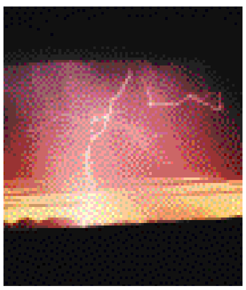
Signatures

Volume 1, Number 1

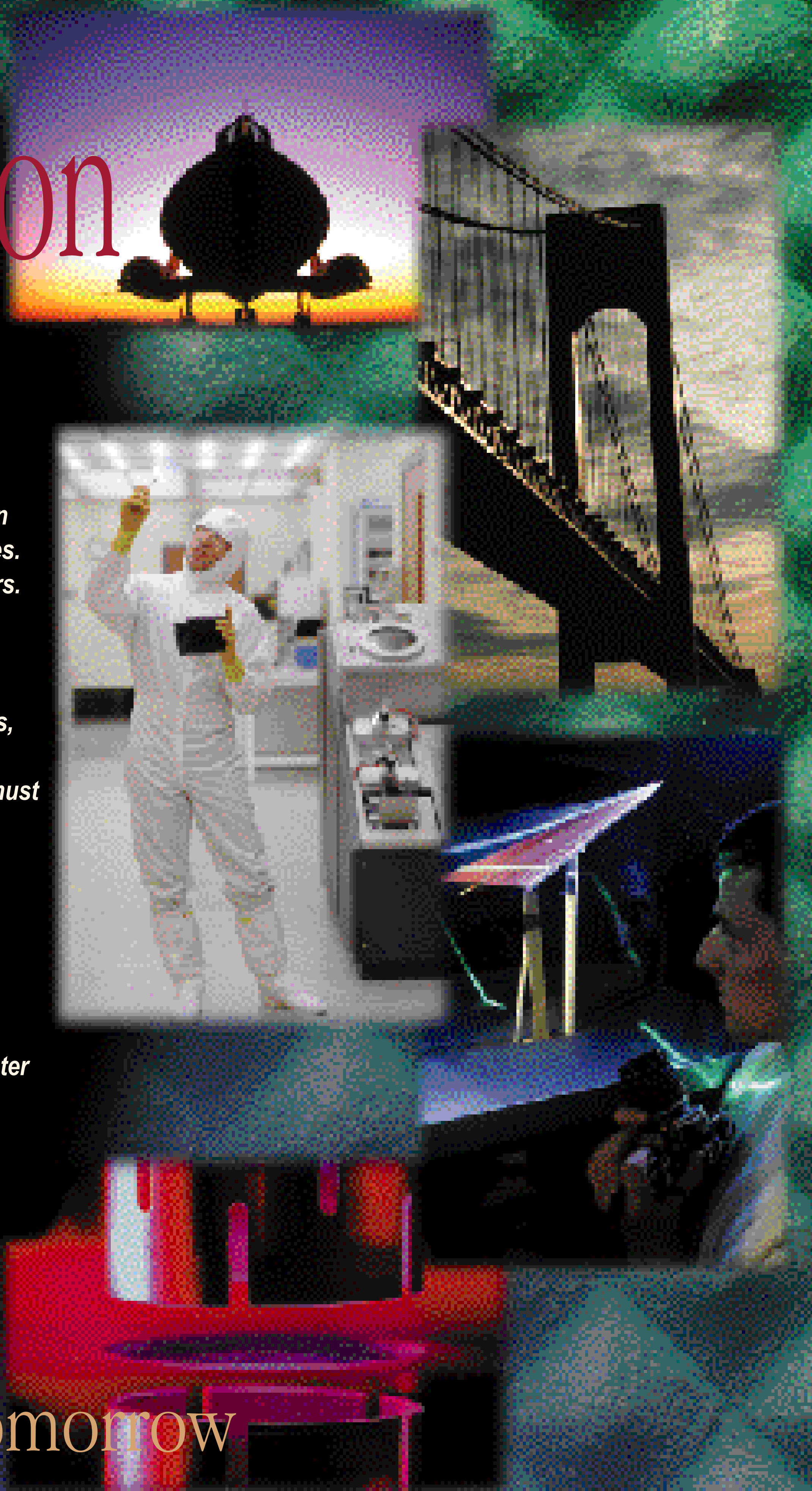
Engineering Advances at the University of Notre Dame

FEATURES



DEPARTMENTS

Based on Tradition



For more than a century, faculty of the College of Engineering have nurtured the educational aspirations of thousands of students and, through their research, have contributed much to the generation of new knowledge and technologies. However, we are not about numbers.

Relative to many of our peers, we have a small college, with approximately 700 undergraduate students, 275 graduate students, 95 faculty, and five departments. Hence, we must choose our targets carefully, and what we do must be done well.

We are committed to providing an undergraduate education that is rich in technical content, relevant to needs of the 21st century, and fosters the growth of moral character and a spirit of service among our students. In our research we must have foci which are linked to important needs and opportunities and prepare our students for leadership in the development and application of new technologies.

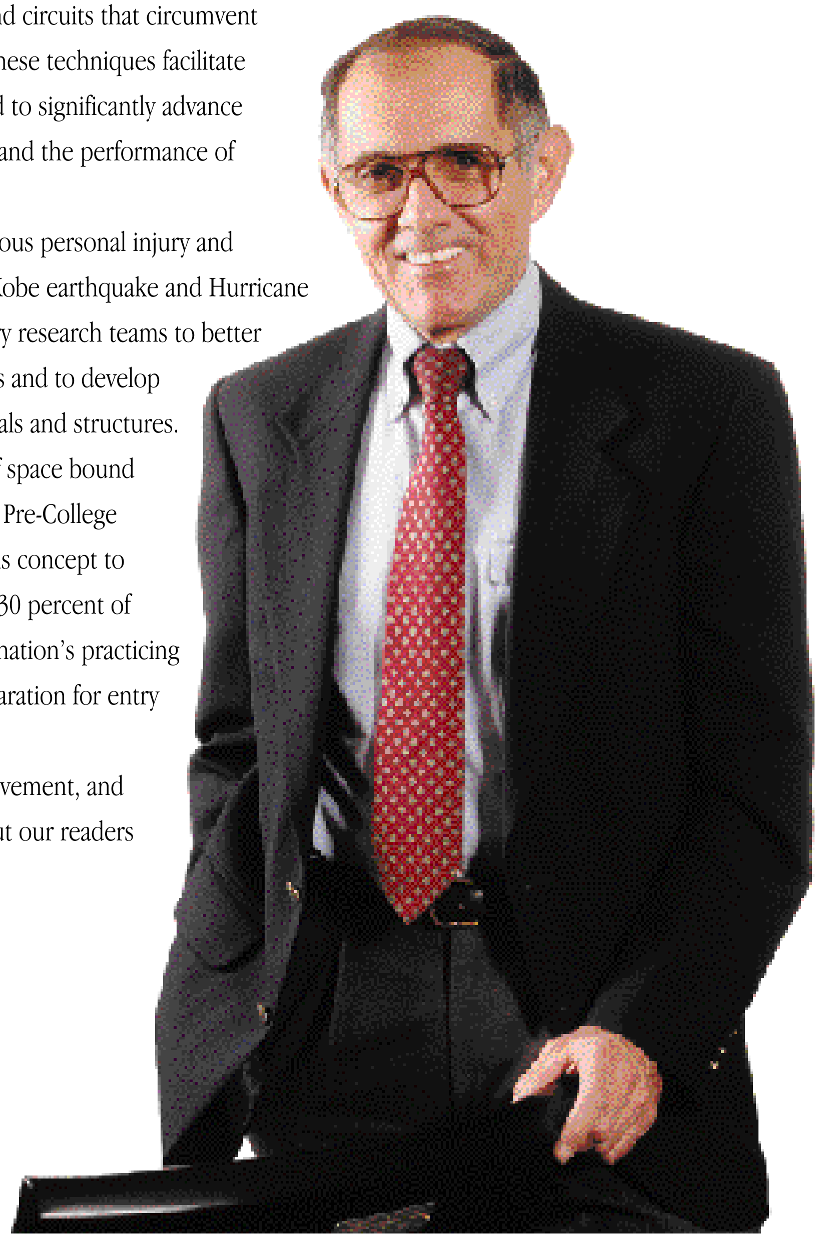
Bound for Tomorrow

Focus on the Future

moving into the next MILLENNIUM...

We are pleased to provide you with a copy of the first issue of a magazine which will be published annually by the College of Engineering. Like many colleges around the country, we have been assessing means of better communicating our activities. An outcome of this assessment has been the decision to use multiple formats, differentiated according to the intended audience. Termed *Signatures*, this magazine is intended for colleagues from other institutions, potential students, industrial partners, and benefactors. Its purpose is to draw attention to special (signature) activities involving teaching, research, and/or service. Feature articles will be substantive, but written in a manner designed to inform and spark interest among a broad spectrum of readers. Shorter articles and notes will describe recent accomplishments of our faculty, students, and staff. Collectively, *Signatures* will chronicle activities which are having or are expected to have a significant impact on technology and society. In this issue, feature articles deal with two areas of research and one outreach activity.

"Current Thinking on Quantum Dots" chronicles efforts by faculty from Electrical, Chemical, and Computer Engineering and the Department of Chemistry to develop nanofabrication techniques and circuits that circumvent fundamental limits associated with microelectronic technologies. These techniques facilitate the creation of arrays of quantum dots and lines which may be used to significantly advance computing power through the development of transistorless chips and the performance of devices such as CD players, optical drives, and digital cameras.



In recent years we have become increasingly aware of the enormous personal injury and property damage created by hazardous natural events such as the Kobe earthquake and Hurricane Mitch. "Movers & Shakers" deals with the efforts of cross-disciplinary research teams to better understand the loads imposed by such events on civil infrastructures and to develop improved design methods, which include the use of "smart" materials and structures.

When we think of distance education, it is often in the context of space bound adults. "Distance Learning at Notre Dame" describes the Ameritech Pre-College Minority Engineering Program (APMEP), a novel effort to extend this concept to minority middle school students. Minority groups represent nearly 30 percent of the college age student population but less than six percent of the nation's practicing engineers. APMEP stimulates early interest in engineering and preparation for entry into college engineering programs.

As with any first attempt, there are many opportunities for improvement, and they will certainly be explored for *Signatures*. We welcome any input our readers may wish to provide in this regard.

F. P. Incropera

Frank Incropera
McCloskey Dean of Engineering
Brosey Professor of Mechanical Engineering

current on Qu

Five million dollars may seem like a lot of money to spend studying dots, but when they're so small you can fit several trillion of them on a chip and you're pioneering a new technology like quantum-dot cellular automata, it's not really that much ...

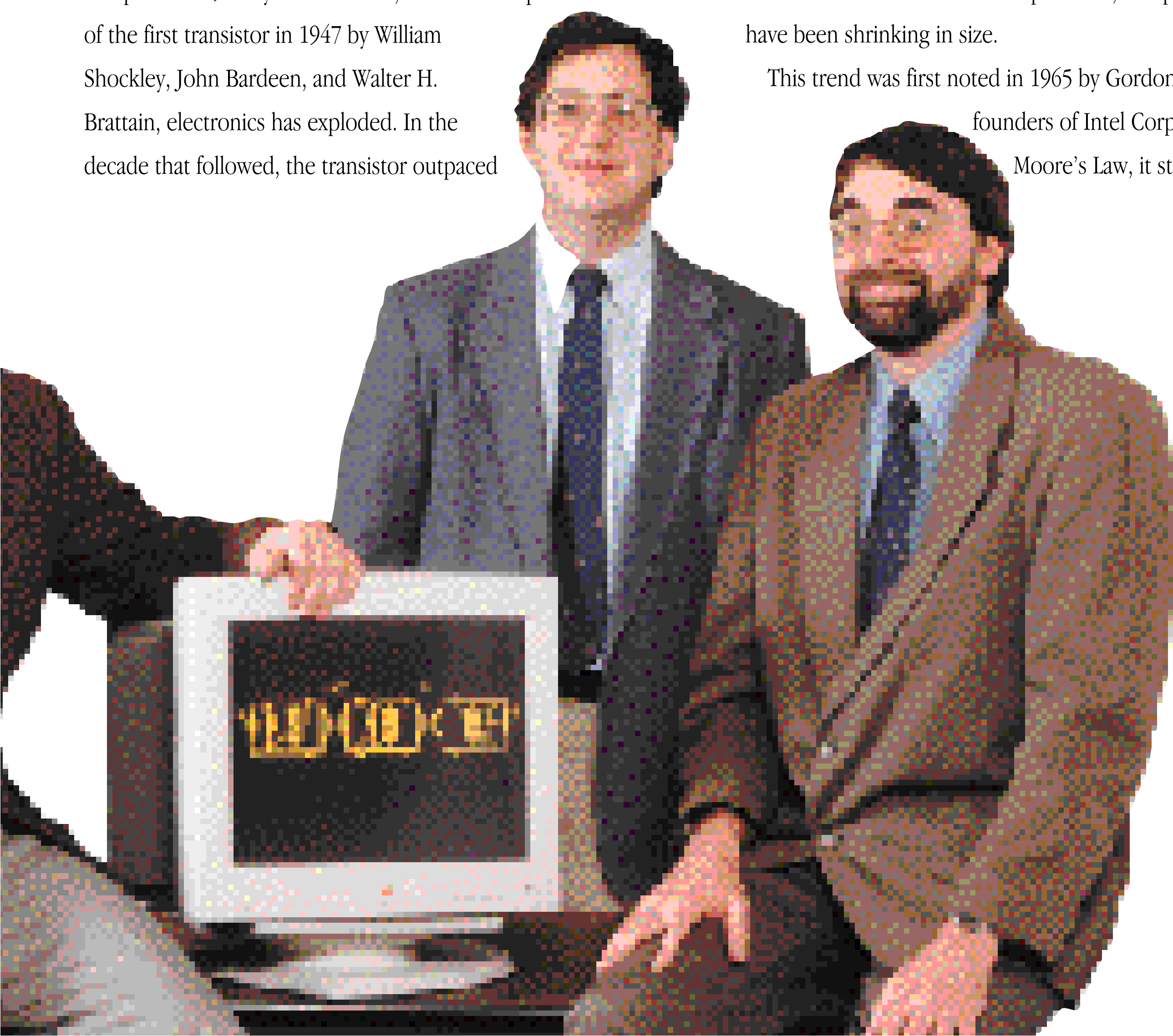
thinking

antum Dots

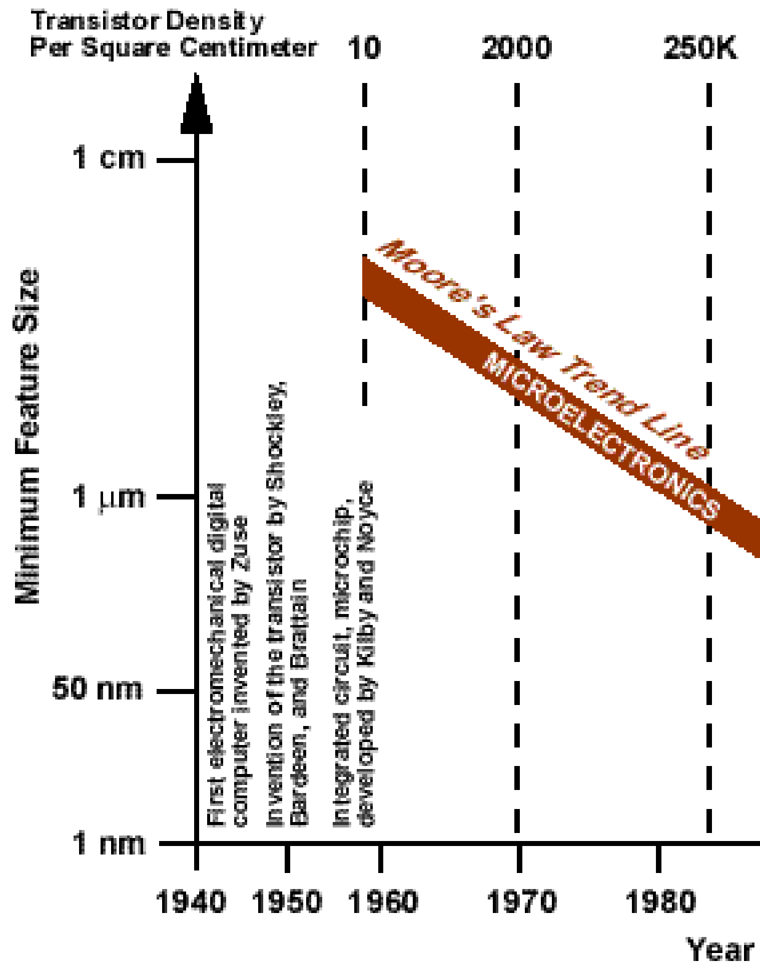
Quantum-dot cellular automata is all about making circuits smaller, faster, and better. A giant leap from conventional thinking, this new technology points toward a transistorless society, and researchers at the University of Notre Dame are leading the way.

