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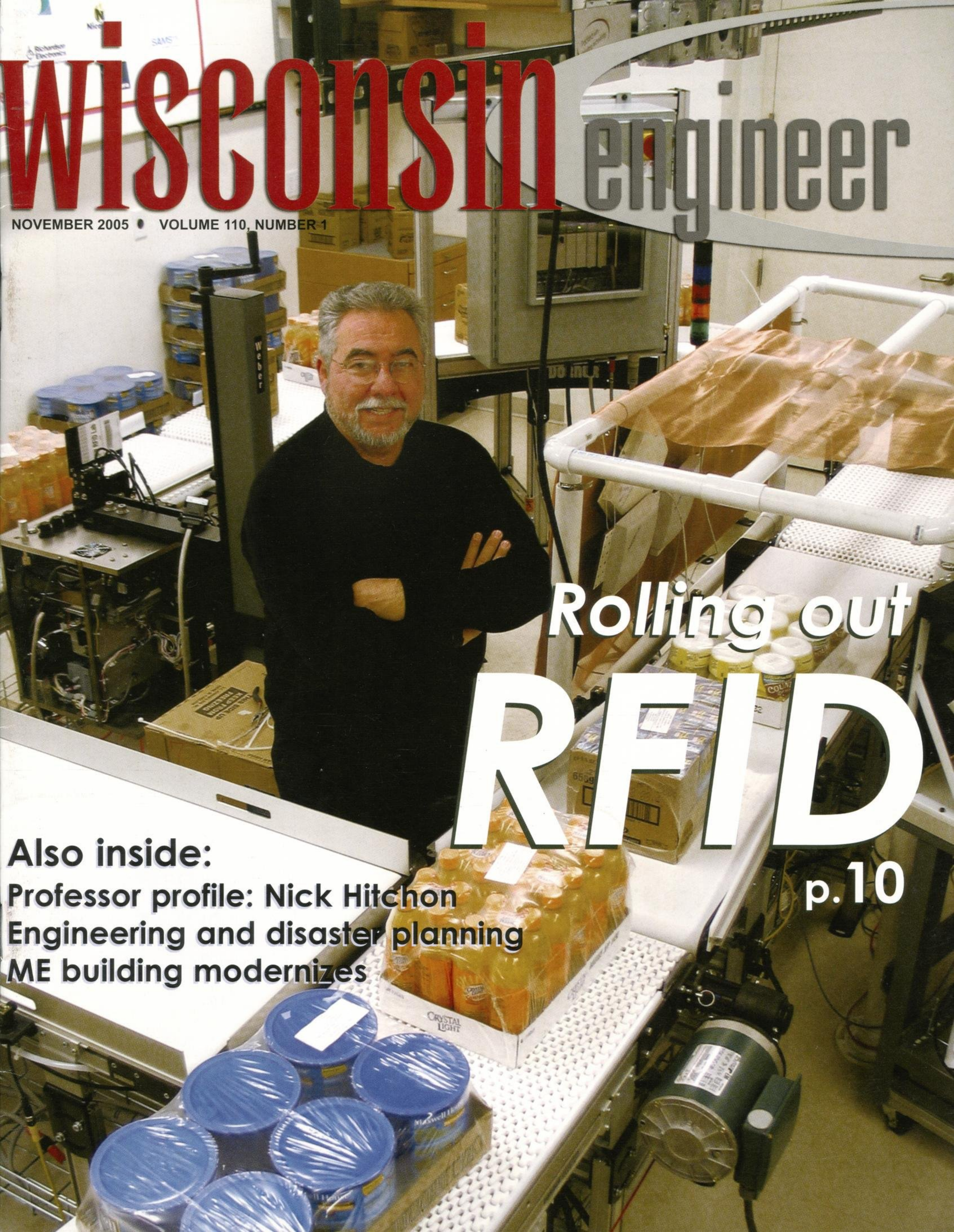
# wisconsin engineer

NOVEMBER 2005 • VOLUME 110, NUMBER 1



## Rolling out RFID

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# wisconsin engineer

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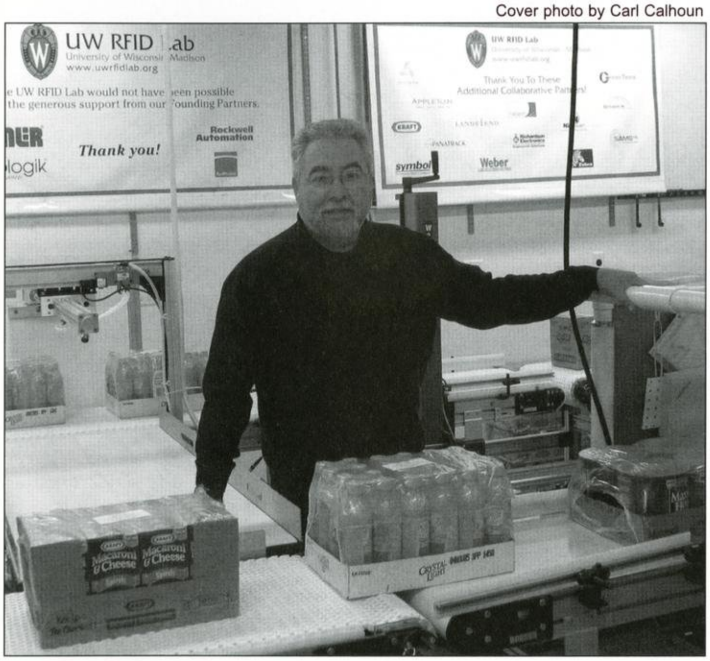
## COVER STORY

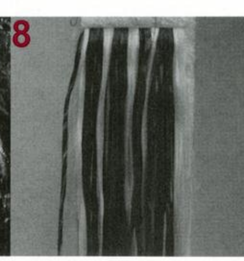


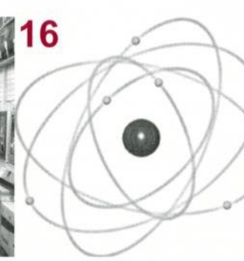
Cover photo by Carl Calhoun




## FEATURES



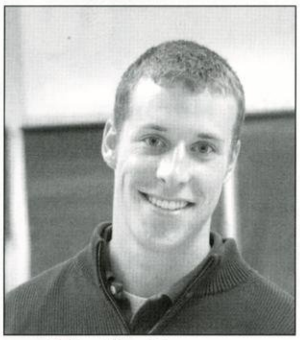





## COMMENTARY

# Reactor report: misleading, incomplete

**Kyle Oliver**
**Writing Editor**



**Martin Grasse**
**Writing Editor**

Editor's note: Kyle and Marty are majoring in nuclear engineering and biomedical engineering, respectively.

On Oct. 13, ABC News aired a report called "Radioactive Road Trip" on its weekly news special "Primetime Live." This report told the story of 10 graduate student interns from the Carnegie Corporation who worked with ABC News to investigate the security of nuclear reactors on university campuses across the country. ABC News claimed to have found "gaping security holes" in many of the 25 American university research reactors, including the one in the Mechanical Engineering Building at UW-Madison.

As student journalists, we understand the intent of ABC News to serve the public through responsible investigative reporting. We believe the pursuit of truth is a mission that unites journalism and the sciences. That relationship is a cornerstone of Wisconsin Engineer's goal of educating the UW-Madison community about developments in science and technology. Given this goal, we feel obligated to address several aspects of this report that we believe were misleading or incomplete.

The report included the account of the two Carnegie interns who came to Madison: Melia Patria of Columbia University and Hsing Wei of Harvard University. When they entered the Mechanical Engineering Building this summer to try to gain access to the reactor laboratory, the two were initially turned away. When they came back again later, they were still not allowed in but were given permission by a student worker to take a picture of the reactor from just inside the laboratory threshold. ABC News presents this incident as a major security breach, but according to a UW-Madison press release, "the university disagrees with the contention that the interns had any meaningful access to the laboratory or that their presence constituted a security threat."

Throughout the televised piece, the Carnegie Fellows and ABC News reporters express utter shock at the security breaches they witnessed at UW-Madison and elsewhere. But more often than not, this shock comes from a lack of understanding of the real danger inherent in these situations. Unfortunately, few of the experts interviewed in this piece could provide this necessary understanding.

For instance, the program talks extensively about the threat of terrorists turning a research reactor into a "dirty bomb." However, none of the interviewees critical of these universities was a trained radiological expert qualified to make such a judgment. Professor Mike Corradini, chair of UW-Madison's engineering physics department and a nuclear engineer who specializes in reactor safety, told the Wisconsin State Journal that a suicide bomber would probably not be able to damage the reactor core, which is protected behind 12 feet of high-density concrete at the bottom of a 40-foot pool of water. He went on to explain that even if the reactor were destroyed, the radiological release would pose little danger to the UW-Madison community. Andrew Karam, research assistant professor at The Rochester Institute of Technology, offered a similar assessment to the industry blog NEI Nuclear Notes.

The program also hints at the possibility of weapons-grade material being stolen from a research reactor. In doing so, they imply that simply because two interns were able to gain brief access to a reactor lab, the material is therefore at serious risk of being stolen. This implication demonstrates a complete lack of understanding of the radiological and practical obstacles of removing deadly material from a heavily fortified structure.

This report did show that security procedures at research reactors do need to be tightened. UW-Madison is taking steps to do just that. But the ABC News analysis of the implications of these security breaches was misleading and created undue alarm. This mishandling of important information demonstrates the difficulty of reporting fairly on this complex and socially loaded issue. We encourage local media to heed this lesson as they continue to follow up on the ABC News report. We and the Wisconsin Engineer staff will endeavor to do likewise.

