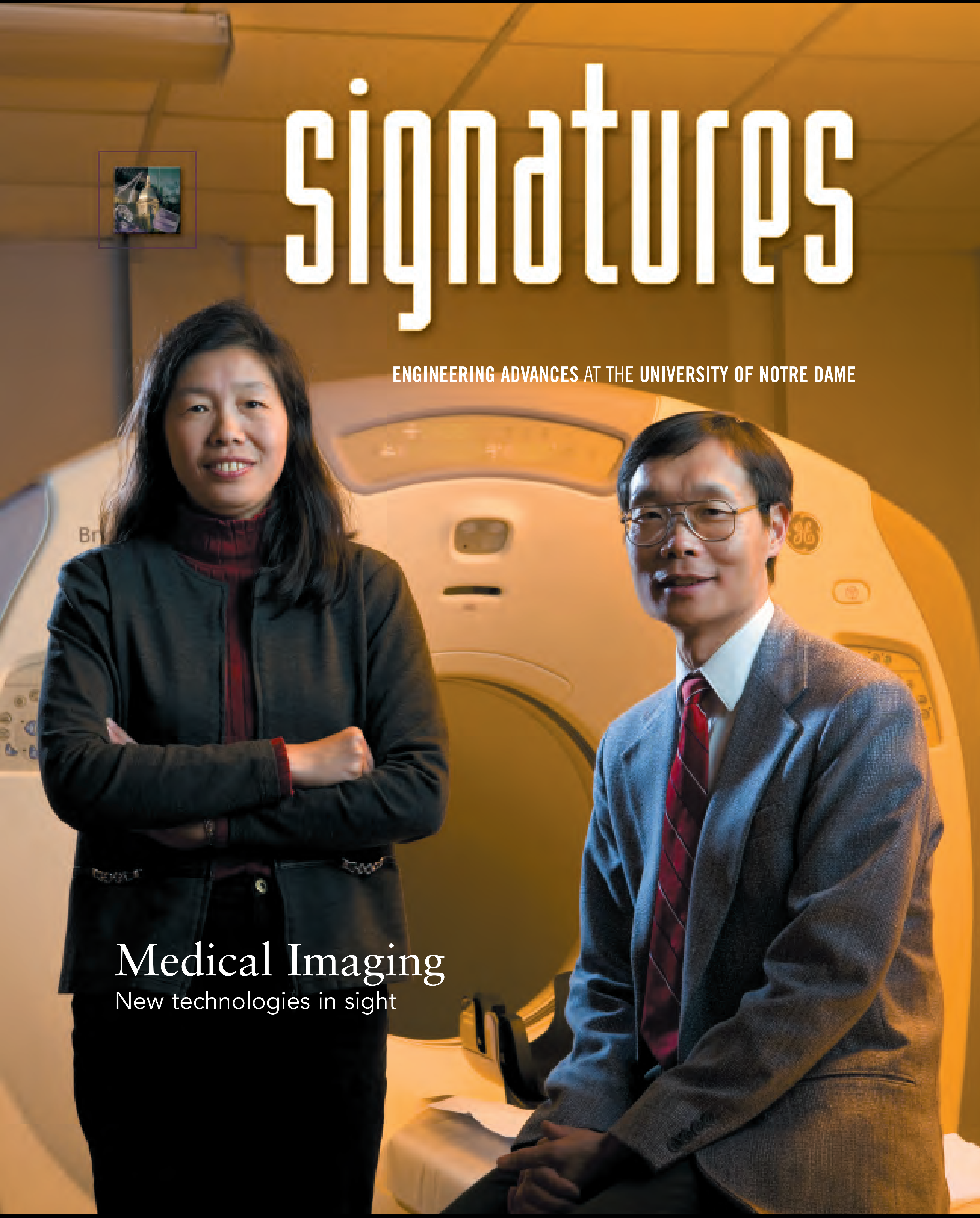

signatures

ENGINEERING ADVANCES AT THE UNIVERSITY OF NOTRE DAME

Medical Imaging

New technologies in sight

Winter 2007 • Volume 8, Number 1

Cushing Hall Dedication, 1932

More than a Coat of Paint

Universities are known for constantly evaluating facilities and repurposing them as required to continue to meet the needs of students. Changes can range from new carpet or a new coat of paint to television and computer projection systems, teleconferencing capabilities, wireless and wired connections, and audio amplification for the hearing impaired. One of the most noticeable changes in the College of Engineering occurred in 2000 when the Cushing Hall auditorium was "remodeled." Since the building's dedication in 1932, the auditorium had served student needs as a lecture hall and, at times, a movie theater. It was a place where students gathered to learn and experience University life. The evolution of the 4,000-sq.-ft. facility from auditorium to Engineering Learning Center was a reflection of the direction of the engineering program, which was becoming more team-focused and multidisciplinary in nature. In the learning center students at all levels, from first year to senior year, have hands-on opportunities to work on real-world problems. It is a unique blend of computer cluster, library, and laboratory, and it has become a vital tool for exploration and experimentation.

To see how students and classes use the learning center, visit the center's live Web cam at **www.nd.edu/~englearn/webcam.**

signatures

On the cover:
Danny Z. Chen, right, professor of computer science and engineering, and X. Sharon Hu, associate professor of computer science and engineering, are two of the faculty working to refine medical imaging technologies (see page 16).

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Departments

Features

seeing the big picture

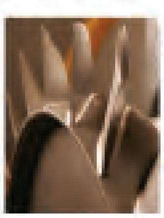
THE REST OF THE STORY

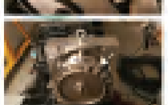
Notre Dame boasts a long tradition of excellence and innovation in aerospace research. In fact, some of the wind tunnel technology used today in federal, industrial, and academic laboratories can be traced to the work of University faculty, such as Professor Albert F. Zahm, who developed the first hand-driven wind tunnel in the country and suggested a better way to launch an aircraft and control its flight; Professors Frank N.M. Brown and Robert S. Eikenberry, who not only built a revolutionary smoke tunnel with a rake and screen feature but were also the first to visualize Tollmien-Schlichting waves; and Professor Vincent P. Goddard, who built the world's first supersonic smoke tunnel. Much of this work was accomplished in the "aero shack," which was adjacent to the Joyce Center.

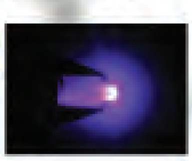
THE HESSERT LABORATORY 15

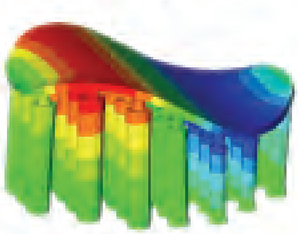
1991 2006

Attendees of the 15th anniversary celebration of the Hessert Laboratory for Aerospace Research echo a pose from the groundbreaking of the building in 1990. From left to right are Stephen M. Batill, professor and chair of the Department of Aerospace and Mechanical Engineering; Professor Flint O. Thomas; Professor Robert C. Nelson; Marilyn Hennebry Hessert; and Thomas J. Hessert (B.S., Commerce '48), founder and former president of the T.J.H. Investment Company; and Roth-Gibson Professor Emeritus Thomas J. Mueller. The facility was dedicated in November 1991 during the University's sesquicentennial activities.





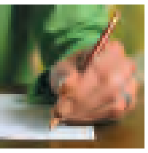




Today, the Notre Dame tradition continues in the Hessert Laboratory for Aerospace Research, which recently celebrated 15 years of service to the University and its research partners. Since the early days of aeronautics at Notre Dame, the College of Engineering has developed a cadre of faculty who are still making their mark on a number of industries, including aerospace and transportation. The 38,000-sq.-ft. Hessert Laboratory, named for its benefactors Thomas J. and Marilyn Hennebry Hessert, contains cutting-edge facilities, such as the Advanced Performance Compressor Laboratory, the Gas-Turbine Laboratory, the Aero-optics Clean Room, the Particle Dynamics Laboratory, the Plasma Flow Control Laboratory, an anechoic chamber, a Mach .05 low-disturbance wind tunnel, an atmospheric wind tunnel, a planar jet facility, high-speed supersonic and transonic wind tunnels, and dedicated machine and electronic shops.

It is also home to the Center for Flow Physics and Control, created specifically to continue to develop techniques for modifying fluid flows — through **aero-acoustics, aero-optics, fluid-structure interactions, multiphase flows, gas-turbine engines,** and **flow control** — for important applications through multidisciplinary activities.

For more information about the Hessert Laboratory, visit **http://www.nd.edu/~ame/facilities/Hessert.html.**



talking points

A LETTER FROM THE DEAN

Dear Friends of Notre Dame,

We are more than halfway through another academic year, and I write to you filled with enthusiasm for the College of Engineering.

At the top of the list is Stinson-Remick Hall, the new multidisciplinary engineering education and research building. We have spent much of the last semester working with BSA Life Structures of Indianapolis, the architectural firm that has guided us through the intricacies of designing what will be a beautiful campus addition on Notre Dame Avenue, opposite the Eck Visitors' Center and Notre Dame Bookstore, with more than 76,000 assignable square feet for undergraduate education and several of the signature research programs of the college. Centerpieces of the building include a beautifully-designed, centrally-located student learning center that is nearly four times the size of the experimental center created in Cushing Hall, and a state-of-the-art nano- and micro-device fabrication and processing facility. The building will also house the Center for Nano Science and Technology with associated electronic materials and device activities, an ultra-high vacuum crystal growth system, our newly-emerging Energy Center, and an extensive materials characterization facility. In addition, the building will provide space for the future senior faculty that we are aggressively recruiting. It is being named in honor of principal benefactors Kenneth and Ann Stinson and Jack and Mary Ann Remick. The learning center will be named in honor of major benefactors Ted and Tracy McCourtney. To these supporters we give our heartfelt thanks.

This fall we also opened a 16,000-sq.-ft. multidisciplinary engineering research building on the north end of the campus, which houses a team of five faculty working on various aspects of orthopedics. These young engineers maintain strong ties to the three major orthopedics companies in Warsaw, Ind., just 30 miles south of campus, providing the industrial experience for our students that should be a hallmark of a modern engineering program. Several of these faculty have joined with me to participate in a statewide task force to build on the presence of the Warsaw powerhouse and contribute to the economic engine of the State of Indiana.

The Stinson-Remick Hall of Engineering will be located on Notre Dame Avenue, opposite the Eck Visitors' Center.

Another opportunity has presented itself this year in the form of a major addition to the Notre Dame Center for Flow Physics and Control (FlowPAC): DARPA, a branch of the Department of Defense, has awarded Notre Dame a new turbine wind tunnel that will be housed this spring in yet another building for aeronautical engineering, located north of the campus across Douglas Road from the Hessert Laboratory. This $3 million machine will enhance the seminal work being conducted through FlowPAC in collaboration with a multitude of major industries.

Other important initiatives are being aggressively pursued for the college. These include an expansion of our bioengineering efforts (a Ph.D. program in this area has just been approved by the University), an interdisciplinary environmental research program that will extend to all corners of the University, and a Center for Research Computing for which we are currently recruiting a director.

Our Lady has blessed us with an inspired faculty, devoted members of the college executive team, and wonderful students. It is, in fact, the students who make this job worthwhile, for Notre Dame attracts the finest students in the land. I am proud and humbled to be allowed to preside over this college, but it is the work of many, many talented people who make the job possible. We are blessed with outstanding leadership in the Office of the Provost and the Office of the President, who envision a major role for engineering in our quest to become a truly great Catholic university. Thanks to my predecessor, Frank Incropera, to whom we owe a monumental debt of gratitude, the college is well positioned to move through the 21st century. So, my report to you, in essence, is that we are on track to be recognized as one of the outstanding engineering programs in the United States.

Sincerely,

James L. Merz

James L. Merz
Interim Dean and the Frank M. Freimann
Professor of Electrical Engineering

Changes in the Dean's Office

From left to right, Ivan Favila, John J. Uhran, and Cathy Pieronek

James L. Merz, the Frank M. Freimann Professor of Electrical Engineering and former vice president for graduate studies and research and dean of the Graduate School, began his one-year term as interim dean of the College of Engineering on August 1. An internationally recognized scholar in the field of optoelectronic materials and devices and graduate of the University (B.S., Physics '59), Merz returned to Notre Dame to direct a team of researchers investigating Quantum-dot Cellular Automata. He had previously served as professor of electrical engineering, professor of materials, and director of the Center for Quantized Electronic Structures at the University of California at Santa Barbara.

Merz follows **Frank P. Incropera,** the H.C. and E.A. Brosey Professor of Aerospace and Mechanical Engineering, who stepped down as dean of engineering in 2006 to return to teaching and research. An experienced administrator, Merz will continue the momentum that the College of Engineering has experienced over the last eight years under the direction of Incropera.

John J. Uhran, senior associate dean for academic programs, has retired after 40 years of distinguished service. Although his research interests focus on communication theory and systems, signal processing techniques, simulation techniques, and artificial intelligence, Uhran has maintained a special interest in engineering education and provided significant leadership in the development of undergraduate programs. Most recently, he served on the organizing committee of a workshop focused on the role of the first year in engineering education with **Cathy Pieronek,** assistant director of academic programs and director of the Women's Engineering Program (WEP). Uhran has long been active in the American Society for Engineering Education (ASEE) serving as the Illinois-Indiana section chair, chair of the instrumentation division, and as a member of the board of directors. In June 2006 he began another term on the ASEE board.