Before discussing this new technology, it is important to understand how far existing technology has come. From Ambrose Fleming's simple electronic "valve," designed in 1904 to detect radio waves, to the invention of the first electromechanical binary computer in 1941 by Konrad Zuse, to the development of the first transistor in 1947 by William Shockley, John Bardeen, and Walter H. Brattain, electronics has exploded. In the decade that followed, the transistor outpaced existing electronic tubes with higher switching speeds, lower power consumption, and smaller weights and sizes. Then, in the early 1960s, Jack Kilby and Robert Noyce took the transistor to a new level, using it as the electronic switching device in the development of integrated circuits. These circuits, when arrayed, became the mainframes for computers. This was a milestone in microelectronics, but even then these first integrated circuit computers were large — about the size of a minivan. For the past three decades, as electronics have become more powerful, computers and transistors have been shrinking in size.

This trend was first noted in 1965 by Gordon Moore, one of the founders of Intel Corporation. Known as Moore's Law, it states that the pace of



Some of the members of the Notre Dame NanoDevices Group are: (left to right) Dr. Craig S. Lent, Dr. Gerald J. Iafrate, Dr. Wolfgang Porod, Dr. Gary H. Bernstein, and Dr. Gregory L. Snider. All part of the Electrical Engineering Department, these faculty members are leading the University's interdisciplinary effort in nanoelectronics, a transistorless approach to computing and other digital applications.



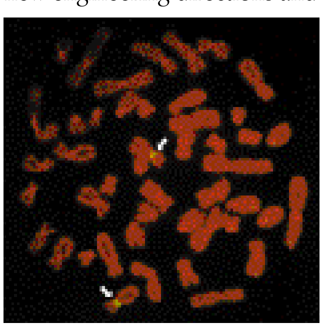
microchip technology is such that the complexity of a chip will double every year to 18 months. When Moore made this observation, manufacturers could fit 1,000 transistors on each square centimeter of chip. The number of transistors on a chip has increased exponentially since then. Today, transistors on commercial circuits measure about one quarter of a micron across — a micron being one millionth of a meter or 1,000 nanometers — and a processor chip now holds approximately 10 million transistors.

Even so, microelectronics is close to reaching the limits of the laws of physics, materials, and fabrication techniques in the minimum size manufacturers can produce a working semiconductor transistor. Moore's law is running out of time. Researchers project the ability to produce transistors as small as 0.05 microns (50 nanometers) but going smaller would affect the function of the chip. Why? Because as more and more transistors are packed into a microchip, more heat is generated. Transistors become less effective at switching the current, that is, turning it "on" and "off." The current stream also becomes smaller and less powerful, so it may not be able to change the state of the next switch. More important, as devices become smaller, electrons no longer act as classical particles, like billiard balls, and quantum mechanical effects take over, making them apt to tunnel between circuit elements and cause malfunctions.

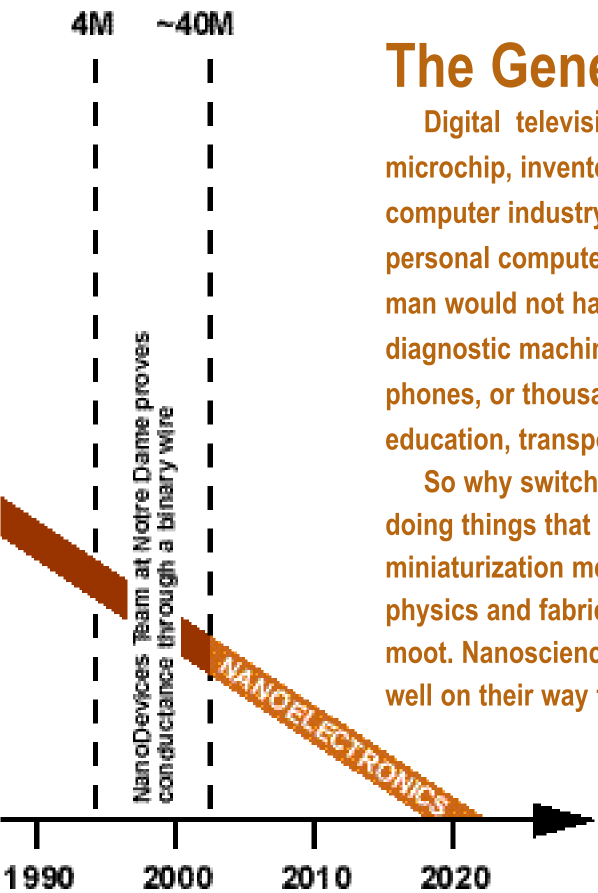
To solve this problem, many researchers are still working within the transistor paradigm that has served the electronics industry since its inception more than 50 years ago. In contrast, the Notre Dame NanoDevices Group has chosen a different path, one that builds on existing knowledge in microelectronics yet addresses new engineering directions and opportunities to create circuit architectures without transistors. That path is called quantum-dot cellular automata.

What is a quantum dot, and how does it work?

A quantum dot is a tiny structure in which an electron can be confined; a group of four or five dots makes a cell. Just like cells in the human body, quantum-dot cells can be arranged in patterns to form larger structures that serve different functions. Quantum-dot cellular automata is based on encoding binary information, just as Zuse originally proposed, but in configurations of quantum-dot cells and using electric fields as the means of forwarding signals. "Zuse had two great ideas," said Dr. Craig S. Lent, Professor of Electrical Engineering. "The first was to use binary



Some day soon chips will be measured in nanometers instead of microns. One micron is equivalent to 1,000 nanometers. For the sake of comparison, look at these chromosomes. Although the length of a chromosome varies, the width of a single chromosome is 1,400 nanometers. The localized genes on the chromosomes highlighted by the white arrows each span approximately 100 nanometers, much larger than a quantum dot.



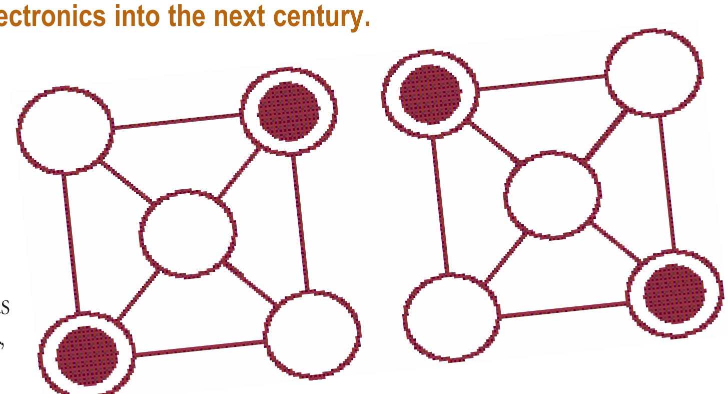
The Genesis of Nanotechnology

Digital televisions, computers, and a host of other gadgets owe their existence to the microchip, invented by Jack Kilby and Robert Noyce. The chip not only created the modern computer industry, transforming room sized machines into an array of mainframes, mini and personal computers, but it also restructured communications and other industries. Without it, man would not have reached the moon. Modern science wouldn't have the complex medical diagnostic machines it has access to today. There would be no portable calculators, cell phones, or thousands of other devices that make life so comfortable. Kilby's chip touched education, transportation, manufacturing, and even the entertainment industry.

So why switch gears with quantum-dot cellular automata? Why investigate a way of doing things that is so different from the conventional? Because the ongoing revolution in miniaturization means that unless engineers do something, technology will be stifled by physics and fabrication challenges. The quest to shrink transistors, and thus chips, will be moot. Nanoscience offers new frontiers in engineering devices on a molecular level that are well on their way to ushering electronics into the next century.

numbers (ones and zeros) to represent information. The second was to encode the one or the zero as a current switch in the 'on' or 'off' position. We are keeping the first idea, but replacing the current switch with an arrangement of electrons. That way we can shrink the system down to the molecular level."

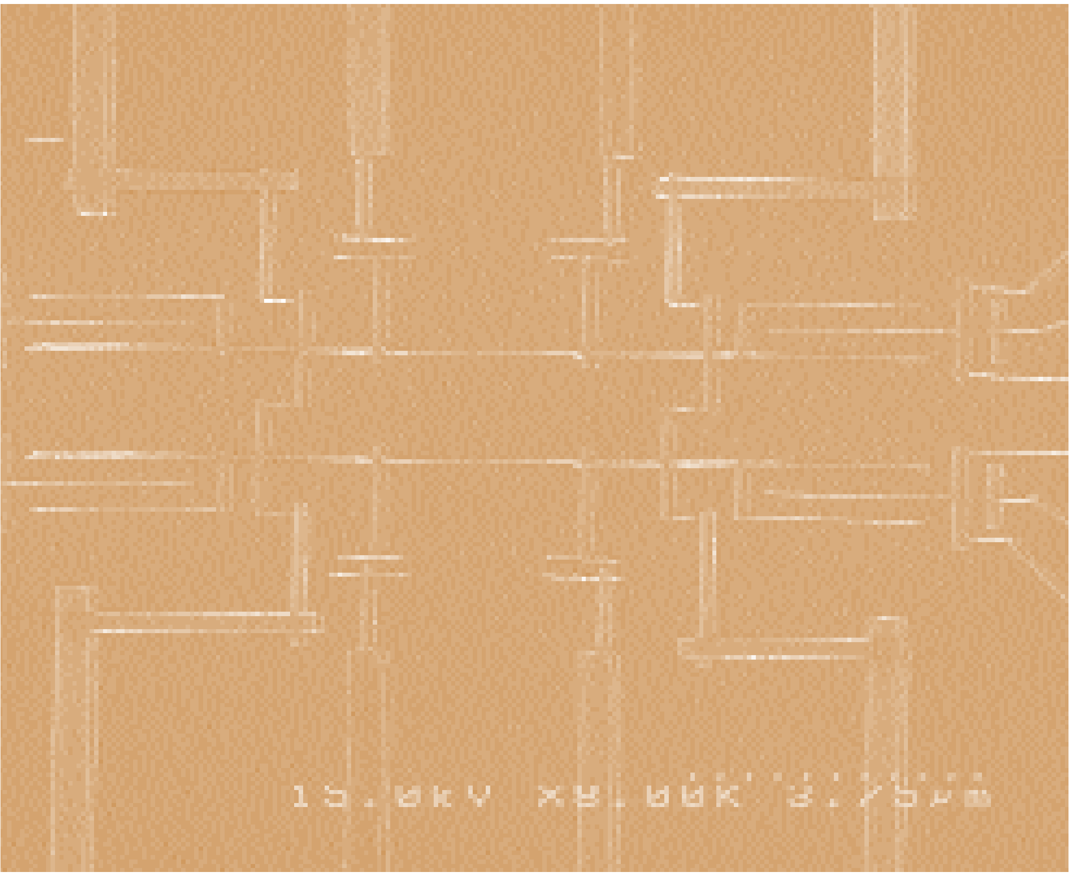
A quantum-dot cell consists of four or five dots; each cell contains two extra electrons. When the cell is isolated, the two electrons occupy opposite "corners." Their mutual repulsion forces them apart, but they lack the energy to escape the cell. However, each electron will interact through Coulomb's Law, which deals with the repulsion between like electric charges — the electrons — along a line. So, when a signal from a control cell changes the state of one electron, it affects the next electron which then repels its neighbor



When a pair of electrons is trapped in an array of dots (a cell), their mutual repulsion forces them to opposite corners of the pattern, causing two possible configurations: "1" or "0" for binary functions. When a signal from the control cell causes a change in the state of one electron, it will propagate to the next electron, transferring data from cell to cell down the line (wire).

and so on down a row of cells.

Assembling a line of these cells forms binary wires, which can eventually be used to form switches and various computer logic devices ... a programmable cellular automata network. Information will be contained in the arrangement of electrons within cells, and there will be no current flow between cells. How a quantum-dot



To create a nanodevice, the Notre Dame Team works with a substrate of silicon dioxide on silicon. Using an electron microscope to define the shapes, a layer of aluminum oxide is then placed between two layers of aluminum, creating an aluminum oxide sandwich at the tunnel junctions and assisting electron movement. This electron micrograph shows an array of quantum dots (aluminum islands) forming a four-dot cell with two electrometers. The smallest feature size in this device is 50 nanometers.

cell or array is assembled determines how it functions, and the Coulombic interaction provides the necessary computing connections.

What does the University's NanoDevices Group plan to do with quantum dots?

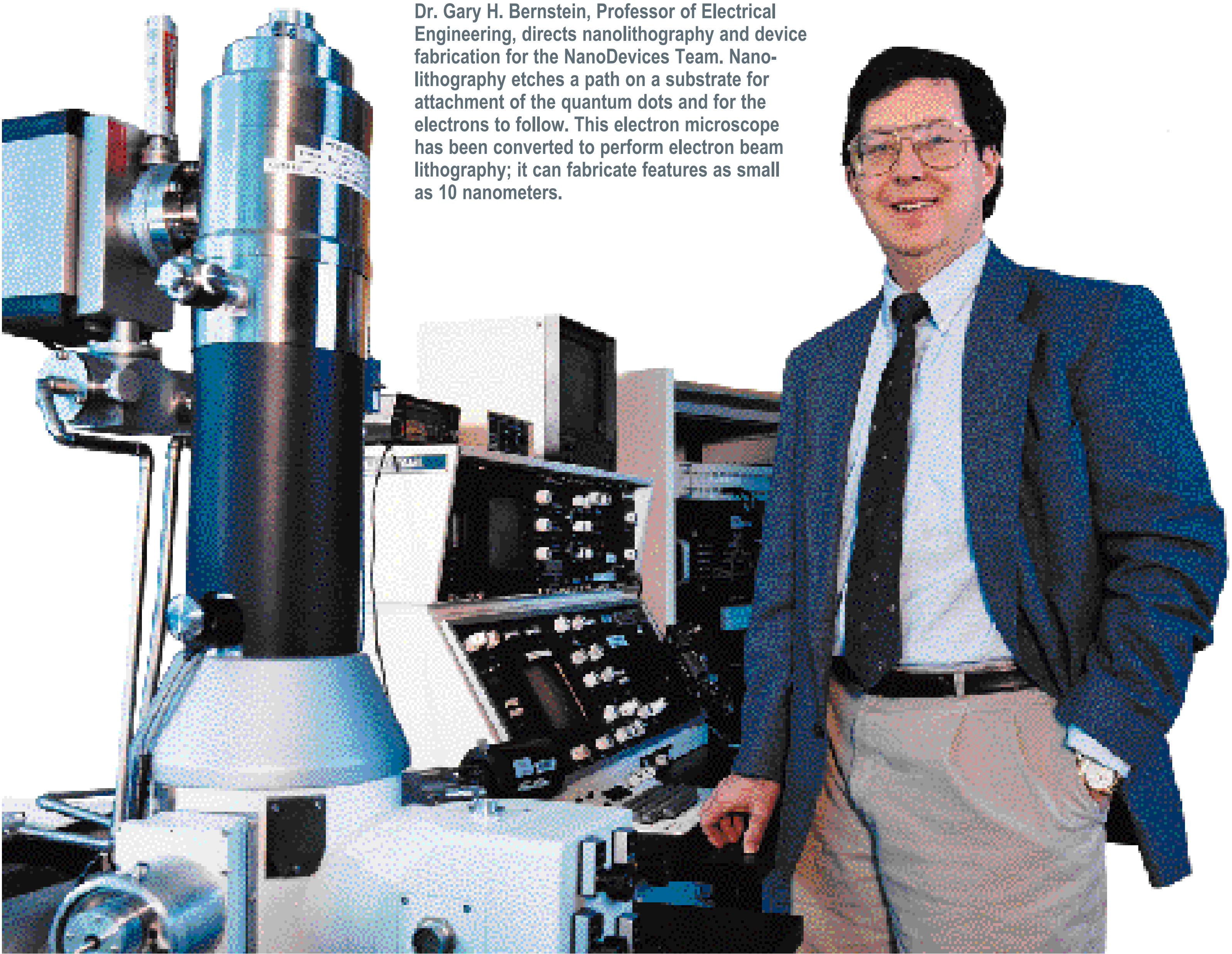
It was the early 1990s when the idea of quantum-dot cellular automata first appeared at Notre Dame. In 1993 a grant proposal to study quantum-dot cellular automata was submitted to the Defense Advanced Research Projects Agency (DARPA) of the Department of Defense. Drs. Lent, Wolfgang Porod, and Gary H. Bernstein of the Department of Electrical Engineering co-authored the proposal and were given approval to proceed, forming the nucleus of the NanoDevices Group. As things progressed, Freimann Professor of Electrical Engineering Dr. James L. Merz, formerly Director of the National Science Foundation's Center for Quantized Electronic Structures (QUEST) at the University of California — Santa Barbara, joined the Group, as did Dr. Gregory L. Snider, Assistant Professor of Electrical Engineering.

Lent and Porod would lead the theory and modeling aspect of Notre Dame's quantum-dot research; Snider would direct the electrical characterization segment of the operation; Bernstein would oversee device fabrication; and Merz assumed the function of leader and coordinator of the Team, while carrying out optical studies. Within six months, Dr. Alexei Orlov joined the faculty as a Research Assistant Professor, working closely with Snider and other members of the NanoDevices Team.

