MATERIALS SCIENCE AND ENGINEERING DEPARTMENT

IOWA STATE UNIVERSITY

MSE ELEMENTS

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Bruce Thompson elected to National Academy of Engineering

In his convocation address last fall, Dean Jim Melsa noted that, of the nation's top 50 engineering schools, Iowa State was the highest ranked institution having no members of the National Academy of Engineering.

That changed in February, when the Academy announced the election to its ranks of Distinguished Professor of MSE and AEEM **R. Bruce Thompson**, director of the Center for Nondestructive Evaluation. According to the NAE citation, Thompson was named to the Academy "for outstanding contributions to nondestructive evaluation, materials processing, and life-cycle management, and for the development of novel ultrasonic technology."

The National Academy of Engineering is one of the National Academies, which also include the National Academy of Sciences, the Institute of Medicine, and the National Research Council. The National Academy of Sciences was chartered in 1863 by Congress to advise the legislative and executive branches of government on scientific and technical matters. The National Academy of Engineering was created as a separate entity in 1964 and currently includes 2,138 U.S members and 165 foreign associates.

"It's very gratifying and rewarding to know that your peers have chosen to recognize you in this way," Thompson remarks.

"My vocabulary isn't good enough to offer the superlatives that describe Thompson's worthiness for this recognition," adds MSE Chair Mufit Akinc. "NAE membership is the highest honor any engineer can achieve. As a department, we've never had a National Academy member, so we're thrilled."

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—Mufit Akinc, MSE Chair

Thompson received his B.A. from Rice University in 1964 and his master's in physics and Ph.D. in applied physics from Stanford University in 1965 and 1971, respectively. Before coming to Iowa State, he served as a member of the technical staff and group leader at the Rockwell International Science Center in California.

Thompson came to Ames in 1980 when the program he had helped manage for DARPA and the Air Force was moved to Iowa State. In 1985, at the request of the National Science Foundation, he helped to establish the Center for Nondestructive Evaluation, now the second oldest research center in the NSF's Industry/University Cooperative Research Program. In 1997, Thompson was named CNDE director.

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Greetings from the MSE department!

I am a very lucky person!

When you read the rest of this newsletter, you will begin to understand why I feel so lucky to be part of the MSE family. I refer to members of this department as "family" because, in many ways, our faculty, staff, and students operate as one big, extended family.

You will read about the election of Distinguished Professor **Bruce Thompson** to the National Academy of Engineering, the highest honor for an engineer in the U.S. Despite his international acclaim, Bruce spends hours in the laboratory each week with students sharing his great passion for engineering.

In this issue, you will also read about the changes the faculty implemented to improve our graduate program. The changes **Professor Tsukruk** and his committee proposed to the faculty were almost revolutionary, yet the faculty gave their resounding support to the proposal. I am confident that the increased stipend and changes in course requirements, coupled with aggressive recruitment, will position the department's graduate program for a leap to the next level.

Professor Martin and his colleagues, one of the most respected research groups in glass and optical materials, are conducting cutting-edge research that is attracting ever-increasing support from many agencies. But what is most impressive about Professor Martin's group is its remarkable degree of "vertical integration"; high-school interns work side by side with post-docs. Steve has a special talent for infusing everyone in the group with excitement for their research.

In preparing our students for the profession, our faculty are implementing state-of-the-art learning techniques. The article on WebCT is one such example. **Professor Constant** is contributing leadership by providing a better learning experience to our students. The article on our Executive-in-Residence Program is another example. We are eternally grateful to the Industrial Advisory Council members and their companies for allowing them to share their experiences and points of view with our students.

Finally, please join us at our reception in Nashville on April 28th at 6:00 p.m. in Checkwood A Room if you are attending the American Ceramic Society conference.

These are exciting times for the department. And it is a great time to be associated with the MSE department!

Mufit Akinc, Professor and Chair

Bruce Thompson elected–

Continued from page 1

During Thompson's tenure at ISU, the CNDE has established itself as the world's foremost NDE research center. From an original base of 14, today more than 20 companies and government agencies support the center's "generic pre-competitive research" on a subscription basis.