In addition to her role as director of the WEP, Pieronek has been named the director of academic affairs and has assumed most of Uhran's responsibilities, including those associated with student recruitment and counseling, interfaces with the offices of development, registrar, student services, admissions, and financial aid, as well as with the First Year of Studies. An alumna, Pieronek received a bachelor's degree in aerospace engineering from the University in 1984 and a law degree from Notre Dame in 1995. Prior to joining the College of Engineering in 2002, she served as director of Law School relations.

Ivan Favila, director of the Minority Engineering Program (MEP) has been named assistant director of academic affairs. He will continue to direct the MEP. Prior to joining the University in 2005, Favila served as assistant director of the Minority Engineering Recruitment and Retention Program and director of the Cooperative Engineering Education Program at the University of Illinois at Chicago.

The Mars Reconnaissance Orbiter was launched in August 2005 and began transmitting images from low orbit in October 2006. Carrying the most powerful camera used on a planetary exploration mission, the Orbiter also features a sounder to find subsurface water and other instruments to detail the geology and structure of the planet.

Flying the Friendly Skies

President George Bush wants the National Aeronautics and Space Administration (NASA) to return to the moon, build a permanent base there, and then begin steps to develop and launch a manned mission to Mars. NASA is also committed to flying the space shuttle through 2010, completing the international space station, and having a new space vehicle ready for flight by 2014. According to **Thomas C. Corke,** the Clark Equipment Professor of Aerospace and Mechanical Engineering and Director of the Center for Flow Physics and Control and the Hessert Laboratory for Aerospace Research, that is quite a challenge considering that NASA's aeronautics budget began to drop substantially two years ago. The Bush administration's proposed 2007 budget would cut funding by another 18 percent, down more than $1 billion from 2004. Corke predicts that the cuts will not only affect the aviation industry and universities, who receive funding for aeronautics research, but it will also impact the nation's status as an aviation leader and hurt the economy. "Aeronautics is the largest exporter in the country," he said. "The total deficit due to exports in 2005 would have been 50 percent higher if it were not for the aircraft industry. Today, countries such as Japan and China are challenging America's role as the global leader in aviation."

The U.S. aeronautics industry is one of the largest contributors to the nation's balance of trade. For example, in the next 24 hours a single company in the industry (Boeing) will export $53 million of goods and services and transport more than 3 million passengers around the world.

Corke is very familiar with the challenge ahead. In 2006 he served on a National Academy of Engineering committee that discussed how the administration's directives could affect U.S. aeronautics. Their report, which was issued in July and aimed at guiding aeronautics research over the next decade, called for renewed support of NASA's aeronautics research and technology development programs. The committee also outlined several goals, including increasing the capacity of the air transportation system by 300 percent in the next decade while maintaining federal guidelines for noise limits on aircraft. Increased air traffic would affect regulations on aircraft spacing, tax existing airports and runway space, and require greater fuel economy, all of which would require new research to insure safety.

An ND First

The International Association for Pattern Recognition (IAPR) has named **Patrick J. Flynn,** professor of computer science and engineering, a fellow of the society. He is the first Notre Dame faculty member to be named an IAPR fellow. Flynn's research interests include biometrics, computer vision, image processing, and pattern recognition. He has served on the editorial boards of three of his field's major journals, including *Pattern Recognition Letters,* which is published by the IAPR. A faculty member since 2001, Flynn co-directs the Computer Vision Laboratory and is currently funded by the National Science Foundation, U.S. Department of Justice, Central Intelligence Agency, and UNISYS. He is also a senior member of the Institute of Electrical and Electronic Engineers and a member of the Association for Computing Machinery.

New Titles and New Faces

In recognition of their outstanding efforts in education and research, the following faculty were promoted, effective July 2006:

Martin Haenggi
Electrical Engineering
From assistant to associate professor

Glen L. Niebur
Aerospace and Mechanical Engineering
From assistant to associate professor

Jeffrey W. Talley
Civil Engineering and Geological Sciences
From assistant to associate professor

Joannes J. Westerink
Civil Engineering and Geological Sciences
From associate professor to professor

There are also some new faces in the College of Engineering, effective August 2006:

Aerospace and Mechanical Engineering
Katherine Wenjue Liu, *assistant professor*
Meng Wang, *associate professor*

Chemical and Biomolecular Engineering
Paul Bohn, *the Arthur J. Schmitt Professor*

Civil Engineering and Geological Sciences
Stefan Green, *visiting assistant professor*
Jae-Sueng Hwang, *visiting assistant research professor*
David Kreller, *visiting assistant professor*
Lynda Soderholm, *adjunct professor*
Richard Woods, *the Melchor Visiting Professor*

Computer Science and Engineering
Michael Ciletti, *visiting professor*
Christopher Sweet, *assistant research professor*

Electrical Engineering
Joerg Kliewer, *visiting assistant professor*
Chris Mack, *the Melchor Visiting Professor*
Kevin Passino, *visiting professor*
Botond Roska, *adjunct professor*

The Next Big Thing in Computers

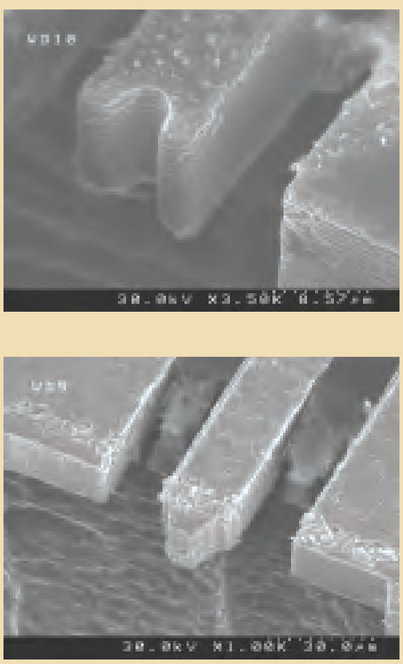
It's not a person ... at least not one person ... although an engineering faculty member is contributing. **Peter M. Kogge,** the Associate Dean for Research and the Ted H. McCourtney Professor of Computer Science and Engineering, has been named to the Interim Council for the Community Computing Consortium (CCC).

Created by the Computing Research Association in conjunction with the National Science Foundation in order to identify major research opportunities and establish grand challenges for the field of computing, the CCC provides scientific leadership and vision on issues related to the future of computing and large-scale computing projects. Many CCC discussions focus on the next big computing ideas — those that will define the future of computing, galvanize the best and brightest minds of the next generation of students and researchers, and attract research investment and public support. Members of the CCC also study computing's impact on industry, as well as the nature and role of research.

A fellow of the Institute of Electrical and Electronics Engineers and an IBM fellow (retired), Kogge has served on many panels, committees, and workshops addressing the future of computing. He has written two books on computer architecture and holds 39 patents and patent applications. An alum (B.S., EE '68), Kogge returned to the University in 1994.

"Quilted" Circuits

Card-trick quilt pattern



Self-aligning keys and slots bridge the gap between neighboring chips, enabling direct chip-to-chip contact. The multi-chip "quilted" system these links create offers high signal bandwidth, reduced power dissipation, reduced production costs, and the option to use heterogeneous materials. Nodules as small as 10 microns have been demonstrated by the Notre Dame team in this National Science Foundation funded project.

The semiconductor industry road map, which corresponds with Moore's Law and states that the density of chips doubles approximately every 18 months, is facing a bit of a roadblock. The experts agree: If all else remains the same, the gains in cost and performance of monolithically integrated chips are going to diminish substantially in the near future, which means that the processing speed of computers will also suffer.

A seamless interface, tailor-made by Notre Dame faculty, may be just the thing to solve the interchip interconnect problem. In fact, a research team led **Gary H. Bernstein,** professor of electrical engineering, has demonstrated a new paradigm for interchip communication called Quilt Packaging (QP).

QP involves the fabrication of contact nodules that protrude from the edge of a chip. The chips needed to form a system are placed side-by-side, with the nodules allowing a direct electrical interconnection. Linking together like the blocks of a card-trick pattern quilt, the various integrated circuits can, in fact, be of heterogeneous materials. In this way, for example, silicon processors could be combined efficiently and inexpensively with optical processors, microwave devices, or memory.

This type of interchip contact offers high-speed signal paths for the high-fidelity transmission of signals between chips at very high frequencies, into the hundreds of GHz. Signals could also be transferred between chips far more faithfully than the conventional approach of going from one chip to another through packages and printed circuit boards. The net result, as demonstrated by the team — Bernstein, **Patrick J. Fay,** associate professor of electrical engineering; **Gregory L. Snider,** professor of electrical engineering; and **Qing Liu,** a graduate student in electrical engineering — is a more efficient use of the die area and better performance in an overall smaller system with the need for fewer chip packages. In short, a better system is achieved at a lower cost.

The team presented experimental results at the Second International Workshop on SOP, SIP, SOC (3S) Electronics Technologies in September 2006, where they unveiled world-record transmission efficiencies at frequencies up to 40GHz. "We used the equipment in the Notre Dame Nanofabrication Facility to build and test the system," says Bernstein, "and we are very excited because this milestone shows that by using Quilt Packaging, the cost of integrated systems, energy use, size, and weight decreases, and performance can be improved. Additional studies may impact portable devices such as laptops and cell phones but could also improve the performance of high-speed systems, such as radar and microwave communication systems."

Changing the Guard

In May 2006 the Department of Electrical Engineering honored Professor **Yih-Fang Huang** with a luncheon and good-natured roast for eight years of service as department chairman, a position from which he officially resigned effective June 30. Huang, who received his master's degree in electrical engineering from Notre Dame in 1980, returned as an assistant professor in September 1982 and has served the department and the College of Engineering in numerous ways since that time.

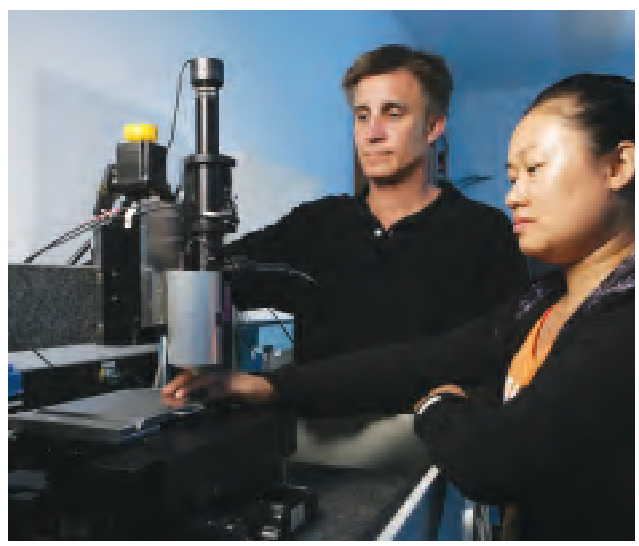
A fellow of the Institute of Electrical and Electronic Engineers (IEEE) and winner of the IEEE Circuits and Systems Society's Golden Jubilee Medal, Huang's research interests are in the area of statistical communications and signal processing, specifically detection and estimation. After a well-earned sabbatical, he will continue his current research, which explores spatial diversity and multiuser diversity for improvements of multiple-input, multiple-output systems.

Noting that he was following in distinguished footsteps, Professor **Thomas E. Fuja** began his tenure as department chair on July 1. Fuja joined the University in 1998. Prior to that he had served on the faculty of the University of Maryland for 11 years. His research focuses on digital communications, error control coding, joint source-channel coding, and information theory.

New ASME Fellow

Timothy C. Ovaert, professor of aerospace and mechanical engineering, has been named a fellow of the American Society of Mechanical Engineers (ASME). Fellow is the highest elected grade of membership in the society, and it is conferred upon a member with a minimum of 10 years of active engineering practice in recognition of significant contributions made to the field.

A faculty member since 2000, Ovaert's research interests are in high-performance materials and materials characterization for tribological, structural, biomedical, and manufacturing applications and include polymeric matrix composites, high-performance polymers, polymer thin films, elastomers, carbon-carbon composites, ceramics, solid lubricants, and novel surface modification techniques. He is also active in the mechanical characterization of bone for bioengineering and pharmaceutical research applications.



Ovaert joins 10 other members of the Department of Aerospace and Mechanical Engineering who have been so honored. They are: **Hafiz M. Atassi, Thomas C. Corke, Patrick F. Dunn, Frank P. Incropera, Thomas J. Mueller, Samuel Paolucci, John E. Renaud, Mihir Sen, Albin A. Szewczyk,** and **Kwang-Tsu Yang.**

Top 25 Recognition

Initially published in the January 2006 issue of *Computer Vision and Image Understanding*, the article titled "A Survey of Approaches and Challenges in 3D and Multi-modal 3D+2D Face Recognition" and authored by **Kevin W. Bowyer,** the Schubmehl-Prein Chair of the Department of Computer Science and Engineering; **Patrick J. Flynn,** professor of computer science and engineering; and **Kyong Chang,** a graduate student in the department, was listed No. 1 on the journal's "Top 25" list (most downloaded according to Elsevier ScienceDirect users) for the periods dating October through December 2005 and January through March 2006. It was No. 8 for the second quarter, April through June 2006. In fact, it was the only article among the top 10 to carry over from previous quarters.