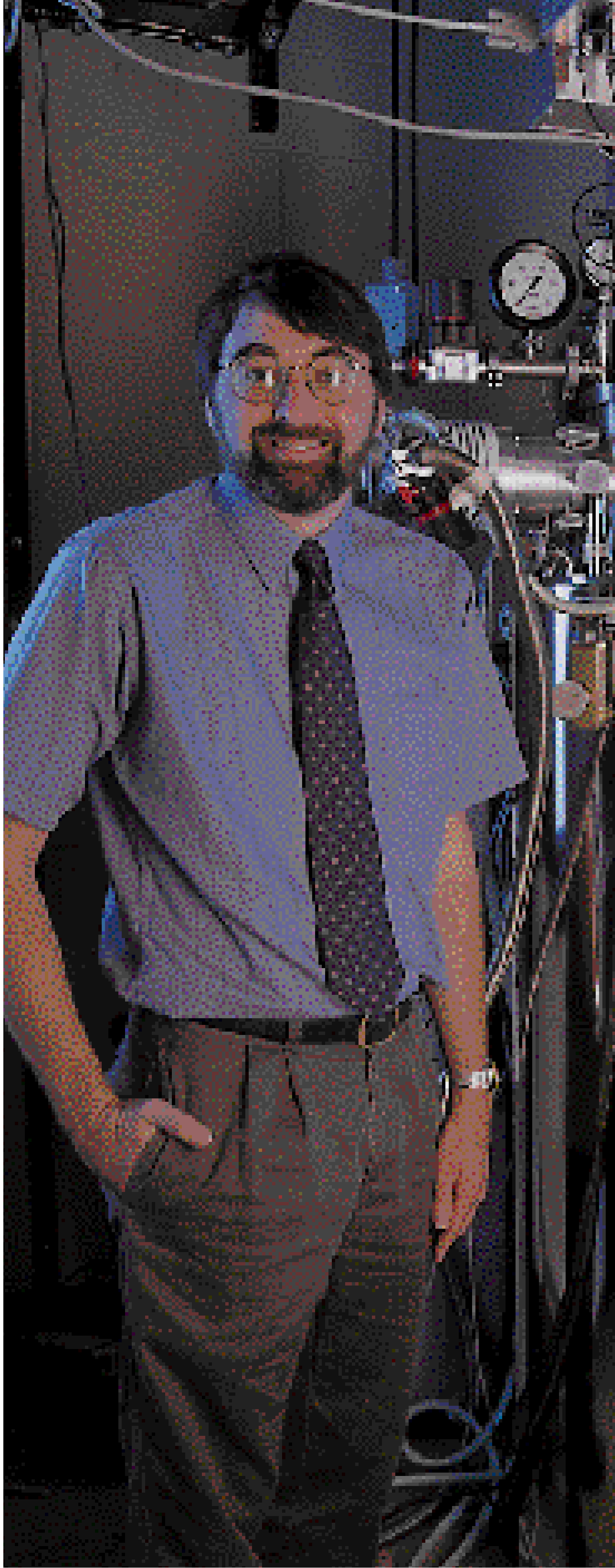
In the summer of 1997, the Team demonstrated the first real nanodevice, a prototype of a quantum-dot cell that validated the proposed operating principles. The University was and is the only research facility to have accomplished this feat, something many of the Team's counterparts in industry said couldn't be done. Keys to this first demonstration were controlling the location of the electron, controlling thermal fluctuations, and being able to verify the electron had actually moved. "It wasn't just a matter of getting an electron to move," said Snider. "We also had to be able to detect that movement." Measurement is difficult, since it requires the ability to sense the charged state of a dot without having the measurement process alter the charge. The team used the active dot in tandem with a ballistic point contact as an electrometer to sense the change in state of an electron, thus tracking its movement.

Since their initial success, Notre Dame researchers have continued to establish a niche in nanostructures, recently completing successful experiments with a line of three quantum-dot cells. They have received funding from the National Science Foundation, the Air Force Office of Scientific Research, the Office of Naval Research, and additional funding from DARPA. The team also received the Excellent Performance Award from DARPA. "We're doing world-class research here," said Bernstein. "We've developed a top-notch team. We were the first to prove that the theory of quantum-dot cellular automata works, and we're looking forward to future developments."

The team continues to grow and has formed collaborations with other universities. While Notre Dame concentrates on the solid-state aspects of quantum-dot cellular automata, visiting professors from partner institutions are investigating circuit theory implications. These researchers include: Dr. Arpad Csurgay, who spends half the year at Notre Dame and half at Technical University of Budapest,



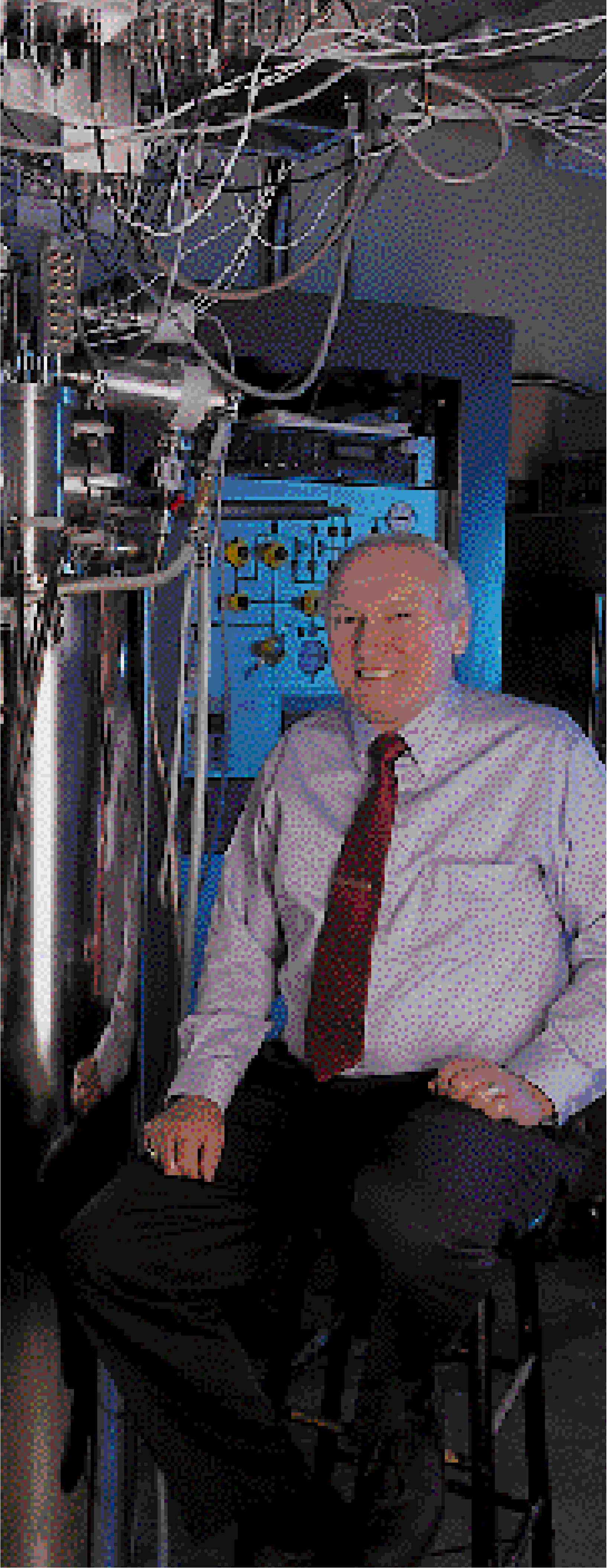
Dr. Gary H. Bernstein, Professor of Electrical Engineering, directs nanolithography and device fabrication for the NanoDevices Team. Nanolithography etches a path on a substrate for attachment of the quantum dots and for the electrons to follow. This electron microscope has been converted to perform electron beam lithography; it can fabricate features as small as 10 nanometers.



"Quantum-dot cellular automata is one of the greatest examples on campus of research that has and will continue to involve engineers, physicists, chemists, and computer architects, all playing interactive roles in the birth of a new technology."

Hungary; Dr. Terry Fountain of University College, London; Dr. Tamas Roska also of the Technical University of Budapest; and Dr. Leon Chua of the University of California — Berkeley.

When Merz became Vice President for Graduate Studies and Research in 1997, Dr. Gerald J. Iafrate left his position as Director of the Army Research Office and came to the University as a Professor of Electrical Engineering and the new NanoDevices Group leader. He and Porod are the driving forces behind the creation of a Center for Nanoscience and Technology. "Notre Dame has developed this area of nano-devices," said Porod. "We now have a strong core competency and expect to expand this, as well as explore other concepts in nanoscience and technology."



In addition to quantum-dot cellular automata, the proposed Center will investigate the principles of nanosciences, new architectures based on nanoelectronic devices, and nano-engineered mechanical, chemical, and electronic systems. Targeting functional objectives is the focus of the Center. Initial projects will include an integrated image processor, a first-generation microprocessor, and a network of quantum based devices that can be used in a variety of digital applications. "The study of quantum dots and nanosized structures follows an evolutionary path similar to that of the transistor when it was first discovered," said Iafrate. "Although it sparked the whole process, the 'discovery' of the transistor is not where the real beauty began. It wasn't until those transistors were put together into an integrated circuit that they began to serve as the functional backbone of computers."

Using nanoprinciples, the Center will allow researchers to experiment on a molecular level with elements that work together and influence one another. These elements will serve as a continuous map of information, making it essential that the NanoDevices Team keep growing, adding faculty and researchers from the Departments of Chemistry and Biochemistry, Physics, and Computer Science and Engineering. The Team will rely on the hard work of current graduate students like Islamshah

The dilution refrigerator, an evaporative helium cooler, shown here with Dr. Gregory L. Snider, Assistant Professor of Electrical Engineering (left), and Dr. James L. Merz, Vice President for Graduate Studies and Research and Frank M. Freimann Professor of Electrical Engineering, operates at a base temperature of 10 milliKelvin (mK). This equipment was used in the first demonstration of a transistorless approach to computing when Notre Dame's NanoDevices Team successfully controlled the relative position of two electrons, bringing information storage down to the molecular level. During the experiment a basic cell made of four dots was connected with tunnel junctions and capacitors and then operated at cryogenic temperatures. As exciting as this achievement is, the NanoDevices Team is looking forward to one of the next challenges — scaling the device down to a size that can operate at room temperature.

More thought

Amlani, John Timler, and Geza Toth, who each play vital roles. Certainly, the research at Notre Dame has already benefited from the work of former graduate students like Greg Bazan, Minhan Chen, Henry K. Harbury, and P. Douglas Tougaw. Perhaps Merz identified the exciting nature of these collaborative efforts best when he said, "Quantum-dot cellular automata is one of the greatest examples on campus of research that has and will continue to involve engineers, physicists, chemists, and computer architects all playing interactive roles in the birth of a new technology. The next step may be to talk to the biologists."

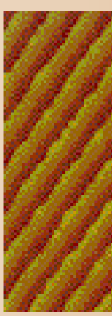
Nanoscience is a vital field for the next generation. What is at stake is not solely logic functions — computers — but lighter and stronger cars, planes, a reduction in energy needs ... a technological revolution. By forming additional multidisciplinary teams, the University of Notre Dame will continue to develop the unique capabilities nanoscience offers to information technology. One of the most recent examples is a joint venture with the Department of Chemistry and Biochemistry in "moletronics," molecular based electronics. The project is supported by a two-year grant from DARPA for $1.5 million.

Nanoelectronics, including quantum-dot cellular automata, focuses on the integration of molecule sized elements. By joining these elements in specific patterns, engineers and scientists have the potential to create a new generation of logic and digital capabilities far beyond what Moore's Law projected for transistors some 30 years ago. There are many challenges to overcome before quantum dots will affect society on a daily basis, including temperature requirements and the feasibility of mass production. Yet, working together in multidisciplinary teams, researchers can and will find a way to make circuits smaller, faster, and better.

Dr. Albert E. Miller, Professor of Chemical Engineering, is also studying nanostructures. His focus stresses two electrochemical self-assembly techniques: electropolishing and anodizing. For example, electropolishing aluminum patterns the surface of the metal into either highly ordered ridges or an egg-carton arrangement of hills, depending on the applied voltage. These patterns are extremely small with ridge-to-ridge and hill-to-hill distances of 90 nanometers and peak-to-valley heights of six nanometers. When the process is complete, these patterns produce either free-standing quantum wires or dots, or a stamp that can be used to transfer the pattern to other materials. In the case of aluminum, the ridge or egg-carton patterns serve as a mask on which a porous aluminum oxide film several microns thick can, through anodization, grow organized pores 10 nanometers in diameter. Those aluminum oxide pores can then be electrochemically filled with metals, organics, or compound semiconductors such as cadium sulfide (CdS). Resulting deposits will produce a quantum dot, aluminum oxide matrix composite. The composite, as in the case of CdS, has strong nonlinear optical characteristics which afford the possibility of using this quantum material in sensor applications.

Miller is collaborating on this project with Dr. Hsueh-Chia Chang, Bayer Professor of Chemical Engineering, as well as Research Associate Dr. Gautum Banerjee and

The stripes (left) and egg-carton patterns are micrographs made by atomic force microscopy of a layer of metal, such as gold, on a semiconductor after electropolishing. Stripes form when the electropolishing takes place within a narrow voltage range for 30 seconds, while the egg-carton pattern forms in a slightly higher voltage range. Electropolishing through the metal film leaves free-standing quantum wires and dots on the substrate. Drs. Albert E. Miller and Supriyo Bandyopadhyay hold the patent on this process.

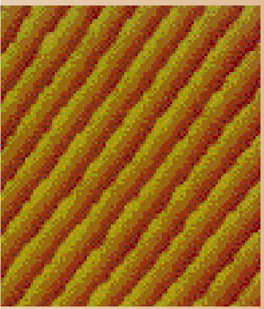


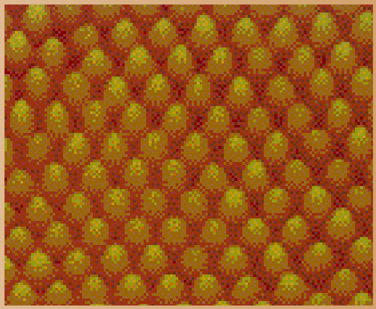
ts on dots ...

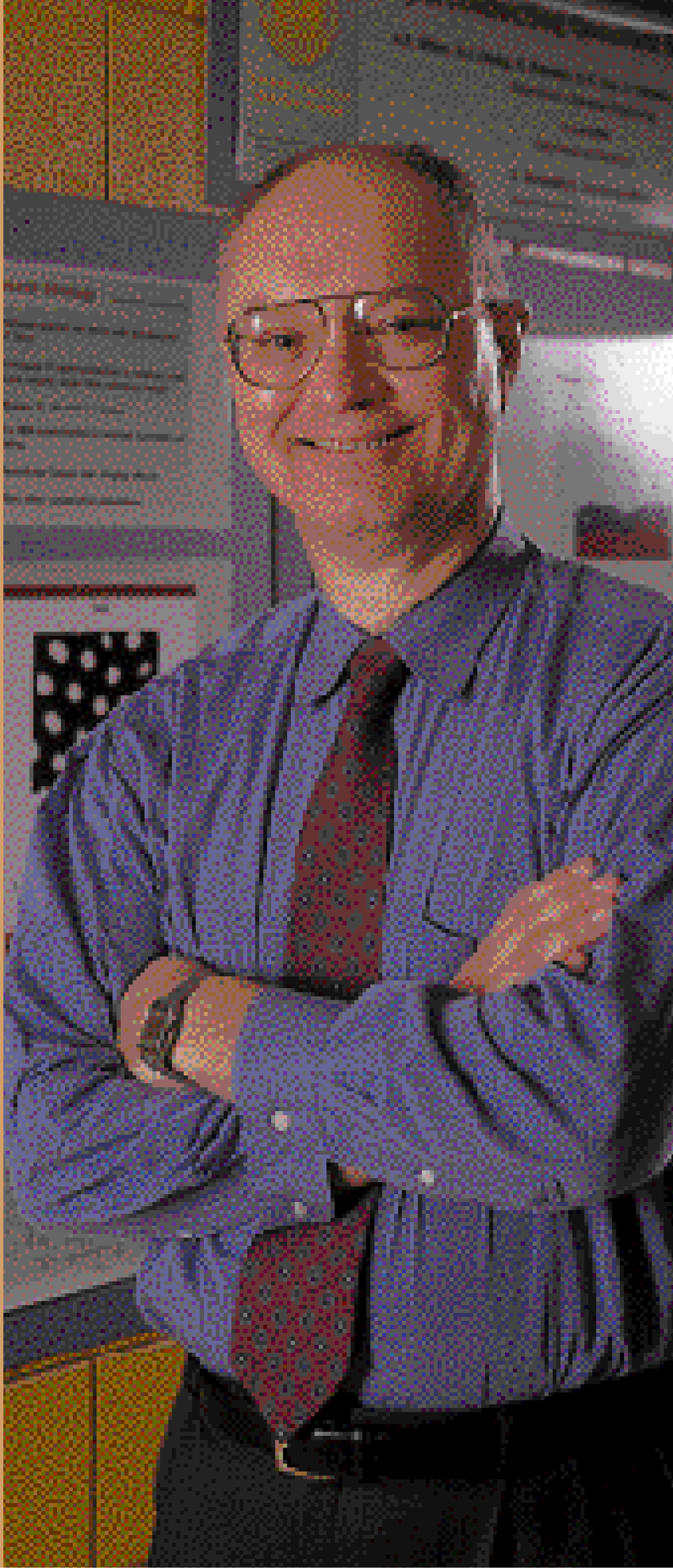
Vadim Yuzhakov, a Chemical Engineering graduate student. “We’ve developed all our theories using aluminum,” said Miller, “but we can electropattern a variety of materials, including zirconium, tin, nickel, silver, gold, and silicon.”

