the lion's share are still in business.

Under normal circumstances, where you don't have the kind of business acceleration support that SPARK offers, you lose about 80–90 percent of the companies. In our case, we have about 90 percent that are still active. And the longer they stay active, the higher the probability of them being successful longer term.

S&D: *What are your days like?*

FINNEY: I try and spend as much of my time as possible focused on the bigger picture, long-term, where are we trying to go as a community. Where do we find the resources that we need? How do we cultivate those resources and how do we then create value or show that there is a payback to the community for the resources that are being invested in us?

I actually spend the balance of my time, probably 50 percent, working on deals. It might be meeting with small entrepreneurs where I'll review the business plan. I have a pretty keen instinct and knowledge in some sectors. I'm an old manufacturing guy. I ran an aerospace manufacturing company for about 14 years, so I have a lot of knowledge and relationships there. I also have pretty good instincts for life sciences. I actually was the person who launched the Michigan Life Sciences Corridor Initiative back in 2000 for the Michigan Economic Development Corporation. I'm certainly not a scientist, but I do understand a good life sciences business plan when I see one.

I also spend an awful lot of time focused on building relationships in our community with key partners, universities, other not-for-profits, key business leaders throughout the community, and cultivating those relationships so that they understand their roles in allowing our community to thrive economically.

S&D: *What resources does SPARK have that might benefit a start-up of a U-M faculty member?*

FINNEY: We manage an $8 million fund for "pre-seed investment" that would be of real interest to University faculty. That money is used primarily as the earliest equity investment made in a company. It typically precedes "angel investing." We generally will loan the money to the company with an opportunity to convert it into equity at an appropriate time.

The maximum amount is a quarter-million dollars, and we do require some matching funds in the form of grants, other equity, a venture capitalist, or the owner's own pockets. So far we've made, I think, eight investments at roughly $200,000 on average. The fund has a life span to last into late 2008 or early 2009.

SPARK also manages a wet lab incubator facility that's located on the north side of town. We got a $1 million grant from the State of Michigan to help us operate the space, and we think we have enough funding to last through the end of 2010. It's about 12,000 square feet, although it's pretty much fully subscribed at this point.

Finally, we were recently notified that we'd be receiving about a half-million-dollar grant to assist in the acquisition and disposition of excess equipment that will come from the Pfizer decision to move its R&D facility out of Michigan.

S&D: *What is the biggest challenge for SPARK?*

FINNEY: I think the biggest challenge is simply getting and keeping the community engaged and believing that investing in this organization is the right way to go. We try to remind the community that if SPARK is successful, many of the other challenges that our community faces can be addressed.

Our first year's results, though, were pretty damn impressive. We had some really big hits with organizations like Google and Toyota Technical Center and Picometrics and so many others. Roughly speaking, the commitments companies made as a part of the incentives they received will generate about 2800 new jobs over the next three years as a result of some of the work that SPARK did. The companies that we worked with committed to invest over $600 million in our community over that time. That's impressive in a community three times our size, let alone a community of this size.

S&D: *What about Pfizer's decision to move out of Ann Arbor?*

FINNEY: We had those pretty good gains and then Pfizer happened, and that had an impact in the opposite direction. So the 2800 jobs that were committed last year were cancelled out by Pfizer's decision to relocate out of the community. But we've already got a number of things in the pipeline that are going to be pretty exciting and that will solve the Pfizer challenges.

S&D: *What else should faculty know about SPARK?*

FINNEY: SPARK is a resource that is very much engaged with many aspects of the University of Michigan, the most important being the Office of Technology Transfer. We work very closely with them, so if faculty have innovations that they are interested in commercializing, whether they want to do it themselves as entrepreneurs or whether they want to simply be a founder and work with some entrepreneurial person to start up a venture, we can be a real financial resource, help find facilities and equipment, and assist with business planning and finding talent to help make that happen.

I would encourage faculty to actually contact the Office of Tech Transfer first. And then we will work in partnership with the Office of Tech Transfer or we'll work with faculty directly, whichever is most appropriate. We have significant resources to make it happen. In many cases, the first quarter-million dollars is what can get a company launched. We have that, it's readily available, and we're looking for good business ideas.

