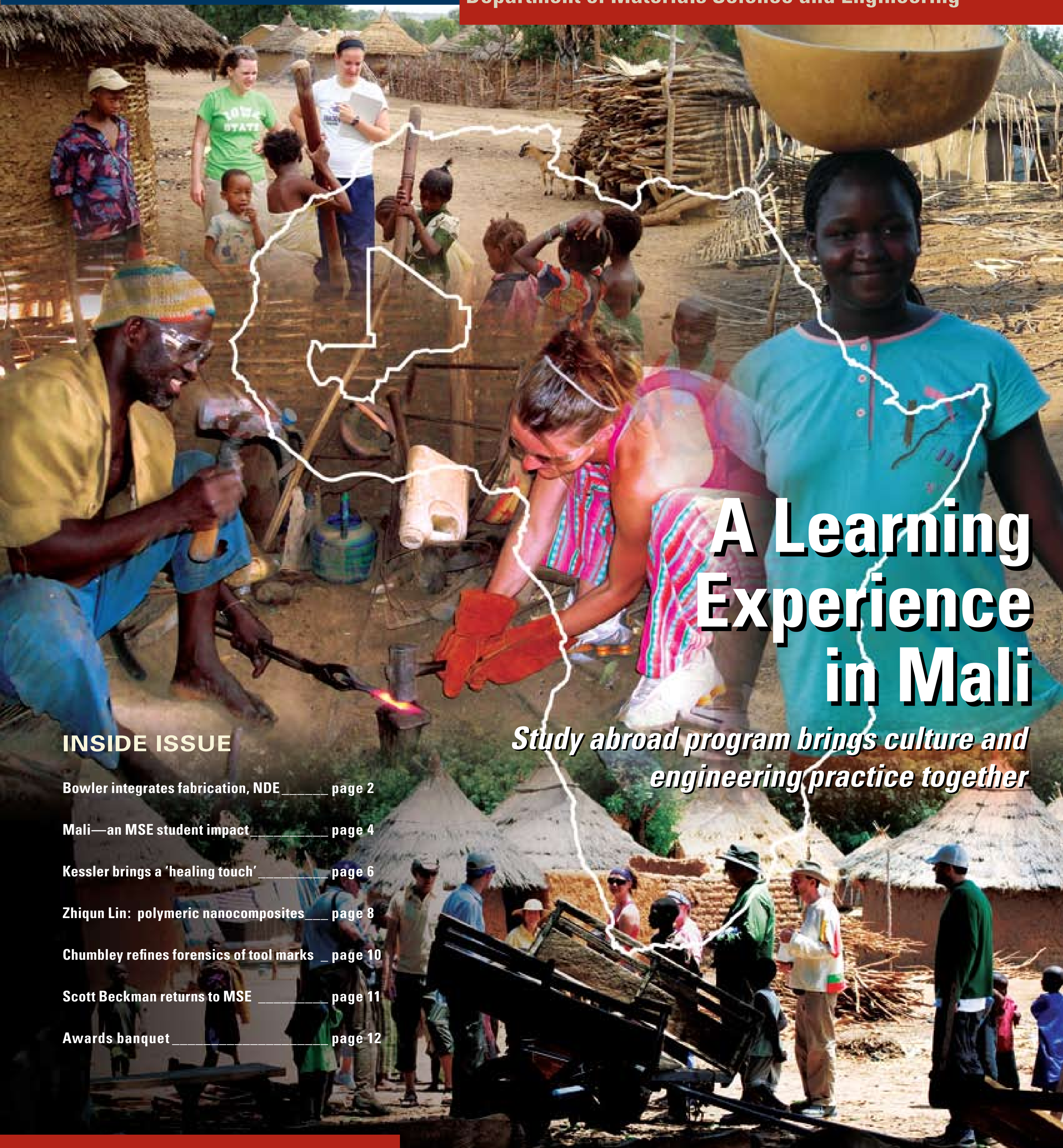
IOWA STATE UNIVERSITY
College of Engineering

Elements

FALL 2008 — Volume 17, Number 1

Department of Materials Science and Engineering



A Learning Experience in Mali

Study abroad program brings culture and engineering practice together

INSIDE ISSUE

From the Chair

It is a beautiful fall morning as I write this note. The air is crisp and cool, the leaves have turned, and the sky is a beautiful blue – Iowa at its best. It fits my mood perfectly. It has been a very good year for the Department of Materials Science and Engineering.

Our undergraduate program continues to thrive. Our enrollment figures are up – last year we added 51 new students. and we are well on the way to matching that figure this year. For comparison, eight years ago we had about 90 students in the entire four-year program. We now have one of the biggest enrollments in the country. Not only do we have an abundance of students, we have great students. The ISU chapter of the Material Advantage student program was named the Most Outstanding Chapter in the Nation for the *fifth* year in a row at the MS&T conference in Pittsburgh. No one could miss our students at that conference; we had over 40 attend. We cannot forget our responsibilities to them, so we continue to modify our curriculum to meet the demands they will face in the global economy. Our efforts are starting to be recognized. Our undergraduate program is now ranked 15th in the country.

We are pleased to have added two new faculty members this past year. Professor Alex King came to Iowa State in January 2008 from his position as Head of the School of Materials Engineering at Purdue University to become the Director of Ames Laboratory, a U. S. Department of Energy National Laboratory located on the Iowa State campus. We are pleased that he is also a Professor in our department, extensively engaged in departmental events and affairs. His wealth of experience and scientific talent add greatly to the department. Arriving this fall is Professor Scott Beckman, who is described in a later article. We are delighted to have Scott join us. He has a passion for teaching and his research is state-of-the-art.

Alex and Scott join an already strong department that includes an excellent group of young faculty, who are featured in this Newsletter. Professor Nicola Bowler combines strong modeling capabilities with experiment and brings an even closer coupling between the department and the Center for Nondestructive Evaluation (whose director, Professor Bruce Thompson, is also in MSE). Professor Michael Kessler works on innovative materials that "heal" themselves from damage, while Professor Zhiqun Lin makes nanostructured polymeric composites that have great promise for many applications, including photovoltaic cells. We also feature an article about Professor Scott Chumbley's forays in forensics. Who would have thought that we could identify marks from individual screw drivers?

The single-most exciting event for me this past year was to take a group of students to Africa as part of a study-abroad class that was sponsored jointly by MSE and the Department of Mechanical Engineering. Anne Stockdale, an MSE undergraduate and president of the Material Advantage chapter, describes her reaction to the class later in this Newsletter. It was clearly a life-changing experience. For me, it was also a remarkable time. My colleague, Professor Mark Bryden (ME), and I had the opportunity to offer students a new way to look at engineering and at themselves as engineers. Anne's article shows that we were successful at that. And we also made a very positive impact on the lives of people in the village. I cannot wait until next May, when we take another group of kids back to the village.