Editor's note: *Printed in the January 2006 issue, the article was posted online in December 2005.*

One by One:

Instructor's Global Impact

Sometimes the most profound moments in a student's academic life occur through contact with one instructor. And, one instructor can impact many students. In fact, **Stephen E. Silliman,** associate dean for educational programs and professor of civil engineering and geological sciences, was recently singled out for the impact he has had globally. The American Society for Engineering Education (ASEE) named Silliman the 2006 recipient of its Global Engineering & Engineering Technology Educator Award.

Presented in June at the ASEE annual conference, the award recognizes ASEE members who have demonstrated excellence in leadership, exceptional knowledge and creative practices contributing to advancements in engineering and engineering technology education, as well as personal and professional development in the global arenas of service, invention, consulting work, or industry participation.

A Notre Dame faculty member since 1986, Silliman has made many contributions internationally over the past decade through a distance-learning course taught from Israel for Notre Dame students, a service program for undergraduates in Haiti involving the development of groundwater supplies, and the development of research and educational initiatives between faculty and students from Notre Dame and at Universite d'Abomey-Calvai in Benin, West Africa.

Silliman studies groundwater flow and transport in heterogeneous media, stochastic hydrology, laboratory flow and transport experiments, groundwater and surface interaction, microbial transport, and water supplies in rural regions of developing countries water supplies. He has also played an integral role in the development of the College of Engineering's first-year program.

***Ryan K. Roeder,** left*

Inaugural Honor

Being honored for your accomplishments as a young professor is a big achievement. But, being chosen as the first recipient of a prestigious award, at least according to **Ryan K. Roeder,** assistant professor of aerospace and mechanical engineering, is an incredibly humbling experience.

Roeder has been named the first recipient of the Early Career Faculty Fellow Award by The Mineral, Metals & Materials Society (TMS) and received the award in February 2007 during the TMS annual conference. Specializing in biomaterials, materials science, and mechanical behavior, Roeder was cited by the TMS for his accomplishments, "specifically those that advance the academic institution with which he is affiliated, as well as those that broaden the technological profile of the society."

Roeder is part of the Biomechanics and Biomaterials in Orthopaedics Group in the College of Engineering. One of his current projects, which is funded by the U.S. Army Medical Research and Materiel Command and the Centers for Disease Control and Prevention, focuses on the development of non-invasive techniques to better detect and image microdamage in bone (see page 21). Another project, funded by the Indiana 21st Century Research and Technology Fund, involves the study of processing-structure-property relationships in hydroxyapatite whisker reinforced polymers for use as synthetic bone substitutes.

A faculty member since 2001, Roeder has authored and co-authored numerous journal articles and conference proceedings and is listed on two patents for synthetic bone substitutes and scaffolds.

Professional Progress Award

Winners of the American Institute of Chemical Engineers' (AIChE) Professional Progress Award have two things in common: They are under 45 years old, and they have already had very active careers. That's the criteria. The winners must demonstrate sustained excellence in the field. What is also notable about the 2006 winner — **Joan F. Brennecke,** the Keating-Crawford Professor of Chemical and Biomolecular Engineering and Director of the Notre Dame Energy Center — is that the award cites her for "fundamental scientific and technological contributions to the development of ionic liquids as separation and reaction solvents." Brennecke has served as a faculty member since 1989. A complete list of winners is available on the AIChE Web site (http://www.aiche.org). Other interesting facts about Brennecke's selection are that she is only the second woman to be so honored and that she is the first Notre Dame faculty member to receive the award.

Working with faculty in the Department of Computer Science and Engineering, Ph.D. candidate James Gentile studies the effects of using several video sources — while also developing appropriate algorithms — to identify key frames from the videos in order to maximize overall recognition performance.

Big Brother Biometrics

"Big Brother is watching." It's a phrase that will make even the most innocent person scan the surroundings for a surveillance camera. The connotation is always negative. But the truth is that video is a crucial tool for the good guys — those who serve and protect — whether the footage is used to identify potential terrorists, capture thieves moving between buildings, or detect troublemakers on a university campus. Unfortunately, the quality of the video, the lighting conditions, and the distance a subject is from a camera affect how well the footage can help law enforcement identify subjects and track their movements.

Kevin W. Bowyer, the Schubmehl-Prein Chair of the Department of Computer Science and Engineering, along with Professor **Patrick J. Flynn** and Research Assistant Professor **Nitesh V. Chawla,** are co-investigators on a project dealing with videographic biometric technologies, which is being funded by the Department of Justice. The goal of their project, titled "Face Recognition from Video," is to study the effects of using a variety of video sources (which feature varying levels of quality) and to develop algorithms which will select and compare multiple frames from several video streams — the type acquired from surveillance applications — in order to maximize recognition levels.

Presidential Appointment

Panos Antsaklis, the H.C. and E.A. Brosey Professor of Electrical Engineering, was appointed to the Technical Advisory Group on Networking and Information Technology, a part of the President's Council of Advisors on Science and Technology.

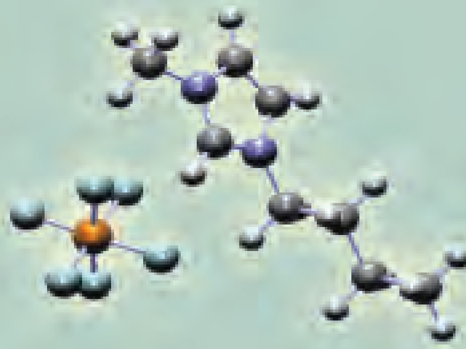
The council addresses matters involving science and technology policy, research priorities, and mathematics and science education. Members are appointed by the President and are drawn from industry, education, research institutions, and other nongovernmental organizations.

A Notre Dame faculty member since 1980, Antsaklis has also been honored by his alma mater, Brown University in Providence, R.I., where he was named the 2006 recipient of the Brown Engineering Alumni Medal. Established in 1997 as a part of the sesquicentennial celebration of engineering at Brown, the award is presented to alumni who have demonstrated exceptional accomplishments throughout their careers.

Antsaklis, who earned both his master's and doctoral degrees from Brown, also served as a faculty member there, as well as at Rice University and London's Imperial College of Science, Technology, and Medicine, prior to joining the University.

taking note

Capturing Greenhouse Gases



Given that President Bush's Global Climate Change Initiative calls for an 18 percent reduction in the nation's greenhouse gas production by 2012, it is not surprising that the Department of Energy (DOE) has been placing an emphasis on the development of clean coal technologies. Nor is it surprising that the DOE wants to be able to use the country's abundant sources of coal — up to 400 years worth of coal (energy) — in a more environmentally responsible way, limiting greenhouse gases and lowering the nation's dependence on foreign oil supplies.

Ionic liquids are salts that are "liquid" in their pure state, near ambient conditions. They exhibit a number of useful properties, including high thermal stability and low volatility.

The truth is that the capture of carbon dioxide (CO_2) from combustion exhausts is one of the areas in which the DOE has expanded its efforts. And, on October 23, the DOE announced the distribution of grants through the Carbon Sequestration Program totaling nearly $24 million for the development of novel and cost-effective technologies to capture CO_2. Notre Dame received $3 million.

Led by **Edward J. Maginn,** professor of chemical and biomolecular engineering; **Joan F. Brennecke,** the Keating-Crawford Professor of Chemical and Biomolecular Engineering and Director of the Notre Dame Energy Center; and **William F. Schneider,** associate professor of chemical and biomolecular engineering, the goal of the Notre Dame project is to exploit the unique properties of ionic liquids and develop solvents for the post-combustion capture of CO_2. This technology has the potential of being used in existing absorption processes, as well as with membrane processes.

Capturing CO_2 from combustion exhausts is not a new concept to University researchers. Two years ago a team led by Maginn and Brennecke demonstrated that ionic liquids have the potential to efficiently capture CO_2 from the flue gas of coal-fired power plants.

Researchers are using a combination of atomistic simulations and targeted experiments to develop a working prototype absorption unit. A graphic of an ionic liquid ion pair, captured from one of their simulations, is pictured above right.

There are a variety of ways to remove CO_2 from emissions (and the air), including pre-combustion, post-combustion, and oxycombustion. Notre Dame is focusing its efforts on post-combustion processes, which involves capturing CO_2 after fuel has been combusted in air. University partners in this area are Babcock and Wilcox, an international energy services company based in Baberton, Ohio; Darmstadt, Germany's Merck KGaA, the oldest pharmaceutical and chemical company in the world; DTE Energy, a national diversified energy company based in Detroit, Mich.; and the Buda, Texas based Trimeric Corporation, which provides process engineering, chemical engineering, research and development, and a variety of services to the public and private sectors.

For more information on this project and other energy-related research, visit the Notre Dame Energy Center at **http://energycenter.nd.edu.**

New APS Fellow

Thomas C. Corke, the Clark Equipment Professor of Aerospace and Mechanical Engineering, has been named a fellow of the American Physical Society (APS). No more than half of one percent of the society's membership is selected annually for election to the status of fellow.

Corke, who specializes in the study of fluid mechanics, was chosen for his "experiments elucidating the structure of turbulent boundary layers, the transition from laminar to turbulent flow in boundary layers and in unconfirmed systems and the control of turbulence."

The founding director of Notre Dame's Center for Flow Physics and Control and director of the Hessert Laboratory for Aerospace Research, he joined the University in 1999. In addition to this most recent honor, Corke is a fellow of the American Society of Mechanical Engineers and an associate fellow of the American Institute of Aeronautics and Astronautics. His research on plasmas has led to a new type of plasma sensor designed for use in hypersonic Mach number, high-enthalpy flows. He is also the author of "Design of Aircraft," which has been adopted as the capstone design text in 12 aerospace departments across the country, as well as by programs in Italy, Finland, and Canada.

Magnetic Logic

Francis Bacon is credited with saying, "Printing, gun powder, and the magnet ... these three have changed the whole face and state of things throughout the world." Things might be changing again: A multidisciplinary team in the College of Engineering has received a $300,000 grant from the National Science Foundation's Emerging Models and Technologies for Computation program to study the potential of lithographically defined nanomagnets within the Quantum-dot Cellular Automata (QCA) architecture scheme — using nanomagnets for computation. **Michael Niemier** (B.S., CPEG '98; M.S. CSE '00; and Ph.D. CSE '04), research assistant professor of computer science and engineering; **Gary H. Bernstein,** professor of electrical engineering; **X. Sharon Hu,** associate professor and director of graduate studies for the Department of Computer Science and Engineering; and **Wolfgang Porod,** the Frank M. Freimann Professor of Electrical Engineering and Director of the Center for Nano Science and Technology, are investigating the viability of nanomagnets for signal processing and other applications by determining if nanomagnets can outperform CMOS systems for a given set of applications. Initial studies are targeting the environments most suited for this implementation of the QCA architecture, such as space and military applications that require very low power and are tolerant to radiation. Embedded systems will also be considered. Niemier and Hu are investigating circuit design, system-level architectures, and performance benchmarking, while Bernstein and Porod are working to fabricate design components.

In a related project, documented in the January 13, 2006, issue of *Science,* another team of University researchers (Porod; Bernstein; **Alexei Orlov,** research associate professor; **Alexandra Imre,** research associate; and **Lili Ji,** graduate student, in conjunction with **Gyorgy Csaba** of the Institute for Nanoelectronics at the Technical University of Munich) demonstrated magnetic QCA with nanomagnets holding information and magnetic interactions executing logic functions. This is the next step in the process toward an all-magnetic information processing system that uses little or no electricity.

Medical Imaging Technologies:

views to a cure

While X-rays have long identified broken bones, emerging imaging technologies are being used to improve the quality of images available for more accurate diagnoses and treatment, assess radiation dosing, and find causes and cures for a variety of diseases.

One of the earliest X-rays is on the left with a more recent radiograph on the right. Although the modern shot is sharper, the images are very similar. The first X-ray tubes were very low power, requiring exposure (to the radiation) for several minutes. Today, the exposure time is much lower, but there is still tremendous potential for improving the image quality.

Angiography, arthrography, chest X-ray, cholangiography, cholecystography, dental X-ray, mammography, myelography, and pyelography ... are more than unpronounceable terms in a medical dictionary. They are all X-rays — radiographic (still) and fluoroscopic (real-time, moving) images — of different parts of the body.

X-rays were discovered by Wilhelm Röntgen in 1895. He called the new rays he found X-rays because their nature was as yet unknown. What he did know was that through the experiments he conducted sending the new rays (a new type of radiation) through objects, even the human body, he could capture an image of the object.

Considered the father of diagnostic radiology, Röntgen produced three papers on the subject and received the first Nobel Prize in Physics for his discovery. In one of the papers, Röntgen revealed the image of the first X-ray of the bones in a living hand, his wife's, and suggested the use of X-rays for medical diagnostic work. Within a year X-rays of the stomach and other organs were being used to identify and locate tumors, and within 10 years hospitals around the world were using X-rays to help diagnose and treat patients. Physicians were finally able to see inside the body without performing surgery.

Milestones in Medical Imaging

1895
German physicist Wilhelm Conrad Röntgen produced the first X-ray picture of the body.

1900
The chest X-ray aided early detection of tuberculosis.

1906
X-ray contrast medium developed.

1924
Radiographic imaging of the gallbladder, bile duct, and blood vessels conducted.

1945
Coronary artery imaging enabled.

1950
Nuclear medicine applied to imaging the kidneys, heart, and skeletal system.

1955
X-ray image intensifier units provided dynamic imaging of a beating heart and its blood vessels.

Panoramic X-ray images taken of the entire jaw and teeth.