In an extension of this work, Miller has teamed up with UCLA, Purdue University, and the University of Nebraska to produce a lateral computer architecture made of organic molecules, using gold dots as the binding posts. The organic computer will not have any electronic components, i.e., no resistors or capacitors. The theory is that the molecules will have all the proper electronic characteristics to achieve the logic function. “What we needed,” he said, “was a way to attach the molecules to the gallium arsenide substrate; electropolishing provides that opportunity.”

The nanostructures Miller is developing have the potential of producing an extremely high-density system that requires very little power. With ridge and hill patterns arrayed in a checkerboard fashion, the ridge pattern becomes the nanowire interconnection between the hill cells containing the organic molecule computational structure. If tests are successful and theory holds, Miller and associates will have reduced the architecture size of a computational network by a factor of 100. This benefit is just one of many offered by the study of nanotechnology; the possibilities are limitless.





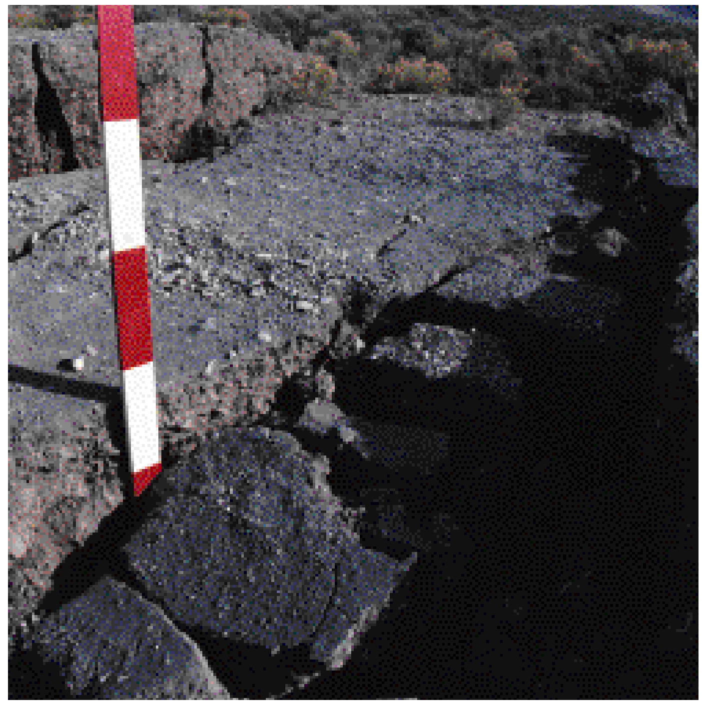


"Acts of God" is a favorite phrase among insurance companies. It means no one can prevent certain natural events, like earthquakes, hurricanes, and tornadoes. These disasters devastate communities. Businesses are lost, and families destroyed. And while it is true that God devised the natural laws that govern

weather, the earth's core, gravity, and other phenomena, it is just as true that He gave man the curiosity and intelligence to develop ways to lessen the havoc caused by natural hazards. Today, leading institutions like the University of Notre Dame, are studying ways to decrease the amount of damage brought about by these disasters. The findings, especially in the areas of earthquake and wind engineering, are encouraging ...

Movers & Shakers:

Natural Hazard Mitigation at the University of Notre Dame



A fault is a fracture in the earth's crust; most faults are the result of repeated movement over a long period of time. Surface rupture like this occurs when movement in a fault breaks through. Not all earthquakes result in surface rupture; however, the ground movement from the sudden shifting of an earthquake affects buildings and other structures.

Curbing the damage from earthquakes

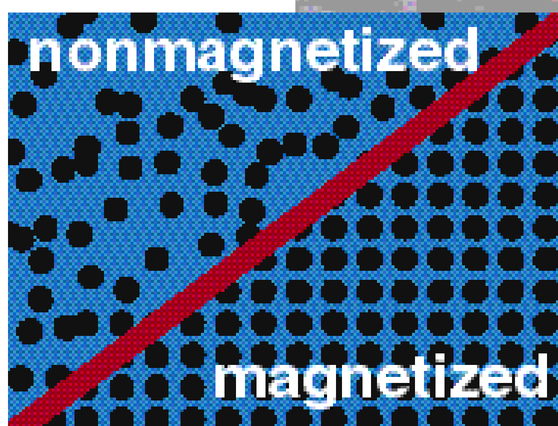
There's a 100 percent chance of an earthquake today, a sudden slip in a fault when plates from the earth's crust shift and grind against one another. And, since the earth's plates are always moving, there will be an earthquake somewhere in the next 24 hours. The National Earthquake Information Center identifies about 35 earthquakes in the United States every day. That's anywhere from 12,000 to 14,000 quakes annually. Some are so light only very sensitive instruments can detect the ground motions — the "shaking." Others rattle windows, jar houses, and topple buildings.

For years government agencies, scientists, engineers, architects, and builders have studied the effects of quakes on buildings, looking for a way to curb the damage they cause. Scientists began recording information on earthquakes around 1880, but it was not until the 1940s that record-keeping instruments were installed in buildings. Over the next few decades as the number and size of buildings increased, so did the number of recording devices.

In 1977 the Earthquake Hazards Reduction Act, Public Law 95-124, established the National Earthquake Hazards Reduction Program (NEHRP). Its objectives were to analyze earthquakes, develop seismic design and construction standards for civil infrastructure, investigate the feasibility of earthquake prediction, prepare plans for mitigation and response activities, and educate the public about earthquakes and how to survive them. Four

Does a Bigger Earthquake Mean More Damage?

Jacob Rabinow, U.S. National Bureau of Standards, invented magnetorheological (MR) fluids and devices. He began working with them in the late 1940s, but his work was relatively unknown. It wasn't until recently that there has been a renewed interest in MR fluids. What's so unusual about them? They change from liquid to semi-solid when exposed to a magnetic field (below). When properly harnessed, this adaptability could help protect a building in the event of an earthquake.



principal agencies are affiliated with NEHRP: the Federal Emergency Management Agency (FEMA), the United States Geological Survey (USGS), the National Institute of Standards and Technology (NIST) and the National Science Foundation (NSF).

It is the NSF that is funding a large portion of the research of Notre Dame's Dr. B. F. Spencer, Jr., Professor of Civil Engineering and Geological Sciences, and Dr. Michael K. Sain, Frank M. Freimann Professor of Electrical Engineering. Their approach is different than those previously considered. According to Professor Spencer, in order to survive large earthquakes, buildings have typically been designed to sustain damage. "That would be like your car breaking every time you go over a pothole. You wouldn't want that in your car; that's why automobile manufacturers use shock absorbers." Professors Spencer and Sain are working on a concept very similar to automotive shock absorbers, but for buildings and bridges. In the structural dynamics world, this is called "supplemental damping."

Much of the research in the last decade has been directed toward active and passive control systems. An active system physically applies force to a structure when the force-generating device (actuator) receives a signal and is activated. Although many active systems have been installed in buildings around the world, concerns do exist within the engineering community. Active systems are not currently cost effective. They are not as reliable as other systems, and the power requirements are high, a liability during a disaster such as an earthquake when power is often interrupted.

Passive dampers provide an alternative to active systems. They require no outside power source. However, they only react to the motion and forces of the building, dissipating energy in a fixed way. Passive dampers cannot adapt to changes in force or vibration.

Professors Spencer and Sain felt the solution lay somewhere between active and passive systems. "For controlling buildings during non-critical times, you want to have the dampers soft so there are no jerky movements. This helps protect the contents of the building," said Spencer. "During an earthquake you want increased damping." For example, during stable periods building occupants should experience the soft, cushy ride of a luxury car. The tight suspension and control of a sports car is sought during a catastrophic event. This additional control helps the building adapt more quickly to ground movements, keeping the structure and its occupants out of danger. Spencer and Sain have developed a shock absorber that uses an oil suspension of tiny iron particles, a magnetorheological (MR) fluid. The unique properties of the fluid are what attracted them to the possibilities of using it in their research.

Earthquakes create shock waves, much like exploding dynamite. For example, to release the same amount of energy or vibration of an earthquake with a magnitude of 4, you'd need to ignite six tons of explosives. This doesn't always mean death and destruction. Often earthquakes occur in remote areas with few buildings or people. Consider Alaska with roughly 4,000 earthquakes every year. Because it is less populated than other states, the damage is not always major. On the other hand, Alaska was also the state to record the largest quake in U.S. history. It happened on March 27, 1964, and had a magnitude of 9.2. The shaking lasted about seven minutes and raised and lowered the ground as much as two meters in some areas. A total of 115 people died, mostly due to the tsunami generated by the quake. The bottom line is that the destructive forces of an earthquake depend on a variety of factors: local geologic conditions, distance from the epicenter, how long the shaking lasts, population density, the number and type of buildings, and how well the area is prepared — adherence to strict building codes and disaster plans — to handle the effects of a quake.

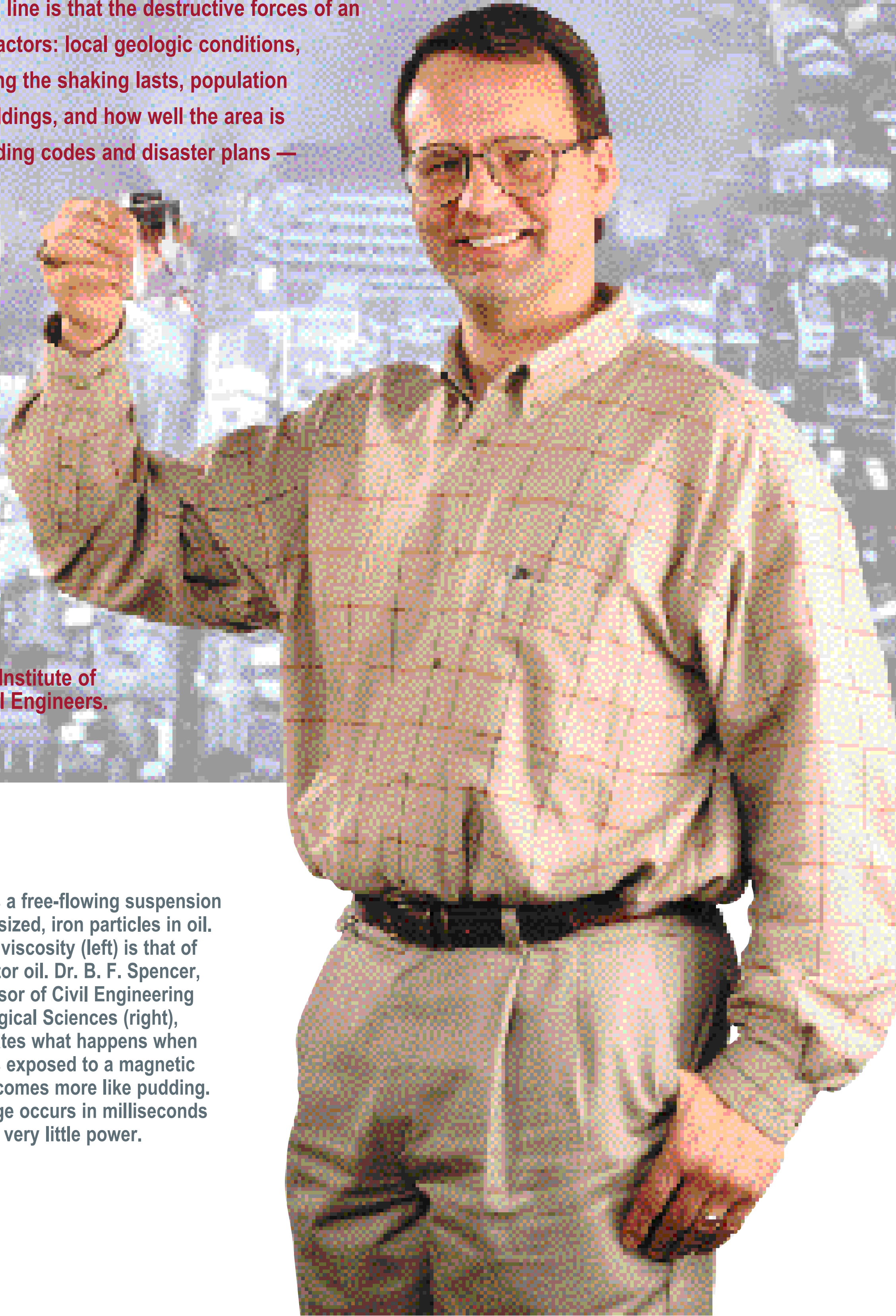


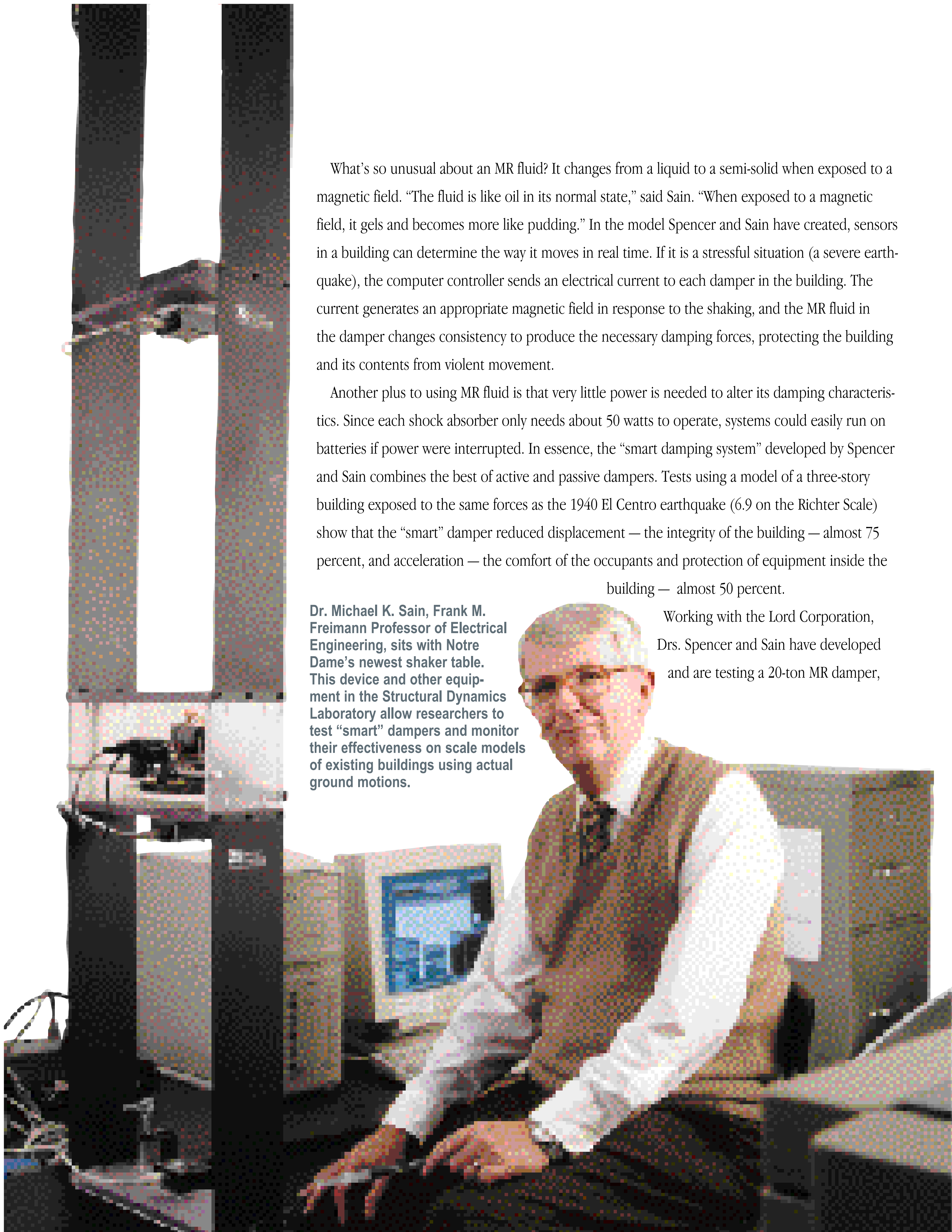
Photo courtesy of the Architectural Institute of Japan and the Japan Society of Civil Engineers.

MR fluid is a free-flowing suspension of micron-sized, iron particles in oil. Its normal viscosity (left) is that of a light motor oil. Dr. B. F. Spencer, Jr., Professor of Civil Engineering and Geological Sciences (right), demonstrates what happens when MR fluid is exposed to a magnetic field. It becomes more like pudding. This change occurs in milliseconds and needs very little power.