Richard LeSar

Richard A. LeSar, MSE Chair

With appointment to MSE,
Bowler integrates fabrication and NDE

"I didn't go out specifically to work in nondestructive evaluation," Nicola Bowler says. "But NDE turned out to be a good fit for my interest in electromagnetic theory."

Think of Bowler's career in nondestructive evaluation since earning her 1994 PhD in physics from the University of Surrey in her native England as a sort of way station on her journey into materials engineering, and you'll have traced her professional trajectory from those theoretical roots to the fruits of application with her 2006 appointment to the MSE faculty.

She'll tell you as well that her work today in novel composites is both the direct outgrowth and flip side of the NDE coin, a transition anticipated by successive postdoctoral positions before joining the Center for Nondestructive Evaluation (CNDE) at Iowa State in 1999. After two years of doing crack modeling for eddy current NDE, Bowler's work in modeling composite materials established the platform for her active research in materials design today.

"The notion was to do some modeling for the design of certain electromagnetic properties in those materials that might be desirable," Bowler recalls. "So I spent two years exploring and discovered just what an enormous field it was."

From theory to experiment

Any aggressive research agenda would wait, however, as at first she followed husband, John Bowler, to Ames, where he took up appointments as professor on the electrical engineering faculty and researcher in electromagnetics at CNDE. Bowler then established herself in her own right as a scientist with CNDE, while also serving as an adjunct associate professor in ECpE.

Although her initial work at CNDE centered largely upon eddy current testing, Bowler still found time to do research. With collaborators from 3M, she procured funding to study radar-absorbing composites for the air force's stealth technologies, focusing on the dispersion of particular particles in a matrix to achieve microwave-absorbing behavior. It was on this project that she established her first direct relationship with MSE faculty outside of NDE, working with Scott Chumbley and one of his students to do SEM work.

With her appointment to MSE, that drive toward applied research in materials has come full circle with the establishment of Bowler's research team. And while her electromagnetic materials design and characterization (EMDC) group is studying the design and fabrication of composite materials for electronic, microwave, and optical applications in general, Bowler expresses a particular interest in so-called "left-handed materials" (LHMs) and the unusual properties arising from their negative index of refraction.

"With a physics background, I'm especially interested in modeling," Bowler says. "But now I'm in a materials science department—I want to see if we can actually fabricate some of these materials that could be used in practice. To date, there's been a lot of theory done, but the experimental demonstration is lagging behind in some respects."

A different vision

This newfound emphasis on fabrication hardly means that Bowler is abandoning NDE—it's still a core focus of her EMDC research team and the subject of an online course she's developed as part of a graduate certificate in NDE [1]. Rather, she has expanded the application of her theoretical grounding in electromagnetics to include NDE's logical correlate in not just evaluating materials, but creating them as well.

"One common thread is that, in NDE, I have a project focusing on low-conductivity materials and how they can be evaluated with a microwave technique," Bowler says. "Then, in left-handed materials, we'll look at those that could be practically used in microwave circuits or telecommunications—a common connection in the frequency range of microwaves."

The current approach with LHMs, Bowler says, is to create highly ordered arrays of custom-shaped elements that must be precisely arranged for the materials to display desired properties. The consequences of such techniques, however, are that the resulting materials are anisotropic—i.e., they can work only from a narrow range of angles.

Bowler has a different vision. "We'd like to engineer particles with a high dielectric constant core that are coated with a low-conductivity material," she offers.

"For a microwave application," Bowler continues, "these may be tens of microns in diameter. By fine-tuning their dimensions and properties, it might be possible simply to mix them into a matrix to create an LHM—an ordered array may not be needed anymore."

Not only might fabrication expenses decrease considerably under Bowler's scheme, LHM functionality would not depend on order in the system: the composite would exhibit isotropic rather than anisotropic behavior, giving it much greater flexibility in application.

Finding an identity

So far, Bowler says her team has developed considerable theory on the subject, which they're using to guide them on the choice of materials to, in her words, "actually try to make something." Yet by joining theory with practice, she has taken a promising first step toward this goal—and toward making her name in materials.

"I have grad students in electrical engineering working at CNDE, and I have grad students based in this department," Bowler reflects. "I was searching for an identity that encompassed all the things I want to do."

She adds, "At MSE, I think I've found it."

1. Bowler, N. 2008. Course in eddy current nondestructive testing to pilot new online graduate certificate in NDT. Mater. Eval. 66:910–2.

Mali also brings meaning— an

Initially, I was interested in the study abroad program because of the opportunity to visit a third-world country, and I thought the experience would be good before entering the workforce. After speaking with Dr. Richard LeSar, a coordinator for the ME/MatE 389X program, seeing his pictures, and discussing the projects, I was convinced and immediately signed up for the class.

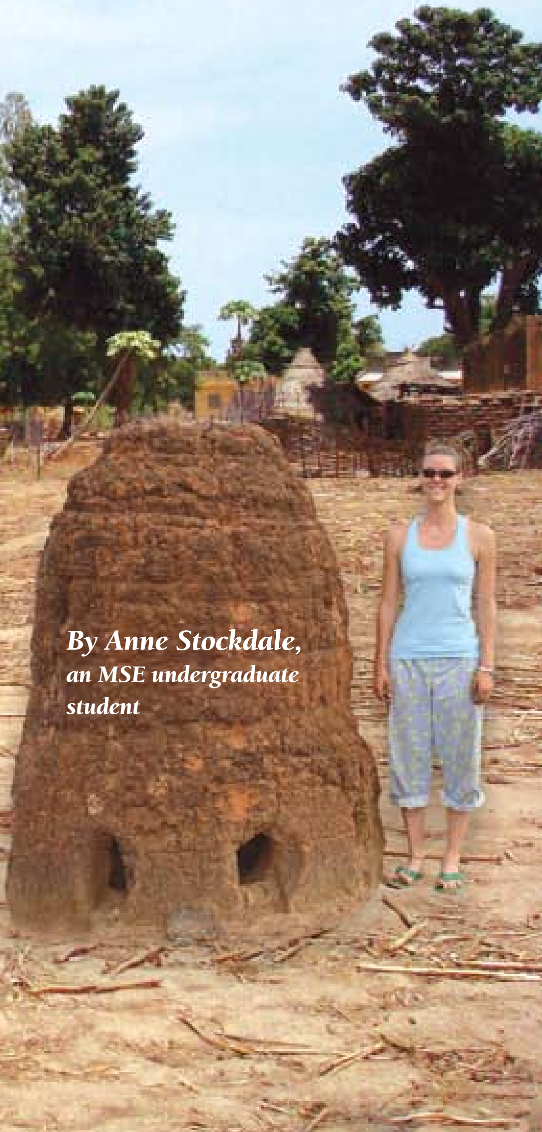
Throughout the spring semester, we learned about many of the challenges faced by Malians each and every day. We learned that Mali (Bambaran for hippopotamus) is a landlocked country in western Africa. It is one of the poorest countries in the world, and a majority of the population survives on subsistence farming. There is virtually no western medicine, no energy sources, let alone electricity, outside the capitol city. Because of these constraints, the importance of appropriate technology and sustainable engineering within a third-world setting became more evident.