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Photo by Carl Calhoun




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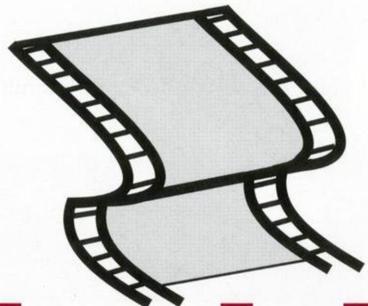


# Physicist on film:

## Seven years good luck for electrical engineering professor

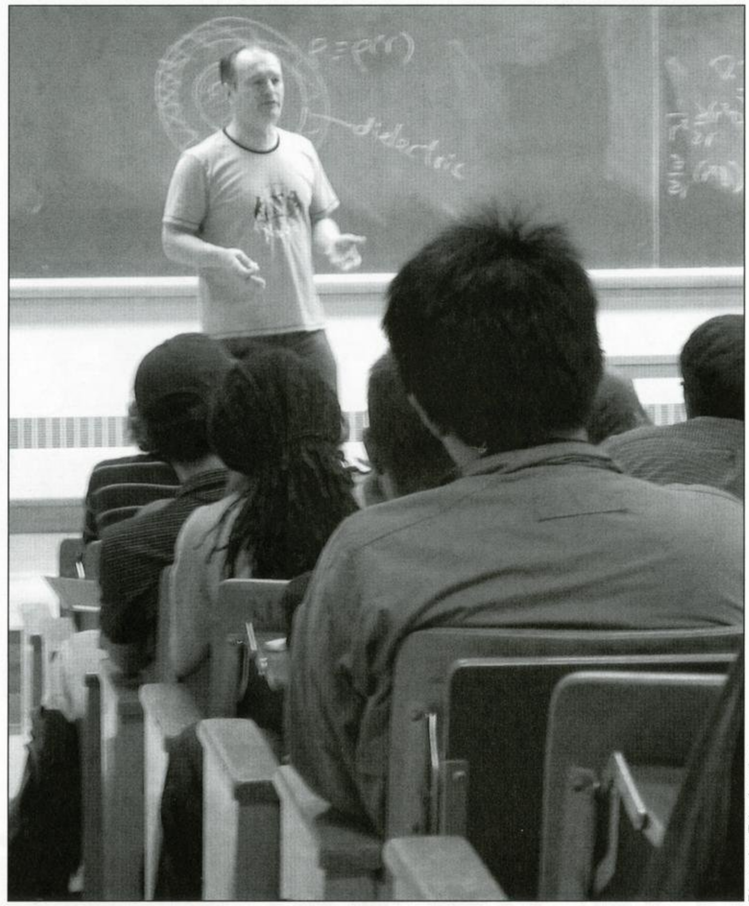


Photo by Erin Jacobs

**Nick Hitchon keeps his students interested while teaching Electrodynamics I at 8:50 in the morning.**

By Nicole Rybeck

This morning, as on many mornings over the past 23 years, William "Nick" Hitchon comes to the Red Oak Grill in Union South for breakfast. On this particular day, he orders bacon and eggs with toast and decaf coffee. Upon receiving his change, he shuffles through the coins and sees that the quarter he has been given is one bearing the imagery of the state of Kansas. He asks the cashier and me if either of us have seen this coin before. He folds it in a napkin in his pocket for his son, who collects state quarters. He then hurriedly picks up a few individually wrapped jelly packages for his toast and leads me to a table where we begin our interview.

Hitchon, UW-Madison professor of electrical engineering, grew up in the small town of Yorkshire Dales, England with his parents and two brothers. He was interested in science from a young age and read science-related books in his free time. He remembers once saying, "I want to find out about the moon and all that."

When asked if he could distinguish a specific moment from his childhood when he realized that science would have an impact on his life, Hitchon described a time when he and a classmate were working on a math problem involving a parallelogram of forces. After his classmate explained the problem to him, Hitchon thought to himself, "I can do this," and he decided to throw himself whole-heartedly into the study of science.

"You can't be an amateur scientist," he says now.

After completing his elementary and high school education, Hitchon attended Oxford University, earning a bachelor's degree in physics and a master's degree in engineering science with a specialization in the science and applications of electric plasmas. He finished his education at Oxford with a doctorate in engineering.

He says that he never really considered a different field of study besides engineering. A high school teacher urged him to study French, but he felt as though he could accomplish more working in the field of science.

Not all of his fellow students took him seriously in college. Hitchon recounts a time when he was living in the dormitories at Oxford and surprised his next-door neighbor. When he told the neighbor what he was studying, he received the reply, "I don't associate intelligence with your accent." He considers this a compliment and has carried it with him for more than 20 years. He describes it as a moment that shaped his youth.

After his education at Oxford, someone presented Hitchon with an opportunity to expand his work. He met Dave Anderson, a professor in the College of Engineering at UW-Madison, at a conference in Germany. They agreed it would be an amazing experience if they had the chance to work together. A short time later, Hitchon was offered a position at UW-Madison to do fusion research.

In November of 1982, Hitchon came to work at UW-Madison for the electrical and computer engineering department and has worked there ever since. He has achieved much in his career, publishing three books, over 70 articles in scholarly journals and several conference papers. He has been recognized at the Polygon Engineering Student Council-sponsored Spring Awards Banquet several times as an outstanding professor in his department.

I'm not the first person to tell the story of William Hitchon. Someone else has been working on it for far longer--and on a much bigger budget. This story begins about 40 years ago.

It all started with an idea formulated by Michael Apted, who is now a member of the Board of Governors of the Academy of Motion Picture Arts and Sciences. The concept was to document a group of 14 seven-year-olds as they matured, catching up with them every seven years to see how they changed. The idea stemmed from the old Jesuit saying, "Give me the child until he is seven and I will give you the man." It essentially defined the project as saying that a person's personality and future are defined by the age of seven.

The 14 children were selected from both extremes of the socioeconomic scale, with half being of great wealth and the other half coming from lower class rural families. The first film was titled "7 Up!" and premiered in 1964. Hitchon was known for his comment regarding what he thought of girls.

"I don't answer that kind of question," he said. He adds now with a smile that perhaps he should use that response a little more often.

The group reconvenes every seven years for a week of filming that documents the changes they undergo. The subsequent films were entitled, "7 Plus Seven," "21," "28 Up," "35 Up," "42: Forty Two Up" and now the recently released "49 Up." The documentaries became somewhat of a phenomenon in England and were aired on television overseas. They are even on Roger Ebert's list of Great Movie Series.

The questions the subjects are asked during the week of observation can be prying.

"[It's like] going into an exam and being asked something completely off the course," Hitchon says. Nevertheless he wants to thank Apted for choosing him to be a part of this process.

"There are other things going on in the world that are interesting and important outside of the little valley where I grew up. That [film] made me think I could accomplish things," Hitchon says.

Hitchon claims that although this film has had some impact on his life, it hasn't defined it. His focus remains on his research and interest in plasma physics--both applied and mathematical.

When asked about why he thought he was chosen to be a part of this film series, Hitchon is nonchalant:

"It really didn't matter who was in it. It just shows how people are." WE

**Author Bio:** Nicole Rybeck is a sophomore majoring in industrial and systems engineering and French. She is also an active member of Polygon Engineering Student Council and is an on-site coordinator for LeaderShape 2006.

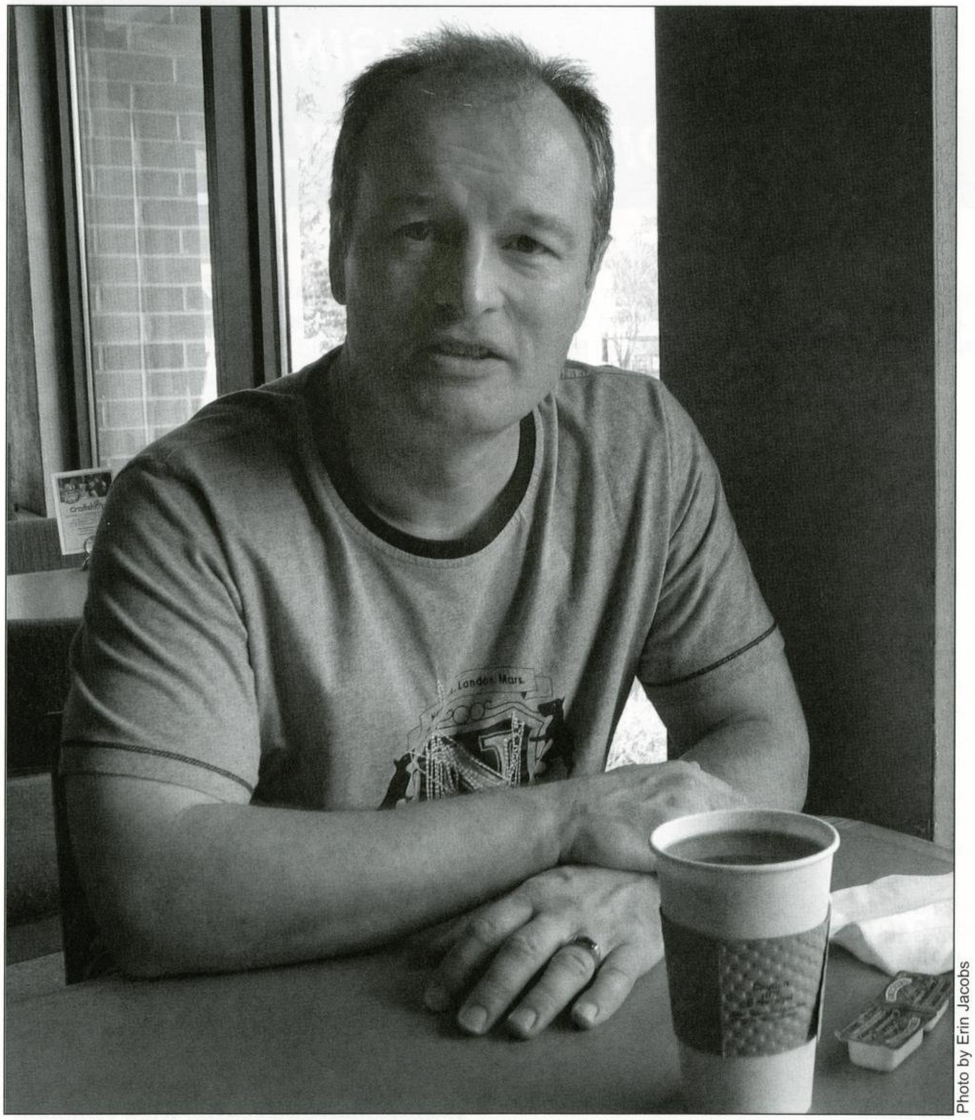


Photo by Erin Jacobs

**Hitchon enjoys coffee while he waits for his breakfast at Union South's Red Oak Grill.**

# Communication Breakdown:

## New roles for engineers in disaster planning

Photo courtesy of rapidfire.sci.gsfc.nasa.gov

By Brad Groh and Sarah Michaels

In the wake of Hurricane Katrina, many experts will be quick to blame the structural components of New Orleans for the disastrous aftermath of the storm. However, according to some experts, the most resounding failure exhibited by the engineering community during this time was a lack of communication. If engineers can learn to become better communicators, they say, there are still opportunities for gain in this tragic time of loss.