We also operate an entrepreneur's boot camp where we typically involve 12 companies at a time and give very early business education to budding entrepreneurs, whether it's faculty, students, staff—and we frequently have three or four prospects from within the University.

S&D: *Where would you like to see SPARK in ten years?*

FINNEY: You know, I'm not as concerned about where SPARK will be in 10 years as much as I am about the community. We would like to see a community that is thriving, that has desired employment growth, desired population growth, rising per capita income, outstanding quality of life, a sought-after location for innovation-based businesses, and a sought-after location for talent. I'd like to see Ann Arbor be a recognized innovation hot spot like the Silicon Valleys, the Bostons. S&D

VIEW FROM WASHINGTON, DC

Indirect Cost Recovery on DOD Research Projects is Capped

In early November, the FY 2008 Defense Appropriations Conference Committee agreed to a spending bill that includes a cap on indirect costs of Department of Defense (DOD) sponsored basic research. The final language calls for a 35 percent cap on the total research award, i.e., the 35 percent cap is on total costs, including both direct and indirect, and will apply just to FY08.

This provision was sponsored by the House Appropriations Subcommittee Chairman John Murtha (D-PA) in response to concerns expressed by one of his constituents about the indirect costs related to funds the constituent received from DOD.

Originally, Murtha called for a 20 percent cap on the negotiated indirect cost rate. Universities throughout the country and DOD officials led a vigorous campaign against this cap, which resulted in the change to 35 percent.

President Mary Sue Coleman, Vice President for Research Stephen Forrest, Vice President for Government Relations Cynthia Wilbanks and several other members of the U-M community played active roles in the effort to overturn this cap. U-M remains deeply concerned about the effect of Murtha's actions on University-based research. The final cap of 35 percent is less restrictive than the originally proposed cap on the negotiated rate, yet it is still arbitrary and sets a dangerous precedent.

The FY 2008 defense appropriations bill with this cap was signed by the President on November 13, 2007. In the coming months, the short-term effect of this cap depends largely on the Pentagon's implementation of the bill's language. In the long term, however, this cap is likely to be the first step in many that Murtha plans to take to address what he perceives as unfair research funding practices by universities. For example, he reportedly is planning to hold Congressional hearings in 2008 on the topic of indirect costs. U-M federal relations officers have already started working with Congressional Committee staff to address this in the coming months. S&D

RESEARCH NOTES

Crain's Detroit Business Cites U-M Research

Last spring, Sheri Begin of Crain's Detroit Business surveyed Southeastern Michigan to find research projects that show promise for big breakthroughs that could "change the way we live—and maybe Southeast Michigan's economy." Of the 10 projects Begin selected to feature in the publication, three were from the University of Michigan in Ann Arbor (including the miniaturized environmental monitor of **Ken Wise** and collaborators described elsewhere in this issue of S&D), and a joint project of U-M and Michigan State University researchers. Here is a short description of each project:

Arul Chinnaiyan, professor of pathology and urology; S.P. Hicks Endowed Professor of Pathology; and director, Michigan Center for Translational Pathology. Chinnaiyan and colleagues conducted a study that showed a scrambling of genes followed by their merge, labeled "gene fusion," to be the likely initiating step in prostate cancer. This knowledge may lead to new ways to detect cancer onset at an earlier stage. Chinnaiyan is a co-founder of Compendia Biosciences, a company that analyzes the molecular profiles of cancers.

ARUL CHINNAIYAN

David Sherman, John G. Searle Professor of Medicinal Chemistry; and director, Center for Chemical Genomics, Life Sciences Institute. Sherman's research group has developed a way to synthesize an anti-cancer compound found in very small amounts in freshwater algae. U-M and Wayne State University, which hold patent rights on the potential drug, are collaborating to identify a pharmaceutical company to take this technology to market.

DAVID SHERMAN

Erdogan Gulari, Donald L. Katz Collegiate Professor of Chemical Engineering, and colleagues at Michigan State University are developing a device that can simultaneously detect microbial pathogens in the air, water, or food in a matter of hours and at a cost of less than $1000. Current technology requires a separate test for each pathogen, costs of several thousand dollars, and requiring a few days to complete. Gulari and his partners have created AquaBiochip LLC to commercialize the technology.