When I entered college, my goal was to graduate in four years in materials engineering and work in industry. However, in May 2008 a study abroad class in Mali changed everything.

Appropriate technology is defined as technology that is appropriate to the environmental, cultural, and economical situation for which it is intended. All of the projects being conducted in the town of Nana-Kenieba revolved around the concepts of appropriate technology and sustainable engineering. We learned about the problems with water valves, the importance of safe, efficient stoves, as well as the limitations of materials selection. Although the pre-trip class was helpful in learning about the objectives of the class, nothing could have prepared me for the adventure waiting on the other side of the world.

We arrived in Bamako via Paris after dark. After spending the evening in a westernized hotel in Bamako, we woke early the next morning and set out for the marketplace to buy cloth. The marketplace is a fast-paced

MSE student impact



By Anne Stockdale,
an MSE undergraduate student

environment with many unique smells, different people, and items for sale (including shrunken heads used for black-magic) . After buying cloth for a dress and skirts to be made by the village tailor, we packed our bags into an all-terrain vehicle and set off for Nana-Kenieba.

The journey of 45 miles took approximately three hours. We arrived there at dusk, and after a quick supper and a check for spiders under our beds, we went to bed. Over the next few days we became acquainted with the village's cultural dynamics. We met the chief and the village elders and received their blessing to work in the village. We were then given a tour around the village. As we weaved through the mud huts, many of the children of the village had taken to following us on our excursion. The village has approximately 800 people with over half the population under the age of 16. The school is fairly small, thus children attend in shifts throughout the day.

During our tour we also learned of many of the health risks in the village such as open pools of raw sewage behind the latrines of many family compounds, which were also a breeding ground for mosquitoes and ultimately malaria. We also looked at many of the both shallow and deep wells in the area. Typically the deeper the well, the cleaner the water, and many of the villagers understand this. However, when the deeper wells dry up, the villagers revert to their previously dug shallow wells – causing a major health concern.

We spent a majority of the first week revisiting many of the technological problems of the village such as leaky water valves and inefficient stoves. As a materials engineering student, I was interested in the stoves and the materials selection associated with building them.

Mali continued on page 6—

Mali continued from page 5—

Many of the village women cook on a three-stone stove. Generally the stoves are used indoors, and the smoke creates a major health concern. The stoves are also highly inefficient and dangerous. We investigated new stove designs and what materials are needed for their construction. I learned quickly of a constraint none of us had really experienced before – lack of information. During one particular discussion about efficiency, one student said, "This would be so much easier if I could just Google the answers." Since there is no electricity in the village, there is obviously no internet, nor are there text books or a technical library. This meant we had to rely on one another for information and be creative.

To learn even more about materials selection in a third-world country, I spent much of my time with the local blacksmith, Modibo Sinaba. Blacksmiths come from the witchcraft family; thus only they are allowed to use fire to make tools out of metal. Much of the time with Modibo was spent assessing his capabilities and the material constraints he faces. He showed me how to make tools such as a hand hoe and a knife, as well as wooden items such as bowls, ladles, and drums. During one of my visits, he handed me a hammer and invited me to work with him to make a knife. In a society where women are not allowed to be blacksmiths, let alone interact extensively with men who are not their husbands, I found his openness to new ideas exciting and moving.

Being an educated female working in a polygamist, patriarchal society was difficult at times . However, it all became worth it when a mother within the village told us through a translator that she was happy that her daughters were able to see educated women. It gave her hope for her daughters' futures.

I honestly never knew such an experience could have such a dramatic impact on my life. Many of the lessons learned in Mali could never be taught in a classroom setting. I learned a lot about engineering in a third-world country and appropriate technology in general, but I also learned a lot about myself.

Currently, I am working with Dr. Richard LeSar and Penn Taylor researching adobe brick and better ways to fire it for use as a building material. Upon graduation I plan to attend graduate school for engineering public policy with an emphasis in international policy, and I have Mali to thank for everything.

Kessler brings a 'healing

Mike Kessler is in the minority: on a roster of 30-odd scholars, he is the only MSE faculty member who is also a professional engineer.

That's hardly surprising—academic engineering generally trends more to fundamental science than to practical application, and nowhere is this tendency more pronounced than in materials. Add the fact that he got his BS at a school without a graduate program, and you might wonder how he got here at all.

Kessler concedes that his research is increasingly oriented toward answering fundamental questions about the materials he works with. Yet his work since coming to Iowa State in 2005 is still intimately tied to solving practical engineering problems, as his heavily industry- and defense-oriented funding portfolio attests.

Toward a biomimetic capability

Over the past several years Kessler has trained his expertise in polymers in a number of novel yet practical directions. For instance, along with co-PI Mufit Akinc, he is currently in the midst of a three-year contract under the U.S. Departments of Defense and Energy along with the EPA to develop more environmentally friendly ways to control the emission of volatile organic compounds and other pollutants during the repair of composites. And lately he had been helping a major Iowa manufacturer refine the kinetics of a pultrusion process that takes materials from a liquid pre-polymer to a glassy thermoset network.

Ask Kessler what most intrigues him about his work today, though, and he's sure to mention his research to develop different approaches to self-healing polymer composites. Sponsored by the American Chemical Society's Petroleum Research Fund, the project seeks to usher in a new generation of materials for use in aerospace and general military applications.

"A long-standing problem in composites is that the polymers are usually brittle, despite their reinforcement with fibers," says Kessler. "Because they're brittle, there are often micro-cracks at the interfaces within the matrix. And those micro-cracks are the precursors to larger-scale damage."

Toughening the material or introducing higher engineering design margins to compensate for a composite's brittleness, Kessler observes, would simply add additional weight to components, which is unacceptable for airframes and uneconomical in any event for virtually any other application. Instead, a self-healing capacity would add to the structural function of components by lending a biomimetic capacity for self-healing.

touch’ to composites

Stopping damage early

Although Kessler and his team have looked at other methods, his current work is based largely in ring-opening metathesis polymerization—“ROMP,” for short—a technique in which he’s been using the ruthenium-based Grubbs’ catalyst to trigger the polymerization process.

This approach, Kessler says, involves incorporating an encapsulated healing agent into the composite matrix at a very small scale. Inside the capsules is a pre-polymeric building block in the form of a monomer in a resinous liquid suspension, which wicks into incipient micro-cracking when damage occurs. The embedded catalyst, Kessler notes, then triggers polymerization of the monomer, thus “healing” the micro-crack before it has the opportunity to grow into significant structural damage.