The levees protecting New Orleans were built to withstand hurricane winds of up to 130 miles per hour and a storm surge of nine to 12 feet. When the 140 mile per hour winds and 29 foot storm surge of Katrina struck the levees of New Orleans this September, the nation witnessed the inadequacy of the system. As the Sept. 12 issue of *Newsweek* stated, "A hurricane like Katrina packs the energy of a 10-megaton nuclear bomb--exploding every 20 minutes."

Ernie Smerdon, former dean of engineering at The University of Arizona, claims that communication is a vital element in responding effectively to traumatic events like Hurricane Katrina. Although there were obvious mechanical deficiencies leading to the levee failures in New Orleans, many engineers were aware that a severe hurricane could devastate the city. By effectively communicating, engineers and politicians could have formulated a proactive response to the danger of high-powered hurricanes. Instead, he says, the lack of communication added to the already threatening situation.

**"The catastrophe was that leaders, including those at FEMA, did not appreciate what could happen"**
**-Ernie Smerdon**

"Some may say this is not an engineering issue, but I say engineers should be in the middle of the discussions," Smerdon says.

While it is primarily policy-makers leading the planning efforts, Smerdon believes that engineers need to take a more assertive stance on issues directly involving potential risks.

"The people making the decisions regarding rapid response, to the best of my knowledge, did not include in any meaningful way engineers and scientists that understood the true magnitude of the potential damage that such a storm could cause," Smerdon says. "The levees could not withstand a storm of this magnitude and informed engineers knew that. The catastrophe was that leaders, including those at FEMA [Federal Emergency Management Agency], did not appreciate what could happen. Warnings were voiced by knowledgeable people, but they were not listened to. Appropriations that should have been used to strengthen the levees went to pet pork barrel projects, which is a national disaster in this country."

Dennis Martenson, national president of the American Society of Civil Engineers and an environmental engineer with over 35 years of experience, also asserts the need for engineers to communicate directly with decision makers.

"We as civil engineers maybe weren't clarifying [the risks of structural failure] to the public," Martenson says. "It's a communication problem, I think."

Jeff Russell, UW-Madison civil and environmental engineering professor, believes engineers need to be at the forefront of the disaster planning process. Russell believes that engineers will also be challenged to evolve into better leaders, both technically and verbally. Russell presents a three-tiered approach for engineers to transition into life after Katrina:

1. Discover what went wrong.
2. Renew the industry's focus on structural and environmental sustainability.
3. Learn from our mistakes to become better leaders and communicators.

At first glance, the steps seem obvious and easy to implement. However, leadership, communication and cooperation were lacking in the industry prior to Katrina and must become a focal point for engineers in the future, according to Russell.

"Engineers have the skills to fix those problems, and we have to be at the interface of those situations when they surface," Russell says.

This is not just a problem for current engineers. According to Smerdon, one of the greatest challenges our country has yet to face will be educating the next generation of engineers.

"I see this as a challenge for the engineering community and engineering educators in particular," Smerdon says. "What changes in engineering education are needed so that engineers become leaders…as critical decisions regarding such natural disasters are made?"

Smerdon makes the following argument: If problems that surfaced in preparing and dealing with Katrina stem from engineers' degree of involvement, then they are indicative of possible deficiencies in our current methods of educating engineers about effective leadership and communication skills.

According to Smerdon, the discipline of engineering needs to transition from mere number-crunching to a holistic field that better incorporates communication and leadership.

"Engineers must be more vocal in presenting alternatives," Smerdon says. "The final decision will be more political than technical. That is probably unavoidable. But we engineers must demonstrate leadership in looking at the options and the costs associated with each."

In addition, he believes translating technical matters into a format that politicians can comprehend will be a major factor in effectively communicating and reacting to disasters like Katrina.

In the meantime, New Orleans is not the only thing in need of reconstruction, according to Smerdon.

"We have to help the victims," he says. "But if we rebuild and put them back in the same high-risk situation with poor economic prospects, we will not have served them well."

**Author Bios:**

Brad Groh is a senior in the civil and environmental engineering department and is also studying technical communication. He is also co-chair of the UW-Madison Concrete Canoe Team.

Sarah Michaels is a senior studying English-literature and technical communication. She enjoys playing piano, reading and running.

Photo by Heidi Mielke

**Jeff Russell, professor of civil and environmental engineering at UW-Madison, advocates the role of engineers as leaders in the disaster planning process.**

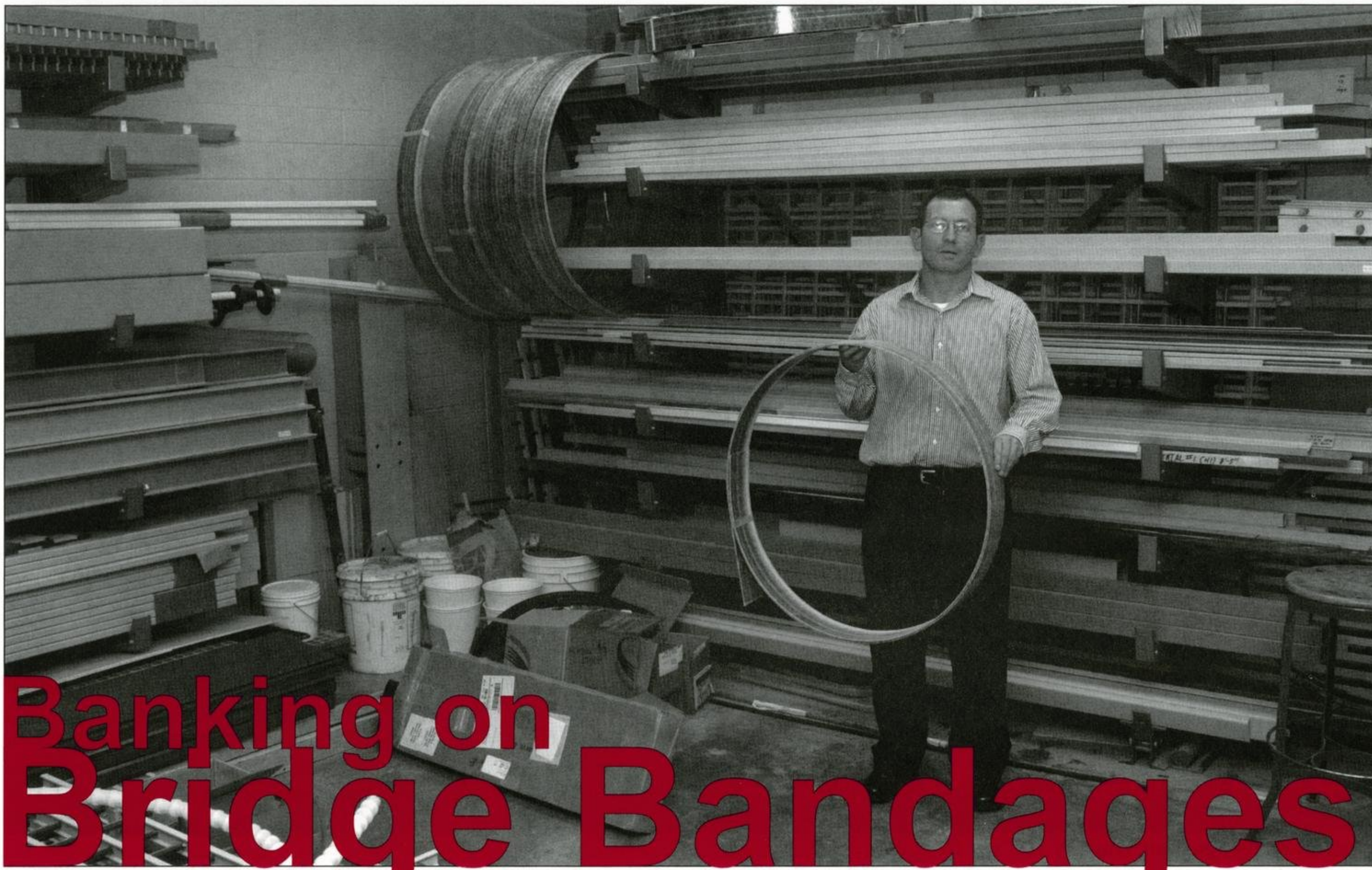


Photo by Andrea Rizzo

# Banking on Bridge Bandages

By Kevin Jayne

The general public frequently overlooks technological advances that impact our lives. We often cruise over aging bridges without concern for their condition but are quite irritated by the time it takes to replace them. So perhaps a new technique created at UW-Madison to extend the life of these bridges will catch the public's attention.

Professor of civil and environmental engineering Lawrence Bank, working in conjunction with his then-student Anthony Lamanna, invented mechanically fastened fiber-reinforced polymer (MF-FRP) strengthening strips. While this term may sound very complex, the strips function much like a device familiar to us all--a bandage.

Photo by Andrea Rizzo

**A view of polymer bandages on County Road 6120 in Phelps County, Missouri.**

These strips are made of composite materials including carbon and glass fibers. They work like bandages to repair bridges in the same way their first aid counterparts hold skin together. Carbon fibers run along the length of the "bandage" to provide tensile reinforcement to the bridge. The strips add additional tension to the structure when it bends, just like an internal reinforcing bar. The glass fibers are arranged in the form of mats or fabrics and allow fasteners to transfer forces from the bridge into the strips. This effect allows the very stiff carbon fibers to increase the strength of the structure.