1960
Ultrasound imaging developed.

1970
X-ray mammography used for imaging the breasts.

1972
Computed Tomography (CT) scanning invented by Allan Cormack, a professor of physics at Tufts University, and Godfrey Hounsfield, a British engineer. Cormack and Hounsfield received the 1979 Nobel Prize in Physiology or Medicine for their efforts.

1978
Digital radiography developed.

1980
Magnetic Resonance Imaging (MRI) developed by Paul Lauterbur, professor of chemistry, biophysics, computational biology, and engineering, and Sir Peter Mansfield, professor of physics at the University of Nottingham. In 2003 Lauterbur and Mansfield received the Nobel Prize in Physiology or Medicine for their work.

1984
Three-dimensional image processing using digital computers and CT or MR data first conducted.

1985
Clinical Positron Emission Tomography (PET) scanning developed by scientists at the University of California.

1989
Spiral CT allows fast-volume scanning of an entire organ in 30 seconds.

1993
Echo Planar MR Imaging (EPI) developed.

Open MRI Systems designed, allowing MR scanning of severely claustrophobic or obese patients who could not tolerate conventional MR imaging in a closed system.

— Imaginis Corporation

A collaborative project with GE Healthcare and Purdue University that focuses on developing statistically based tomographic reconstruction algorithms for computed tomography has yielded much clearer images than previously available. The conventional reconstruction method is shown using a helical CT scan of the head, top photo, and the advanced technique, developed by Ken D. Sauer, associate professor of electrical engineering at Notre Dame; Jean-Baptiste Thibault (M.S., EE '98; Ph.D., EE '06), a CT scientist in the Applied Science Laboratory at GE Healthcare; Charles A. Bouman, professor of electrical and computer engineering at Purdue University; and Jiang Hsieh, chief scientist in GE's Applied Science Laboratory, bottom photo.

"It's hard to imagine the excitement this must have caused in the scientific and medical communities," says **Ken D. Sauer**, associate professor of electrical engineering and director of the Engineering Honors Program, "even though we can track the incredible and continued development of medical imaging technologies, such as CTs, MRIs, and the creation of three-dimensional imaging, and related equipment. The purpose of each innovation, of course, has been to wring as much information as possible from an X-ray (scan) quickly and accurately without harming the patient."

X-rays are particularly helpful for viewing bones but can also identify some diseases in soft tissue, such as lung cancer, pneumonia, or pulmonary edema. The majority of soft tissue images, however, are better served through computed axial tomography (CAT or CT scanning), magnetic resonance imaging (MRI), or ultrasound. According to Sauer, the workhorse of tomography has

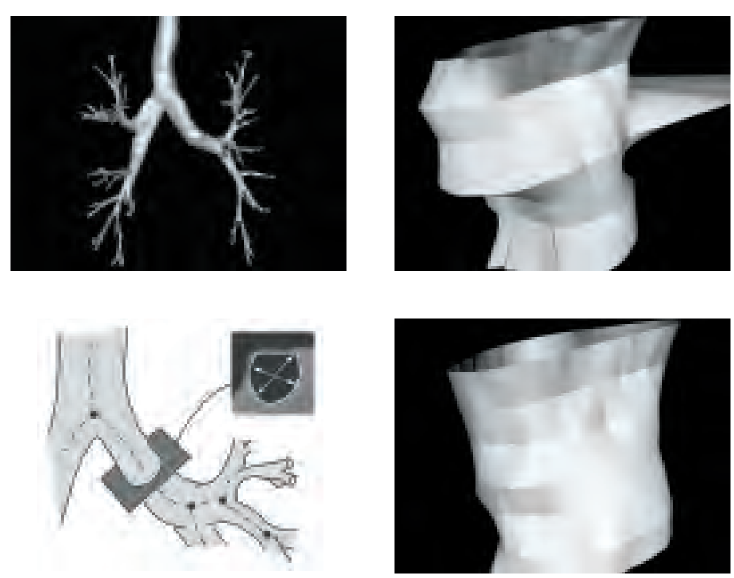
The algorithms developed through the collaborative efforts of Notre Dame, GE Healthcare, and Purdue University are designed to run on the GE Lightspeed VCT scanner, shown here.

been CT scanning. Much of his research focuses on improving the methods for image reconstruction in these types of scans. “We don’t work on the machine itself or design the X-ray emitters,” he says. “We take the data that’s created during the scan and apply very specific algorithms (part of a software package) to help us better reconstruct the images. When these algorithms are successful, they are built into special-purpose hardware, which increases the speed and accuracy of image reconstruction.”

Sauer has been developing statistically based tomographic reconstruction algorithms for almost 20 years. In the past five years he has noticed an increase of interest in lowering the amount of radiation patients are exposed to during a procedure. “Lowering the radiation a patient encounters during a scan means lower-quality images, unless we do something to aid the reconstruction process. That,” he says, “is the challenge.”

Radiation therapies for cancer treatment present different challenges for medical imaging technologies. Intensity-modulated radiation therapy (IMRT), for example, is designed to protect normal tissue through a series of treatment steps: organ contouring, beam angle selection, dosage calculations, leaf sequencing, and delivery. Organ/tumor contouring begins with a CT scan. The location and contours of the target tumor area and surrounding tissue are determined via the CT images. Using the information garnered during the contouring stage, a radiation dosage is calculated. Leaf sequencing then helps identify the movements that should be taken by the machine delivering the radiation, such as a linear particle accelerator, to assure that the correct amount of radiation is distributed accurately to the tumor in the minimum amount of time.

Researchers at Notre Dame, in conjunction with researchers at the University of Iowa and the University of Maryland School of Medicine, are addressing some of these steps. **Danny Z. Chen,** professor of computer science and engineering, has been working with **Milan Sonka,** professor of electrical and computer engineering at the University of Iowa, on a National Institutes of Health project to refine image segmentation (organ contouring). “Medical imaging is a physician’s eye into the body,” says Chen. “Even when you know the disease, you have to know exactly where it is located to avoid damaging healthy tissue and vital organs. You need all of this information before you can accomplish effective treatment.”



Notre Dame’s Danny Z. Chen, professor of computer science and engineering, and Milan Sonka, professor of electrical and computer engineering at the University of Iowa, have applied for a patent on the approach they have developed to refine the organ contouring process. Their approach is faster, more accurate, and has solved problems once considered computationally intractable when imaging three-dimensional objects. From bottom left, clockwise, the photos show the cross-section of the artery being scanned, the outcome of the scan employing the commonly used 2-D algorithms, and the result of the new 3-D approach designed by Chen and Sonka.

Bo Zhou, a postdoctoral research associate working with X. Sharon Hu and Danny Z. Chen, tests the programmable board the Notre Dame team is using to address challenges in medical imaging technologies. In a related project, a hardware-based radiation dose calculation system developed by Hu and Chen, together with Kevin M. Whitton (M.S., CSE '06) and Dr. Cedric Yu at the University of Maryland, has been licensed by Prowess, Inc., an international provider of medical software products and services for the radiation therapy community. The new technology, which performs the calculation on a programmable chip, alleviates the bottleneck in radiation treatment planning.

Chen and **X. Sharon Hu,** associate professor of computer science and engineering and director of the department's graduate studies program, are also developing hardware-based methods to enhance image registration. One of the major problems in medical imaging is that scans of the same area in the same body do not always "match," meaning it is not easy for a physician to pinpoint one location from scan to scan. "This is very important," says Hu, "especially for mapping organs that move (change shape, such as the heart and lungs), tracking the amount of radiation absorbed by a tumor, or assessing the growth or reduction of a tumor." Hu says there are many applications outside of the medical field — such as the registration of satellite images, but she and Chen have been concentrating on medical imaging. Whether for radiation treatment or computer-aided surgery, fast and accurate image registration is vital.

But achieving quick and precise image registration is not easy. Chen and Hu are employing programmable hardware to assist in the task. Boards based on programmable hardware (e.g., a field programmable gate array — FPGA) can be plugged into a computer to greatly improve the accuracy and speed of image registration. "We can buy the chips and build the board ourselves," says Hu, "but for research purposes, we purchase the programmable board, develop the bitstream data (code) ourselves, and download that information onto the board, which plugs into the computer and works like dedicated hardware." This allows Chen and Hu to test their work with the speed, but not the cost, of a dedicated system. As a result of their efforts, the group has successfully developed an FPGA-based solution for radiation dose calculation.

Dr. Cedric Yu, professor of radiation oncology and chief of physics at the University of Maryland School of Medicine, and **Bo Zhou,** the postdoctoral research associate working with Chen and Hu, have been testing the Notre Dame algorithms on the machines in the Department of Radiation Oncology at Maryland, with promising results. The Notre Dame researchers and Dr. Yu have filed for two patents for radiation treatment, and are working on additional projects to employ the imaging software and hardware in the planning of cancer surgeries.

Chen and the Notre Dame computational medicine group also developed new leaf sequencing algorithms and software called SLS. The algorithms, based on graph theory models and computational geometry techniques, are producing IMRT plans that reduce the treatment time by more than 60 percent while providing higher quality images. In fact, the software is being used in the University of Maryland Medical Center and the Helen P. Denit Cancer Center in Montgomery General Hospital in Olney, Md., where it has aided the treatment of hundreds of patients since 2003.

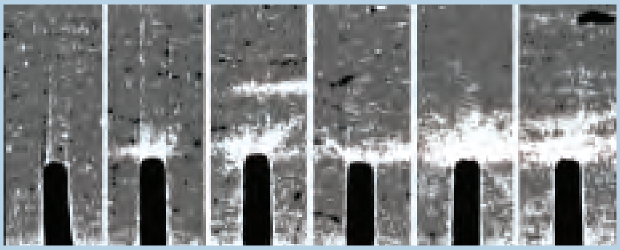
Chen and Yu are also working on the challenges involved in image-guided surgeries, monitoring the surgery in real-time so the surgeon can "see" not only where the organs are but also confirming that radiation, if it is being applied, is hitting the target areas and not healthy tissue. "We are using another novel method to solve these problems," says Chen, "a marriage of computer science and medicine, that we hope will form the cornerstone for more effective treatment."

Matthew Meagher, a junior in the Department of Chemical and Biomolecular Engineering, uses a dynamic light-scattering device to measure the size and identify other qualities of a new nanoparticle contrast agent, which will help visualize microdamage in bone.

Passing the Bone Mass Test

Bone is a living tissue. Like every other part of the body, it needs proper nutrition and exercise at each stage of life. Conditions such as osteoporosis and certain types of cancers can weaken bone, causing fractures. Bones can also crack or splinter at any time for a number of reasons. The standard clinical tests that currently measure bone density, like dual energy X-ray absorptiometry (DXA), measure the quantity but not the quality of the bone. This is key, because approximately half of the patients who "pass" a DXA test — including people over the age of 50; postmenopausal women not taking estrogen; people taking corticosteroids, anti-seizure medication, or high-dose thyroid replacement drugs; and people with diabetes, liver disease, kidney disease, or a family history of osteoporosis — still experience a fracture. In short, "passing" the test provides a false sense of security for many of those still at risk.

The most common causes of fractures — not including osteoporosis — are trauma (accidents) and overuse (people who participate in intense physical activity, such as athletes, manual laborers, and military personnel). In fact, medical costs relating to the treatment of military personnel with stress fractures exceed $10 million annually. Add the treatment costs for osteoporotic related fractures and the country is footing a bill in excess of $13 billion each year. Researchers in the Department of Aerospace and Mechanical Engineering think that's a bit steep for preventable injuries, and so do the agencies sponsoring them.



As part of the "Contrast Agents for Micro-computed Tomography of Microdamage in Bone" project, University researchers employ 2-D, above, and 3-D micro-CT images of notched, cortical bone specimens. The bright region above each notch is stained with a heavy metal contrast agent to highlight microdamage. Shown from left to right, the "stain" or damage increases as the number of loading cycles is increased. The images shown here were generated by Xiang Wang (Ph.D., AME '05) and Huijie Leng (Ph.D., AME '06) in conjunction with Assistant Professor Ryan K. Roeder and Associate Professor Glen L. Niebur.

Assistant Professor **Ryan K. Roeder** and Associate Professor **Glen L. Niebur,** funded by the U.S. Army Medical Research and Materiel Command, the Centers for Disease Control and Prevention, and the National Institute of Arthritis and Musculoskeletal and Skin Diseases program, are developing new contrast agents for micro-computed tomography of microdamage in bone. The goal of their work is to design compounds that, binding to a microfracture, will more accurately identify damaged tissue on a CT scan or X-ray. These new contrast agents could help researchers develop applications for assessing the effects of the damage to bone strength, load capabilities, and fracture susceptibility, improving the diagnosis and prevention of fractures. Working with Roeder and Niebur are Mark Z. Zhang, a postdoctoral researcher in the department; graduate students **Matt Landrigan** and **Ryan Ross;** and undergraduates **Carl Berasi** and **Matthew Meagher.**

making the grade

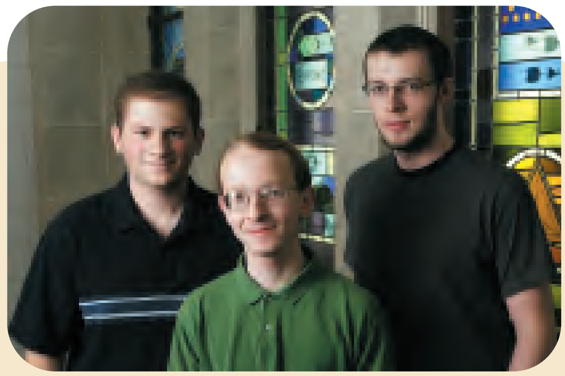
STUDENT ACHIEVEMENTS AND EVENTS

Send a Volley Cheer

Go Irish! **Kevin Braun,** a senior in the Department of Computer Science and Engineering, has been leading the charge as the Notre Dame Leprechaun this year. “Being the Leprechaun — traveling to all the road games, meeting Notre Dame fans of all ages and backgrounds, and being close to the action — has been a wild and thoroughly enjoyable experience,” he says. “Although juggling the commitments of algorithms homework sets during road trips is a tough balancing act.” Braun, a native of Landisville, Penn., would like to

teach high school math. Upon graduation he hopes to be accepted into the University’s Alliance for Catholic Education or Teach for America.