The advantages of such an autonomic technology, Kessler notes, are significant. Besides the ability of aircraft components and armor to respond without outside intervention to potentially catastrophic events such as bird strikes, tool drops, and even hostile fire, the ability of the technology to extend the working life of the material has obvious economic benefits. But besides refining the chemical reactions, equally significant challenges remain.

“One of the things we need to address is the kinetics of polymerization,” Kessler observes. “There are several important time constants—for example, the time for the resin to transfer to the damage region, the dissolution kinetics of the catalyst, the polymerization kinetics. “The time can be very quick at one scale,” he adds, “but not at another.”

Tools for tomorrow

Key to this effort was the receipt of an NSF equipment grant by Kessler and MSE Professor Steve Martin that allowed them to acquire nearly $200,000 in state-of-the-art equipment for characterizing polymers and composites both in their solid state and during the curing process.

“We have to characterize the material from the constituents up to the full material system,” Kessler says. “This grant enables us to do the research better than we would be able to do otherwise.”

Zhiqun Lin: A young career, *a fast start in polymeric nanocomposites*

Barely six years out of the PhD, **Zhiqun Lin** already has a résumé the envy of scholars many years his senior.

Since coming to Iowa State in 2004, Lin has published more than two dozen papers in journals such as *Advanced Materials, Journal of the American Chemical Society*, and *Physical Review Letters*. And his technique for creating novel, hierarchically ordered "coffee ring" structures through evaporation-induced self-assembly has attracted increasing attention from funding sources.

Yet while continuing work on his initial successes, Lin has also recently turned his attention to ambitious projects in other areas of his research specialty in functional polymeric nanocomposites. Of particular note is a three-year project recently funded by the NSF to develop efficient semiconducting organic-inorganic nanocomposites based on organic conjugated polymers and inorganic nanocrystals (i.e., quantum dots and quantum rods) for photovoltaic applications.

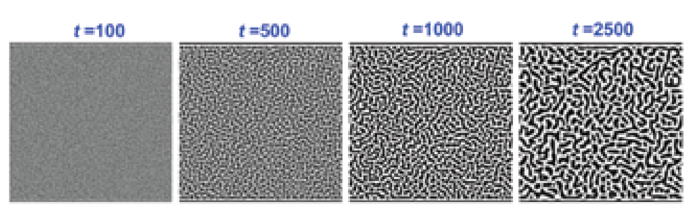
An organic-inorganic hybrid

Currently, Lin notes, a number of researchers have attempted to develop this hybrid technology simply by physically "mixing" quantum dots with conjugated polymers. The problem with this approach, he says, is that the interface between the two different types of semiconductors is not well controlled, thus reducing efficiency of the charge transfer between the organic and inorganic semiconductors.

Lin has a better way. "By directly grafting the conjugated polymer onto quantum dots and rods," he says, "we can better exploit the polymer's semiconductor-like optical and electronic properties for use in solar cells."

Upon the absorption of photons, Lin notes, the conjugated polymer generates excitons, which diffuse to the donor/acceptor interface where electron and hole separate and migrate to their respective electrodes to complete an external circuit. The problem with conjugated polymers, however, is that while they absorb sunlight effectively, alone they are inefficient in converting photons into electricity: while their hole mobility is good, because of the low dissociation probability of excitons and inefficient hopping carrier transport, their electron mobility is typically quite low, thus requiring another component as an electron acceptor.

Lin believes that inorganic quantum dots (QDs) and quantum rods (QRs) are uniquely well suited for this purpose, offering greater electron affinities than conjugated polymers so that charge transfer at the organic-inorganic interface occurs rapidly. Not only are the size-dependent optical properties of QDs and QRs capable of absorbing a wider spectrum of sunlight, but, unlike conjugated polymer, they can also generate multiple excitons from a single photon of sufficient energy, dramatically increasing photocurrent and solar energy conversion efficiency.



Time evolution of the PDLC morphologies confined between two parallel surfaces. The calculations are carried out in 256 × 256 lattice sites. ϕ_{LC} = 0.5.
(t=seconds)

Promising early results

The challenge now lies in optimizing the transfer of electrons from conjugated polymers to QDs and QRs. And here, Lin's nanocomposite approach offers decided advantages over the composite approach typically employed in such schemes.

"What we're looking at are QD- and QR-conjugated polymer nanocomposites as opposed to composites," Lin says. "We bring QDs and QRs into chemical contact with conjugated polymers, not just physical contact in which the interface is not close enough or well controlled. This way we can maximize the interfacial area and also prevent the QDs and QRs from aggregation."

Although the project is young, Lin's team is already fabricating a prototype photovoltaic cell—a QD-conjugated polymer nanocomposites thin film prepared through layer-by-layer deposition and sandwiched between two electrodes—as well as performing tests to measure current-voltage characteristics and power conversion efficiency.

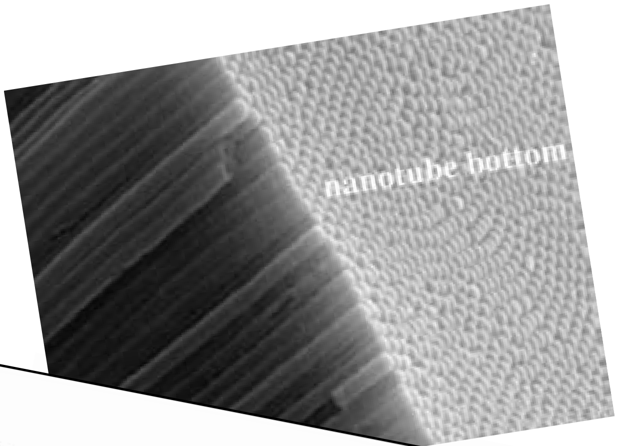
Initial results, Lin says, are promising. For example, one critical metric involves the fluorescence lifetime of the photo-generated excitons, which represents the charge transfer rate from the organic conjugated polymer to the quantum dots. A rapid transfer is desirable, as the longer it takes to separate the exciton's electron from the hole, the likelier it is that the exciton will recombine and be unavailable for conversion by the QDs.