**Developed here at UW-Madison, polymer bandages will extend the life of bridges.**

The application of fiber composite materials for strengthening bridges has existed for many years; it is Bank's method of applying these strips that is unique. The traditional process involves using an adhesive to bond the strips, relying on the glue to hold them in place.

Bank saw room for improvement.

"I have never really liked the bonded method," Bank says. "I just feel it's too dependent on the surface, too dependent on the environment and the adhesive can degrade as well. I'm more traditional in my approach. I like to see a nail or mechanical fastener hold two pieces together."

The new bandages do just this, using power-driven nails or wedge bolts. This method is now patented, and the strips are produced by a division of Strongwell in Chatfield, MN under the name "Safstrip."

"There have been a number of patents for adhesively bonding fiber composite materials to structures for strengthening," Bank says. "But this was the first time someone had looked at not using any adhesives and achieving a similar type of strengthening propensity."

The original idea for this project was inspired by a separate but similar venture involving the use of fiber-reinforced polymers to develop a lightweight highway guardrail able to absorb high energy collision impacts. This research allowed Bank and his colleagues to make an important observation.

"We recognized that a certain type of failure mechanism in the composite material was critical and beneficial to absorbing energy--a tearing type failure," Bank says.

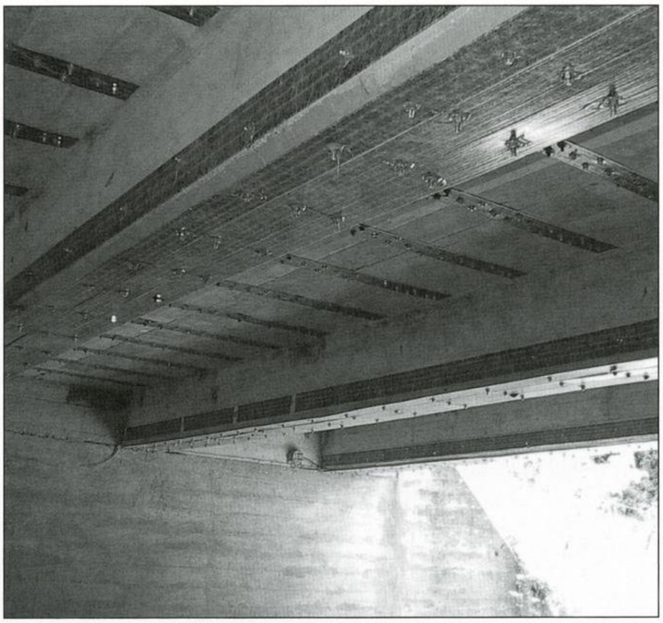


Photo by Andrea Rizzo

**Polymer bandages give new life to an aging rural Missouri bridge, adding support to the existing structure.**

This mechanism allows the bandages to fail more gradually. Conversely, strips attached with an adhesive can fail catastrophically, causing a more sudden and undesirable collapse.

Armed with the insight this observation provided, Bank and Lamanna began extensive research and experimentation. It took five years of testing to finalize the present design. Much of the later development work focused on finding the optimal ratio of carbon to glass fibers in the strip to maximize strength.

"We went through at least 10 different combinations of fibers and resins, as well as assortments of fasteners," Bank says. "It took a long time and we finally got to the point where we felt we had a whole system that worked. I think the key here is that this is a system, not just the strip, not just the fastener. The success of a bridge repair is really dependent on the whole system functioning together."

Structural advantages aside, the strips are beneficial from a financial standpoint as well. They are much cheaper to use and can be applied in a fraction of the time it takes to install strips using traditional adhesive methods. This technology is spreading as a number of researchers around the country continue to explore other practical applications.

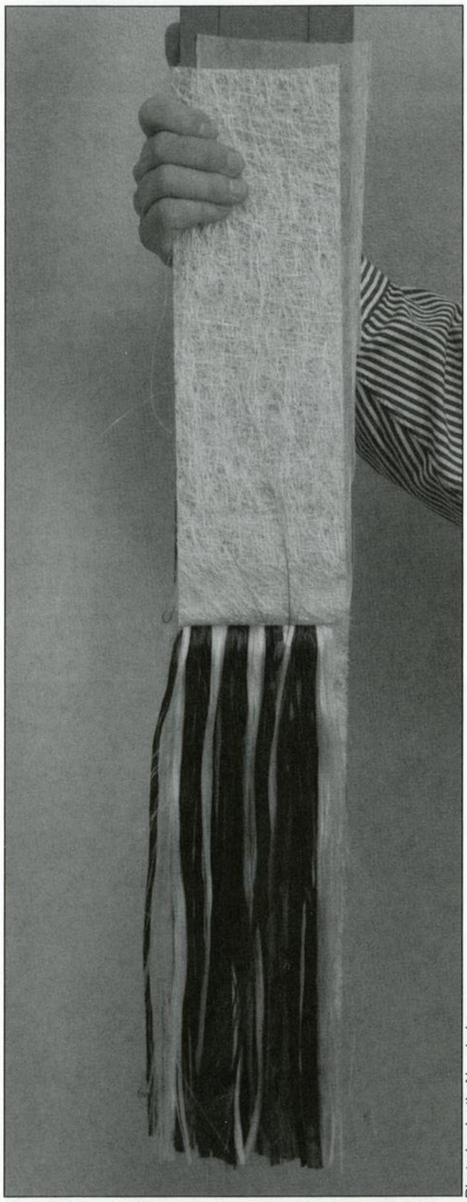


Photo by Justin Novshek

**Professor Bank shows the multi-layer construction of the polymer bandages.**

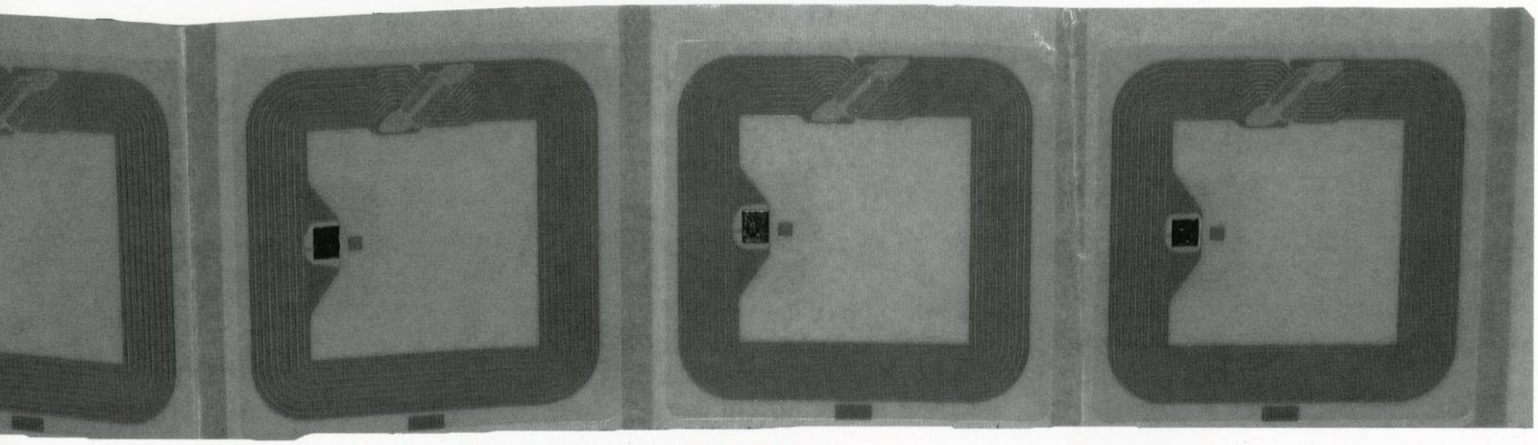
Bank has received a lot of positive feedback from those giving his bandages a try.

"They like it. It's a lot easier than using the conventional method. When you're working on a bridge, you're doing things overhead, and when you try to apply adhesives it drips on you and becomes quite an unpleasant job. This method is really much more user-friendly. Now, more and more people are starting to look at it for use on their own bridges," Bank says.

So, next time you're crossing over an old bridge, your safety may be in the hands of Bank's bridge bandage. WE

**Author Bio:** Kevin Jayne is a junior majoring in mechanical engineering. This is his first experience working for Wisconsin Engineer.

# Rolling out RFID



## New lab brings RFID to member businesses

By David Michael Drenk

A sandbox where industry can come and play and practice" is how Alfonso Gutiérrez describes the UW Radio Frequency Identification (RFID) lab. The new laboratory is dedicated to helping companies implement RFID, a technology that is transforming asset management.

Although the technology at the heart of RFID was invented during World War II, it was not until recently that microchip technology became small enough that RFID could be used practically to help companies track their inventory. Gutiérrez, director of the UW RFID Lab, tells the story:

"In World War II the British were sending their airplanes to Germany, but when planes came back they didn't know whether they were their own airplanes or the Germans'. They had radar, which was a great new thing at that time, but that couldn't tell them if the planes were enemies or not. So they invented what is called a transponder."

A transponder is a device that receives a signal and automatically sends a reply. When the transponder received a radar signal, it sent back a message that identified the plane as British. "That was the beginning of this identification technology," Gutiérrez says.

RFID has been used in many ways over the years, including key chains that can unlock car doors remotely and the "EZ Passes" that allow cars to pay tolls without having to stop at tollbooths. These technologies are expensive because they require a battery or some other power source to send out their identification signals. The breakthrough that allowed RFID to reshape asset management is the ability to make small, inexpensive, passive tags--tags that do not require a power source.