Thompson began working in NDE as soon as he left graduate school in 1971, applying his expertise that had been originally developed using ultrasonic phenomena in signal processing devices. He was first employed by the North American Science Center (later acquired by Rockwell International), which, in Thompson's words, was originally a "basic research think tank." However, circumstance soon changed, and attention turned to practical topics such as using ultrasonic waves to detect flaws in materials. "I thought that would be an interesting way to take the experience I had in ultrasound and use it for a totally different application," he recalls.

While at North American, Thompson met and worked with CNDE founding director Don Thompson (no relation) on the Air Force/DARPA project that eventually would take both of them to Iowa State. "We had a large contract to develop a science base for NDE," Thompson says. "Our job was initially to develop a new technology. However, as the program matured, the need evolved to include working with companies to disseminate the technology and also train students. None of this was easily done within the confines of one particular company."

That emphasis on combining fundamental and applied research applies today at CNDE, though the center's focus has had to change with a changing geopolitical climate.

"When we came here," Thompson points out, "defense was the major driving force. But in 1989 the cold war ended, with decreases in DOD budgets and a tremendous contraction in the defense industry. Our direction clearly had to change. About the same time other problems became more noteworthy, one of them being the problem of aging aircraft."

The terrorist attacks of 2001 arguably present another sea change in the profession's focus. And while much of the emerging homeland security equation will address biological and chemical issues, Thompson says, "another component having to do, for example, with improved x-ray systems to screen people in airports, or to examine the contents of containers for metallic objects, will certainly drive new research in that area."

As one of the world's foremost experts in NDE—and now as one of the nation's top technology advisors to the government—Thompson will be in a key position to help shape the nation's response to future threats. "We're watching carefully as problems become defined," he says. "And as they become defined with sufficient precision, we want to be part of the solution."

MSE, *college reach for the top*

If MSE Chair Mufit Akinc has the look of a satisfied man, he probably deserves it.

After all, although it has only one-tenth of the college's faculty, materials science and engineering brings in almost one-third of the research dollars—nearly $15 million a year—to Iowa State's College of Engineering. And while faculty collegewide average only 1.6 doctoral students each, MSE faculty average about twice that number.

MSE's classroom instructors routinely surpass 4.0 on a scale of 5 on both graduate and undergraduate evaluations. And the department has maintained these levels of student satisfaction while doubling enrollments and research expenditures over the past six years.

However, Akinc is not a satisfied man: successful people seldom are. "One area we're not as great as we could be is the number of Ph.D.s we produce every year," Akinc remarks. "Our graduate program is not where we should be. We need to improve."

Although ISU's College of Engineering has long been in the nation's top 10 engineering schools in terms of undergraduate enrollment and the success of its graduates, Dean James L. Melsa's recently announced "Reach for the Top" campaign seeks to position the college among the nation's top 20 in terms of combined undergraduate and graduate education. MSE's success may serve as a model for the effort.

MSE has for years exhibited the kind of forward-looking, collaborative focus that other departments in the college are now adopting. Especially significant, Akinc says, is the department's involvement in research centers and other extra-departmental collaborations.

"We are very much of a collaborative mindset," Akinc observes, "and we are the leaders in getting large groups doing outside research. Half of our faculty or more are doing research through Ames Lab or IPRT centers, including CNDE."

Outside collaborations notwithstanding, Akinc realized long ago what most successful leaders know: you're only as good as the talent you attract. And Akinc has attracted some of the best. Not least among these is the department's director of graduate education, **Vladimir Tsukruk.**

"Tsukruk is one of the most successful ones, and we hired him three years ago," Akinc notes. "Right now he has 12 graduate students and two post-doctoral associates."

That's a high bar for any researcher to clear. And while Tsukruk doesn't necessarily hold his colleagues to his own exhausting pace, he nonetheless agrees with Akinc that, if the department is going to meet its goals, MSE faculty will have to produce even more—and better—students on both the graduate and undergraduate levels.