What's so unusual about an MR fluid? It changes from a liquid to a semi-solid when exposed to a magnetic field. "The fluid is like oil in its normal state," said Sain. "When exposed to a magnetic field, it gels and becomes more like pudding." In the model Spencer and Sain have created, sensors in a building can determine the way it moves in real time. If it is a stressful situation (a severe earthquake), the computer controller sends an electrical current to each damper in the building. The current generates an appropriate magnetic field in response to the shaking, and the MR fluid in the damper changes consistency to produce the necessary damping forces, protecting the building and its contents from violent movement.

Another plus to using MR fluid is that very little power is needed to alter its damping characteristics. Since each shock absorber only needs about 50 watts to operate, systems could easily run on batteries if power were interrupted. In essence, the "smart damping system" developed by Spencer and Sain combines the best of active and passive dampers. Tests using a model of a three-story building exposed to the same forces as the 1940 El Centro earthquake (6.9 on the Richter Scale) show that the "smart" damper reduced displacement — the integrity of the building — almost 75 percent, and acceleration — the comfort of the occupants and protection of equipment inside the building — almost 50 percent.

Working with the Lord Corporation, Drs. Spencer and Sain have developed and are testing a 20-ton MR damper,



Dr. Michael K. Sain, Frank M. Freimann Professor of Electrical Engineering, sits with Notre Dame's newest shaker table. This device and other equipment in the Structural Dynamics Laboratory allow researchers to test "smart" dampers and monitor their effectiveness on scale models of existing buildings using actual ground motions.

the largest ever constructed. Although not yet commercially available, its implications on public safety and cost savings for communities around the world are enormous.

Built in 1991, the Structural Dynamics & Control Earthquake Engineering Laboratory (SDC/EEL) houses a uniaxial earthquake simulator, a shaker table. Former Ph.D. candidate Shirley J. Dyke (left) was instrumental in developing the SDC/EEL with Drs. Spencer and Sain (not shown). Since receiving her doctoral degree, she has joined the faculty of Washington University in St. Louis, Missouri, as an Assistant Professor. More recently, Dyke was presented with the 1998 Presidential Early Career Award for Scientists and Engineers during a ceremony at the White House earlier this year. The award cited her work in mitigating structural damage from natural hazards.

Partnerships at Work in Natural Hazard Mitigation

Although this article focuses on Drs. Spencer and Sain, research within the Structural Dynamics & Control Earthquake Engineering Laboratory (SDC/EEL) involves scientists, faculty, students, government agencies like the National Science Foundation (NSF), and corporations from around the world. In fact, Notre Dame's efforts are often in tandem with Japanese researchers, because U.S.-Japan collaborations take advantage of the many synergies between the two leading countries in this field.

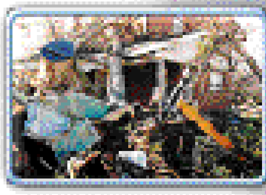
Personnel currently working in the SDC/EEL include: Dr. Erik A. Johnson, Visiting Research Assistant Professor of Civil Engineering and Geological Sciences; a visiting research student on leave from Nihon University, Yoshinori Satoh; Civil Engineering and Geological Sciences doctoral candidates Guangqiang Yang and Richard E. Christenson; Electrical Engineering doctoral candidates Gang Jin, Yun Chi, and Khanh Pham; and Greg Baker, a master's candidate in Civil Engineering and Geological Sciences. Each of these individuals is supported in part by SDC/EEL research funds. In addition a number of corporations and universities have sent engineers to Notre Dame to learn more about mitigating natural hazards. These researchers, who are supported by their sponsoring organizations, include: Hirokazu Yoshioka, a visiting scholar on leave from the Research and Development Institute at the Takenaka Corporation in Japan; visiting scholar Toshiyuki Suzuki, on leave from the Research Institute of Ishikawajima-Harima Heavy Industries (IHI) in Japan; Juan Carlos Ramallo, a visiting scholar from the Universidad Nacional de Tucuman, Argentina, who is being sponsored by the Argentinean government; post-doctoral research associate Dr. Y. Ohtori on leave from the Geotechnical & Earthquake Engineering Department at the Central Research Institute of Electric Power Industry (CRIEPI) in Japan; and Scott Burton, a Civil Engineering and Geological Sciences doctoral candidate on leave from General Electric Aircraft Engines in Cincinnati, Ohio.

Industrial partnerships and funding are also vital to the University's research in structural dynamics. Companies that provide partial financial support to this program include: the Lord Corporation in Cary, North Carolina, a leader in controllable fluid technology; one of the top five construction companies in Japan, the Takenaka Corporation; a leading heavy industry company in Japan, IHI; Sanwa Tekki, one of the largest Japanese manufacturers of high-capacity dampers; and Visteon, a division of Ford Motor Company responsible for the interiors/exteriors of Ford vehicles in Dearborn, Michigan.

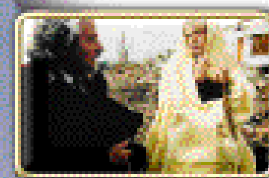
Government agencies also fund this research. They include the NSF, Earthquake Hazard Mitigation Program for Civil and Mechanical Systems; the Multidisciplinary Center for Earthquake Engineering Research (MCEER) in Buffalo, New York; and the NASA Indiana Space Grant Consortium.

The death toll for the 1998 hurricane season topped 12,000, the deadliest year on record in this hemisphere.

Hurricanes are tropical storms with winds in excess of 74 miles per hour.



The Fujita Scale rates the intensity of a tornado by examining the damage caused by the storm after it passes over a man-made structure.



Every year about 1,000 tornadoes touch down in the U.S.

The High Price of Wind

One hundred million dollars a minute ... that's the amount of damage caused by Hurricane Andrew during its on-shore rampage. All totalled, it generated more direct and indirect economic losses than any other natural event in this country — in excess of $30 billion, not including the damage to offshore structures. But consider this: As devastating as Andrew was, if it had continued just 20 miles further north in Florida, the losses would have increased dramatically. Or if, instead of moving north, it had traveled as far west as New Orleans, the damage could easily have exceeded $100 billion. Think of the consequences — not only the damage to homes and other structures, but the loss of lives, the limits of the insurance industry's ability to sustain those losses, and the sheer time factor ... being able to rebuild before the next storm hits. The fact is that hurricanes and tornadoes are the deadliest types of natural disasters in terms of personal and property loss. With 75 percent of the U.S. population expected to live in coastal regions by 2010, it is likely they will remain the most destructive. Lessening the effects of high winds on homes, cityscapes, and bridges, as well as coastal structures and offshore installations is a problem that needs to be addressed before the price becomes too great to bear.

Battling the effects of strong winds

In the United States today, tornadoes and hurricanes kill more people and destroy more property than any other type of natural disaster. Economically, they are just as destructive, and the damage is not confined to one type of building or class of architecture. Wind related hazards impact structures old and new, high and low, on and offshore with the same fury. It is a daily struggle.

Modern unconventionally shaped structures with complex exterior geometry and innovative structural systems are sometimes more sensitive to high winds than buildings constructed 50 years ago, even though building codes have improved significantly. On the other hand, high-rise structures that meet the code for lateral drift requirements can still sway in strong winds. This movement may not be enough to cause structural damage, but it can adversely affect a building's occupants. Low-rise structures, bridges, and offshore platforms are also susceptible to wind.

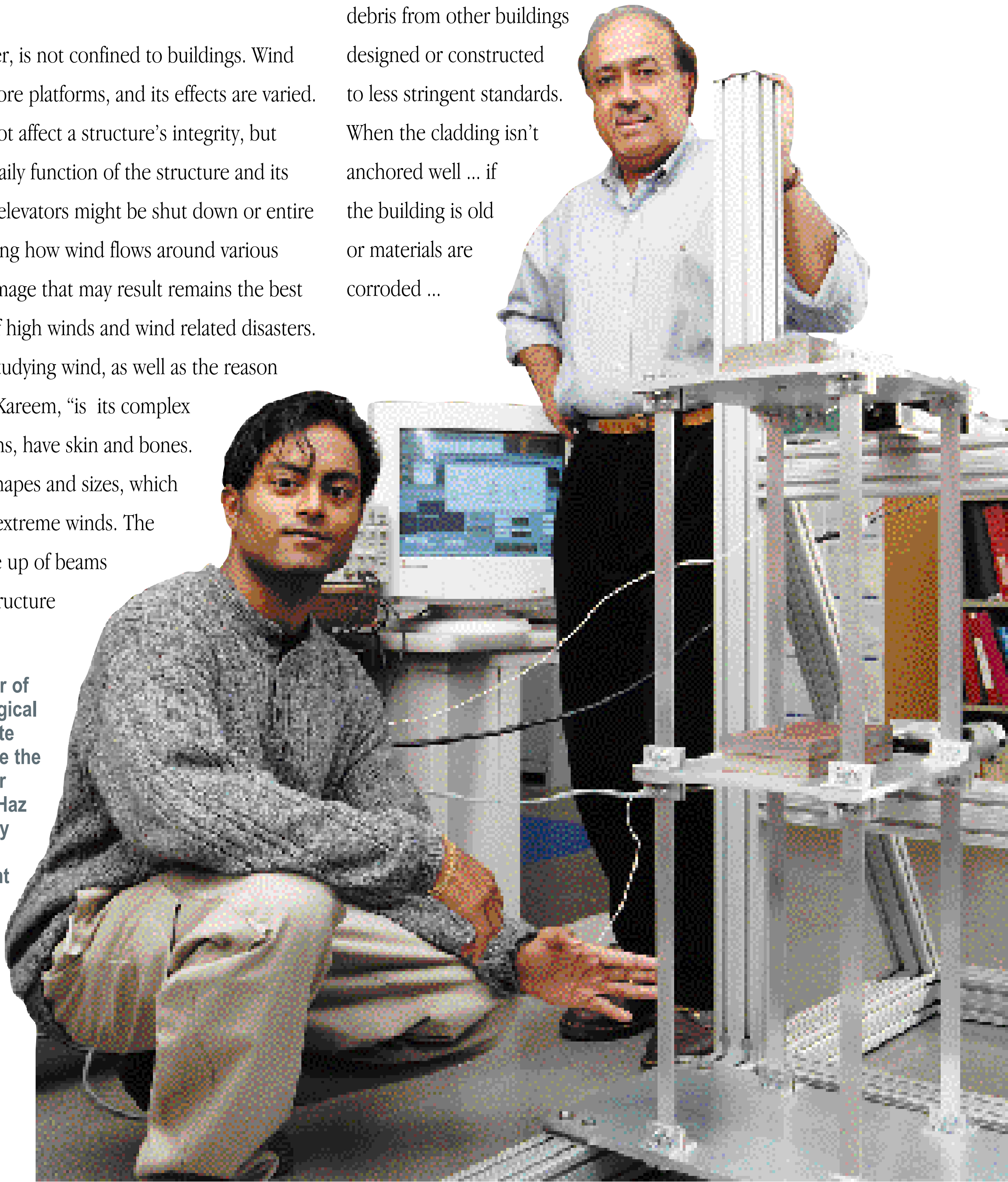
Dr. Ahsan Kareem, Professor of Civil Engineering and Geological Sciences, is a leading researcher in dynamic fluid-structure interactions, structural safety, and the mitigation of natural hazards — specifically wind, waves, and earthquakes. One of his specialties is wind engineering, studying how structures react in the wind. Funded by the National Science Foundation, the Office of Naval

Research, Lockheed Martin, Texas Advanced Technologies, the American Institute for Steel Construction, and a host of major oil companies, Kareem's work has already brought about improvements in building codes and standards. For example, his research led to the revision of the ASCE7-95 Standard for Minimum Design of Loads on Buildings and Other Structures, which, in turn, helped create safer and more wind-resistant areas in the United States and the Caribbean and currently serves as a model for building codes around the world.

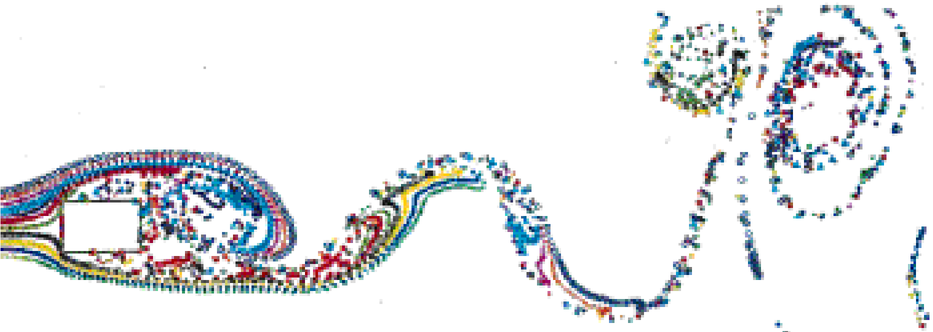
The threat of wind, however, is not confined to buildings. Wind also attacks bridges and offshore platforms, and its effects are varied. Movement in the wind may not affect a structure's integrity, but that motion can disrupt the daily function of the structure and its occupants. In extreme cases, elevators might be shut down or entire buildings closed. Understanding how wind flows around various structures and the type of damage that may result remains the best defense against the ravages of high winds and wind related disasters.

"One of the difficulties in studying wind, as well as the reason it's important to do so," said Kareem, "is its complex nature." Buildings, like humans, have skin and bones. They also come in different shapes and sizes, which determine how they react in extreme winds. The skeleton of a building is made up of beams and girders; this is where a structure gets its strength. Cladding, the skin of a building, protects its skeleton. Siding, shutters, glass panels, bricks, and sheet metal are examples of cladding. Unfortunately, cladding is the part of the building most affected by wind.

Skyscrapers can experience damage to cladding during intense winds. For instance, if the wind pressure exceeds design criteria, pieces of the cladding may break away. Even if the structure is built to high tolerances, it could still be impacted by windborne debris from other buildings designed or constructed to less stringent standards. When the cladding isn't anchored well ... if the building is old or materials are corroded ...



Dr. Ahsan Kareem, Professor of Civil Engineering and Geological Sciences (right), and graduate student Swaroop K. Yalla use the computer controlled actuator system in Notre Dame's NatHaz Modeling Laboratory to study the dynamic effects of wind on structures. The equipment shown here tests a scale model of a tall building.



With the help of high-speed computers, Kareem's group can generate virtual visualizations of wind flows around buildings of differing geometry. An integrated intelligent system coupled with Geographical Informational Systems (GIS), Global Positioning Systems (GPS), and a virtual computational environment will eventually provide a valuable tool for monitoring, in real-time, the potential for damage by wind as, or before, a storm hits. This system could be used to assist emergency response and recovery teams, as well as city planners.

windows pop out, pieces of the roof fly off, and loose sheet metal buffets about.

To help minimize this and other types of wind damage, Dr. Kareem has pioneered several techniques to study wind. One of these is the use of wavelets, which serve as "mathematical microscopes" to paint a portrait revealing the minute details of how wind affects a structure and determine what causes structural damage. He also uses advanced statistical simulation and modeling, visualizations of wind flow around buildings of different shapes, and physical modeling. With the help of high-speed computers, he can monitor, in real-time, the actions of wind as it wraps around structures. He has also successfully developed numerical approaches as modeling tools and is collaborating with researchers from other universities to develop large-scale simulations of wind flow over residential areas and urban centers. Information from these studies will eventually provide city planners, architects, and builders a "virtual environment" so they can evaluate a variety of options before construction begins.

This is especially important considering some of the concerns that have risen about current structures. Due to increased competition, cost-control issues, and the availability of lightweight, high-strength materials, designers are under pressure to be more cost conscious and conserve the use of steel. As a result, they are making buildings lighter. Older structures, such as the Empire State Building, weigh about 25 pounds per cubic foot. Many newer buildings, high-rise and low-rise alike, average much less than that. They lack the bulk to withstand high winds.

These lightweight structures are literally attacked by the wind, and like a person walking down a sidewalk, the buildings are impacted from all sides. Pressure fluctuations on the face of a building in the direction of the oncoming wind push and pull the structure. Imbalances in the pressure distribution on a building's surface result in a twisting motion, and wind passing around a building generates swirling whirlpools. When this happens, a building's reaction is inevitable; it will sway and twist.

Long-span bridges are also sensitive to these buffeting actions, especially the whirlpools. In aeronautical terms this movement is called "flutter." Currently, Kareem is developing numerical and experimental procedures specifically for bridges that will help identify and overcome this phenomena.

"Any type of movement in a structure is potentially dangerous, but twisting is the worst motion, especially in office buildings," said Kareem. "It disrupts the human sense of balance causing a type of nausea associated with sea sickness. In some cases workers in tall buildings may lose several days of work due to wind generated motion sickness." Fortunately, a structure can be stabilized by using active, semi-active, or passive control systems to dampen the movement. These devices lessen structural damage while minimizing the motion felt by the building's occupants.