The Leprechaun was named the official mascot in 1965. Prior to that, University teams were represented by Irish Terriers.



Team Irish Blue
left to right, Christopher Fallin, Daniel Dugovic, and Jeffrey Smith

Blue-and-Gold Computing

Two teams from the Department of Computer Science and Engineering were among the 116 teams from 64 colleges and universities in the East Central North American Region that participated in the 2006 Association for Computing Machinery International Collegiate Programming Contest in November.

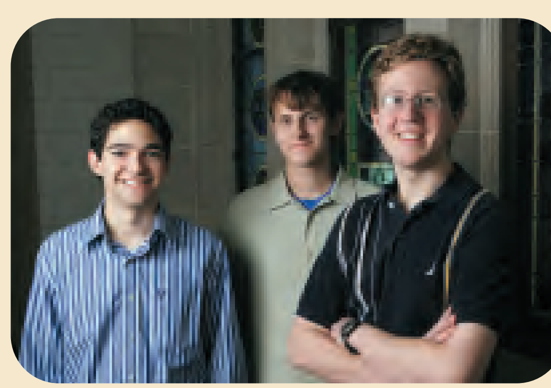
Each year participants are challenged to solve eight complex problems. The team that solves the most problems in the fewest attempts, and the least amount of time, is the winner.

Irish Blue — senior **Jeffrey Smith,** junior **Daniel Dugovic,** and freshman **Christopher Fallin** — completed five of the problems. Smith and Dugovic, who were also on the team last year, repeated their ninth place finish.

Junior **Nicholas Schott,** freshman **Joseph Schmitt,** and freshman **Eric Riedl** — Irish Gold — placed 36th. Last year the Irish Gold team — **Ben Keller,** a junior studying electrical engineering, and **Pavan Sadarangani,** a junior in computer science and engineering — placed 56th.

The East Central region includes universities from Indiana, Ohio, Michigan, western Pennsylvania, and eastern Ontario. **Ray Sepeta,** academic adviser for the University’s First Year of Studies Program, served as the adviser for both teams.

Team Irish Gold
left to right, Nicholas Schott, Joseph Schmitt, and Eric Riedl



Outstanding Student Section

Katie Murphy, the president of the Notre Dame student section of the Society of Women Engineers (SWE), has announced that the University section received the first place award for Outstanding Medium Collegiate Section (36 to 100 members) at the SWE national conference in October 2006. During the conference, SWE also honored large (more than 100 members) and small sections (35 members or less), as well as the Outstanding New Collegiate Section. A not-for-profit educational and service organization founded in 1950, SWE consists of nearly 100 professional and 300 student sections.

NOTRE DAME SECTION
SWE
SOCIETY OF WOMEN ENGINEERS

"We're thankful and excited to be recognized for the work we do to enhance awareness of the opportunities for women in engineering," says Murphy. SWE-ND adviser **Cathy Pieronek,** the director of academic affairs and the Women's Engineering Program, credits the award to the enthusiasm and commitment of the SWE-ND members. She says, "SWE-ND has become one of the most active and vibrant engineering organizations on campus. They hosted the 2005 Region H Conference and increased membership more than 40 percent last year alone."

In addition to on-campus events SWE-ND is active in the community, participating in programs such as Ms. Wizard Day and Expanding Your Horizons (annual workshops that introduce middle school girls to careers in engineering and science), assisting local Girl Scout troops with technology badges, and judging local middle school science fairs.

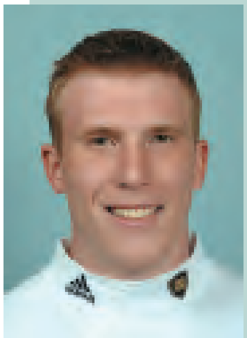
The award is not the first the SWE-ND section has brought back to campus. In the last four years the group has received the Best Student Section award from the SWE Chicago regional section three times.

NCMR Money

Juniors **Brendan Hennessy** and **Andrew Harms** in the Department of Electrical Engineering were selected National Consortium for Measurement and Signatures Intelligence Research (NCMR) scholars. The NCMR initiative, a Defense Intelligence Agency program, provides cutting-edge research to the intelligence community. Its scholarship program was developed to encourage students to consider career paths within the intelligence community. Funds are committed to assisting juniors and seniors with college expenses, specifically tuition, textbooks, and room and board. The awards are presented to full-time students who are U.S. citizens. Scholars, who are also required to submit an essay about their interests and why they want to pursue work in this area, are selected on the basis of their academic record and faculty recommendations.

Top Gun, Top Grades

Before he graduated with a bachelor's degree in mechanical engineering in May 2006, **Robert Woods** was presented with the Top Gun Award at the 14th annual Academic Excellence Awards Dinner, sponsored by the Office of Academic Services for Student-Athletes and the Athletics Department. The award is given to the graduating varsity athlete with the highest cumulative grade-point average (GPA). Woods, a native of Atlantic, Iowa, came to the University on a football scholarship and graduated with a 3.95 GPA.



Other engineers honored at the dinner included Jericho, Vt., native **Jack Goetz,** a mechanical engineering student on the fencing team, and **Patrick Davis,** a computer science major from Clearwater, Fla., who was on the swimming team. Goetz and Davis also graduated in 2006.

Giving Back

Paul Brenner, a graduate student in computer science and engineering and mentor for a team of 10 undergraduate engineers, was awarded the 2006 Rodney F. Ganey Collaborative Community-based Research Mini Grant by the Center for Social Concerns. The grant, given to University researchers in order to stimulate partnerships between Notre Dame and the community, is being used to enhance the effectiveness of a number of local outreach projects. For example, Brenner and the undergraduates, who have named themselves Student Engineers Reaching Out, assist the Logan Center and St. Joseph's Regional Medical Center by modifying commercial toys so that they are more functionally suitable for children with a variety of disabilities. The team is also helping maximize the line efficiency of a local nonprofit packaging and distribution company that employs adults with developmental disabilities.

Paper Trail

Alec Pawling, a graduate student in the Department of Computer Science and Engineering, received the award for Best Student Paper at the annual conference of the North American Association for Computational Social and Organizational Sciences in June 2006. The paper, "Anomaly Detection in a Mobile Communication Network," was co-authored by **Nitesh V. Chawla,** research assistant professor, and **Gregory R. Madey,** associate professor. It will be published in an upcoming issue of *Computational and Mathematical Organization Theory.*

In This Corner

A final check for $52,000 from the 2006 Bengal Bouts, Notre Dame's annual charity boxing tournament, was presented to Rev. Thomas W. Smith, C.S.C., director of Holy Cross Missions, on November 15. In Bangladesh, where the funds will benefit Holy Cross efforts, Smith says that $52,000 is worth approximately $500,000.

Engineering students who participated in the 2006 bouts were: **Jesse Brawer, Andrew Breslin, Tomas Castillo, Fernando Contreras, John Cooney, Mark Dummett, Kevin Hederman, Joseph Herzog, Phillip Hicks, Steve Klein, Bryan Marek, Sean Mallin, Nicholas McLees, Chris Nanovic, Alec Rackish, Jeff Schaal, Roque Strew,** and **Dan Ward.**

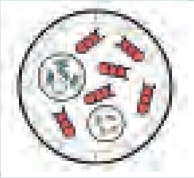
Twice as Nice

According to their adviser, **Eric J. Jumper,** professor of aerospace and mechanical engineering, graduate students **Donald Wittich** and **Alice Nightingale** are two of the seven students in the U.S. who were awarded scholarships from the Directed Energy Professional Society (DEPS). This is the second year they have received recognition from the DEPS but the first that Notre Dame was the only university to receive scholarships.

Awarded annually, the purpose of the scholarships is to encourage graduate research in the development and application of directed energy technologies, which includes high-energy lasers and high-power microwaves, for national defense and civil applications. The applicants must be full-time students who are U.S. citizens or have demonstrated interest in becoming citizens. They must also provide details of the research area in directed energy technology they expect to pursue upon graduation.

In addition to the DEPS scholarship, Nightingale won the student paper competition at the 2006 American Institute of Aeronautics and Astronautics Plasmadynamics and Laser Conference for her submission "Adaptive-optic Correction of a Regularized Compressible Shear Layer."

SwarmFest



Ph.D. candidates **Ryan Kennedy,** computer science and engineering; **Kelly Lane,** biological sciences; and **Gerhard Niederwieser,** a visiting graduate student from the University of Innsbruck, Austria, received the Best Presentation Award for the poster, software demonstration, and talk they presented — "Modeling Disease Transmission in Long-tailed Macaques on Bali, Indonesia" — at the Tenth Annual Swarm Agent-based Simulation Meeting (SwarmFest 2006) at the University in June.

Agent-based modeling is a simulation and modeling technique with methodological roots in computational social science, artificial life, cellular automata, complex systems, self-organization emergence, and complex adaptive systems. Applications of agent-based modeling include problems in economics, ecology, social science, environmental science, urban planning, business, cognitive science, biocomplexity, and the design and engineering of complex systems.

SwarmFest is the annual agent-based modeling conference for engineers, scientists, modelers, and programmers from many fields. The 2006 meeting was hosted by the Department of Computer Science and Engineering and the University's Interdisciplinary Center for the Study of Biocomplexity. They also hosted SwarmFest 2003. Associate Professor **Gregory R. Madey** was on the organizing committee for both events. Madey and his research group are currently applying Swarm modeling techniques to problems in environmental geochemistry and a National Science Foundation study of the Open Source Software development phenomenon.

old man river

A total of 49 undergraduates, two graduate students, four members of the Notre Dame faculty and staff, and four members of the U.S. Army Corps of Engineers toured the Southern Louisiana and Mississippi region in November 2006. The trip was sponsored in part by the Murphy Travel Fund, provided to the Department of Civil Engineering and Geological Sciences by Dennis F. Murphy (B.S., CEGEOS '71).

Everyone in the country knows about Hurricane Katrina. They have seen footage on the evening news of homes and lives devastated by the storm.

They have heard about rebuilding efforts. What most Americans may not realize is that "fixing the problem," involves more than time and money. Vital to the country's economy and culture, the Southern Louisiana and Mississippi region presents critical challenges in a number of areas, including marshland ecology and environmental engineering, structural and soil engineering, hydraulic engineering, and plate tectonics.

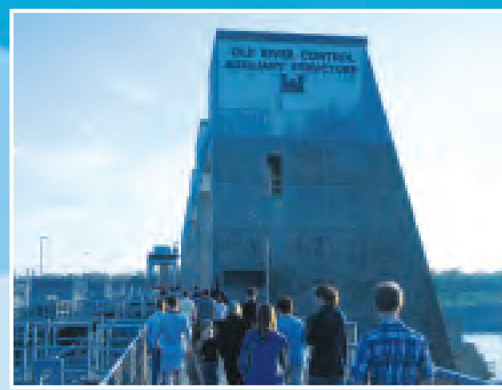
Faculty wanted to help students in *CE30125: Computational Methods* and *CE30300: Introduction to Environmental Engineering* better understand these challenges by having them learn about the area's infrastructure, why the levee system failed, and the technologies that can help build a better and safer flood protection system. To accomplish this, they designed a tour of the area for students. All but one of the students, a mechanical engineering major, were from the Department of Civil Engineering and Geological

For detailed information about the trip, visit **http://www.nd.edu/~jjwteach/30125/fieldtrip.html.**

Sciences.

Also joining the group were four members of the U.S. Army Corps of Engineers stationed in the area.