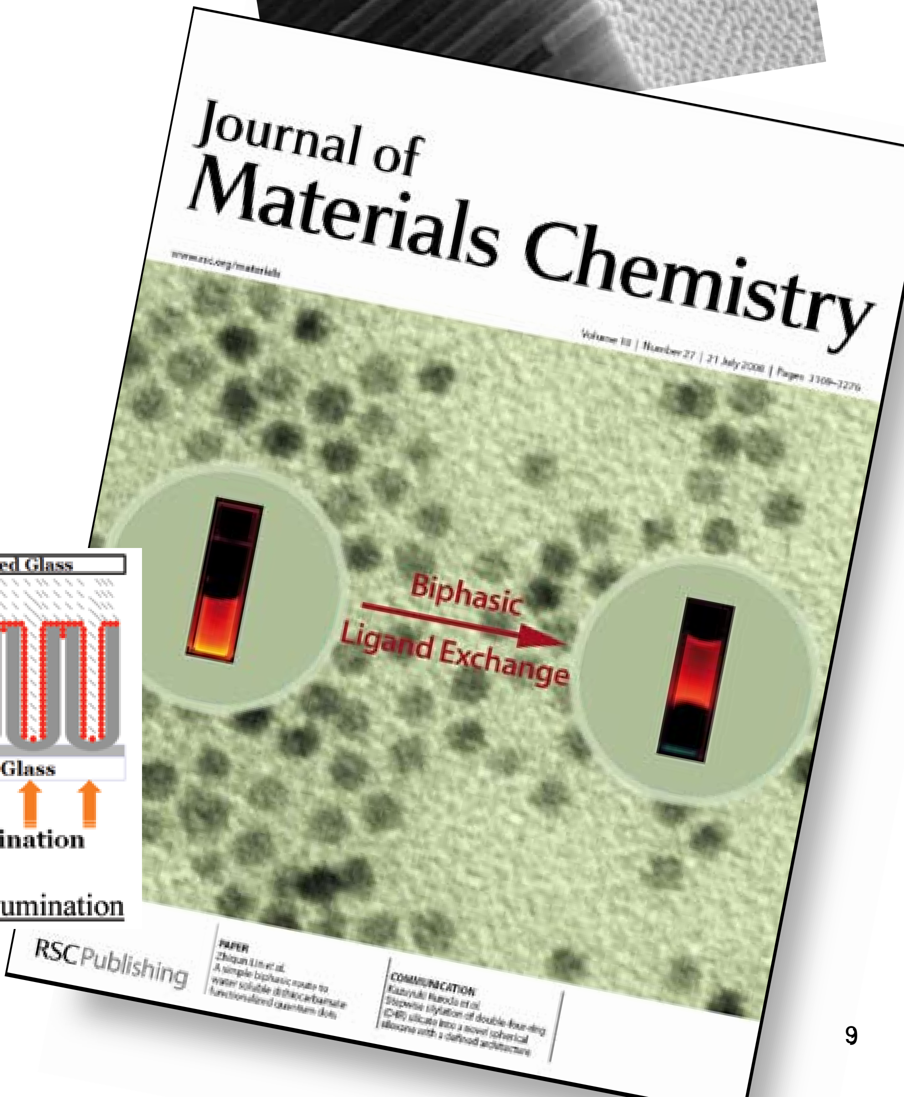
Charge transfer in conjugated polymers, Lin notes, takes place at a rate of 240 picoseconds, while transfer from a conjugated polymer to a physically mixed quantum dot clocks in at a fluorescence decay of 490 picoseconds. By contrast, Lin's chemically bonded nanocomposites boast a transfer rate of only 160 picoseconds—three times more efficient than the standard method—a rate, Lin notes, "so fast you really cannot see that the transfer has already happened."

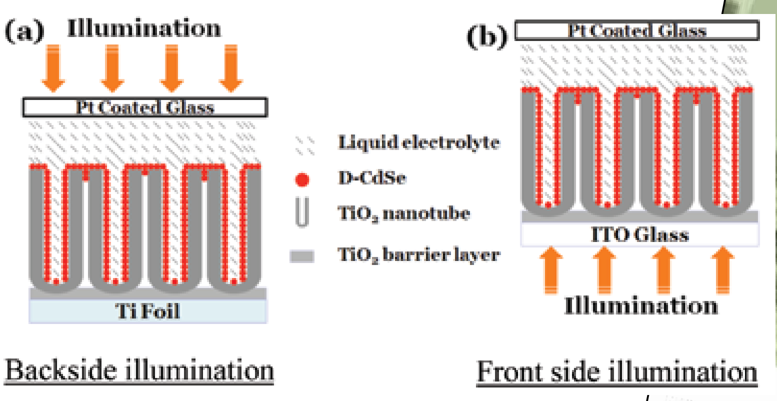
A 'stunning' achievement

If such levels of efficiency can be taken from the lab to production, the implications could establish a new paradigm for solar energy production. Indeed, so tantalizing is the potential of Lin's approach that earlier this year he authored an invited concept article on the subject for *Chemistry: A European Journal*.

"The editor said they found the work 'stunning,'" Lin recalls, revealing once again the drive to excel that has placed him in the top tier of the college's younger faculty.







CSI MSE:

Chumbley and colleagues refine the forensics of tool marks

In a small lab in Spedding Hall, MSE Professor **Scott Chumbley** sits in front of a computer screen scrutinizing two images resembling bar code patterns turned on their sides. Hunched over a comparison microscope next to Chumbley is James Kreiser, a retired forensic analyst from the Illinois State Crime Lab.

"This is not a match," Kreiser informs Chumbley, his fingers adjusting the two lead plates beneath the microscope's objective lens.

To the untrained eye, the patterns of horizontal lines in the images appear similar, black and grey striations in random alternation. However, on closer observation the images reveal apparent discrepancies, and a layman would be hard pressed to call them a match.

Kreiser then moves one of the plates up a fraction of an inch—and the two "bar codes" reveal themselves as identical.

"There's your match," he says, as his finger traces the perfectly aligned stripes top to bottom.

Seeking a degree of certainty

The "bar codes" are, in fact, impressions made by dragging the tip of a screwdriver over a lead plate. The marks are just two in a library of more than 1,200 samples from 50 different tools, part of a project undertaken in 2004 by Chumbley and Max Morris, professor of statistics and industrial engineering, through the Midwest Forensics Resource Center (MFRC) of the U.S. Department of Energy's Ames Laboratory.

Chumbley is responsible for data acquisition, obtaining samples and characterizing their surfaces using a surface profilometer that measures the roughness of the marks produced by Kreiser. The data are then analyzed using a computer algorithm developed by Morris.

Started with seed funding by the MFRC, the work soon attracted major support in the form of a $390,000 grant from the National Institute of Justice. The goal of the project is to bring to the forensic analysis of tool marks left at crime scenes such as vandalism, burglary, and other forcible entry the degree of certainty approaching that associated with firearm ballistics and fingerprints.

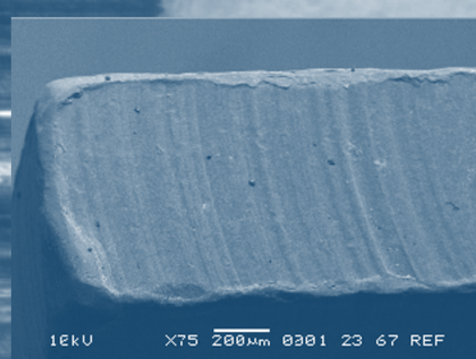
Inspired by the 1993 "Daubert standard," in which the U.S. Supreme Court ruled certain "expert" testimony inadmissible due to lack of scientific grounding, Chumbley's work seeks to give forensic analysts such as Kreiser evidentiary tools rigorous enough to withstand legal challenge.