Each tag is composed of three parts: an antenna, a microchip and a substrate. There are a variety of antenna configurations: some are trails of copper wound on a

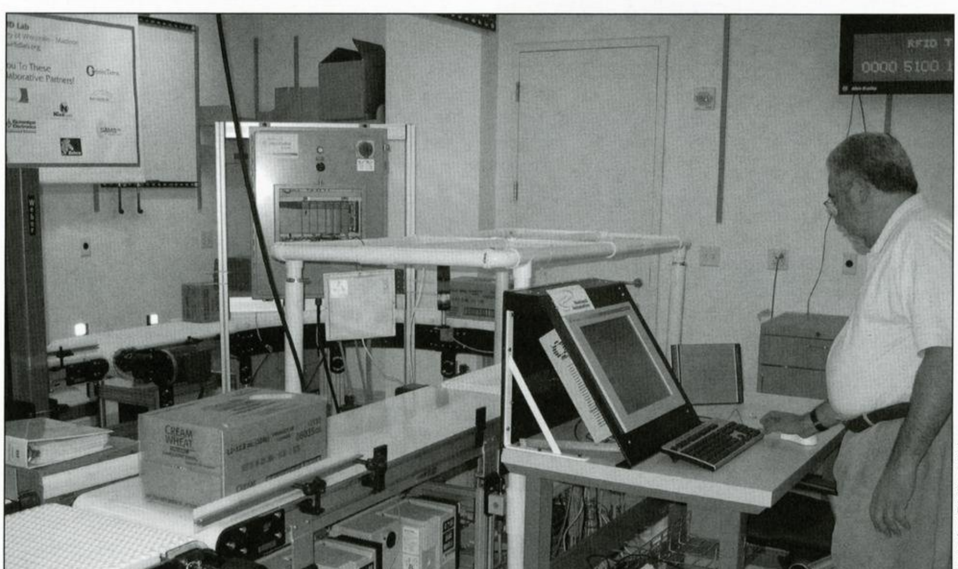


Photo by Philip Micha

**Alfonso Gutiérrez demonstrates the use of the conveyor belt to test the scanning of RFID tags at high speeds.**

plastic band, while others are compact polygons printed onto clothing tags using magnetic ink. Regardless of the configuration, each tag contains a microchip that stores identifying information about a product or asset. The substrate holds the antenna and chip together and can be made of paper, plastic or other materials.

**Instead of having to run a scanner over each box that arrives at a warehouse, an RFID reader can simultaneously scan all the goods on a pallet.**

Since new devices are passive, their power must come from the tag reader. The reader communicates with the tags by sending out electromagnetic waves. Like television and radio broadcasts, these waves are regulated by the Federal Communications Commission, which has assigned them a specific frequency range. When the waves hit the antenna of an RFID tag, the antenna concentrates the wave's energy and sends it to the microchip. Using this energy, the microchip sends its ID information back to the reader. The reader then looks up that information in its database and can tell what the product is, where it has been and any other information assigned to that tag.

RIFD tags have two advantages over the bar codes they are replacing. Bar codes have to be passed over a scanner to register, but RFID tags can have a range of 10 to 15 feet. Instead of having to run a scanner over each box that arrives at a warehouse, an RFID reader can simultaneously scan all the goods on a pallet. In addition, bar codes are static--once they are printed they cannot be changed--but RFID microchips can be reprogrammed by the reader. Instead of just asking a tag for information, RFID readers can add information to a tag or assign it a new identification number.

The UW RFID Lab is the creation of a consortium called the UW E-Business Consortium (UWEBC). The UWEBC was established in 1998 by Raj Veeramani, UW-Madison professor of industrial and systems engineering and operations and information management.

"At that time he consulted with a number of companies who were saying, 'We need to better understand where this Internet technology is going to fit.' So he created this consortium with the idea of the university helping the companies figure out how new technologies could be adopted," Gutiérrez says. Since its founding, the consortium has grown to include over 60 companies.

Two years ago, the members of the UWEBC tackled the issue of RFID.

"We perceived there was a need for a trusted and non-commercial forum for knowledge-sharing," Gutiérrez says. As a result, the UWEBC members formed a special sub-organization called the RFID Industry Workgroup.

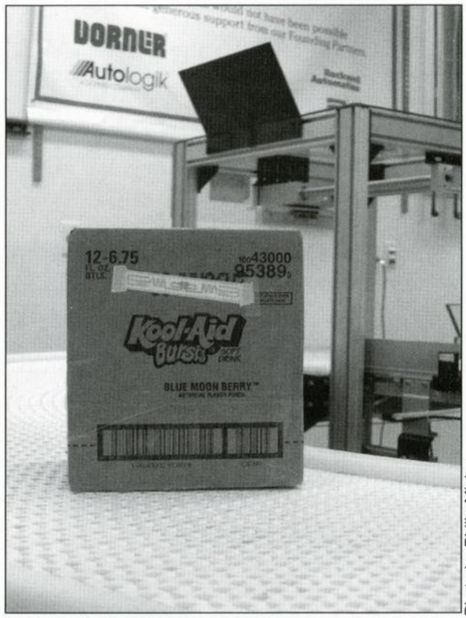



Photo by Philip Micha

**Old technologies like UPC codes and new technologies such as RFID tags are used together on products.**

The members of the RFID Industry Workgroup meet once a month for an all-day knowledge exchange. They share their ideas, listen to subject experts and discuss new standards and case studies.

"It's a good forum to get people together who wouldn't normally talk to each other, even though they're doing similar things--just for different companies. To pull them all together in one room and get them talking for a day is very valuable," says Brad Geiger, a UW-Madison graduate who worked on RFID implementation as a consultant for Accenture before returning to UW-Madison to pursue a master's degree in public health and policy. Geiger manages the UW RFID Lab.

**One example of an RFID tag that uses a microchip and a copper antenna on a plastic band.**

The major achievement of the RFID Industry Workgroup's effort was the grand opening of the UW RFID Lab in August 2005. The RFID lab provides a controlled environment filled with specialized equipment obtained through donations and grants. The lab is run by Gutiérrez and other researchers and students. The lab's focus is to study the practical aspects of RFID and also the principles behind it.

"One of the elements we wanted to capture is the knowledge-sharing," Gutiérrez says. "Another one is that it is not just theoretical; it is also experiential."

The lab can solve specific problems that a company wants to research, like where to place an RFID tag on a bottle of liquid detergent, yet can also study broad-reaching problems, like how to deal with signal interference from metal loading dock doors.

"Something that is special here is that we are very independent. We have partners in industry, but independent, objective research is conducted here--we don't have any interests tied to corporations," Geiger says.

**The breakthrough that allowed RFID to reshape asset management is the ability to make small, inexpensive, passive tags--tags that do not require a power source.**

The lab's equipment doesn't fit into one room. There is a room for simulating a "Portal/Dock-Door," which includes palettes, tag printers and scanners all interacting around a symbolic archway. The room is used to emulate an environment where a multitude of tags pass through a checkpoint quickly. Another room contains three conveyor belts, one of which can reach the 600 feet per minute speed mandated by Wal-Mart--one of the companies driving the development of RFID. There is also a machine that blows RFID labels onto packages as they rush by so that the boxes don't have to stop.

A third room contains an anechoic chamber--a space that isolates electromagnetic waves. The chamber's exterior is lined with a wire mesh to deflect or ground any electromagnetic signals. Its interior is lined with blue foam pyramids, making it look like the Nerf version of an iron maiden. The foam is a very expensive anechoic material that contains metal and polymer. The shape of the foam is designed to capture waves traveling at any angle. On one end of the room, a reference antenna sends out electromagnetic signals. An RFID tag can be placed on a rotating antenna measurement system that stands near the other end of the chamber. The data collected provides baseline information about how a tag operates in the air or attached to various products.

Another part of the lab is the computer room, where the students do much of their analysis.

"Currently nine students are dedicated to the RFID lab, but they kind of get shared across some of the other groups too," Geiger says. "I work specifically in the RFID side. Everyone is employed, either hourly or as a project assistant, and in some situations they can also receive up to three credits for the work they do there." Geiger sees great benefits for the students involved in the lab.

**"That is a function of the university. We want to share with the world what we learn."**
**- Alfonso Gutiérrez**

"They're getting two really great types of experience out of this," Geiger says. "One is the technical skills around RFID--what is it, how does it work, what are the business drivers, and how do you develop them. But then on a broader level, students are getting really good project management experience, which can be applied to most jobs in industry--how to set deadlines, develop work plans, manage to those work plans, and get a complex project done in a set time." The UW RFID Lab is currently accepting applications from interested students.

By combining the efforts of students, faculty and members of industry, the UWEBC's RFID Industry Workgroup has created a kind of playground where businesses share their toys and figure out how to make them work together with an advancing technology. This interaction between the university and industry is what makes the UW RFID Lab such a unique opportunity for all who are involved.

"That is a function of the university. We want to share with the world what we learn," Gutiérrez says. WE

**Author Bio**: David Michael Drenk is a UW-Madison graduate with a bachelor's degree in electrical engineering and computer science. He recently returned to the university to pursue a Technical Communications Certificate offered by the College of Engineering.