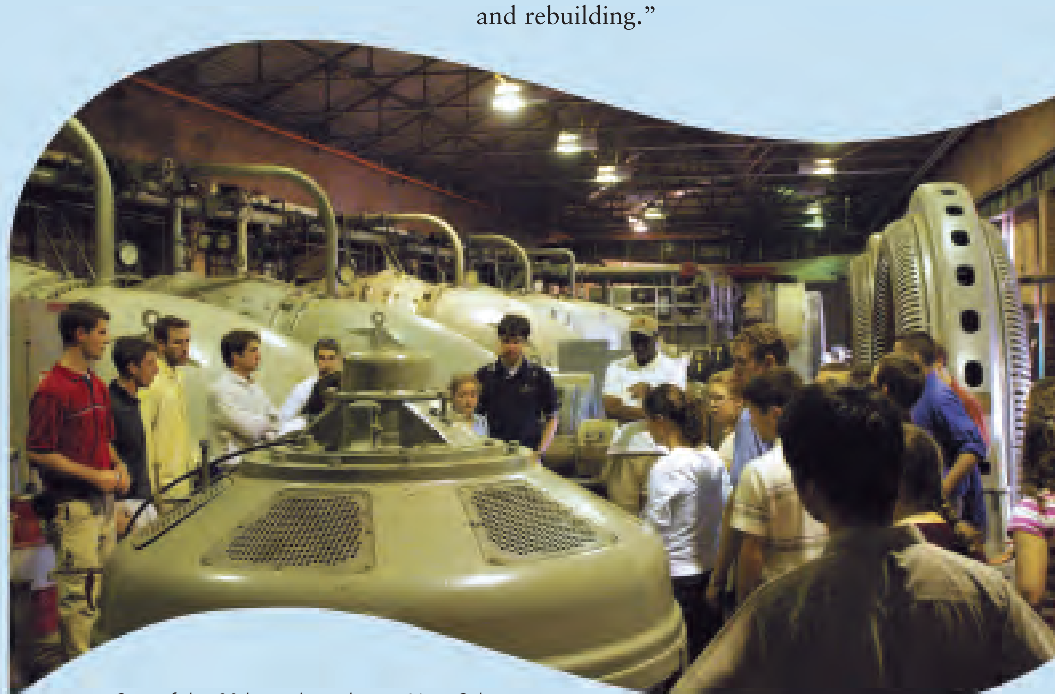
The technology behind the rebuilding was one focus of the tour. As students visited the New Orleans District and Engineer Research and Development Center, they met with senior project managers, the district engineer, and the head of the Hurricane Protection Office, who explained the reconstruction process. Corps engineers also demonstrated physical models that are being used to better understand levee behavior. They toured the 26th largest supercomputer in the world, which is being used to analyze hurricane storm surge and hydrodynamic loads in the area, and they were able to see pump stations and other facilities, such as the Old River Control Structure that keeps the Mississippi River flowing by New Orleans instead of changing course toward the Atchafalaya River.



The Mississippi River changed its course about 750 years ago and began flowing to the area that is now New Orleans. Over the last 100 years the river has been trying to adjust its course once again. In the 1950s acting the under Congressional order, the U.S. Army Corps of Engineers built the Old River Control Structure to help maintain the course of the river around the city.

Another focus was the link between natural geologic processes and the engineered environment, specifically balancing the needs of the environment with the safety of area residents and the economic importance (locally and nationally) of waterways and ocean and inland navigation.

During the trip students were able to experience the food and culture that is uniquely New Orleans, More important, they saw a personal side to engineering, the humanity motivating the technology. In an article for Notre Dame's *Observer,* the student newspaper, junior **Dustin Mennella** wrote: "An area called the Ninth Ward was in close proximity to one of the levee breaches and, as one would imagine, was hit hard. Here, the water did not just flood the area — a tidal wave of escaping water crushed everything in its path. ... Even the trees had died, due to the salt content of the floodwater. Telephone poles laid on the ground, and more than once all that was left of a house were the front steps, because the entire house had simply been swept away. Incredible as the destruction was, hope remains, and the people of New Orleans are slowly but surely returning and rebuilding."



One of the 20 levee breaches in New Orleans during Hurricane Katrina occurred at the 17th Street Canal levee. During their field trip, Notre Dame students and faculty were able to tour the pump house.

Women in Machine Learning

Ph.D. candidate **Deborah Thomas** received a travel fellowship to attend the first Workshop for Women in Machine Learning in October 2006 in San Diego, Calif. During the workshop she presented a poster-paper she co-authored with Schubmehl-Prein Chair of the Department of Computer Science and Engineering **Kevin W. Bowyer,** Professor **Patrick J. Flynn,** and Research Assistant Professor **Nitesh V. Chawla.** The paper, titled "Strategies for Improving Face Recognition in Video Using Machine Learning," describes a process of selecting diverse images from video clips and employing principal component analysis and clustering methodologies to increase the video's performance and boost recognition levels. The team then compared their findings using this approach to an existing approach to quantify the results.

Although it is one of the fastest-growing areas of computer science research, the percentage of female researchers in this area is lower than many others in computer science. The workshop offered Thomas and other attendees the chance to interact with female researchers from around the world in the same field. Thomas, a resident of Bangalore, India, said one of the most informative and interesting portions of the workshop was a panel session where students were able to question female faculty members about their experiences in academia and learn from them.

Wastewater Prize

The Department of Civil Engineering and Geological Sciences' **Christine Dube, Brenna Mannion, Ryan O'Larey,** and **Christopher Schlax** — participants of Assistant Professor **Robert Nerenberg's** Wastewater Design course — walked away with a first place trophy from Metcalf & Eddy's (M&E) Wastewater Design Competition.

For the past three years M&E, an international engineering consulting firm known for its water and wastewater treatment work, has sponsored the Wastewater Design Competition. Every year a number of design topics are offered, each reflecting real-world needs. The Notre Dame team tackled the problem of adapting common treatment technologies for both developed and undeveloped cities. It proposed a decentralized method of treatment — sequencing batch reactors (SBRs) — that would work both in large commercial buildings, such as those found in New York, as well as in residential and underdeveloped areas such as those found around Mexico City. SBRs are a treatment technology pioneered at Notre Dame that carries out functions such as equalization, preliminary treatment, aeration, and settling. SBRs minimize the size, complexity, and cost of the treatment process, while allowing greater operational flexibility.

Based on their 45-page design report and poster, the Notre Dame team was chosen as a finalist and invited to the company's New York City offices for a 15-minute presentation and interview. The judges, which included three M&E employees, a senior environmental engineer, and a managing editor for *Engineering News Record,* commended the team on its professionalism and thoroughness. According to Nerenberg, taking top honors was even sweeter since another Notre Dame team **(Manuel Caldera, Margaret Martin, Maryanne McElwee, Derek Ray,** and **Nick Shultz)** placed a very close second in the previous year's competition.

From left to right, Christine Dube, Brenna Mannion, Assistant Professor Robert Nerenberg, Ryan O'Larey, and Christopher Schlax display the award for first place in the 2005-06 Metcalf & Eddy Wastewater Design Competition. Leon Downing, Ph.D. candidate and teaching assistant for the Wastewater Design course, is not pictured.

A Creative Bent

Top photo: *A basic ambulatory assistance system was developed by the Leg O'Maniacs — Vanessa Carr, Kim Dueffert, Mike Hennig, Eileen Jackson, Steve Klein, and Dan Turnure.* **Bottom photo:** *Gordon Farmer, Mike Johnson, Eric Laumann, Bryan Marek, and Phil Moss developed the Mini Mozart, an interactive keyboard for 3- to 6-year old children.*

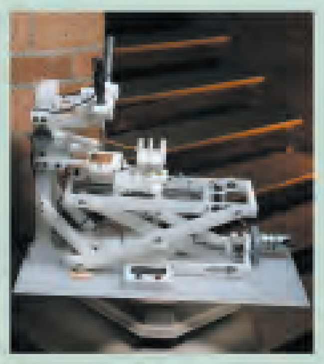
An extremely technical discipline, engineering is also an extremely creative one. Engineers are naturally curious about the way things work. They are equally as passionate about making them work better. That's exactly what seniors are challenged to do in capstone courses throughout the College of Engineering.

For example, last semester mechanical engineering majors were asked to design and construct a working prototype of one of four products: a basic ambulatory assistance system; an innovative musical instrument; an automated circuit board assembly, solder, and test system; or a human-powered potable water still, which could also be entered in the 2007 American Society of Mechanical Engineers Student Design Contest.

The goal of the ambulatory assistance device was to help an able-bodied individual who had sustained a knee, ankle, or foot injury maintain as much mobility and independence as possible during the recovery process. Teams opting to pursue this type of device needed to design a low-cost, all-weather product that was more sophisticated than crutches, more compact than a golf cart, and more flexible than a wheelchair.

One of the challenges for teams designing an innovative musical instrument was to integrate their musical interests with their engineering skills. The "product" needed to be able to play a range of tones (or notes) both manually and in an automated fashion, similar to a player piano. In their final presentations, some of the teams suggested that their devices could help teach children to read and play music or provide motor skill rehabilitation (enhance dexterity) for disabled patients.

Falling under the category of automated fabrication and robotic-enhanced devices, students could also choose to design a device that would take a component from a cartridge, position it on a circuit board, and solder it in place. The device would then test the integrity of the final board and display the state of the board to the operator.



According to team members Nicholas Frohmader, Jeff Lammermeier, Mike Lavery, Dave Rowinski, and Brad Shervheim, SolderBaat grabs a circuit element, transports it to a board, and makes a precise soldered connection, while providing the operator feedback throughout the process.

The fourth product involved the creation of a human-powered water distillation system that could be used by disaster victims, the military, and developing countries where water supplies might be suspect. While design parameters included that the final product needed to be compact, easily transported, durable, and easy to operate, the most important aspect of the device was that it could boil, distill, and supply potable water to the user, who would power the device.

After a few minor adjustments, Team InnovationNDistallation — Dan Driscoll, Michael Giordano, Kevin Hederman, and Todd Ptacek — plans to enter their emergency water recovery system in the 2007 ASME Design Contest.

Nanotechnology:
Shaping the World Atom by Atom

Wolfgang Porod
Department of Electrical Engineering

The emerging fields of nanoscience and nanoengineering are leading to unprecedented understanding and control over the fundamental building blocks of all things physical. This is likely to change the way many things are designed and manufactured, with tremendous potential for innovative applications across a vast array of fields including healthcare, the environment, biotechnology, energy and food production, information technologies, and aerospace. This momentum has been building for quite some time.

During a Congressional hearing in April 1998, the chief science adviser to President Clinton and former director of the National Science Foundation (NSF) Neal Lane stated, "If I were asked for an area of science and engineering that will most likely produce the breakthroughs of tomorrow, I would point to nanoscale science and engineering." Subsequently, in its 2001 budget submission to Congress, the Clinton administration raised nanoscale science and technology to the level of a federal initiative, referring to it as the National Nanotechnology Initiative (NNI).

Nanotechnology remains a top research priority. Today, the NNI maintains a collaborative program among 25 federal agencies with a long-term strategic plan. President Bush signed the 21st Century Nanotechnology Research and Development Act in 2001, and the 2007 budget provides roughly $1.3 billion for nanotechnology research. The United States Patent and Trademark Office has even established a new cross-reference digest for nanotechnology, designated Class 977/Dig.1 and titled "Nanotechnology."

"Nano," which derives from the Greek word for dwarf, is used in science as a prefix to denote one billionth of something. One nanosecond is one billionth of a second (light travels about one foot in a nanosecond), and one nanometer is one billionth of a meter (roughly the size of a small molecule). The term "nanotechnology" is used to refer to engineering on the length scale of 1-100 nanometers. This is the natural spatial context for molecules and their interactions, which ultimately determine the macroscopic properties of materials and structures. As Nobel laureate Richard

Ph.D. candidate Jeffrey Bean, left, and Wolfgang Porod, the Frank M. Freimann Professor of Electrical Engineering and Director of the Center for Nano Science and Technology, load a silicon wafer into the Elionix ELS-7700 electron beam lithography system. The system, which will create patterns on the wafer, is capable of producing features as small as 5 nanometers, approximately 10,000 times smaller than the diameter of a human hair.

FIRST LEGO® League (FLL) combines hands-on interactive robotics and real-world challenges with a sports-like atmosphere. During the pilot program in 1998, 1,600 children participated in two U.S. tournaments. A total of 7,460 teams — 60,000 children worldwide — participated in 2005. Each year the challenge covers a a different technology or problem that impacts society. The 2006 challenge was called Nano Quest. As the students learned about nanotechnology, they had to offer a solution to a problem using those principles. Notre Dame's Wolfgang Porod, the Frank M. Freimann Professor of Electrical Engineering and Director of the Center for Nano Science and Technology, and Carol Osmer, formerly with the center and now in the Office of the President of the University, were part of the team of five professionals who designed the 2006 challenge. They also organize the annual regional FLL competition at the University.

Smalley said, "Nanotechnology is the builder's final frontier."

The University of Notre Dame has a long tradition for contributions to this young field. In the late 1980s — when the term "nanotechnology" was barely known — the College of Engineering strongly supported research in nanoelectronics. This work led to the discovery of a new concept for transistorless computing, called Quantum-dot Cellular Automata (QCA). Invented at Notre Dame in the mid 1990s, QCA is sometimes referred to as "Notre Dame logic." It is recognized by the semiconductor industry as one of the candidates for an emerging device technology, and it is part of the International Technology Roadmap for Semiconductors.

Nanotechnology is a priority area at the University, with its focal point in the Center for Nano Science and Technology (ND*nano*). Established in 2000, the center explores new device concepts and associated architectures that are enabled by novel phenomena on the nanometer scale. It serves as a catalyst for multidisciplinary research and education in nanoelectronics, molecular electronics, nano-bio and bio-fluidic microstructures, circuits, and architectures. It also facilitates collaborations between participating faculty from the departments of electrical engineering, computer science and engineering, chemical and biomolecular engineering, mechanical engineering, chemistry and biochemistry, and physics, as well as with partners from industry and organizations around the world.

In addition to an active and internationally recognized research program, ND*nano* maintains a strong focus on educational and outreach activities. Numerous undergraduate research projects are under way, and the center hosts a nano-bio summer Research Experience for Undergraduates (REU) program. ND*nano* also hosts a summer Research Experience for Teachers program, which targets local high school teachers and students. Just as exciting is the partnership that the center has developed with the FIRST [For Inspiration and Recognition of Science and Technology] LEGO® League (FLL), a not-for-profit organization that engages children in the pursuit of science and technology. In fact, two Notre Dame representatives were on the FLL team that designed the 2006 nanotechnology-based challenge in which approximately 75,000 young people participated.