Because of increased security measures since the terrorist attacks of 2001, however, the market for good international students has tightened considerably, Tsukruk says, with visa delays running two to three times longer than before 2001.

"It's a critical impact," Tsukruk notes. "Usually, we have 50% or more international students, and we take 15–20 new graduate students per year. But now we have problems with visas. In the past, we would have one or two students denied per year; recently we are experiencing five or six."

Professor Tsukruk with grad student Melburne LeMieux

Discovering opportunity where others might see only barriers, Tsukruk and the department answered the challenge in part by redoubling efforts to recruit domestic graduate students. They've increased marketing, with mailings to every materials department in the country. And, after surveying graduate compensation at other top departments, they leveraged external funding to restructure their own stipend system, making it more attractive for prospective graduate students.

In addition, the department is restructuring the Ph.D. qualifying exam, increasing the emphasis on lab research instead of classroom work. "It was pretty tough several years ago," Tsukruk admits. "Students were required to take 36 credit hours of classes—three years of classes and nothing in the lab." The goal, he says, is to shorten the path to the Ph.D. from six to five years or less after the B.S. degree.

Tsukruk stresses that these increased efficiencies also apply to undergraduates and points to the department's concurrent B.S./M.S. program as an example. "We take the brightest undergraduate students," Tsukruk says, "and enroll them in the master's program as well. Now 5–6 undergraduates per year elect this track."

Following Akinc's example, however, Tsukruk assigns proper credit for this success as well, pointing to the efforts of MSE Assistant Chair Larry Genalo in recruiting a growing and ever-more qualified base of undergraduate students to feed into the program. "He's been doing a great job," Tsukruk acknowledges.

"It's our people who have achieved this," Akinc concludes. "And part of the credit should go to Dean Melsa, who brought the vision, brought the excitement, showed the direction, and gave us the tools to achieve these goals."

IAC member and Caterpillar product manager ***Michael Readey*** chats with MSE students and staff

Beyond advice:

MSE's Executive-in-Residence Program
brings industrial savvy to the classroom

Previous IAC Executive-in-Residence:

Donald Bray, Poco Graphite

Dean Wiley, International Technologies, Consultant, Inc.

Everybody, it seems, has advice for you. And while that's often useful, sometimes you need people to go the extra mile and offer some hands-on help.

Enter MSE's Industrial Advisory Council (IAC). More than advice, over the past few years the council has developed, in conjunction with the department, an Executive-in-Residence Program that goes beyond academics to introduce MSE students to the ins and outs of engineering as a profession.

Typically, an IAC member will spend the better part of a week on campus, visiting classrooms, sitting in on the meetings of student organizations, and even making himself available to students individually during office hours. MSE Associate Professor **Alan Russell** is an enthusiastic supporter of the program and is quick to point out the very real benefits it offers students.

"Not only do the executives talk about the technical aspects of their work, which brings in the fundamental concepts we've been trying to emphasize," Russell says, "but the students now see this in a real-world perspective. Equally valuable, they spend a fair amount of time just talking about the structure, politics, and interpersonal dynamics of what it's like to work in industry."

"Until they get that first co-op assignment, most of our undergraduate students have little or no experience in a working engineering environment," Russell adds. "They're really kind of hungry for direct reports from the battlefield."

IAC member and Caterpillar product manager **Michael Readey** is MSE's most recent executive in residence, having visited Iowa State just last fall. In a very real sense Readey is the program's ideal visitor: not only does he have an extensive resume in industry, he spent a number of years in academia himself, both as a recruiter for Northwestern and Georgia Tech and on the faculty of Carnegie-Mellon University in Pittsburgh.

Perhaps due to his considerable academic experience, Readey is quick to acknowledge the importance of solid work in the classroom in preparing students for engineering careers. However, he notes, most coursework is theory-based and doesn't really give students enough exposure to practical engineering issues. As a result, he feels many undergraduates have an uninformed notion about what materials engineers actually do.

"One of the big shocks for students when they get into the industrial world," Readey says, "is that they're here to make money, not to do scientific experiments. They need to have that appreciation of engineering as a compromise between the perfect technical solution to a problem and what's affordable."