In addition to his other collaborations, Dr. Kareem is working with Dr. Jeffrey Kantor, Professor of Chemical Engineering and Associate Provost, to develop real-time intelligent control strategies for winds and earthquakes. Wind, wave, and earthquake loads are tested on campus in the NatHaz Modeling Laboratory, which represents the next generation of dynamic loading facilities because loads can be mimicked by a set of computer controlled actuators. Equipment in the Laboratory applies pressure at various points of a scale-model building to simulate loads, and the building's reactions are recorded. For instance, one of the current modeling studies tests a semi-active liquid damper. By manipulating the water motion in a tank on top of a building, movement can be reduced more than 50 percent.

"Experiments in NatHaz Modeling Laboratory are key," said Kareem. "However, to model details of wind effects on structures, scale models are used in wind tunnels." Traditionally operated for aeronautical applications, wind tunnels — like the one located in the Hessert Center for Aerospace Research — are becoming common tools for civil engineers. Kareem's research in the Hessert wind tunnel includes tests on a wide range of scale structures from the Nanjing Television Tower in the People's Republic of China to suspension bridges and offshore installations. Because offshore platforms are susceptible to both wind and wave interactions, studying the behavior of these structures also includes duplicating a variety of ocean conditions in order to determine safety and reliability measures and make them more suitable for deep-water operations.

With all of the research — with computer modeling and physical simulations — the fact remains: wind cannot be controlled. Nor can it be ignored. However, the havoc it creates can be managed. The more Dr. Kareem and other researchers monitor buildings, bridges, and offshore structures ... the more they study wind flow in urban and residential areas ... the better engineers, architects, and city planners will understand the enigmatic nature of wind related hazards. From that, safer design codes and construction practices, as well as more effective emergency preparedness plans for business and residential communities, can be developed. And, the less destructive the next high wind might be.

Graduate student Fred L. Haan, Jr. readies a scale model of the 1,000-foot-high Nanjing Television Tower for testing in a wind tunnel at the Hessert Center for Aerospace Research. To investigate the tower's sway, Dr. Kareem modeled the effects of wind in the city of Nanjing, People's Republic of China. Based on those and other findings, a research team, including Dr. Kareem, designed an active damper system to help control the tower's movement.

Distance Learning

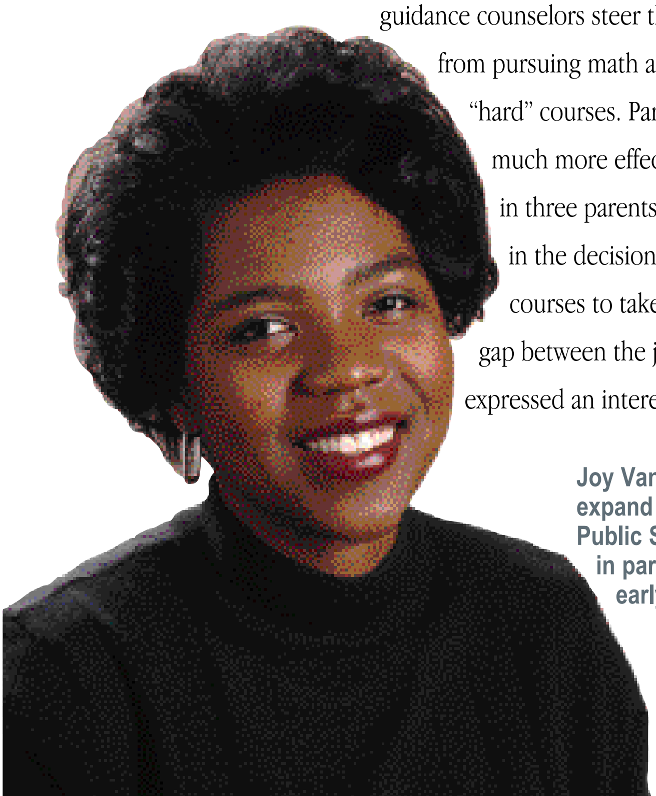
A new twist in educating tomorrow's engineers

Ask ten kids what they want to be when they grow up. Some will say "a doctor." Others want to be "a teacher" or "president." What happened to the kids who wanted to be astronauts, the ones who thought studying the earth's core was cool, the kids who loved chemistry and physics? There simply aren't as many of them as there used to be. Even if they are interested, they're not prepared for college and probably not looking at high-tech careers. It's a fact; 15 percent of all students and only six percent of minority students graduate from high school with mathematics courses through precalculus and science courses through physics.

Why don't they take the higher-level courses? Can't they handle the academic load? Are they just lazy? That's not it at all. They're discouraged. They're not motivated to excel by the adults they come in contact with. Two out of every five students say their guidance counselors steer them away from pursuing math and other "hard" courses. Parents aren't much more effective; only one in three parents gets involved in the decision about what courses to take. So, the gap between the jobs kids expressed an interest in and the work it took to get there just kept growing, especially in the fields of science and engineering. Nationwide, the trend in declining engineering enrollment began in the 1980s. Today, in many colleges and universities across the country, minority enrollment is down ten percent since 1992. That's just one of the reasons Notre Dame founded the Minority Engineering Program (MEP) in 1987. Since that time, minority enrollment has jumped from six to 15 percent. But there was more work to do.

> "Interest in engineering among minority students needs to be encouraged before high school ..."

"To increase awareness and bolster enrollment many institutions offered pre-college programs, summer sessions, and science camps, and we did that, too" said Joy Vann-Hamilton, Director of MEP at Notre Dame. "But we felt we needed something more." Vann-Hamilton believed that if MEP could reach students at a younger age, before high school, the program could produce greater results. The dream was to take middle school minority youth and show them how math, science, and engineering related to their everyday lives. The goal was to help learning



Joy Vann-Hamilton, Director of the Minority Engineering Program, is currently working to expand the distance learning program to other cities in Indiana. To date the Indianapolis Public School System and Kokomo Center Township School System have indicated interest in participating. They could be on-line with Notre Dame's distance learning program as early as Fall 1999.

at Notre Dame:

From October to May, students from six different middle schools meet two times a month as part of Notre Dame's pre-college engineering program. Two-way videoconferencing technology allows the students at each of the four home sites to interact with their instructors and volunteers through hands-on science and engineering projects. Learning is fun and attainable.

become fun, exciting, and achievable. Students would meet role models — minority and female engineers, scientists, and mathematicians serving as instructors and teaching aides. What they were learning in school would become easier to understand, and parents would become more involved in the education process.

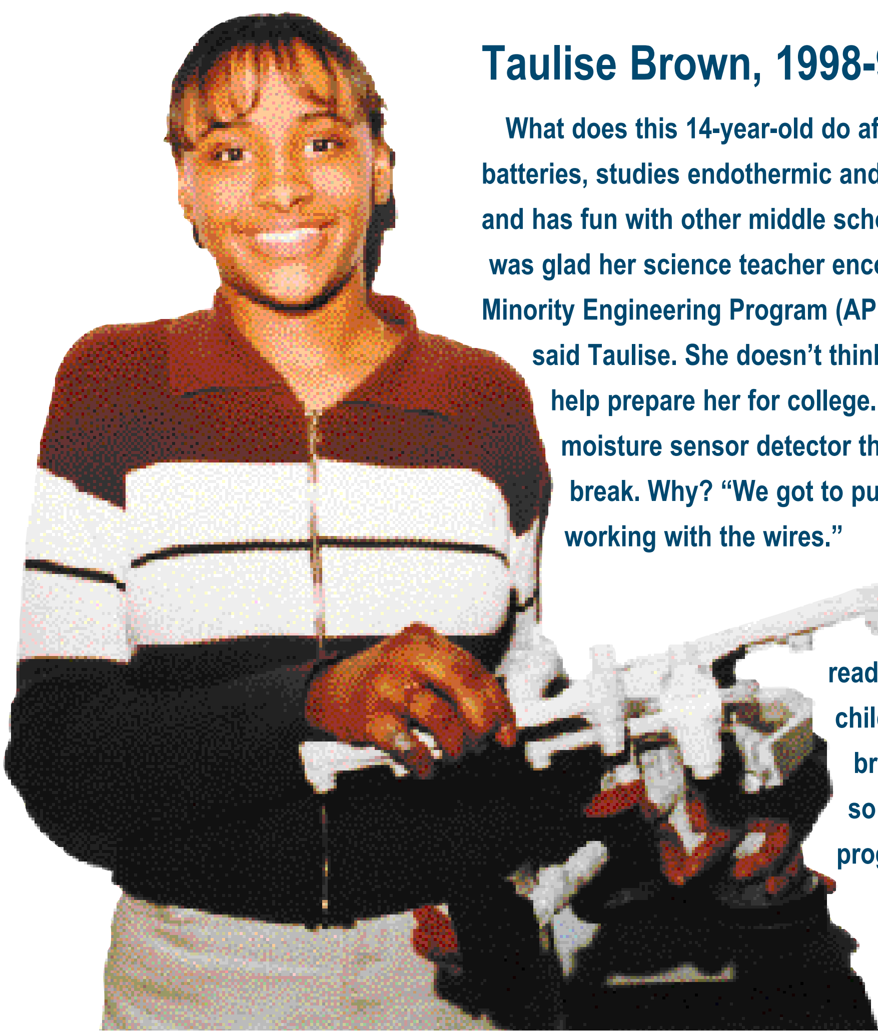
Notre Dame administration agreed this was a good place to start. "Interest in engineering among minority students needs to be encouraged before high school," said University President Father Edward Malloy. "Without such interest, students simply will not choose, or succeed in a high school curriculum that will sustain them through college careers." Supported by the University, Vann-Hamilton completed research within South Bend-Mishawaka community and then began working with local organizations to get the program up and running.

A not-for-profit affiliate of Ameritech, The Corporation for Educational Communications pledged $53,000 (most of which went toward videoconferencing equipment) for the first year of the pre-college program. "Technology is the key that opens doors to learning and career success," said Kent Lebherz, president of Ameritech Indiana, "so we're pleased to sponsor the Ameritech Pre-College Minority Engineering Program at Notre Dame." Ameritech supports underrepresented students in technical fields through various grants and has recently contributed $60,046 to continue the APMEP. We are grateful for their support and dedication to educating tomorrow's leaders.

Another partner, the South Bend Community School Corporation, donated the space for three of the required four classrooms and also agreed to provide transportation for the students from their respective middle schools to the classrooms and then to their homes. Notre Dame provided the main site. University faculty, graduate students, and undergraduates, in tandem with the teachers at the middle and high schools, formed the teaching teams needed for each site. All the pieces were coming together, but there was not enough funding to rollout the program successfully. That's when Leo Dilling, a member of the Advisory Council of the College of Engineering, generously wrote a personal check for $10,000 to cover the gap in first-year funds.

By Spring 1997 the Ameritech Pre-College Minority Engineering Program (APMEP) was ready to launch. A distance learning initiative, APMEP was different from other pre-college programs because of its videoconferencing component. The four-way conferencing would allow all students to join in discussions, demonstrations, and question-and-answer sessions in real time. It would foster a team environment and encourage participation. "We consider this program one of the first to integrate interactive video technology into the delivery of pre-college engineering programs," said Vann-Hamilton.

As a final step minority students in grades 6 and 7 were invited to



Taulise Brown, 1998-99 APMEP Participant

What does this 14-year-old do after school every other Wednesday? She makes batteries, studies endothermic and exothermic reactions using water and baking soda, and has fun with other middle school students. Although Taulise likes math best, she was glad her science teacher encouraged her to apply to the Ameritech Pre-College Minority Engineering Program (APMEP) at Notre Dame. "It sounded like fun," said Taulise. She doesn't think the work is very hard, but she feels it will help prepare her for college. One of her favorite projects at APMEP was the moisture sensor detector the students worked on just before Christmas break. Why? "We got to put it together and take it home," she said. "I liked working with the wires."

Taulise is a seventh grader at Clay Middle School in South Bend, Indiana. She enjoys reading and playing sports. She is the oldest of three children. Her sister is eight. And, her 11-year-old brother likes what he sees Taulise doing in APMEP so much that he's looking forward to being in the program in a couple of years.

submit applications for the program. APMEP recruited early so by the time the children were in the program they would be in grades 7 and 8. A total of 78 students were accepted into the 1997-98 program. To become part of APMEP, students had to have at least a B average, an ISTEP score of 65 percent, and two letters of recommendation. But that was just the beginning. Each student and family accepted in the program were required to sign a "Family Participation Pledge." Signing the pledge meant a student and his or her family agreed to complete all homework assignments not only in APMEP but also in regular school courses. They agreed to be active participants in the APMEP sessions, to show respect for themselves and other students, and to follow APMEP guidelines. Parents agreed to help their children stick to the pledge.

Family participation is key. Parents are required to become actively involved in homework, starting with the orientation session. This shows students how much their parents are supporting their studies and, over the course of the year, gives parents a glimpse of the wide range of career opportunities in engineering available for their children. In addition, there are two planned Family Engineering Activities Days, one in the Spring and one in the Fall.

Sounds good. How does it work? Well, APMEP participants meet on the first and third Wednesday of every month from October through May. These sessions, however, are more than classroom lectures. A tremendous amount of work goes into planning and executing each session. "As technologically advanced as the video-conferencing equipment is," explained Vann-Hamilton, "it can still be like watching television if we don't actively engage the kids."

First, the faculty and graduate students outline the materials and presentation for each session, including the development of scripts. The scripts are used to detail lesson flow as well as provide cues to the main instructor about when to engage all the sites. Instructors also map out projects for the kids, making sure they are interesting and will hold the students' attention. For instance, one week students might be experimenting with heat transfer; the next they might be making a moisture sensor detector.

APMEP students get homework. They are given technical writing assignments to complete with their families, like designing a holding tank device for a water treatment plant. They even take "virtual" field trips. Recently, students participated in a long-distance telecast with Lockheed Martin Missiles and Space in Sunnyvale, California. The video field trip gave students the opportunity to meet several engineers and see some of the actual devices involved in the deployment of a satellite.

Students think these activities are "cool." What's more important is that these activities show the kids how engineering affects their lives while stimulating their imaginations. Parents like Gina Thundy agree. Her son, Zach, improved his classroom performance and his Science grades. "We know that APMEP has contributed immensely to this productive, rewarding year for Zach," she said. "He enjoyed it very much, and we believe it had a positive influence on him."

In addition to in-class instruction, homework, and field trips,

Education is not the filling of a pail, but the lighting of a fire.

— W.B. Yeats

students must give oral presentations about an engineering or technology related subject. They are evaluated on content and delivery. This is in addition to the formal quarterly progress reports their parents receive. During a video awards ceremony at the end of the program, students receive a certificate of recognition.

The 1998-99 session of APMEP marks the second year of the program. Currently, 62 minority youth from six different schools meet at Washington High School, Riley High School, Adams High School, and the University site. "APMEP truly makes a difference in Notre Dame's ability to reach out to the surrounding communities to share our blessings of talented students, faculty, and administrators," said Father Malloy. However, the University is also planning to expand the program to include other school systems in Indiana. The Indianapolis Public School System and Kokomo Center Township School System have expressed immediate interest. "If all goes well," said Vann-Hamilton, "they could be on-line as early as Fall 1999."

A lot of time and effort from a lot of different people have made APMEP possible. University faculty, graduate students, undergraduate students, middle and high school teachers and administrators, community volunteers, and parents believe it is already a success. They've seen the results in class and at home. But, what does this program really do for the students? Only time will tell. Right now, it makes them think. In addition to helping them understand basic engineering concepts, it promotes teamwork, research skills, and a sense of accomplishment. In short, it prepares them for a bright future.

Students work with volunteers in each APMEP session on a project that puts the theories they've just learned into practice. Shown (left to right) are: Ashley Frazier, Clay Middle School; Jessica Yeh, Clay Middle School; Jucain Butler, a graduate student in the College of Engineering; Rachel Alvarez, Clay Middle School; Julie Cramer, who teaches English as a second language at Clay Middle School; and Jennifer Woods, Holy Cross School.

College News

Marian Kennedy Fischer Hall (top) is centrally located so faculty and students can explore and experience the best that London has to offer. It is less than a 10-minute walk from theatres, art galleries, financial institutions, and colleges of the University of London.

In between classes students can study in one of the two major libraries (above left) or access the Internet or local networks from one of four computer clusters. All of the computer systems in the London Centre are connected to the University's server.

A large common room (above right) shows off the decorative molding reminiscent of the original complex.

Marian Kennedy Fischer Hall Dedicated

On February 6, 1999, the trustees and administration of the University of Notre Dame dedicated the London Study Centre at Trafalgar Square. The building itself, named Marian Kennedy Fischer Hall in honor of the mother of trustee and alumnus Charles Fischer who is underwriting the project, has a long and distinguished history.

It was founded in 1821 as the United University Club (UUC), a club for members of Oxford and Cambridge, all male universities. Original membership was made up of 284 clergy, including the Archbishop of Canterbury; 100 peers; baronets and knights; and approximately 200 politicians including Robert Peel and Lord Palmerston. Members enjoyed coffee and drawing rooms, libraries, a smoking room, a card room, and a map room.

In 1904 the UUC's financial condition had so deteriorated that a new lease was negotiated, and the property was rebuilt. The new design included 10 bedrooms for members. World War I brought two major problems. First, the club had to resort to employing female staff. Men and boys were off to war. It also brought food shortages, causing the introduction of one meatless day per week and two days each week without potatoes.