"We can still tell them apart"

"A screwdriver mark is tougher than a firearm mark," observes Chumbley, "because in a firearm, you always have the same geometry, the same force, the same configuration. The only variable is the ammunition manufacturer."

"The bullet goes down the barrel the same way most of the time," Kreiser adds, slipping a new set of plates beneath the microscope. Someone using a screwdriver, he notes, may attack a door lock from different angles with varying amounts of pressure. "So that mark can change a lot, even though it came from the same screwdriver."

Still, Kreiser insists, their methods can distinguish between marks made by different tools, even if both are seemingly identical—and, he adds, even if they were forged from the same die.



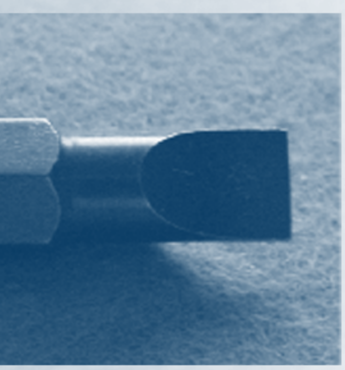
"These screwdriver tips Scott acquired," Kreiser notes, "were all 50 consecutively made tips. One after the other, coming off the same machines," Chumbley remarks. "They're as close as you're going to get—and we can still tell them apart. So if we can tell those apart, it should be even easier to tell apart tools that have been in service for years through different processes and different owners."

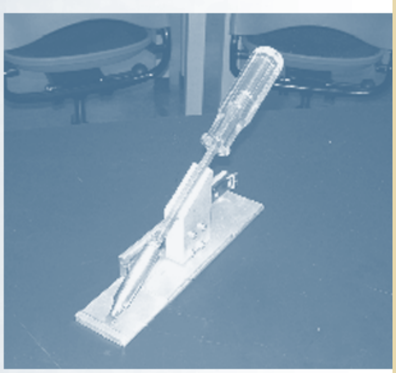
Assumptions into science

Chumbley and Kreiser tested the latest iteration of Morris's algorithm at a recent conference of forensic examiners in Honolulu using a mixture of samples both correctly and incorrectly categorized by the algorithm. While the algorithm batted only .500 for the 20 samples, professional examiners called matches correctly in virtually every instance, with only a handful of abstentions due to uncertainty.

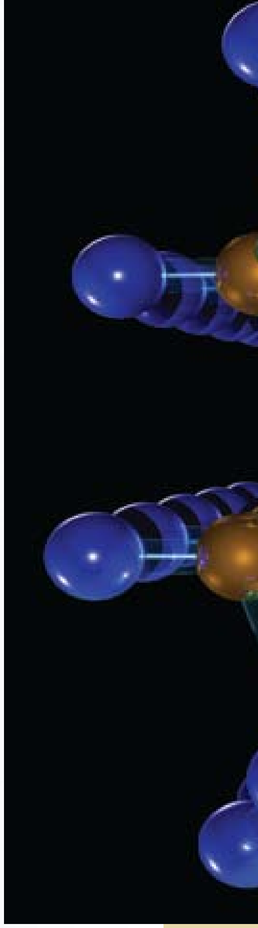
That disparity, Chumbley says, pointed out a number of ways the algorithm could be improved. Pending additional funding, he and Morris plan to explore the use of filters to improve the algorithm by screening out extraneous data that may obscure matching elements. The ultimate objective, he stresses, is not so much a technology that replaces the informed judgment of the experienced examiner, which will almost always be superior to any technology, but rather a tool that objectively and scientifically supports the examiner's intuitive response to he evidence.

"The deliverables," Chumbley notes,"are simply research that speaks to the accuracy, error rate, and reliability of all these assump-tions that people have been operating on for 100 years."





Scott Beckman returns to MSE— and the lab



When **Scott Beckman** left MSE in 1999, he was a seasoned experimentalist with two conference proceedings and a journal paper. But his lab days were numbered. "After these," he says, "all my work was theory and computation."

In grad school, Beckman focused on dislocations in semiconductors. Yet rather than a faculty position after Berkeley, he strove for a more expansive view of materials, immersing himself in core physical principles with scholars who had pioneered the marriage of physics and engineering. "I got into nanostructures and ferroelectrics," Beckman says. "My postdoctoral career forced my research to be broader."

Beckman's recent work at Rutgers focused on "polar-ization flipping" in ferroelectric random access memory, a faster, more energy-efficient replacement for DRAM. But his earlier work at Texas set the stage for his agenda at Iowa State.

There, Beckman predicted substantial changes in the optical properties of Ge nanowires smaller than 3 nm. He also participated in a project on Heusler nanocrystals that inspired what he calls his "continued enthusiasm for defects," particularly in the area of self-diffusion in nanostructures.

The easiest pathways for diffusion, Beckman says, are through a nanostructure's vacancies and interstitials—its intrinsic defects. But while this has been studied extensively in bulk semiconductors, only a handful of studies have been done in nanostructures.

"Defects in nano are very different," Beckman says. "There's no easy way to predict those properties. At the same time, it's impossible to make a device without introducing point defects."

Beckman sees opportunities in nanostructures in much the way his predecessors opened frontiers in bulk materials. "We're at the beginning of something technologically useful and exciting," he says.

The field is also at the point where researchers can move deeper into the fundamentals of nanostructures through experimentation, and Beckman is eager to get closer to practical engineering.

"There's been a lot of lab-scale work in this field," Beckman says. "But when they try to scale up from lab to industrial, a lot of problems exist. I hope the basic science I do can take other people's work and scale it up to something larger, something useful."

2008–2009

Awards Banquet

MSE Scholarship and Award Recipients

*The 2008 Spring Awards Banquet was held at the Iowa State Center in April 2008. MSE Professor and Ames Lab Director **Alex King** captured the audience with his banquet address "Out of the Lab and on the Loose: Some of the Other Things You Can Do with Your Training in Materials." He presented detailed pictures of his guitar collection, each guitar very unique and special all in its own, but also each one made from a different material. He also told of his experience as part of a research team that came up with a solution for "degassing" Lake Nyos in Cameroon that helped prevent the residents from being suffocated by carbon dioxide accumulating in the lake. The banquet concluded with special awards and scholarship presentations.*

Alcoa Foundation Scholarship
Jamelia Hershiser

Oscar L. Bock Scholarship
Mary Burroughs*

Otto and Martha Buck Materials Science and Engineering Scholarship
Michael Horras