Nanotechnology is definitely going strong at Notre Dame, so the next time you see ND, I'd like you to think that "ND" stands for "NanoDevices."

A faculty member since 1986, Wolfgang Porod, the Frank M. Freimann Professor of Electrical Engineering and Director of the Center for Nano Science and Technology, is the co-inventor of Quantum-dot Cellular Automata and has received numerous awards and appointments for his expertise in quantum devices and architectures for nanoelectronics.

Corn Bread Are Square

Changing Misconceptions about Engineering

There's an old joke that recounts a young man's first visit home after a semester of college in the big city. His father gives him a bear hug welcome and then asks him to share something he has learned. The boy pulls himself up as straight and tall as he can, looks his father in the eye, and proudly says, "πr^2." Well, the father, who didn't go to school himself and had sacrificed much to be able to send his son to college, explodes. "I don't understand how they could teach you something like that," he says. "Everyone knows pie are not square! Pie are round. Corn bread are square." The truth for an engineer as he or she works to find solutions to real-world problems often lies somewhere in between "round" and "square," where conventional knowledge meets creative application, but far from the misconceptions people nurture about technology and those who make it work.

Misunderstanding has long plagued engineering, and society has often labeled engineers as square pegs — brilliant but nerdy. According to Pat Remick and Frank Cook, the authors of *21 Things Every Future Engineer Should Know: A Practical Guide for Students and Parents,* these wrong ideas are taking their toll on the next generation. Many of the country's most promising students are not considering careers in engineering because of these misconceptions. They think it's too hard to be an engineer and that other majors may be less demanding. Mostly, they do not understand what engineers do or how profoundly they impact daily life.

Obviously, engineers have to be able to comprehend the complicated math and science that is so intertwined with the profession. There are theories and algorithms they need to be able to employ, concepts they need to be able to understand. An engineer who is not technically proficient is not going to make much of an impact. But, as Remick and Cook point out, the most important thing to know about engineers is that they are problem-solvers, which means that in addition to "book smarts," they need to be inquisitive, creative, and motivated.

Undergraduates, high school teachers, and high school students benefit from College of Engineering outreach programs. Jose Roberto Diaz, left, a student at the Mayaguez campus of the University of Puerto Rico, worked with Robert Nerenberg, assistant professor of civil engineering and geological sciences, and Jeremy B. Fein, professor of civil engineering and geological sciences and director of the Environmental Molecular Science Institute, on a project titled "Cadmium Adsorption by Mixed-culture Biofilms under Metabolizing and No-metabolizing Conditions." Lisa Vukovits, above, a science teacher at Washington High School in South Bend, Ind., also worked with Fein to determine the nature and extent of the adsorption of heavy metals and radionuclides onto bacterial surfaces.

While *21 Things* offers insights into engineering disciplines, career paths, and college programs, the University of Notre Dame has taken a more interactive approach to changing some of the misconceptions about engineering, one that highlights the ingenuity, curiosity, and activities that are as much a part of being an engineer as is a good grasp of math and science. Several departments within the University have developed educational outreach programs that allow students — and their teachers — to experience engineering and technology up close and personal. Two of these programs are Research Experience for Undergraduates (REU) and Research Experience for Teachers (RET).

In the REU program undergraduates from universities across the country spend the summer, eight to 10 weeks, at Notre Dame conducting hands-on research under the supervision of Notre Dame faculty and alongside graduate students and other undergraduates. They gain experience and are able to explore a particular field in more depth than is possible during the academic year. Sponsored by the National Science Foundation, the REU program also requires participants to make a formal presentation of their research, which hones their communication skills.

Although many of these students are already in engineering programs, REU helps them identify their specific interests while confirming their choice to pursue engineering. Nationally, this is important as up to 60 percent of the students who enter college as engineering majors leave the program before graduation. (Notre Dame's average, at 40 percent, is much lower. The College of Engineering's graduation rate from sophomore year to senior year is 90 percent.) The difference, according to many of the students, is being able to work as an engineer with faculty and other students on high-profile research projects.

During the 2006 session students participated in projects as varied as building and experimenting with radio and sensor hardware modules, modeling chemical reactions in biological systems, creating new operating system features to better protect a computer from hackers, studying bacterial adsorption through soil and aquifer materials, designing semiconductor nanostructures for use as chemical sensors, and tracking the solubility of uranium minerals in the environment.

Another summer program, RET targets area high school teachers. Participants work with faculty from

Nevin Longenecker, a science teacher at John Adams High School in South Bend, Ind., talks with junior Joseph O'Rourke in one of the school's labs. O'Rourke's project, "Managing Gas Evolution and Reduction and Other Factors in the Direct Methanol Fuel Cell to Increase Power Output," was funded by the Indiana Academy of Science.

a variety of departments on research projects that also cover a wide range of mathematical, scientific, and technological topics and last up to eight weeks. In addition to the research itself, participating teachers are encouraged to take what they learn and incorporate it into curriculum modules for their classes during the academic year. The teachers receive a stipend for the program, and many also receive graduate-level credits.

Nevin Longenecker, who teaches science at John Adams High School in South Bend, Ind., spent his summer researching basic concepts related to fuel cells, specifically microbial and enzymatic fuel cells. Working in the laboratory with **Robert Nerenberg,** assistant professor of civil engineering and geological sciences, Longenecker designed, built, and tested a prototype fuel cell — one that could also be constructed and used in classrooms.

Although Longenecker did not work on a specific research project with them, he also credits Valli Sarveswaran, education and outreach administrator for the Environmental Molecular Science Institute, and Alex Hahn, professor of mathematics and director of the Kaneb Center for Teaching and Learning, for his positive experience and the success of the program. "The RET program has benefitted me and my students," says Longenecker. "I have become more familiar with various types of equipment, which can be used to test and improve the efficiency of fuel cell prototypes. As important, the principles of my work on fuel cells (circuitry, enzyme action, electroplating, and electron transfer) are widely applicable to other investigations that my students are performing."

Longenecker has six students working on the principles underlying the operation of fuel cells and a total of 18 students conducting sophisticated science investigations ... four of which are funded by the American Association for the Advancement of Society. "This is so exciting for a teacher to see," he says, "and I am confident that their experiences will encourage them to pursue careers in technology."

Not concerned with "round" or "square," Longenecker and the other RET participants are the best examples their students could have. They are debunking the misconceptions about engineering and technology and instilling in their students a curiosity for how things work and a love of learning that will prepare them for college and beyond.

Information on REU and RET opportunities for 2007 can be found on each department's or center's Web site. Simply visit the College of Engineering site **(www.nd.edu/~engineer)** and click on Departments/Centers.

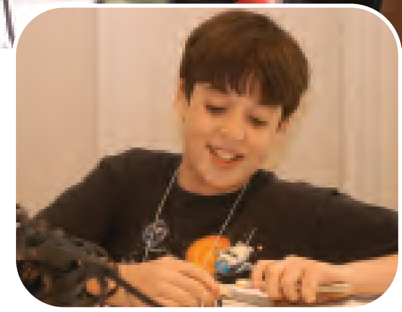
Summer Camp

Some summer camps feature zip-lines and rock-climbing walls. Others, like Notre Dame's Sensing Our World, help students explore the technology around them. The week-long camp for middle school students focused on physical science, materials, physics, and sensors. Students worked with lasers and electronics. They studied the technology behind different kinds of sensors, and they learned how to separate water into hydrogen and oxygen atoms.

Organizers **Karen Morris,** assistant professional specialist in chemistry and biochemistry, and **Suzanne Coshow** of the Joint Institute of Nuclear Astrophysics (JINA) at Notre Dame received help from College of Engineering personnel: **Dennis Birdsell,** laboratory manager of the Center for Environmental Science and Technology; **Leon Downing,** graduate student in civil engineering and geological sciences; **Jennifer Forsythe,** research technician in the Environmental Molecular Science Institute (EMSI); **William Kinman,** graduate student in civil engineering and geological sciences; and **Jennifer Szymanowski,** research technician in EMSI. The college team gave tours of several laboratories in the Department of Civil Engineering and Geological Sciences and demonstrated macroscopic and microscopic research techniques.

The 2006 camp was sponsored by JINA, the Arthur and Helen Shrieman Fund, the Community Endowment Fund of the Community Foundation of St. Joseph County, the departments of physics and chemistry and biochemistry, the Kaneb Center for Teaching and Learning, the Nuclear Structure Laboratory, and faculty researchers at the University. Morris is currently working on plans for the 2007 program.

Middle school students spent a week exploring physical science, materials, and physics during the first Sensing Our World summer day camp at the University in June 2006.



green places

"A thing of beauty is a joy forever." That's how the saying goes, but as 10 students in the Notre Dame section of the Society of Women Engineers (SWE-ND) found out, that is not always the case when a city decides it needs to cut costs. At risk in late 2006 were the Ella Morris and Muessel-Ellison Botanical Conservatories and Potawatomi Greenhouses in nearby South Bend, Ind.

Since the 1920s the greenhouses have supplied flowers and plants for South Bend parks, the Potawatomi Zoo, municipal golf courses, fire stations, and other local facilities. In the 1960s the city began to build the conservatories, which now showcase tropical plants, a desert dome, and waterfalls. Generations of residents have enjoyed the facilities and attended flower shows, meetings, and even weddings on site.

Unfortunately, the structures cost the city significant money to operate — up to $200,000 annually for utilities alone. As city officials met with the parks department, local residents, representatives of the South Bend and St. Joseph County Historic Preservation Commission (HPC), and members of the Michiana Garden Club, the Notre Dame team was putting the finishing touches on an energy-efficiency study, which they shared with the parks board and other city officials.

Team members left to right, included Julie Matteo, Camille Legault, Megan Kimmet, Courtney Darlington, and Jen Vogel. Not pictured are Katie Murphy, Rachel Paietta, Charlotte Low, Tamika McLean, and Colleen O'Hagan

According to **Jen Vogel**, SWE-ND vice president, she and the other team members analyzed the heating and irrigation systems of the conservatories and greenhouses. The purpose of the project was to identify the greatest sources of inefficiency and offer solutions, including the projected expenses associated with implementing the suggested changes.

The first area of concern identified by the SWE-ND team was the fact that the facilities' heating system was manually controlled. For example, if a temperature problem were to arise in the middle of the night, greenhouse personnel had to go to the facilities and physically adjust the decades-old boilers. In addition, many of the fans designed to distribute air throughout the facilities, as well as several of the air vents on the top of the buildings, no longer functioned.

Vogel also said that many newer greenhouses use a thermal blanket for added insulation. After interviewing many experts, the team suggested that the installation of a double-layered blanket would help the single-pane glass in the facilities maintain a constant temperature. They also recommended replacing the current irrigation system with an automated system to better control the amount of water used and eliminate labor costs associated with hand watering.

A mid-September meeting of the board of parks commissioners offered a bleak outlook for the conservatories and greenhouses, as the recommendation was made to close the facilities. But within a month — after receiving the student report and a petition signed by hundreds of residents — South Bend mayor Steve Luecke and Catherine Hostetler, the executive director for the HPC, were able to announce the receipt of a grant for repairs to the facilities. Luecke also met with representatives of a local bank to organize capital for ongoing operating needs, which would support the next phase of improvements and efforts to reach maximum efficiency.

Although they did not accomplish the task alone, SWE-ND team members were among the many volunteers and local businesses who worked to keep the greenhouses open for the community to enjoy. Team members were: from the Department of Chemical and Biomolecular Engineering — Vogel (a junior), **Courtney Darlington** (a junior), **Megan Kimmet** (a senior), and **Julie Matteo** (a junior); from the Department of Aerospace and Mechanical Engineering — **Camille Legault** (a junior), **Katie Murphy** (a senior), and **Rachel Paietta** (a junior); from the Department of Civil Engineering and Geological Sciences — **Charlotte Low** (a junior); from the Department of Computer Science and Engineering — **Tamika McLean** (a junior); and from the Department of Electrical Engineering — **Colleen O'Hagan** (a senior).

Because the facilities face similar climate challenges, the SWE-ND team visited greenhouses at the Frederik Meijer Gardens & Sculpture Park in Grand Rapids, Mich., and the Fort Wayne Children's Zoo in Fort Wayne, Ind., as they were preparing their recommendations for the South Bend Parks Department.

staying in touch

ALUMNI HIGHLIGHTS

In May 2006, **Larry M. AUGUSTIN** (B.S., EE '84) was appointed to the board of directors of XenSource, Inc. He also serves on the boards of Fonality, Hyperic, JBoss, Medsphere, OSDL, Pentaho, SugarCRM, and VA Software, formerly VA Linux, which he founded in 1993.

Eric T. BAUMGARTNER (B.S., AERO '88; Ph.D., AERO '93) was named dean of the T.J. Smull College of Engineering at Ohio Northern University in Ada, Ohio, in July 2006. Previously, Baumgartner had spent 10 years at NASA's Jet Propulsion Laboratory in Pasadena, Calif.

Dennis BOYLE (B.S., ME '75) was awarded the 2006 College of Engineering Honor Award from the Department of Aerospace and Mechanical Engineering. He is a principal and senior design studio leader at IDEO, a global product design firm whose headquarters are in Palo Alto, Calif. Boyle holds more than 50 patents and is the originator of the "Tech Box."