ERDOGAN GULARI

Presidential Early Career Award goes to College of Pharmacy Professor

In early November, the White House Office of Science and Technology Policy announced the names of 58 researchers who received the Presidential Early Career Award for Scientists and Engineers (PECASE). Gus R. Rosania, assistant professor of pharmaceutical sciences, College of Pharmacy, was selected as a PECASE recipient this year by the National Institutes of Health in recognition of his work creating experimental and computational tools useful in drug development targeted to specific sub-cellular compartments.

Rosania has posited that a drug's microscopic distribution within compartments called organelles is a major determinant of drug efficacy and toxicity. His experimental methods employ specialized microscopic imaging instruments to determine the local distribution and dynamics of small molecules inside cells. To analyze the image data, he has been developing innovative computational tools and statistical strategies with machine vision. With the information gained through experiments, he is building mathematical models that simulate drug transport and distribution in single cells and higher order cellular organizations.

"We envision a day when drugs will be designed, optimized, and ultimately approved for clinical use in terms of their site of action, as much as drugs today are designed, optimized, and approved based on their molecular mechanism of action," says Rosania.

Faculty Honors

In each issue of *Search & Discovery*, we plan to list a few of the faculty who were recently recognized for their outstanding research and scholarship. Please send information on these items to searchanddiscovery@umich.edu.

Is America Ready for Rechargeable Cars?

Teams of researchers at the University of Michigan and Pacific Northwest National Laboratory (PNNL) will explore the future viability of plug-in hybrid electric vehicles (PHEVs) with $2 million from the Offices of Electricity Delivery and Energy Reliability and of Energy Efficiency & Renewable Energy, U.S. Department of Energy.

PHEVs are considered by some experts to be the next logical step in cleaner driving. They are similar to today's gas-powered electric hybrids in that both have a gas engine as well as an electric motor. However, in PHEVs, a larger battery is charged by plugging the car in to a standard household outlet. Compared to the hybrids on the road today, the electric motor in a PHEV can propel the car a much longer distance without using any gasoline, until the battery runs low and it reverts to standard hybrid electric vehicles operation.

"This program provides an outstanding opportunity to address the technical challenges as well as the social issues that will determine the viability of the plug-in hybrid electric vehicle," said Gary S. Was, director of the Michigan Memorial Phoenix Energy Institute and a nuclear engineering professor. "The interplay between the vehicle, the nation's electric utility grid, and consumer attitudes and behaviors is a microcosm of the complexity of the world's energy problem."

The Michigan Memorial Phoenix Energy Institute will coordinate efforts among several University departments; industry partners such as General Motors Corp., Ford Motor Co., and DTE Energy; and PNNL. A preliminary report on the future of PHEVs will be available in January during the North American International Auto Show in Detroit.

Theodore S. Lawrence, Isadore Lampe Professor and Chair, Department of Radiation Oncology, Medical School, was elected to the Institute of Medicine.

Antonia M. Villarruel, professor, Division of Risk Reduction and Health Promotion, and director, Center for Health Promotion, School of Nursing, was elected to the Institute of Medicine.

David Ginsburg, Life Sciences Institute research professor and the James V. Neel Distinguished University Professor, Medical School, was elected to the National Academy of Sciences.

James S. House, Angus Campbell Collegiate Professor of Sociology and Survey Research, and research professor, Institute for Social Research, was elected to the National Academy of Sciences.

Arul M. Chinnaiyan, S.P. Hicks Endowed Professor of Pathology, and director, Michigan Center for Translational Pathology, was selected as a Howard Hughes Medical Institute investigator.

Friedhelm Hildebrandt, Frederick G.L. Huetwell Professor for the Cure and Prevention of Birth Defects was selected as a Howard Hughes Medical Institute investigator.

Rosina M. Bierbaum, professor and dean of the School of Natural Resources and Environment, was elected to the American Academy of Arts and Sciences.

Arthur Lupia, Hal R. Varian Collegiate Professor of Political Sciences, College of Literature, Science, and the Arts, and research professor, Institute for Social Research, was elected as a member of the American Academy of Arts and Sciences.