Despite a stretch as a university professor himself, Readey doesn't work a classroom from notes or even come in with predetermined topics. "I don't have a set presentation or agenda," he says. "I talk through certain life experiences I've had, and how the things I learned in school helped me out—and some of the things I wish I'd learned in school!"

Foremost among the latter, according to Readey, is the business of engineering. "I always recommend they go and take some aspect of a finance class that teaches them about money issues," he says, "because, while students get the technical idea from their course work, they're rarely exposed to the economic side of engineering."

But despite everything the visiting executives give MSE students, participants are quick to acknowledge they get something in return.

"Rarely do I get a chance to spend 48 hours in front of 200 students who can all become potential job candidates in the next year or two," Readey says. "If I can get Caterpillar's name out there as a company that's doing some fascinating things in materials, then I've increased the probability of getting some top-notch students from ISU—and that's always a good thing."

Staff addition

Joshua Klesel *joins the MSE family as a systems support specialist. He graduated from Iowa State University with a B.S. in management information systems (MIS) in December 2002. He worked as an hourly student for the department from 1999 through 2002. His duties include administration of all computational equipment for the department including managing the MSE student computer lab and maintaining the new MSE Web site.*

Professor Martin's research group

Martin's team is developing a class of glass electrolyte separators to substitute for the polymer-based electrolytes used in conventional earthbound lithium batteries.

Anyone who thinks research and teaching are from different planets hasn't considered the planet Professor **Steve Martin** and his student researchers are coming from: namely Venus, where NASA plans to land a rolling lab to explore the planet's surface.

Like your cell phone, NASA will use lithium batteries to power onboard tools of the Venus probe. Unlike your cell phone, though, NASA's equipment has to function in temperatures upwards of 450° C.

Enter Martin's researchers, who are developing a class of glass electrolyte separators to substitute for the polymer-based electrolytes used in conventional lithium batteries. Specifically, a project on fast ion conducting (FIC) glasses by graduate student **Jason Saienga** and undergraduate **Bryce Campbell** will provide battery chemistries that can withstand conditions in Venus' hot and aggressive environment.

Saienga thinks their glasses are up to the job. "While they don't melt to a liquid until 800 or 900 degrees Celsius," he says, "we have obtained glasses with a high temperature stability limit of ~300°C, combined with high Li-ion conductivity. Now we're optimizing our compositions to push temperature limits even higher."

"Ion-conducting glasses have been known for awhile, but these applications are very new," Martin observes, adding that some batteries currently on the market—hearing aid and watch batteries, for example—operate with glasses in them. "The reason we're working on glasses is because our applications are fairly exotic," he adds.

While the team's FIC research may begin with NASA, it hardly ends there. They are collaborating as well with the Netherlands' Delft University in a project to use batteries in telemetry applications for drilling rigs, where extreme temperatures at the drill head are common. Team members are also working with Poly Plus, a Berkeley, California-based firm, to develop thin glass films to supplement polymer-based electrolytes common in consumer-grade batteries.

According to Martin, ions returning to the lithium metal anodes (the negative terminal of the battery) in standard polymer electrolytes during recharge tend to form sharp dendrites that gradually push through the electrolyte. In turn, the dendrites eventually short-circuit the battery over repeated recharging cycles.

Professor Martin and grad student Jason Saienga

MSE sophomore Melissa Grimsley

"Poly Plus wants us to develop a new glass chemistry we can put on top of the lithium metal, between 10 and 100 microns thick," Martin says. "And since glass is relatively durable, lithium dendrites can't grow through it or don't even grow at all. So batteries last longer." Also, using protective glass films, he adds, batteries have the potential to hold higher and longer charges.

Under the direction of Martin and collaborator Professor Alan Constant, undergraduates **Dan Palan** and **Matt Larson** are designing a sputtering system to form these glass compositions into the thin films required by Poly Plus. "Dan and Matt have done a superb job of building a state-of-the-art sputtering system on a shoestring budget," Martin says.