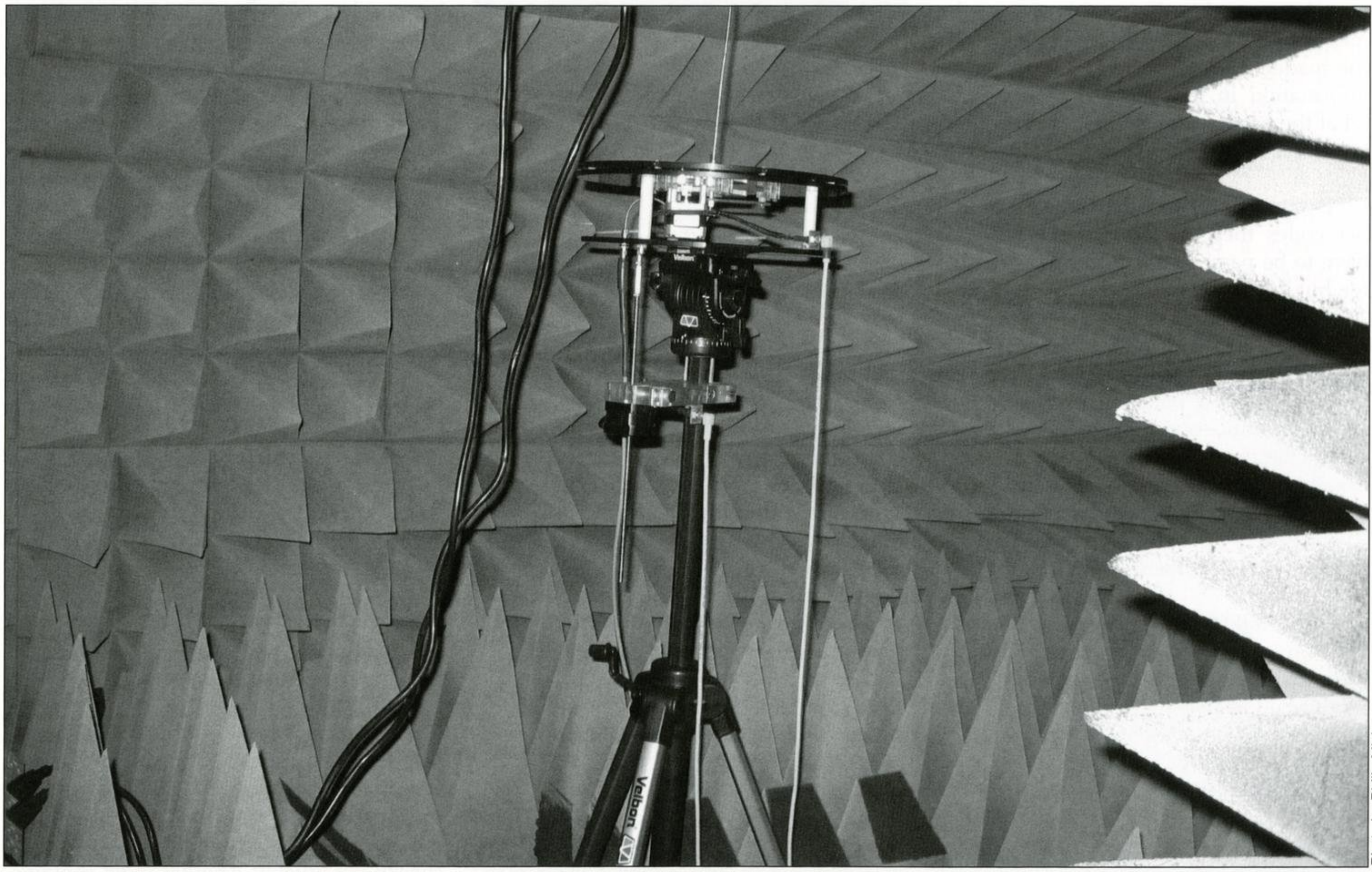



Photo by Philip Micha

**The anechoic chamber is lined with blue foam pyramids that isolate the antenna measurement system from stray electromagnetic waves.**

# Highly Defined
# A New World of Television

By Nate Holton

Most who have had the pleasure of viewing a high-definition television (HDTV) will say the difference is night and day. Whether it be nature shows, March Madness or simply the evening news, HDTV brings with it a realism whose only true competition can come from a pair of eyes watching the event in person.

"When I went to my first Badgers basketball game, I said to myself that it was just like watching it on HDTV," UW-Madison senior Abby Peterson says. "I guess in reality it's the other way around."

The superior image quality of HDTV comes from the greater number of scan lines that make up the image. A normal television in the United States has 525 scan lines. An HDTV, depending on the format, can contain up to 1,080 scan lines--more than double that of a normal analog television. These additional lines allow a viewer to see the makeup on a newscaster's face or the individual blades of grass on the 50 yard line.

Currently, there are six different HDTV formats available to television stations. Of the six, five involve progressive scanning, which updates every line on the television screen 60 times per second. The sixth HDTV format uses interlaced scanning, where the television only shows the odd lines for one frame and the even lines for the next frame. Both the odd and the even lines are updated 30 times each second. The difference between these formats is noticeable; an interlaced screen can show flicker that will not appear on a progressive image.

Though the Federal Communications Commission (FCC) is forcing all television stations to broadcast an HDTV signal by 2007, they are not mandating any specific signal among those available.

"The FCC doesn't require a specific [signal], and this makes life complicated for everyone," UW-Madison electrical engineering professor Yu Hen Hu says.

All analog signals send color and intensity information for each scan line to the television by means of cable, satellite dish or a television antenna. That information is sent through the airwaves and into the antenna in a 6 MHz signal. In order to allow HDTV signals to coexist with analog signals for the time being, HDTV signals also have to fit in the 6 MHz frame.

All of the additional data contained in an HDTV signal would be impossible to fit in the comparably tiny analog signal. Fortunately,


Photo by Keith Doxtator

**A Sharp (TM) plasma high-definition television demostrates the superior image quality of a top-of-the-line model.**


Photo by Jonathan Klabacha

**An aisle at Best Buy gives consumers a side-by-side comparison of the many new models of televisions available to them.**

the signal can be condensed considerably using MPEG-2 technology. This form of compression captures a frame and then only broadcasts the changes to that frame. The unchanged portions of the frame remain untouched, preventing the signal from having to repeat itself. As a result, the amount of data being transmitted to a television is reduced by a ratio of about 55 to 1.

Furthermore, the MPEG-2 encoder gives an HDTV signal considerable versatility. While already the standard for DVD videos, MPEG-2 allows an HDTV program to be stored on and played from a computer.

**"It is the ultimate convergence between computers and consumer electronics." -Yu Hen Hu**

"It is the ultimate convergence between computers and consumer electronics," Hu says. "We call it the three C's: communications, computers and consumer electronics. It's becoming harder and harder to differentiate products."

Indeed, the development of HDTVs is only one example of a new age of more sophisticated technology that is available to consumers. Laptops, iPods, TiVos, PDAs and cell phones are all variations of computers. With so many new products constantly being invented, one may wonder if classic technologies like analog televisions and regular telephones will disappear.

"When airplanes were invented, what happened to the car? It got even more popular. Different things exist for different purposes. When laptops came around people thought the desktop would be gone, and they're still around. Some things will disappear though," Hu says.

In terms of televisions, it is impossible to tell which of the new generation televisions will last and which will fall by the wayside. Liquid Crystal Display (LCD) televisions, plasma screens and Digital Light Processing (DLP) televisions all offer compelling reasons to stay at home and be a couch potato. However, each model also has drawbacks.

Plasma televisions excite rare natural gases like xenon and neon with electric pulses, forcing them to glow and produce light. The product is a screen with a lush image that is bright from top to bottom and can be viewed from virtually any angle. However, plasma screens are less effective at high altitudes, tend to only come in large sizes and lose the crispness of their image over time as the gases begin to fade away.

DLP televisions get their amazing image by tilting around 1.3 million micromirrors individually toward or away from a light source. The light on each mirror is then sent through a color wheel that spins 120 times per second and then projected onto a screen. Though DLP televisions do not have the incredible viewing angle of plasma screens, consumers only need to occasionally replace the light source to ensure the DLP television maintains its image quality indefinitely.

LCD televisions use an electric current to manipulate the positions of liquid crystals that either block light or allow it to pass through. This technology is often used in flat-screen computer monitors. The downside of these screens is that they are still expensive, tend to only come in small sizes and the darkness of the black colors does not match up with the other types of televisions.

Nevertheless, all these types of televisions, combined with an HDTV signal, have the ability to offer a picture so lifelike that someone could get drawn into even the driest of programming. The potential of new developments like HDTV will only continue to grow as designers come up with new and more exciting ways to use this remarkable technology. In the meantime, 50 yard line seats or a view from a mountain top are only one remote control click away. WE

**Author Bio:** Nate Holton is a senior majoring in philosophy and mechanical engineering. He plans on attending law school next fall.

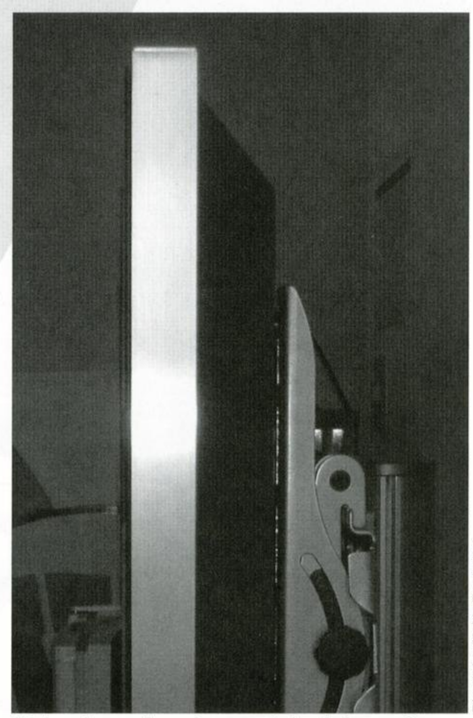


Photo by Keith Doxtator

**Side view of a plasma television. Some high-definition plasma and LCD models can be as thin as two to three inches.**

# Simulation studies: Computers track virtual atoms

By Matt Stauffer

A powerful new tool has been added to the materials scientist's repertoire. Multimillion atom computer simulations allow engineers to explore the physical and compositional properties of materials on the one-billionth meter scale.

Research teams at UW-Madison, led by Assistant professor of materials science and engineering Izabela Szlufarska, have performed massive computer simulations for systems consisting of nearly 19 million atoms to study nanoengineered solid materials. The atomic simulation uses multiple computers linked together to track every single atom in the system. With atomic simulation, scientists can study the interactions among individual atoms-something that is very challenging to do in lab experiments.