Clayton Family Scholarship for Studies in Powder Metallurgy
Amy Bergerud*

Clayton H. Cooper Scholarship
Nathaniel Grinvalds

College of Engineering Scholarship *and* Engineering Undergraduate Merit Scholarship
Amy Bergerud*
Mary Burroughs*
Austin Cudworth*
Ryan Gebhardt*
Taylor Grieve*
Eric Harms*
Matt Heinemann*
Barry King*
Emily Kuster*
Alyson Lieser*
Kristen Lipschultz*
Anthony Marton*
Sara Moser*
Lisa Nielsen*
Matthew Poulter*
Daniel Putnam*
David Riegner*
Kathryn Schlichting *
Cory Sents*•
Sarah Timmons*•
Jordan Trachtenberg*•
Justin Wang*•
Emma White*•

Deere Foundation Scholarship
Andrew Adams
Christine Gunzel*
Eric Ostrander

Engel Scholarship Endowment in Engineering
Kyle Debelak

Engineering Leadership Program Scholarship
Justin Knight
Emily Kuster*
Leo Salat

Engineering Student Leadership Development Scholarship
Seth Berbano

Engineers' Week Scholarship
Ashley Assink
Laura Barker
Lindsay Brown
Jennifer Byer
Kara Christensen
Tim Cullinan
Charles Fisher
Rachel Hawkins
Trenton Jacobson
Elease McLaurin
Samantha Meyer
Anne Stockdale
Michael Vosatka

Fehr-McGee Scholarship
Amanda Ranard

Clarence H. Ford Scholarship
Jarrett Wendt

Murray Gautsch Scholarship
Adam Boesenberg

Chair Richard LeSar, presenter—Eric Ostrander

Christine Gunzel

Nicolas Martinez

Laurence T. and Jessie Davidson Gaylord Scholarship
Nicolas Martinez

Lyle J. and Marcia L. Higgins Scholarship
Jeffrey Czerniak
Jace Indrelie
Benjamin Pierce

Frank Kayser Scholarship
Timothy Cleveland

Joe M. King Scholarship
Benjamin MacMurray
Alicia Weum

Mary and Donald Martin Memorial Scholarship
Fabian Stolzenburg

Frank McCutcheon III Scholarship
Paul Czyz*

Micron Technology, Inc., Scholarship
Katherine Lawler

David C. Moll Scholarship
Andrew Steinmetz

Edward Henry Ohlsen Scholarship
Adam Rabe

David T. Peterson Scholarship
Samuel Young

P. Fred Petersen Scholarship
Mitchell Scherbring
Greg Vetterick

Harry Oakley Price Scholarship
Benjamin Rattle
Kevin Severs*

Rockwell International Scholarship
Amy Bauer

Schneider Electric/Square D Company Scholarship
Emily Decker
Michael Haynes

Roderick Seward, Flossie Ratcliffe, and Helen M. Galloway Scholarship
Craig Ament
Travis Brammer
Erik Manatt
Peter Olsen
Timothy Pearson
Kevin Severs*
Alexander Smith

John D. Verhoeven Scholarship
Paul Czyz*

Samuel Walker and Jennie Morrison Beyer Scholarship
Michael Radle

Memorial Endowment for Leslie Miller Wallace, Jr., Scholarship
Scott Long

David R. Wilder Scholarship in Materials Science and Engineering
Christine Gunzel*

* *Scholarship funding from two or more sources or multiple scholarships received*

• *Scholarship supporting National Merit*

2008–09 MSE National Merit Scholars
Sara Moser
Cory Sents
Sarah Timmons
Jordan Trachtenberg
Justin Wang
Emma White

2008–09 MSE National Achievement Scholar
Elease McLaurin

2008–09 MSE George Washington Carver and MVP Scholars
Seth Berbano
Elease McLaurin
Eric Ostrander
Leo Salat

2007–08 MSE Special Awards

MSE Outstanding Senior Award
David Lantz

MSE Student Leadership and Service Award
Emily Merrick

Rohit Trivedi Best Student Paper Award
Xiaohui Zhao

Zaffarano Prize (Honorable Mention) for Graduate Student Research
Baris Unal

MSE Graduate Research Excellence Award
Baris Unal

Akinc Excellence in Teaching Award
Michael Kessler

Akinc Excellence in Research Award
Iver Anderson

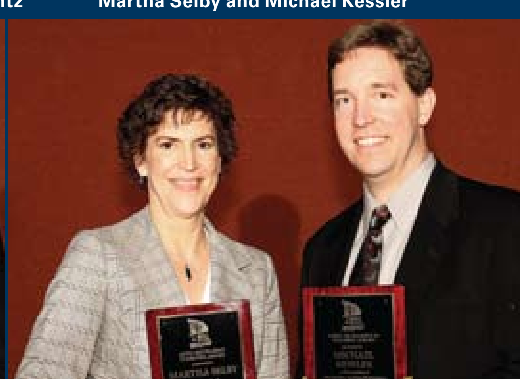
Akinc Excellence in Service Award
Martha Selby

2008 MSE Banquet Speaker
Alex King, MSE Professor
Director, Ames Laboratory

"Out of the Lab and on the Loose: Some of the Other Things You Can Do with Your Training in Materials"

David Wilder, former dept. chair/grandson, David Lantz

Martha Selby and Michael Kessler



Croat—*Hall of Fame*

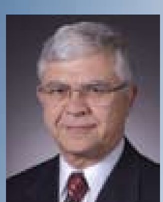
MSE alum **John Croat** has made quite a name for himself in the magnetic world. During the early 1980s, Croat played an instrumental role in the discovery of $Nd_2Fe_{14}B$ bonded permanent magnets. He currently holds 11 patents in this area.

A major portion of Croat's career has been dedicated to the commercial development of these materials. His selection to the MSE Hall of Fame recognizes his leadership role in discovering and commercializing this family of materials. He is one of the founders of two companies currently producing the $Nd_2Fe_{14}B$ bonded magnets. These magnets are used extensively in motors for a variety of computer peripheral, office automation, and consumer electronic products. In 2008, over one billion motors and other devices will be produced using these magnets.

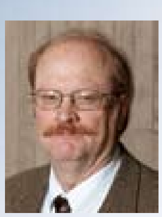
Croat received his BS degree in chemistry from Simpson College in 1965 and his MS and PhD degrees in metallurgy from Iowa State University in 1969 and 1972, respectively. Upon completion of his doctorate, he started working for General Motors Research Laboratories in their physics department. His efforts focused on the research and development of permanent magnet materials from rare-earth-transition metal alloys.

In 1984, he transferred to the Delco Remy Division of General Motors where he helped start the Magnequench business unit, which was formed to commercialize $Nd_2Fe_{14}B$ magnets. Between 1984 and 1995 Croat held various positions in this company including chief engineer, sales manager, and managing director (1991–1995). He is currently chairman and CEO of International Magnetics Technology, which produces rapidly solidified $Nd_2Fe_{14}B$ magnetic powder at a facility in Saraburi, Thailand.