Martin's team conducts research at different levels, from the basic science of how ions conduct through various glass mediums to the highly specific applications sought by NASA, Delft University, and Poly Plus. "We have three levels of research in our group," he says. "Graduate students **Ben Meyer**, **Qiang Mei**, and **Wen-Long Yao**, and undergraduate student **Melissa Grimsley** work on very basic science: 'Just how do ions wiggle through these solid materials?' Then there's Jason and Bryce's project, funded by NASA Glenn. They're interested in the fundamental aspects of ion conduction, but they've got some targeted guidelines, so that bridges the gap between basic and applied research. At the third level are the NASA JPL Venus Lander and Dan and Matt's Poly Plus project—these are highly targeted, with specific, mission-oriented goals we have to meet."

This balance and range of investigation, moreover, is reflected in the makeup of Martin's research team, which includes six undergraduates, eight graduate students, and three postdocs. In fact, Keokuk native Grimsley began doing advanced research with Martin under the auspices of the Society for Women in Engineering's summer intern program when she was still a student in high school.

They are all, Martin says, full collaborators. "I don't consider my students as subordinates; they're colleagues" he stresses. "I give them tremendous responsibility for their projects. That fosters independence and entrepreneurship."

No 'Dogging'
course assignments with WebCT

Dog ate your homework? Uh-huh. Well, in today's on-line classroom, Fido would have to take some pretty big bytes. And if you're in Professor ***Kristen Constant's*** *ceramics processing course, you'll need another excuse.*

Welcome to WebCT, an on-line tool that allows instructors to transfer course content and delivery to the Web. Constant has used the product for two years, and though initially somewhat labor intensive, software improvements have now made it a valuable classroom tool.

"What's powerful about WebCT," Constant says, "is that if someone has access to the Web, they have access to the course." And since it is Web-based, it's unnecessary to purchase or manage software. From syllabus to exams, all course content can be accessed through the browser interface.

The course is set up on the WebCT server (sorry, no dogs allowed) by the instructor, who creates whatever filters may be necessary either to restrict or permit student access to various areas of the on-line "classroom." And with the program's management tools, Constant can easily determine what's working on the site, and what's not. "I can tell how many times students have logged on, how many articles they've read, and how many they've posted," Constant relates. "I can also tell where they've been."

Still, WebCT doesn't give unmotivated students opportunities to shirk they wouldn't have otherwise. For instance, while Constant makes her class notes available on WebCT, she used to do so even before going online. Besides, she adds, those who take advantage of WebCT tend to be among her better students.

Another benefit, Constant notes, is how the relative anonymity of the Web encourages interaction among people who might not participate in classroom discussions otherwise. For example, Constant's WebCT homepage features a discussion board that allows students to communicate with her and each other.

"Say it's 11 o'clock at night, and a student can't figure out a problem," Constant says. "Well, he can go to the message board and figure out the answer with another student's help." Also, she adds, advanced messaging functions called "white boards" allow for real-time communications that one day could replace the physical classroom altogether.

Still, don't look for that to happen anytime soon. Constant structures her courses to encourage maximum face-to-face interaction. WebCT is merely supplementary, she says, a tool to enhance student participation. "It simply facilitates communication," Constant stresses. "Students say things through WebCT they would never say to my face."

Except, perhaps, for that line about the dog.

(For more information about WebCT, visit the site at http://www.webct.com)

Excitement grows as Hoover nears completion

Already at the forefront of research and teaching at Iowa State, the Department of Materials Science and Engineering has set its sights on becoming an even more highly recognized materials program at the national level. First-rate programs, however, demand first-rate facilities in which to conduct state-of-the-art research and teaching.

That's about to happen, as construction crews put the final touches on Hoover Hall this summer for a fall dedication on Saturday, October 4, 2003 . And MSE faculty and students couldn't be happier.

"Hoover should have a huge impact on this program," says Professor Vladimir Tsukruk. "Now, for example, in the polymers program you have to do one kind of experiment over here, one over there. Here, you will have a specifically devoted space, a huge lab for polymers and related experiments. This will be very important."