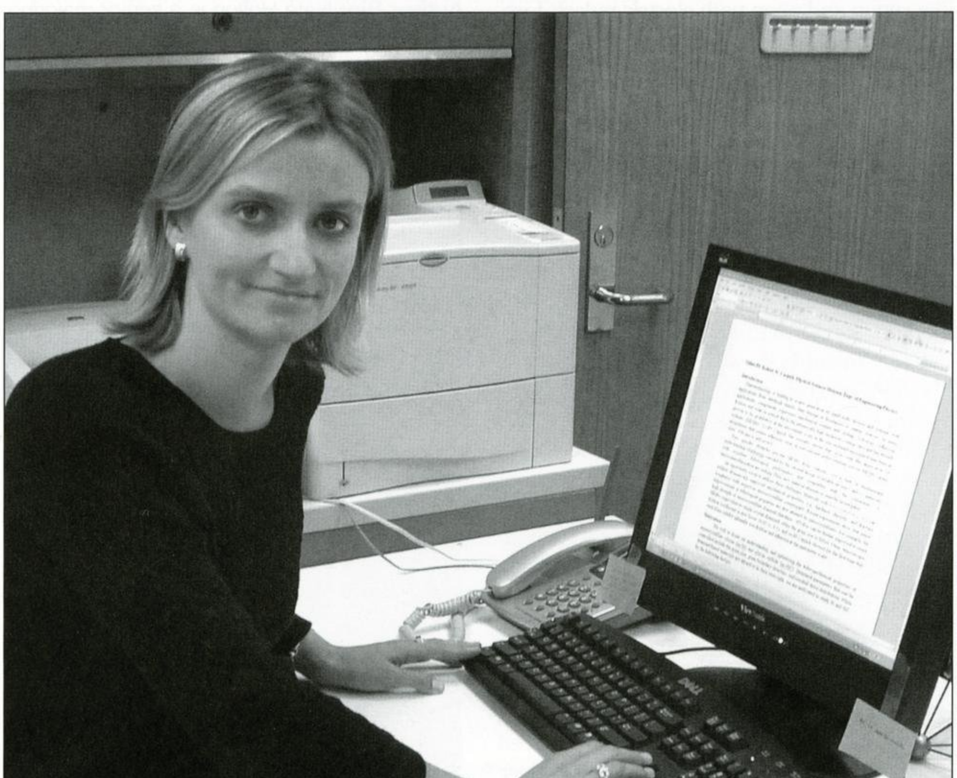


Photo by Puteri Syafawati Faizan

**Assistant Professor Izabela Szlufarska describes the benefits of atomic simulation to the field of materials science.**

"Atomic simulation is a combination between theory and experiment," Szlufarska says. Researchers are able to simulate lab experiments and get quantitative results, such as the material's hardness, without ever actually having the material they are testing.

"In lab experiments, you can't learn everything about the atoms because the Transmission Electron Microscopy (TEM) images can only show the location of the nanocrystals in the system," Szlufarska explains. Computer simulations not only give the exact location of every single atom in a system, they can also track the movement of the atoms and crystals during simulated experiments.

Typical experiments, even in nanotechnology, are done on systems with millions or more atoms. For example, a piece of silicon carbide big enough for hardness tests is composed of millions of atoms. Therefore, to match experiments, similar numbers of atoms need to be treated in atomic simulations. The computers running the simulation need to account for every atom in the system. Newton's second law of motion needs to be computed for each atom during the simulated test. Needless to say, this takes a bit more computing power than your average Dell. These computations are currently sent to super-computing facilities such as those at the Department of Defense or National Science Foundation.

In order to complete a computation of this magnitude, the entire physical system has to be divided into subsystems--one for each computer. The computers need to communicate with one another during the experiment to track what is happening throughout the system. This is called parallel computing. Szlufarska and her colleagues wrote the programs to track atomic movement during the massive parallel simulations.

This tool has important scientific and industrial applications because of the increased significance of nanoengineered materials. By controlling atomic structures at the nanoscopic level, one can control the mechanical properties of a material. An example of a nanoengineered material is a nanocrystalline ceramic, which is made by "sintering" a fine powder of a substance into the desired solid. Sintering is the process of applying sufficient heat and pressure to a powder to consolidate grains with various sizes into the desired material. It has already been found in nanostructured metals that decreasing grain size down to about 12 nm can significantly improve the material's overall physical and mechanical properties.

Szlufarska is particularly interested in ceramic materials, particularly a substance known as nanocrystalline silicon carbide. She uses simulations to determine which alloys can be used and which grain size yields optimal properties. Ceramics are very hard materials making them useful for a large number of products. The drawback to using ceramics in industry is that they are also very brittle. This makes it difficult to mold ceramic materials into a desired shape and causes them to fail faster. Normally there is an inverse correlation between hardness and ductility. The harder the material gets, the more brittle it becomes. What Szlufarska has found in the nanoengineered silicon carbide is "that as you decrease grain size, you can effectively increase the ductility without compromising hardness." This phenomenon is very important because it makes possible the production of an extremely hard material that can be worked into a specific shape.

Szlufaska's most recent publication explains the exact mechanism within the microstructure of silicon carbide that accounts for this unique property. Silicon carbide has a two-phase microstructure. One phase is an amorphous matrix, and the other consists of hard crystalline particles within this matrix. The amorphous phase is made of highly disordered particles that can easily flow past one another. Imagine a beanbag filled with the usual small pellets as well as larger foam blocks. The pellets don't show any order in their arrangement. They are the amorphous matrix. The foam blocks are the highly ordered crystals that retain their shape.

There are three different types of deformation that occur in ceramic materials under stress: elastic deformation, quasi-elastic deformation and plastic deformation.

In elastic deformation, the material changes shape under stress but is able to go back to its original shape when the stress is removed.

In plastic deformation, the shape of the material is changed permanently. When the load increases to a point where the amorphous phase can't change to accommodate, the grains must begin to rotate. This is analogous to permanently changing the shape of the beanbag by applying a load that moves the foam blocks.

Silicon carbide undergoes what is called quasi-elastic deformation. When stress is applied to the system, the atoms begin to shake. Silicon carbide is a non-equilibrium system, which means the atoms will relax and move toward an arrangement of lower energy. When this happens, only the amorphous phase changes; the crystalline material stays intact. When the load is removed, the atoms in the amorphous matrix will not go back to their original positions. Again think of the beanbag: if you were to set a small object on the beanbag, the pellets would move to accommodate the load, but the foam blocks would not have to move. When you took the object off of the beanbag, it would not go back to its original shape, but the deformation would be minimal.

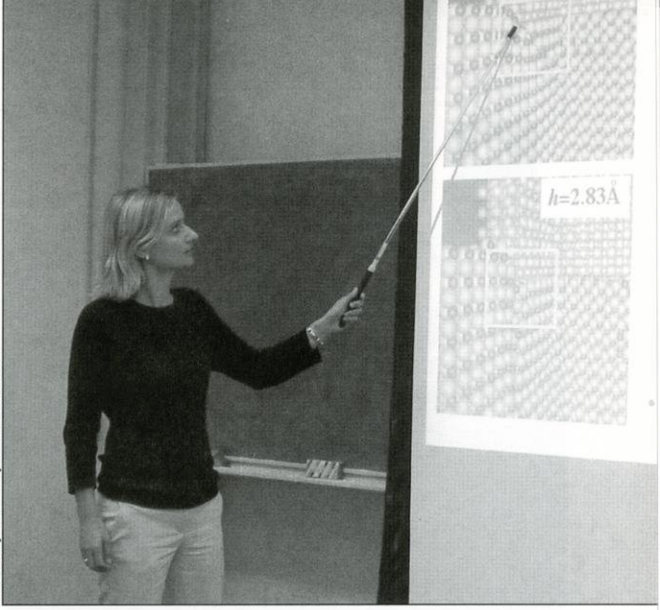



Photo by Puteri Syafawati Faizan

**Assistant Professor Izabela Szlufarska uses a visual from a simulation to help describe what is taking place at the atomic level of a material.**

Szlufarska's simulations track the movement of atoms as these deformations occur. After the computer runs its test, the results appear as a large group of numbers. These numbers represent the coordinates of each atom along with various atomic properties, such as local stresses.

**"The visualizations help to first see what is happening at the atomic level. From there we can go on to calculate and quantify results."**
**-Izabela Szlufarska**

"Scientific visualization and data mining techniques are an essential part of our toolbox for understanding what these numbers mean and extracting useful information from them," Szlufarska says. "The visualizations help to first see what is happening at the atomic level. From there we can go on to calculate and quantify results."

Szlufarska and her team are on their way to find the optimum design of nanostructured ceramics and several companies, have contacted Szlufarska about her work. Silicon carbide could be of great interest to NASA because of its high resistance to radiation, a critical characteristic for materials used in solar system explorations. However, Szlufarska believes more testing needs to be done before trying to apply her results on the industrial level. Szlufarska has recently joined forces with experimental groups here at UW-Madison so that the ideas from her simulations can be implemented in prototype devices.

"It is going to take some time before our ideas can be translated into a manufactured product, but this study is an important first step in that direction and we are very excited about these results," she says.

Professor Szlufarska is part of a larger effort in computational materials at UW-Madison; she and professor of materials science and engineering Dane Morgan have started a Computational Materials Group (CMG) that employs graduate students. Their developments in simulated materials have inspired the renovations that are currently under way in the basement of the Materials Science and Engineering Building. Soon the materials science and engineering department will have its own bank of computers that will be capable of handling the massive amounts of data needed to conduct large-scale atomic simulations.

Current progress in nanoengineered materials only scratches the surface of the huge potential that atomic simulation holds.

"It is a great field to be in right now," Szlufarska says. "We are learning new things every day. Each study reveals another direction that we want to explore." WE

**Author Bio:** Matt Stauffer is a sophomore majoring in materials science engineering.

# BUILT TO LAST

## ME Building Modernizes

Photo by Muhamad Asyraf Yahaya

By Paul Calhoun and Carly Mulliken

After waiting 70 years, the mechanical and industrial engineers of UW-Madison are finally getting a building that meets their needs for the coming century.

Beginning in 1999, Paul Peercy, dean of the College of Engineering, and members of the mechanical and industrial engineering faculty began brainstorming about the possibility of a new building to house their departments. They decided the new building would need to be flexible in order to respond to the growth of engineering education and research and to respond to the needs of future advancements in the world of engineering.