Faculty awards



Mufit Akinc, MSE professor, recently received the 2008 Fellow Award from the Board of Trustees of ASM International at the ASM Awards Dinner during the MS&T Conference held in Pittsburgh, Pennsylvania, in early October. His elevation to fellow status recognizes his distinguished contributions to the science and technology of ceramic and alloy powders and his leadership in materials education. Akinc was also officially selected by the J. William Fulbright Foreign Scholarship Board as a Fulbright scholar to Turkey, where he is a visiting professor this fall. He was also recently chosen to be an international adviser to the National Institute of Materials Science of Japan, a position he will hold through 2010.



Eldon Case, MSE alumnus, was named in March 2008 a fellow of ASM International, a professional materials society. The honor of fellow represents recognition of his distinguished contributions to the science and technology in microcracking and fatigue behavior of structural ceramics and bioceramics. Case currently serves as a professor at Michigan State University.

In March 2008, **Karl Gschneidner, Jr.**, MSE Distinguished Professor and recent National Academy of Engineering honoree, received the Acta Materialia Gold Medal at the annual meeting of The Minerals, Metals & Materials Society, held in New Orleans, Louisiana. He delivered the keynote address during the conference at a symposium held in his honor. The gold medal is considered by many to be the top award in the field of materials research. This award is presented annually by the board of governors of Acta Materialia, Inc., based on demonstrated ability and leadership in materials research.

Steve Martin, MSE University Professor, recently received the George W. Morey Award for achievements in glass science and technology, which is presented by the Glass and Optical Materials Division of The American Ceramic Society and is sponsored by PPG Industries. Morey was a pioneer in the study of glass properties as well as an honorary member of The American Ceramic Society. He also wrote the book The Properties of Glass, which is highly regarded in glass technology today.

MSE professor and National Academy of Engineering member, **Dan Shechtman** has been awarded the Materials Research 25th Anniversary Award for his work on discovering five-fold symmetry of crystals or quasicrystals. Shechtman's research has shown the value of electron diffraction in determinations of crystal structure. Currently, quasicrystals are being used in maraging stainless steel. Shechtman received this award at a ceremony held at the 2008 European Materials Research Society meeting in Strasbourg, France, on May 28th. This award is presented only once every five years and is the highest recognition conferred upon a materials scientist by the society, which is Europe's leading organization for the support and advancement of research in materials.

Additional awards for MSE—2007–2008

Faculty

Iver Anderson, senior metallurgist at the U.S. Department of Energy's Ames Laboratory, received the 2007 Distinguished Scientist/Engineer Award by the Electronic, Magnetic & Photonic Materials Division of The Minerals, Metals, & Materials Society. The award was presented to him at the March 2008 TMS Meeting in New Orleans. The award honors Anderson specifically for his development of a tin-silver-copper solder alloy that has been widely adopted by the electronics industry to remove harmful lead from the environment. To date, the patented lead-free solder has been licensed by some 60 companies worldwide and has generated more than $16 million in royalties for Ames Lab and Iowa State University.

Scott Chumbley, MSE professor, was one of several faculty members honored from each of 23 engineering student groups at the 8th annual Engineering Student Leadership Banquet held in February 2008.

Kristen Constant, MSE Associate Professor, will be honored by the Carrie Chapman Catt Center for Women and Politics as one of twelve women featured on the third annual "Women Impacting ISU" calendar representing those women whose leadership has made a difference at Iowa State University.

Surya Mallapragada, MSE professor, received the Iowa State University Award for Mid-Career Achievement in Research in September 2007. This award recognizes a faculty member who has demonstrated outstanding accomplishments in research at the mid-career stage.

Krishna Rajan was named the new director of Iowa State's Institute for Combinatorial Discovery in October 2007.

Martha Selby received the 2008 College of Engineering Superior Engineering Advisor Award.

Xiaoli Tan was promoted to associate professor; he also received the Iowa State University Award for Early Achievement in Research in September 2008, an award that recognizes a faculty member who has demonstrated outstanding accomplishments unusually early in his or her professional career.

Pat Thiel, MSE Distinguished Professor, received the 2008 Honorary Member Award from the Iota Sigma Pi national honor society for women in chemistry. The prestigious honor is awarded to one person every three years This is the highest honor that Iota Sigma Pi bestows on outstanding women chemists.

Staff

Lynne Weldon, MSE staff, was one of eight engineering faculty and staff members who were honored by Iowa State University at the 2007 25-Year Club banquet held in February 2008.

Students

Jennifer Byer, MSE undergraduate, took first place representing MSE at Iowa State University, in the undergraduate student poster contest held at the MS&T Conference in Pittsburgh, Pennsylvania in October.

Randi Christensen, MSE graduate student, won the best-looking mug contest at the October 2008 MS&T Conference.

Charles Fisher, MSE senior undergraduate student, received the Wallace E. Barron All-University Senior Award for 2008 in March. The award, which is given by the Iowa State Alumni Association, recognizes exceptional performance in academics, leadership, and community service. Fisher also was awarded the Dean's Student Leadership Award at the 8th annual Engineering Student Leadership Banquet held in February 2008.

Jing Teng, former MSE graduate student, was one of 15 College of Engineering graduate students who received the fall 2007 Teaching and Research Excellence Award from the Iowa State University Graduate College.

Alums

Don Bray, MSE alum, received the 2008 ECD James I. Mueller Memorial Award. He is currently the business director, new technology, for Morgan Carbon in Fostoria, Ohio.

Mitchell K. Meyer, MSCerE'91 and PhDMSE'95, was one of three recipients of the Professional Progress in Engineering Award (PPEA) at the Marston Club dinner held in April 2008. Established in 1989, the PPEA recognizes outstanding professional progress, personal development, and distinguished community service in a field of engineering specialization by alumni under the age of 46. Meyer is the U.S. national technical lead for reduced enrichment for research and test reactors fuel development, Idaho National Laboratory, Idaho Falls, Idaho.

An MSE team was chosen as one of the winners in a statewide Pappajohn New Venture Business Plan Competition in April 2008. Graduate students **Joel Rieken** and **Andy Heidloff** and Adjunct Professor **Iver Anderson** received an award of $5,000 for their new venture, Iowa Powder Atomization Technologies. In the competition, students pitch innovative business plans to a team of professional investors. The winners were chosen on the basis of the content and viability of their plans by a panel of judges from Equity Dynamics, John Pappajohn's venture capital firm.

Materials Engineering at Iowa State University is ranked 15th among materials engineering programs in the country, 10th among public universities by *U.S.News & World Report*.

Material Advantage student chapter won the Most Outstanding Student Chapter in the United States for the ***FIFTH*** year in a row!

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Your support to Materials Science & Engineering makes a difference!

Generous gifts from our alumni, corporate sponsors, and other partners enable the Materials Science & Engineering Department to continue its tradition of academic excellence. Your contributions to the Materials Science & Engineering Department Fund make a lasting impact on our program and the success of our students through initiatives that include:

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- **Attracting top-caliber faculty to Iowa State**

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