Twenty-five years and several expansions later, World War II caused more changes when the UUC was notified that it must accommodate 200 people from the general population, not membership, in the event of an air raid. The building did not suffer any major damage due to the war, but because of the air raids, dinners were served after 7:30 p.m. Food wasn't the problem it had been during World War I; however, when France fell, the sale of burgundies and clarets was restricted to odd days of the month. By now, the UUC was more than a building. It was a complex that stretched down the street and reflected the various functions needed by previous owners.

During the 1950s, 1960s, and 1970s, membership fell again and usage of the complex declined. It is now owned by the Crown Commissioners who manage it on behalf of the Crown. Notre Dame took possession of the facility when it assumed the lease that had been granted by the Crown Commissioners to the British School of Osteopathy. After an extensive renovation, the five-story, 27,000-square-foot Centre is now a showcase among the University's foreign study programs. Many of the original features remain in tact, including an impressive staircase, mahogany doors to the main rooms, intricate ceiling molding, and ornate fireplaces. The Centre features several classrooms, two major libraries, four computer clusters, Internet and local network access in every room, commons rooms, faculty and administrative offices, a gallery, and five private residences, which provide a housing base for visiting academics from South Bend. Offering instruction in the professions and liberal arts by adjunct professors from London universities as well as Notre Dame faculty, we are confident that Marian Kennedy Fischer Hall will meet the needs of our students now and well into the future.

London Program Still Growing

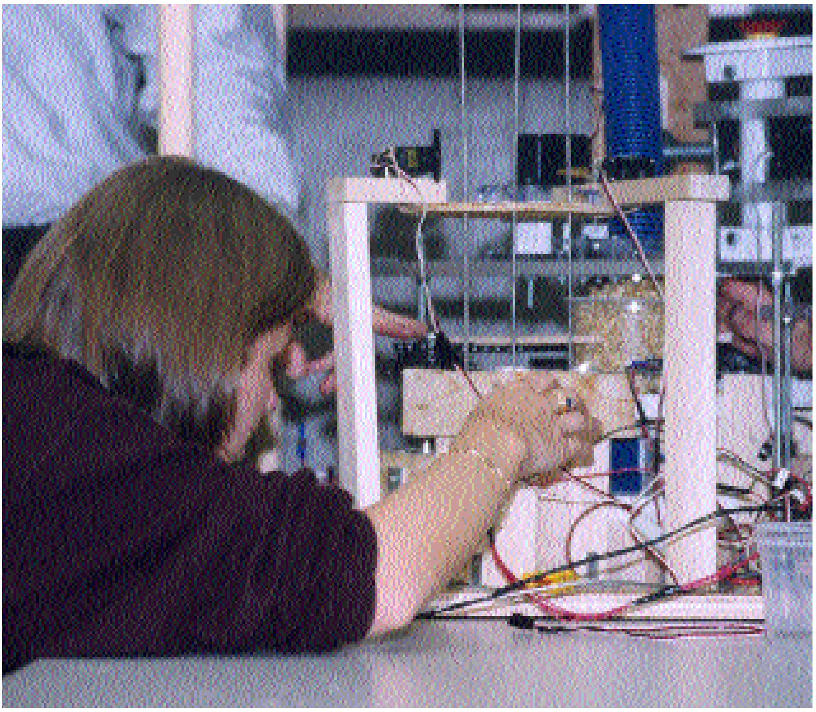
Last year 14 engineering juniors spent a semester in London. This year two professors and 18 juniors from the College of Engineering participated. The students — seven from Aerospace and Mechanical Engineering, seven from Computer Science and Engineering, three from Electrical Engineering, and one from Chemical Engineering — were among the 85 Notre Dame undergraduates who studied in London during the Fall 1998 semester.

Professor of Aerospace and Mechanical Engineering, Dr. Albin Szewczyk, taught courses in Differential Equations and Fluid Mechanics, as part of a continuing aerospace/mechanical London Program. Computer Architecture I, its associated laboratory, and Signals & Systems, an Electrical Engineering course, were taught by Dr. Eugene Henry, Professor of Computer Science and Engineering.

Ingersoll-Rand Funds New Scholarship and Grant

The Ingersoll-Rand Company of Woodcliff Lake, New Jersey, a manufacturer of equipment and components for industrial and commercial applications worldwide, has funded a scholarship for senior mechanical or civil engineering students who demonstrate outstanding academic achievement, leadership qualities, and financial need. In addition, the company is providing grant monies for the purchase of laboratory equipment for the Departments of Aerospace and Mechanical Engineering and Civil Engineering and Geological Sciences. The total gift, scholarship and grant, is $630,000.

Department News



The Fall 1998 semester project was a handling system for granular material. Students were given a scenario: If the current state-of-the-art process is for an individual to stand and manually open a bin, fill a container, weigh it, and seal it ... how would you completely automate the process? They then had to build a product prototype that automatically fed in a supply of containers and lids, filled and sealed the containers, and placed them on a conveyor belt.

Aerospace and Mechanical Engineering

Mechanical Engineering Seniors Present Capstone Design Projects

Each semester mechanical engineering seniors demonstrate their capstone design projects. This year 53 seniors, working in teams, will develop prototypes of automated material handling systems. Classes are split to make it more manageable for students and faculty. "Twenty-three students took the course in Fall term, and 30 are taking it this semester. Splitting the class lets everyone have a very active role," said Professor Stephen Batill, course instructor. "We've set the course up as close as we can to simulate what happens in industry."

Teams are given a Request for Proposal, a general product requirement statement. They then work through the project, setting their technical goals, and developing proposals that formally document the intended product design. Each team then presents the proposal to a panel of industry reviewers in a Critical Design Review. Finally, they fabricate the prototypes based on their designs.

"One of the other benefits to splitting the class is that it allows us to offer a new challenge each semester. For instance, instead of filling plastic containers as the final step for the Fall semester, Spring semester students need to fill and seal a 'ziplock' type bag," said Batill. "Next Fall we anticipate developing laser guided air cushioned vehicles."

Each prototype has around 200 parts. Although some are outsourced, most of the parts are made by students in the department's machine shop, which includes manual machine tools and CAD/CAM systems. All of the prototypes are completely computer controlled. So in addition to building the product, students must program the single-board microprocessor which controls it.

FACULTY HONORS & ACTIVITIES

Edmundo Corona
Assistant Professor of Aerospace and Mechanical Engineering
Was promoted to Associate Professor with tenure.


Mohamed Gad-el-Hak

Mohamed Gad-el-Hak
Professor of Aerospace and Mechanical Engineering
Was named the 14th Freeman Scholar by the American Society of Mechanical Engineers. The prize is the highest honor bestowed by the division of fluids engineering within the ASME and is awarded biennially. The Freeman Prize, announced in 1997, was awarded as part of a special ceremony during the International Mechanical Engineering Congress and Exposition in Anaheim, California.

Thomas J. Mueller
Roth-Gibson Professor of Aerospace and Mechanical Engineering
Received the Rev. James A. Burns, C.S.C., Graduate School Award for 1998. This award is given annually to a faculty member for distinction in graduate instruction or other exemplary contributions to the graduate education program.


Thomas J. Mueller

John E. Renaud
Assistant Professor of Aerospace and Mechanical Engineering
Was promoted to Associate Professor with tenure.

Kwang-Tzu Yang
Viola D. Hank Professor of Aerospace and Mechanical Engineering
Was promoted to Professor Emeritus.

Was presented the 1998 Distinguished Service Award by the Heat Transfer Division of the American Society of Mechanical Engineers (ASME) at the International Mechanical Engineering Congress and Exhibition in Anaheim, California. This award recognizes the high regard and deep appreciation of the Society for his valued services in advancing engineering.

CHEMICAL ENGINEERING

"Green" Engineering Begins at Home

"Design Projects in Green Engineering," offered by Professors Joan F. Brennecke and Jeffrey C. Kantor, Associate Provost, is a new course in the Chemical Engineering Department. Its goal is to apply the concepts of environmental engineering to University activities. Student teams investigate ways to lessen pollutant generation and energy use on campus ... everything from re-using chemicals in labs to reducing energy consumption by the campus computer network. At the end of the class, students are required to submit a report outlining their suggestions for process improvements, including the economic impact of the proposed changes.

This course is an outgrowth of a larger initiative, a three-year combined research and curriculum development program grant sponsored by the National Science Foundation. The overall program goal is to incorporate research on environmentally conscious chemical manufacturing processes, not just remediation, into engineering curricula. According to Brennecke, the course and the development grant seek to answer the question: How do we design and operate chemical processes so we reduce pollution ... eliminate it at the source? "We need to change our mind-sets and prevent pollution in the first place," she said. "Inevitably, this will save money." Other universities participating in the program grant include West Virginia University and the University of Nevada, Reno.

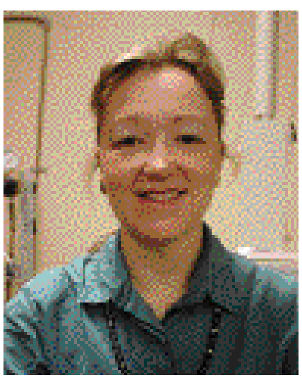
Stadtherr Receives Top AIChE Award

Mark A. Stadtherr, Professor of Chemical Engineering, received the 1998 Computing in Chemical Engineering Award from the American Institute of Chemical Engineers (AIChE). This award is the top national recognition given for outstanding contributions in the field of computing in chemical engineering.

Stadtherr is an internationally known author and lecturer in the field of chemical process systems engineering. His primary research focuses on developing computer methods for the design of chemical manufacturing processes that are safer, less costly to operate, and better for the environment.

He is currently collaborating on a National Science Foundation project aimed at incorporating the results of recent and ongoing research on environmentally conscious chemical process design into chemical engineering curricula. This will help shift the focus of environmental teaching efforts from remediation, treatment after the fact, to prevention. Stadtherr joined the Notre Dame faculty in 1996.

FACULTY HONORS & ACTIVITIES



Joan F. Brennecke

Joan F. Brennecke
Associate Professor of Chemical Engineering
Was promoted to Professor.

Received a 1998 Presidential Award from the University. Since joining the faculty in 1989, her impact has been substantial. This award was given in recognition of her classroom teaching, graduate student mentoring, research and service efforts on behalf of the University and the chemical engineering profession.

James. J. Carberry
Professor of Chemical Engineering
Was promoted to Professor Emeritus.

Hseuh-Chia Chang

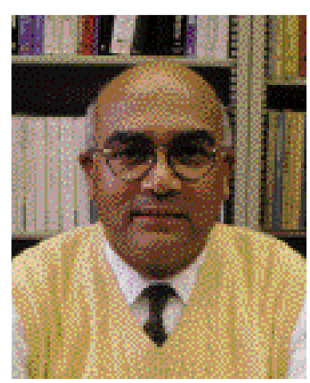
Hseuh-Chia Chang
Professor of Chemical Engineering
Was named the Bayer Professor of Engineering. Chang joined the faculty in 1987, having previously taught at the University of Houston and the University of California at Santa Barbara.

Was elected to the grade of Fellow in the American Physical Society. He was cited for his contributions to the physical and mathematical understanding of waves on thin films.

Edward J. Maginn
Assistant Professor of Chemical Engineering
Received the Dow Outstanding New Faculty Award for 1998 from the American Society of Engineering Education during its national conference in Seattle, Washington. One of only eight people selected, Maginn's current research focuses on the use of molecular-level computer simulations to understand the thermodynamic and transport properties of materials such as polymers and catalysts. Since joining the Notre Dame faculty in 1995, Maginn has also received the National Science Foundation Faculty Early Career Development Award (1997) and the Notre Dame Chemical Engineering Teacher of the Year Award (1998).

Edward J. Maginn

Arvind Varma
Arthur J. Schmitt Professor of Chemical Engineering
Received the 1998 Ernest W. Thiele Award in Chemical Engineering from the Chicago Section of the American Institute of Chemical Engineers (AIChE) The award honors his contributions in advanced materials, catalyst distribution, and reaction stability.



Arvind Varma

Civil Engineering and Geological Sciences

Where There's Not a Drop to Drink

Most Americans think nothing of downing a tall glass of cold water on a hot summer day, or any time they're thirsty. People in Third World countries aren't as fortunate. Often the only source of water they have is the nearest river, which offers water Americans wouldn't dream of drinking. Dr. Stephen E. Silliman, Associate Professor of Civil Engineering and Geological Sciences, believes that helping people in developing nations access safe drinking water is an activity that meshes with Notre Dame's mission. "For several years we've been involved in water treatment in Third World countries," he said. "Most recently we've been pursuing opportunities for our students to play a part in expanding clean water resources in these underdeveloped areas and expanding their education in the process."

Haitian villagers pose with their new pump, installed in 1997 by a team from Lifewater International in conjunction with Dr. Stephen E. Silliman from Notre Dame. Involving the men of the village in the drilling of the well and training them to maintain the pump brings a sense of ownership that provides benefits beyond the obvious ... safe drinking water.

Silliman leads a three-unit course, "Third World Water Supply," where students — mostly senior civil engineering majors — learn how to be better engineers in terms of working with Third World countries. Approximately a third of the class is devoted to the types of technologies that are appropriate to these developing nations. For example, an engineer cannot walk into a small community that has no electricity, no technicians, and no college graduates; install an electric pump; and then expect the members of the community to be able to get water. Engineers must be prepared to develop technologies at the level these communities can use.

Haitian children celebrate the taste of clean water. In many villages children and women are the ones responsible for carrying the water from its source back to the village.

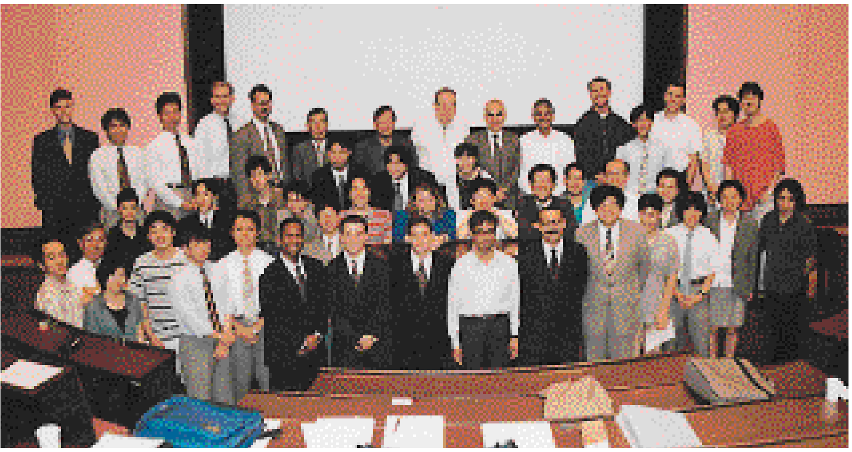
Another aspect of the class is the social context of the water and efforts to develop it. To explain this, Silliman sites the large number of hand-pump wells in Haiti which are idle due to the failure of a simple component or a missing bolt. He observes that when the people served by the well are active participants in the drilling and maintenance of the well, they take ownership and make sure that simple repairs are completed quickly and correctly. However, when a well-meaning relief agency "donates" a well to a village without local participation, the villagers feel little ownership or pride for the well and have little incentive to make repairs. The result is that the well becomes inactive as soon as the simplest of parts fails. "The social consequences of an engineer's actions are exactly what our undergraduates must realize," said Silliman. "They need to understand how to place engineering into a social context, to identify where people are at, and learn how to work within that context."

Students in Silliman's class also learn to stress the cost benefit analysis: what the company or organization installing the pump has to spend, what the village has to spend, what maintenance costs will be, and what the benefits are. "As Americans we look at the dirty river water and think the benefits are obvious — clean water means less disease. As engineers, our students need to look deeper than the obvious." Some Notre Dame students will have a chance to do just that this Spring as they travel to Cap Haitien, Haiti, as part of a one-unit course. Silliman, seven students, a Lifewater International volunteer, and Father John Herman, C.S.C., will be traveling to Haiti to train villagers in pump repair. The International Studies program is funding the trip, and Kathleen Maas-Weigert of the Center for Social Concerns is the co-faculty member for the one-unit course.

Dr. Silliman and students Darren Kelly and Jennifer Nash (left to right) get the India Mark II hand pump ready for their trip to Haiti. While there, Notre Dame students will train Haitian men to repair the pumps. This provides jobs and establishes a maintenance system so the villagers won't have to wait for the next relief agency to visit to get a pump repaired.

Eleven U.S. Graduate Students Benefit from Summer in Japan

Every year since the early 1990s students in the Japanese Summer Institute and Monbusho Summer Program have been hosted by university, government, and corporate laboratories throughout Japan, but mostly in the Tokyo and Tsukuba areas. This year 11 U.S. structural engineering graduate students spent the summer learning from Japanese host engineers and researchers. Greg Baker (University of Notre Dame); Daniel Bratt (Duke University); Aaron Brown (University of California — Santa Barbara); Richard Christenson (University of Notre Dame); Kenneth Farrow (University of Notre Dame); A'gota Fejes (Manhattan College); Scott Jones (Texas A&M University); Jerome Lynch (Stanford University); Eric Matsumoto (University of Texas at Austin); Clay Naito (University of California — Berkeley), and James Sims (University of Notre Dame) observed and performed cutting-edge research, attended various symposia, and went on a number of laboratory tours and site visits. They also presented research at their host institutions, discussed a variety of topics with Japanese colleagues, and collaborated on specific research projects. "Through this program," said Kenneth Farrow, "we were able to establish valuable contacts with professors and professionals in Japan that may open the door to future partnerships." Farrow and fellow student, Richard Christenson, published a recap of their experiences in a recent issue of the Newsletter for the International Association for Structural Control (IASC).