Six U-M faculty members contributed to the work of the Intergovernmental Panel on Climate Change, which received the Nobel Peace Prize for 2007. They are: **Rosina M. Bierbaum,** professor and dean of the School of Natural Resources and Environment; **Henry N. Pollack,** professor emeritus of geological sciences, College of Literature, Science, and the Arts; **Joyce E. Penner,** professor, Department of Atmospheric, Oceanic and Space Sciences, College of Engineering; **Natalia G. Andronova,** research scientist, Department of Atmospheric, Oceanic and Space Sciences, College of Engineering; **Maria Carmen Lemos,** associate professor, School of Natural Resources and Environment; **Edward (Ted) A. Parson,** professor of law, Law School, professor, School of Natural Resources and Environment.

Energy Institute Names Outreach and Development Director

In June, the Michigan Memorial Phoenix Energy Institute (MMPEI) welcomed David T. Walker as its first associate director for outreach and development. At MMPEI, the enabling institution for energy research and education at U-M, the outreach director facilitates relationships between U-M researchers and corporations, government agencies, and other academic and research institutions. These relationships are formed around joint research projects, the transfer of energy technologies into the marketplace, shaping public policy and business practices, and sharing knowledge of faculty and industry experts.

Walker was previously chief scientist with the Advanced Technology Division of the Michigan Research and Development Centers at General Dynamics in Ypsilanti, where he developed and managed research programs in ocean remote sensing and hydrodynamics. Nor is he new to the University. He has been an associate research scientist with the Department of Naval Architecture and Marine Engineering since 1996, and was also assistant professor in that department from 1989 to 1996.

Stem Cell Research Update

Just about a year ago, *Search & Discovery* wrote about research by Professor Sean Morrison, who had uncovered some important similarities between cancer and the aging process. In September, Morrison reported in *Nature* some rather startling findings about stem cells which required some extra effort on his part to get published.

For several decades, scientists have believed that stem cells, the progenitors of nearly all specialized cells and tissues in the body, have a way to prevent the accumulation of mutations as it repeated spawns new cells and tissues over multiple generations of cell division. One idea, called the "immortal strand hypothesis," suggests that newly synthesized chromosomes in a dividing stem cell move together into one daughter cell, which becomes a specialized cell. The original chromosomes are kept together and pass to the other new cell, which remains a stem cell. A process such as this would prevent mutations from mixing into the store of stem cells and causing serious problems in the future.

A mechanism for accomplishing this has been proposed, and Morrison set out to test it in the stem cells that lead to red blood cells. This was possible because Morrison had methods available to identify and track these blood-forming stem cells as they go through cell division and specialization. The experimental results indicated that the immortal strand hypothesis did not apply to this type of stem cell, a finding that reviewers of his report found hard to accept. He needed to go through several more experiments of increasing sensitivity before the *Nature* reviewers would permit the work to be published.

Morrison says his work was held to a higher standard than other stem cell research. "Papers that present evidence in favor of an idea don't show that most stem cells do something, only that some stem cells do something." Yet Morrison was asked to show that more than 99 percent of blood-forming stem cells did not conform to the immortal strand hypothesis before his research was accepted.

What this report does, though, is call for a reexamination of most other stem cell types to see if the immortal strand hypothesis in fact holds true.

FluMist Royalty Agreement Cited

The U-M Office of Technology Transfer was selected by the *Ann Arbor Business Review* for its "Deal of the Year" award for negotiating an agreement with Drug Royalty Corp. of Toronto to sell the rights to future royalties for FluMist, a nasal-spray influenza vaccine. The agreement could earn the University $35 million, which would be spent in support of research and graduate education.

In announcing the award, the *Business Review* noted, "The University, including Ken Nisbet, director of the U-M Tech Transfer Office, has received widespread praise for its heightened focus on tech transfer."

Stephen Forrest, U-M vice president for research, added, "In the Great Lakes region, we're particularly pressured by macro trends in the U.S. economy. And because of that we realize we cannot idly sit by and not play our proportionate role in the transformation that everybody knows we need to undergo." S&D

OFFICE OF
THE VICE PRESIDENT
FOR RESEARCH

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

UNIVERSITY OF MICHIGAN

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

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
734/614-6468, 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
George F. Vande Woude, Interim Executive Director
734/615-5045, bkissel@umich.edu

U-M Substance Abuse Research Center (UMSARC)
Open
734/998-6500