Air Force colonel **Michael T. GOOD** (Ph.D., EE '73), was named to the crew of the 2008 Hubble Space Telescope repair mission on October 31, 2006. The purpose of the flight, Good's first shuttle mission, is to boost the satellite into a higher orbit and replace its batteries and gyroscopes.

In September 2006 on the 50th anniversary of the development of the first practical solar cell, triple Domer **Lawrence L. KAZMERSKI** (B.S., EE '67; M.S., EE '68; and Ph.D., EE '71) was presented with the Nelson W. Taylor Award in Materials Science at the University of Pennsylvania. Earlier in the year he was also honored at the 2006 World Conference on Photovoltaic Energy Conversion for his "outstanding contributions to the advancement of photovoltaic science and technology." Kazmerski is the director of the National Center for Photovoltaics at the National Renewable Energy Laboratory, a facility of the U.S. Department of Energy, in Golden, Colo.

Carlos A. PAZ DE ARAUJO (B.S., EE '77; M.S., EE '79; and Ph.D., EE '82) has received the 2006 Daniel E. Noble Award from the Institute of Electrical and Electronics Engineers for his work in ferroelectric random access memory. The award is presented annually in recognition of outstanding contributions to emerging technologies. Paz de Araujo, a professor of electrical and computer engineering at the University of Colorado at Colorado Springs, is the first American university professor to receive it.

Applied Micro Circuits Corp announced that **Niel RANSOM** (Ph.D., EE '73), former chief technology officer of Alcatel, was elected to its board of directors in July 2006. Ransom also serves on the boards of ECI Telecom, Overture Networks, and Teknovus.

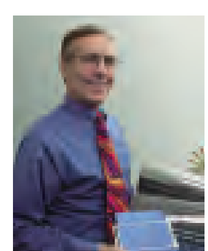
James P. SCHMIEDELER (B.S., ME '96) received a 2006 CAREER award from the National Science Foundation. An assistant professor of mechanical engineering at The Ohio State University, his award-winning proposal will study how the brain initiates motor skills in order to develop a robot that will aid in physical rehabilitation.

Kenneth STINSON (B.S., CEGEOS '64), chairman of Peter Kiewit Sons' Inc., was elected to the Board of Trustees of the University in May 2006. He has served as a member of the college advisory council since 1996.

In April 2006 PlanView, Inc., of Austin, Texas, named **Patrick A. TICKLE** (B.S., EE '87) chief marketing officer, responsible for worldwide marketing operations. Prior to joining PlanView, Tickle served as vice president of marketing and product management at ITM Software.


Baumgartner


Good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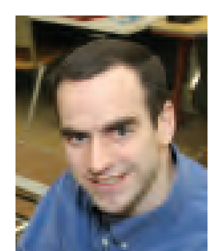
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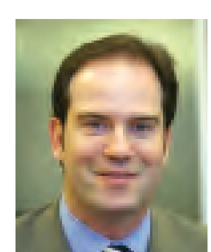

Tickle

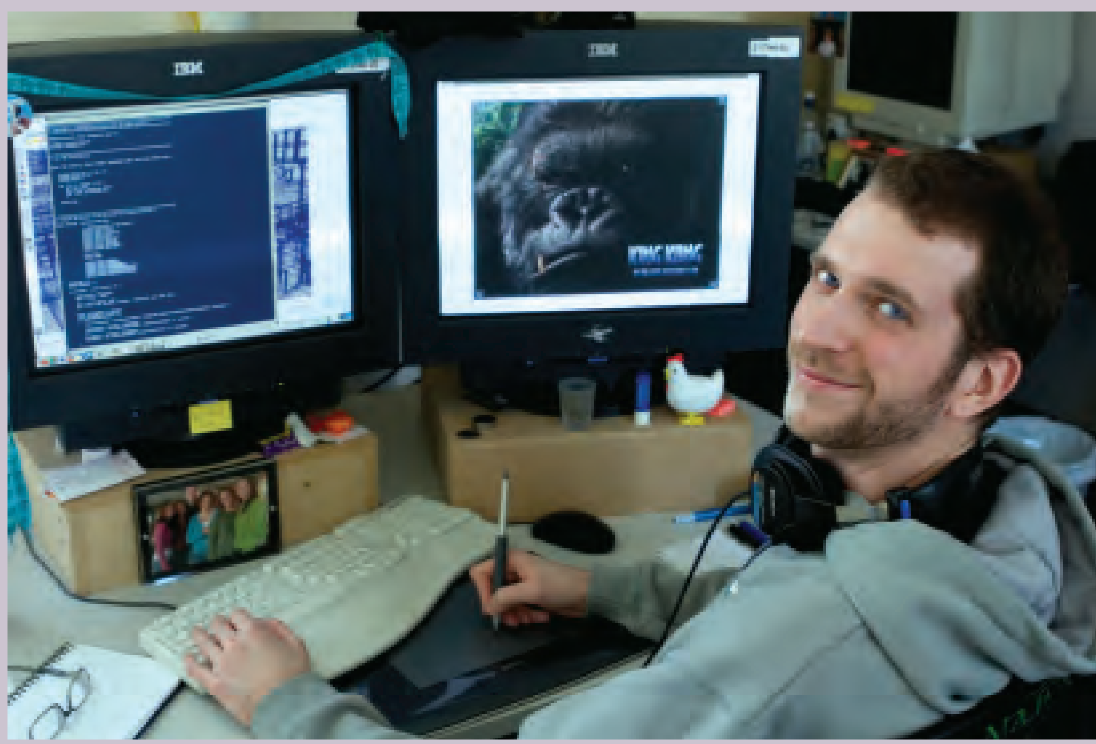
To submit information for **Alumni Highlights,** offer story ideas, or comment on *Signatures,* contact the editor at: **nwelding@nd.edu.**

Engineering: **True Hollywood Story**

After sitting spellbound for two hours in a crowded theater as amazing special effects flash across the screen bringing fantastic stories to life, how many people leave the building saying, "Wow, did you see the engineering in that movie?" The truth is that without engineering — or at least without one Notre Dame engineer — the special effects audiences loved in some recent high-profile movies may have looked a little less fantastic than they did.

Allen Hemberger, who graduated in 2001 with a dual major in computer engineering and art design, began his career in computer animation at Big Idea, Inc., in Chicago, the company responsible for *VeggieTales*. After that, he moved to San Francisco to work at ESC Entertainment on the *Matrix* films, *Catwoman,* and *The Ladykillers*. He then took a short break from the special effects business to teach courses in visual effects at the University. "Actually, I was laid off," says Hemberger. "It's the nature of the industry, one of those not-so-fun parts of the job, because you are usually hired 'per project.' After a few years working in the business, you end up with friends all over the globe at every studio in the world. Then when a given project ends, you e-mail your buddies and make your next move."

Allen Hemberger's dual major (computer engineering and art design) prepared him to be able to translate natural phenomena into mathematics and write software programs that could generate a sequence of images resembling the "real thing." In addition to working on Jonah: A VeggieTales Movie, The Matrix Reloaded, The Matrix Revolutions, The Lady Killers, Catwoman, *and* X-Men: The Last Stand, *Hemberger was part of the Oscar-winning visual effects team for* King Kong.



Most recently, Hemberger finished work as technical director on *Eragon,* which was released late last year, and will soon begin working as technical director on the film *Fantastic Four: Rise of the Silver Surfer.*

He was on campus in December 2006 to present a talk to students titled "Superheroes Need Pants: Adventures in Visual Effects for Film," during which he discussed some of the effects he has produced and how his dual background in engineering and art helped him accomplish them.

Cushing Centennial

John F. Cushing

More than 100 years after he graduated from the University with a degree in civil engineering, John F. Cushing's presence is alive and well at Notre Dame. Students attend classes and work in many of the laboratories of the John F. Cushing Hall of Engineering every day. What they may not fully appreciate is Cushing's vision of the future — their future. It was one of the reasons he gifted the University $300,000 toward the construction of a new hall of engineering.

In a letter to University President Rev. Charles L. O'Donnell, C.S.C., dated April 16, 1931, Cushing outlined his hopes and purpose for the donation. He said: "Engineering has written a glorious chapter in the history of progress in our time. The glory is not all of the past, it has not all been won. There are still great opportunities for those prepared to seize them. The field of service, indeed, is constantly broadening. ... The native genius, inventor or discoverer is, no doubt, born and not made. But he alone would not get very far. Our best hope is the high level of professional intelligence and professional character developed in the colleges and technical schools of the land. It is there the thought needs to be instilled that men owe it to their profession not to lay it down, finally, exactly as it was when they took hold if it, but to pass it on a finer thing, enriched and advanced and more valuable to the world because of the use they made of it.

Members of the Cushing family gathered on the Notre Dame campus for a weekend reunion in June 2006. They were also celebrating the 100th anniversary of the graduation of John F. Cushing. A total of 16 members of the family have attended the University.

"Being deeply impressed with 'The Needs of Notre Dame' ... and because I find at Notre Dame the conditions that make for the twofold training of great engineers in all the departments of engineering, ... and because I feel I owe Notre Dame a debt of gratitude which I can never fully discharge, I ask you to accept from me a gift of three hundred thousand dollars toward the erection of a Hall of Engineering to serve the immediate needs of the College of Engineering and to meet the expectations of older men like me who confidently look back to Notre Dame to produce the men that are to carry on."

Cushing's expectations for future students' leadership and vision were those he had been living as the fourth president of Great Lakes Dredge & Dock Company of Chicago. He knew how to plan, and build, for the future. The Cushing years at Great Lakes were full of significant activity, which enabled the company to become a leader in the American dredging industry, with projects such as construction of the foundation for the Randolph Street Naval Armory in Chicago and building the Peoria Lock on the Illinois River.

Cushing died October 7, 1935, when a United Air Lines plane in which he was traveling crashed near Cheyenne, Wyoming. He had been returning to Chicago from a business trip on the West Coast. (It is said that several years earlier — March 1931 — Cushing had cancelled another flight reservation but that Knute Rockne, Notre Dame's football coach at the time, had taken his seat. It was the flight on which Rockne died.)

As it often seems when lives are tragically cut short, there is a compelling story. Cushing's is no exception. Born in Arapahoe, Neb., he was the son of a blacksmith. He worked his way through the University of Nebraska at Lincoln, spending two years there, and then entered Notre Dame.

At the end of his junior year, Cushing apparently told President Rev. Andrew Morrissey, C.S.C., that he would be unable to return for the final year due to a lack of funds. Morrissey told him not to worry about the money, that he was to come back and finish his studies. Cushing graduated from the University in 1906. He began work for Great Lakes shortly after that and, by 1922, was named president of the company.

John F. Cushing's children, grandchildren, and great grandchildren celebrated the 100th anniversary of his graduation from the University during a family reunion in June 2006. Of the 115 descendant families contacted, 100 family members were able to attend.

A total of 16 family members have attended the University. In addition to John F. Cushing, they are: Paul J. Cushing (B.S., CEGEOS '31); Jerome J. Cushing (B.S., CEGEOS '35); Gregory P. Cushing (B.S., AME '39); Vincent J. Cushing (B.S., Physics '45; M.S., Mathematics '46); Robert P. Cushing (B.S., Commerce '58); Paul J. Cushing Jr. (B.S., CEGEOS '59); Vincent J. Cushing Jr. (B.S., EE '70); David J. Cushing (B.S., EE '73); Brian J. Cushing (B.A., Economics '75); Michael F. Cushing (B.S., Physics '80); Daniel P. Cushing (B.S., EE '81); James R. Braun (B.S., AME '86); Elizabeth A. Cushing (B.F.A., Art Studio '02); Erin C. O'Brien (B.A., Psychology '03); and Kenneth A. Cushing, who will graduate in May 2007 with a bachelor's degree in psychology. Although he did not attend the University, James T. Cushing served as a professor of physics and philosophy at Notre Dame from 1966 until his death in 2002.

Left photo: *Graduating in 1906 with a degree in civil engineering, John F. Cushing was ready to take on the world as he posed atop the pedestal on which Father Edward Sorin's statue now stands.* **Middle photo:** *The John F. Cushing Hall of Engineering was dedicated in 1932. Today, its auditorium is home to the Engineering Learning Center (see the inside front cover).* **Right photo:** *Cushing Hall, shown here, is attached to Fitzpatrick Hall, dedicated in 1979. Both house most of the facilities of the College of Engineering, although construction on a new engineering building will soon begin to meet the growing needs of the college for teaching and research space.*

signatures

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Looking Back

Although the Department of Aeronautical Engineering was not formally established until 1936, University researchers were studying the physics of flight 21 years before Wilbur and Orville Wright made history at Kittyhawk, N.C. Glenn Curtis, far left, Charles Manley, center, and Albert F. Zahm pose with the Hammondsport Machine, a manned glider they launched from atop Notre Dame buildings.

Laying the "Groundwork" for Aerospace Research

Aerodynamicist **Albert F. Zahm** was the first professor of mechanical engineering at the University. He also built the first hand-driven wind tunnel in the United States and organized the first International Aeronautical Congress, which was held in Chicago during the 1893 World's Fair. Known on-campus for his late-night glider flights, which were launched from the roofs of University buildings, Zahm had a tremendous influence on the history of aerospace research in the U.S. In fact, he was the first to discuss a modern method of launching an airplane and controlling its flight — by rotating parts of the wings to balance it laterally while using a double tail to decrease pitching and yawing. He also made contributions to aerospace research at the University. It is a tradition that continues today.

(See SEEING THE BIG PICTURE, page 2.)