Students attended two symposia on earthquake engineering for U.S.-Japan young researchers. One was hosted by the University of Tokyo; participants are shown above. Fourteen Japanese researchers and seven U.S. students presented their work. Waseda University hosted the second symposium, where 10 U.S. students and five Japanese researchers reviewed their research.

These summer sessions are sponsored by the U.S. National Science Foundation, the Japanese Science and Technology Agency (STA), and the Japanese Ministry of Education, Science, Sports, and Culture (Monbusho) as part of a fellowship program. Professor B. F. Spencer, Jr. served as mentor and professional activities coordinator for the students, under the auspices of the U.S. Panel on Structural Control Research.

FACULTY HONORS & ACTIVITIES

Peter C. Burns
Assistant Professor of Civil Engineering and Geological Sciences
Received the first Young Scientist Award from the Mineralogical Association of Canada. This award recognizes the promising career of a scientist under the age of 40 who is either a Canadian citizen or a scientist working in Canada. Burns was cited for his contributions in the areas of mineralogy and crystallography.


Peter C. Burns

Ahsan Kareem
Professor of Civil Engineering and Geological Sciences
Was named Distinguished Alumnus of Colorado State University in recognition of his exceptional contributions to engineering through education, publication, leadership, and service. He received his Ph.D. from Colorado State in 1978, and joined the Notre Dame faculty in 1990.

Jerry Marley
Associate Professor of Civil Engineering and Geological Sciences
Along with his wife, Marge, received the Grenville Clark Award. It honors members of the Notre Dame community "whose voluntary activities and public service advance the cause of peace and human rights." The Marleys' on-campus efforts cover everything from pre-cana counseling to providing a support structure for aging priests. They were recognized for their contributions and support to the elderly, ill, and house-bound. In addition, Marley has served as president of his parish council, and his wife has volunteered her nursing skills.

B. F. Spencer, Jr.
Professor of Civil Engineering and Geological Sciences
Appointed the Schmidt Distinguished Visiting Professor at Florida Atlantic University in Boca Raton, Florida.

Computer Science and Engineering

Medusa: Prototyping the Next Generation of Software and Applications

Notre Dame's Parallel Experimental Systems for Dynamic Computations group, led by Assistant Professor Nikos P. Chrisochoides, develops problem-solving environments for complex engineering and scientific computing problems. Much of the group's work revolves around "Medusa," one of the latest SP-series computers received through IBM's Shared University Research Program. Medusa is a smaller but similar "building block" to the machines used for the teraflops computer in the San Diego Supercomputing Center (SDSU). "With the software we are developing in our group, we can connect other computers, like the 'Hydra' in Notre Dame's Laboratory for Scientific Computing, to create a parallel platform 'isomorphic' to future supercomputers capable of delivering close to 1,000 trillion floating point operations per second (one peraflop)," said Chrisochoides. This level of performance is necessary for detailed simulations of phenomena such as crack propagation in fracture mechanics. The SP-machine positions the University to benefit from the high-performance computing and communications pyramid model implemented by the National Science Foundation and could attract more research opportunities. "With Medusa," said Chrisochoides, "Notre Dame researchers can develop and test their codes and then port them to SDSU for production runs." Medusa will also assist the University in exposing computer science students to future teraflops and petaflops computers, as well as enhance instruction on the hardware requirements of large-scale simulations.


(Left to right) Laura Sichitiu, Dr. Nikos Chrisochoides, Kevin Barker, Jeffrey Dobbelaere, and Démian Nave make up Notre Dame's Parallel Experimental Systems for Dynamic Computations group.

FACULTY HONORS & ACTIVITIES

Danny Z. Chen
Assistant Professor of Computer Science and Engineering
Was promoted to Associate Professor with tenure.

Eugene W. Henry
Professor of Computer Science and Engineering
With John J. Uhran, Jr., received the Fluke Corporation Award for Outstanding Laboratory Development and Instruction at the American Society for Engineering Education's Annual Conference in Seattle, Washington.

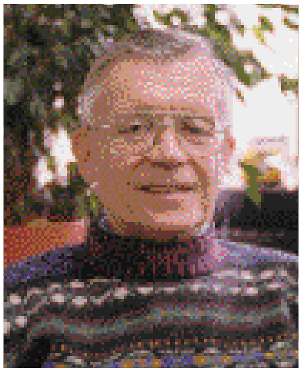
Was elevated to the rank of Senior Member in the Society for Computer Simulation.

Eugene W. Henry

Andrew Lumsdaine
Associate Professor of Computer Science and Engineering
With J.G. Siek, received the prize for the best contribution to the SciTools '98 web-based proceedings for their work on "Generic Programming for High-Performance Numerical Linear Algebra."

Edwin Hsing-Mean Sha
Assistant Professor of Computer Science and Engineering
Was promoted to Associate Professor with tenure.

John J. Uhran, Jr.
Professor of Computer Science and Engineering
With Eugene W. Henry, received the Fluke Corporation Award for Outstanding Laboratory Development and Instruction at the American Society for Engineering Education's Annual Conference in Seattle, Washington.



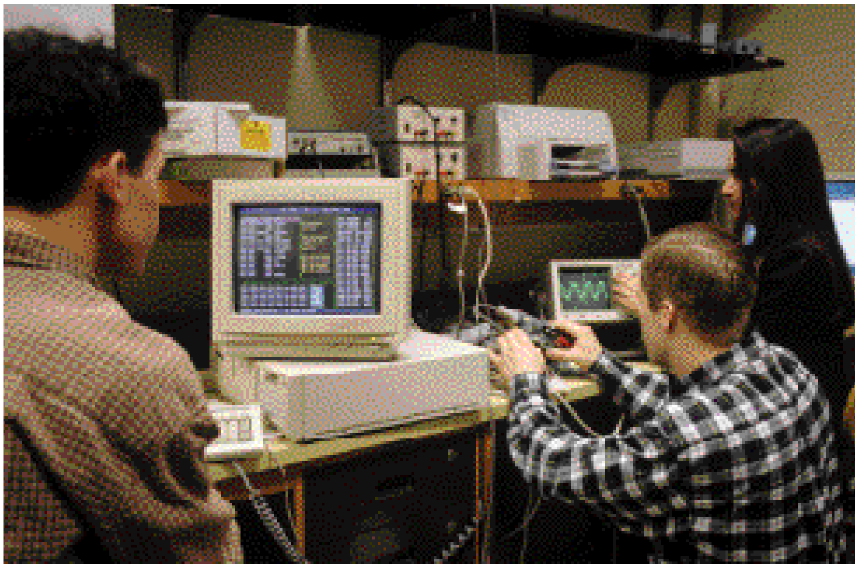
John J. Uhran, Jr.

ELECTRICAL ENGINEERING

Electrical Engineering Seniors Benefit from Mentoring Program

"Working with the Bayer Fluidics group has given me the opportunity to work on an engineering project that involves both technical and economic requirements. This experience will help me be a better engineer when I work in the private sector," said Larry Paul, senior electrical engineering student. How does a "student" work with the Bayer Fluidics group or with any corporation while still in school? Isn't that a bit unusual? Not really, especially if the student is a senior electrical engineering major at Notre Dame.

For the last four years students in senior design courses have had the opportunity to work closely with industry mentors in all phases of product design and fabrication. This year two of the projects are being sponsored by Bayer Laboratories. They involve the design and fabrication of micromachined, microliter fluid delivery systems, as well as the design of a digital signal processing system for noise cancellation in clinically based medical instrumentation. Paul is working on the fluid delivery system, designing a microchip with channels that will use capillary action to bring the fluid into a reaction chamber so its glucose level can be measured. Another group is working on an antenna switching device for an automotive cellular telephone system. Representatives from the Onstar Division of General Motors serve as mentors for that team.



Working with practicing engineers from Bayer helps students like Michael Bangert, Ben Turin, and Valerie Maldonado (left to right) learn how to organize a team, identify the key elements of a project, and present their work to management. It helps corporations develop relationships with Notre Dame faculty. Most important, it gives students an overview of the many employment opportunities available in a variety of areas.

The third partner in the mentoring program is the Army

Research Laboratory (ARL). Located in Adelphi, Maryland, the ARL often works with local universities; however, they have also developed relationships with institutions like Notre Dame and West Point. Michael V. Scanlon of ARL believes there is a definite benefit to teaming with students and faculty. "The team approach in developing hardware works well," said Scanlon. "As an engineer in a real-world environment, I feel I give them (the students) a new perspective on what really goes on in the development of new technologies. We discuss all aspects of design, as well as how the end-user will use the device, and what the benefits are." The Acoustic Monitoring Pad being developed by the student team has civilian and military applications. For instance, an Army medic might use the device for monitoring the vital signs of soldiers in the battlefield, but the same monitor can potentially be used to save a baby from Sudden Infant Death Syndrome (SIDS).

Dr. Gary H. Bernstein, Professor of Electrical Engineering, is the course instructor. Another faculty member, Dr. Gerald J. Iafrate, Professor of Electrical Engineering, has also been heavily involved in the program. Before coming to Notre Dame, Iafrate was at the Army Research Office (ARO). His interactions with ARL while at ARO and since coming to the University established the groundwork for this collaboration.

1998 Resnik Award Goes to Collins

Oliver M. Collins, Associate Professor of Electrical Engineering, received the Judith A. Resnik Award in acknowledgment of his outstanding contributions to space exploration. Established by the Institute of Electrical and Electronic Engineers (IEEE) Board of Directors in 1986 in honor of the late Challenger astronaut, it is the highest international honor given by IEEE. As the 1998 recipient Collins received a bronze medal, a certificate, and $3,000.

Collins specializes in deep-space communications, satellite communications, and coding theory. His work was instrumental in allowing the Galileo Probe to transmit information back to Earth without telecommunications upgrades — avoiding the expensive and time-consuming alternative of sending another Probe to Jupiter to realign the unit's malfunctioning antenna. He has also helped NASA's Jet Propulsion Laboratory design and build a machine that decodes information transmitted from deep space. Collins joined the Notre Dame faculty in 1995.

FACULTY HONORS & ACTIVITIES

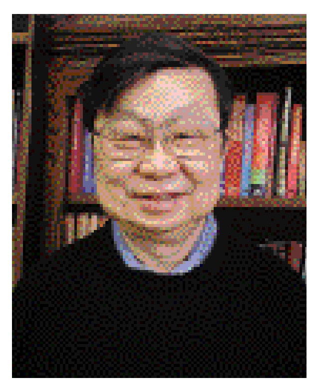
Gary H. Bernstein
Associate Professor of Electrical Engineering
Was promoted to Professor.

Daniel J. Costello, Jr.
Professor of Electrical Engineering
Received a 1998 Presidential Award for his success as teacher, scholar, and administrator. He has taken seriously the Catholic character of the University and has labored tirelessly to promote the overall mission of the University.

Daniel J. Costello, Jr.

Gerald J. Iafrate
Professor of Electrical Engineering
Received the Hammer Award as part of Vice President Al Gore's National Program for Reinventing Government. Dr. Iafrate, a member of the Federated Laboratory Team, was one of the individuals who helped create the Federated Laboratory Concept.

Ruey-Wen Liu
Freimann Professor of Electrical Engineering
Was awarded the Institute of Electrical and Electronics Engineers Circuits and Systems Society 1998 Society Meritorious Service Award.



Ruey-Wen Liu

Anthony N. Michel
Freimann Professor of Electrical Engineering
Received the Distinguished Member Award from the IEEE Control Systems Society in recognition of significant technical contributions and outstanding long-term service.

Student Activities & Events

Engineering Students Give Back to Michiana

Many Notre Dame students have a strong desire to better a community, even while they're in school. Often that service doesn't relate to what they're learning. That's not the case with the 41 students and five faculty members involved in Engineering Projects for Community Service (EPICS). "EPICS offers students an opportunity to interact with real people to address real engineering needs," said EPICS advisor Lloyd H. Ketchum, Jr., Professor of Civil Engineering and Geological Sciences.

EPICS students (left to right) Gina M. Morton, Maureen D. Neville, and Vanessa L. Norris work with Gary A. Gilot, Public Works and Utilities Director and President of the Elkhart Board of Public Works. Another member of the Elkhart EPICS team, Chad S. Green, is not shown.

One of the groups the EPICS program worked with during 1998 was the city of Elkhart, Indiana. Located approximately 15 miles from campus, Elkhart was one of the first Project Partners with EPICS. "Elkhart has a number of community service projects," said Eric Horvath, Manager of Engineering Services for the city and a Notre Dame alumnus. "We were excited to have the students join our efforts. They have worked on things we wanted to get done, but were unable to tackle because daily activities are so hectic. Also, as a Notre Dame graduate, I believe this broadens the student experience." During the first phase of the project, "Assessing the City's Environmental Assets," students identified and prioritized the urgency of protecting Elkhart's rivers, river front areas, ponds, wetlands, wooded areas, and parks. Next, they developed policy papers on how to best use and protect these environmental assets. Specific tasks included coordinating wetlands management, producing CAD drawings of the city's properties, and designing and implementing a windmill powered pumping system.

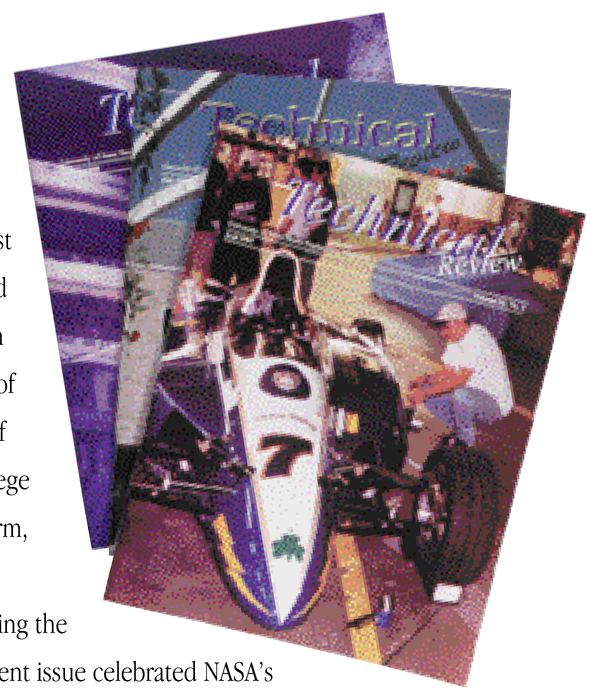
Another Project Partner was the South Bend Heritage Foundation (SBHF), a non-profit community development corporation specializing in the creation of affordable housing. A wide variety of groups from the College of Engineering worked with SBHF, doing everything from assessing the mechanical/energy efficiency of properties managed by the Foundation ... to developing software that can track maintenance calls, schedule personnel, and trace inventory used for repairs of the Foundation's 300+ units.

Industry Day a Success for Everyone Involved

For the last 18 years students from the College of Engineering have organized and held Industry Day, an event featuring a banquet and career fair. Members of the Society of Women Engineers, the Joint Engineering Council and other volunteers invite companies to the Fall event. It gives engineering majors and MBA students with engineering undergraduate backgrounds the opportunity to access opportunities in the job market. "The goal is not really to get a job on Industry Day, although that would be nice," said Anne Fitzpatrick, planning committee chair. "It's more about making contacts." Industry Day begins with a banquet, a more informal setting where representatives and students can interact. It's followed by a career fair, which usually takes an entire day.

Sixty-five companies participated in Industry Day '98, including some that had never before recruited at Notre Dame. They were able to meet and talk with more than 250 students. Committees are making plans for the next Industry Day in November 1999. Interested organizations should contact Dr. John Uhran in the College of Engineering.

Technical Review Celebrates 50 Years of Excellence



Technical Review walked away from the Engineering College Magazines Association meeting with three awards: a first place for "Best Single Issue," a second place for "Best Layout/Single Issue," and a third place for "Best Layout/All Issues." What better way for the student-run quarterly to celebrate its 50th anniversary? For half a century the staff of *Technical Review* has stayed true to its mission: "to present material of interest and importance to the students in all departments of the College of Engineering." Each issue of *Technical Review* seeks to educate, inform, excite, and entertain fellow students.

Over the years staffers have covered a variety of topics from harvesting the ocean for food to using laser beams in communications. The most recent issue celebrated NASA's 40 years in space, a serious undertaking for full-time students carrying full course loads. With a total of 13 students now on staff, the publication is designed on computers and is printed digitally. Staffers are also developing an interactive web site that will feature current articles and allow readers to reply. Why? To fulfill the mission developed 50 years ago. *Signatures* salutes *Technical Review* for 50 years of innovation and information ... a job well done.