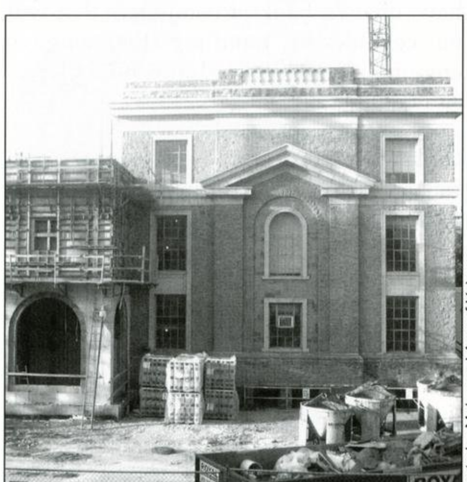


Photo by Muhamad Asyraf Yahaya

**Backside view of the ME building construction.**

"The old building was built when steam engines were the cutting edge of mechanical technology," Neil Duffie, chair of the department of mechanical engineering, says. "We need to move into the 21st century. We don't have enough space, and the space we do have is not the right kind of space."

In August 2000, the Mechanical Engineering Building Addition and Remodeling Project was approved by the State Building Commission for the 2001-2003 Capital Budget Plan. A professional design team was hired in 2002 to begin formal design of the project, with construction commencing in January 2004. The outdated 1920s structure known as "the Sawtooth"--named for its uniquely shaped roof--was demolished to make room for the addition. According to Dean Peercy, the expansion project was made possible, in part, because of "the space the new Engineering Centers Building provides."

"There simply isn't enough space elsewhere on campus for the large number of people and labs that would be displaced," Peercy says. He adds that a crucial aspect of the project involved fundraising, which was made possible through generous private donations and state funding.

The demolition of the Sawtooth provided room for the section that is currently under construction in phase one of the project. Phase two will gut the interior of the Mechanical Engineering Building, allowing for the installation of updated features while preserving its classic facade. The anticipated completion of the project is summer of 2007.

**"The old building was built when steam engines were the cutting edge of mechanical technology."**
**-Neil Duffie**

Harry Steudel, chair of the industrial and systems engineering department, says the new building will solve three major problems: sprawl of the departments, outdated classrooms and antiquated research labs. Dean Peercy personally worked with the architects to ensure the new building would include the most advanced and modern resources available. This process included bringing the designers and engineers to the Georgia Institute of Technology to inspect their state-of-the-art facilities.

With modern classrooms, and more than doubled laboratory and office space, the new facility promises to provide adequate housing for the mechanical and industrial engineering community at UW-Madison.

"The new ME and IE building will bring the faculties together, allowing for interaction and creating the synergy and communication necessary for successful departments," Steudel says.

**These labs will provide the space and infrastructure necessary for UW-Madison to retain its top ranking among research universities**

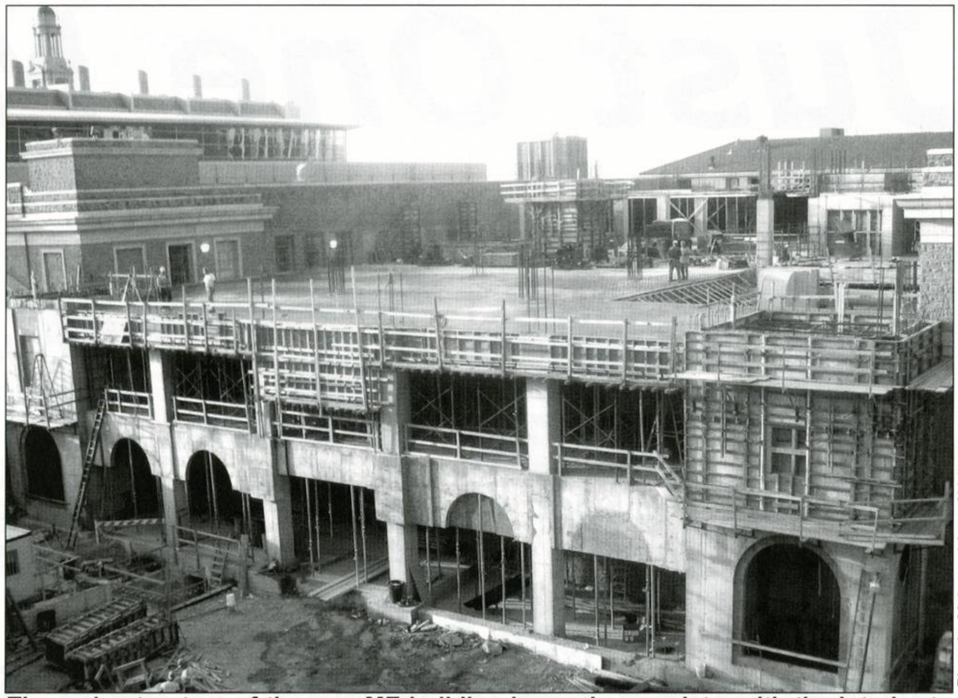


Photo by Muhamad Asyraf Yahaya

**The main structure of the new ME building is nearly complete, with the interior to follow shortly after.**

New additions to the facility are the human and communication interface labs. The new labs will allow professors and students to have hands-on learning experiences that were unavailable in the outdated rooms. The new classrooms will allow up to 60 students to have space for team workshops.

"A good part of what industrial engineers need to do is work in teams and communicate effectively," Steudel says.

As an answer to Steudel's third objective, the new facilities will meet the research standards of future engineers. In the new building, there will be three classifications of laboratories: A, B or C. Type A labs will be set up for light-duty computer applications. Type B will be used for lab support, electronics and equipment assembly and manufacturing. Type C labs will be heavy-duty labs intended for use with large machinery and equipment. These labs will provide the space and infrastructure necessary for UW-Madison to retain its top ranking among research universities from Washington Monthly Magazine.

The new ME and IE building is just one of the improvements planned for the College of Engineering. This building, along with other ideas for the UW-Madison campus, are part of the ongoing improvement that, according to Dean Peercy, "will be capable of taking us well into the 21st century." WE

**Author Bio**: This is Carly's second semester working on the Wisconsin Engineer magazine and Paul's first.

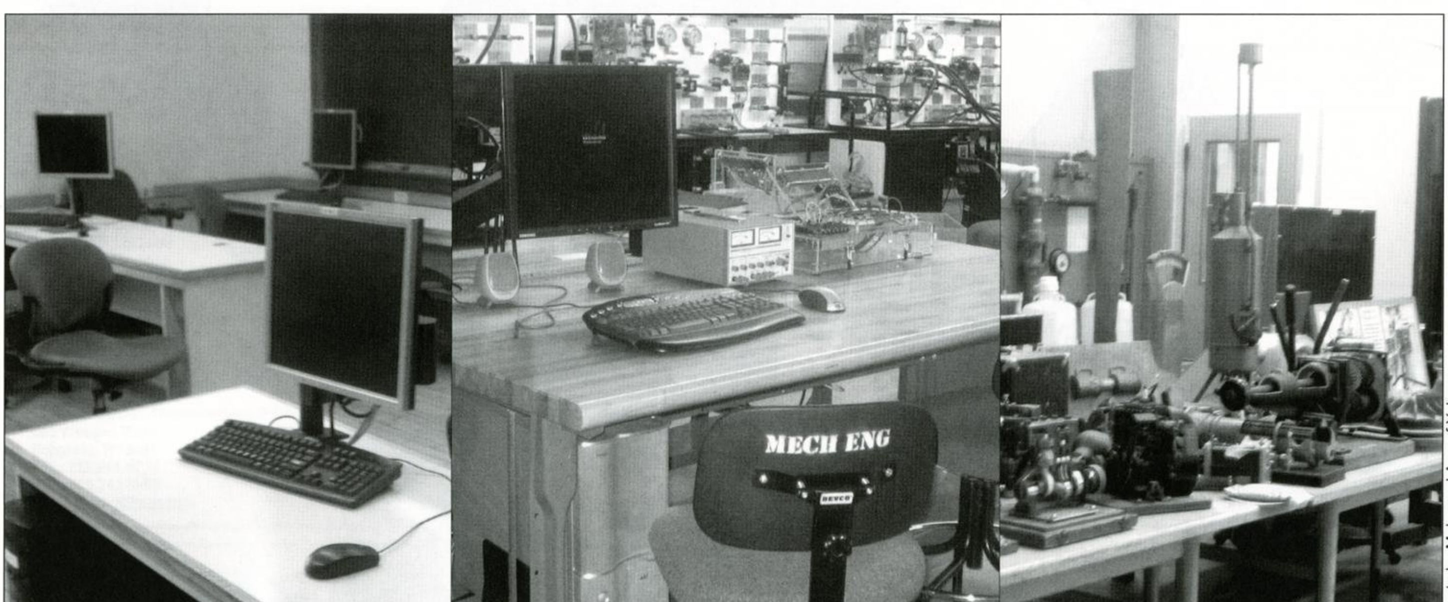



Photo by Muhamad Asyraf Yahaya

**From left, a Type A lab, intended for light-duty computing; a Type B lab, intended for lab support; and a Type C lab, intended for use with heavy machinery and equipment.**

# Just One More

## The Finest in Eclectic Humor

By Skye McAllister

IT IS A LITTLE KNOWN FACT THE HUNCHBACK OF NOTRE DAME WAS NOT A HUNCHBACK AT ALL. HE WAS SIMPLY A HARDWORKING ENGINEER SPENDING LONG HOURS IN SECLUSION - MOST LIKELY WORKING ON HOMEWORK. ONCE IN A WHILE, HE WOULD ENTER THE REAL WORLD WITH THE HOPE OF CATCHING A GLIMPSE OF A WOMAN. HIS QUIET AND ISOLATED WAYS LED TO A SUCCESSFUL CAREER, BUT HIS QUIRKY HABITS AND GIANT BACKPACK KEPT HIM FROM BEING ACCEPTED INTO MANY SOCIAL CIRCLES. DESPITE THIS LACK OF INTERACTION, HE IS STILL AN INSPIRATION TO ALL OF US AND IS PROOF THAT NO MATTER HOW DORKY AND AWKWARD WE ARE AS ENGINEERS, MAYBE, JUST MAYBE, ONE DAY DISNEY WILL MAKE A MOVIE ABOUT US.

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