Named for Gary Hoover, BSME'61, and his wife Donna, who provided a leadership gift of $3 million for the project, the building will feature multidisciplinary labs, including a fabrication lab, a mechatronics lab, a 400-seat auditorium, and four large classrooms.

In addition to flexible spaces that can be assigned as workgroups and technologies evolve, the new facility will better centralize members of the department currently working elsewhere on campus. Such concentration, MSE Chair Mufit Akinc suggests, will significantly improve collaboration among faculty, resulting in even better productivity. That's a benefit, he says, that will pay dividends for students as well.

"Hoover will give our students access to the kinds of facilities just not available in a shared building," Akinc notes. "They will have their own lounge and other spaces where they can interact outside of labs or classrooms. The facility will be a powerful recruiting tool to bring the best MSE students possible to Iowa State."

A remaining challenge, however, is to furnish the department's new home with equipment as up-to-date as its surroundings. Observes Tsukruk, "It makes no sense to bring twenty-year-old stuff to a new building. So the equipment committee is doing a lot of work, trying to find donations and submitting proposals."

Check the Hoover progress at www.eng.iastate.edu

Honors and Awards

Honors and awards accrued to various MSE faculty, staff, students, and alumni over the past academic year.

2002

Professor and MSE Chair **Mufit Akinc** was elected to the Executive Council of the University Materials Council.

Alumnus **Paul Berge** (BSMetE'88/MS, MSE'94) received the Lloyd E. Anderson Superior Service to Industry Award.

Associate Professors **Michael Conzemius** and **Surya Mallapragada** were designated the first recipients of the Bailey Research Career Development Award.

Distinguished Professor of MSE **Karl Gschneidner** was named a Fellow of the American Physical Society, as well as receiving the Federal Laboratory Consortium's Mid-Continent Award for Outstanding Regional Partnership.

Professor **David Jiles** was selected for both *Who's Who in America* and *Who's Who in Science and Engineering*.

Rachel Neuendorf (BSMatE'02) won Second Place in the American Ceramic Society Student Speaking Contest.

Professor **Vitalij Pecharsky** received the Federal Laboratory Consortium's Mid-Continent Award for Outstanding Regional Partnership.

Adjunct Assistant Professor **John Snyder** was selected for *Who's Who in America*.

2003

Assistant Professor **David Cann** won the Engineering Student Council Outstanding Professor Award.

Associate Professor **Brian Gleeson** was elected Vice Chair of the Gordon Research Conference on High Temperature Corrosion.

MSE staff member **Josh Klesel** received the Engineering Student Council Outstanding Service Award.

MSE Researchers Garner Patents

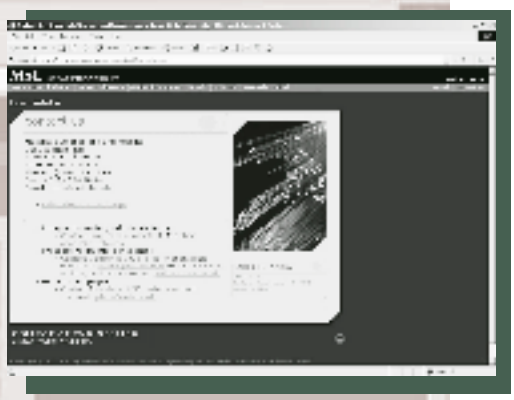
MSE faculty and alumni continue to set the pace for patents awarded in the College of Engineering.

MSE alum and Ames Lab Assistant Scientist **Matthew Besser** (BSCerE'94, MSMSE'02) received two patents, both with MSE Adjunct Professor **Iver Anderson** and MSE Adjunct Assistant Professor **Daniel Sordelet** listed as co-inventors. The first patent was for a "one-piece, composite crucible with integral withdrawal/discharge section"; the second was for a "thermal sprayed composite melt containment tubular component," together with the method for making the component.

Sordelet was awarded a patent in his own right for an "abrasion-resistant coating," along with the method for making the coating. Sordelet's patent recognizes **Besser** as co-inventor.

Finally, Adjunct Professor **R. William McCallum** was awarded a patent for his "material for magnetostrictive sensors and other applications based on ferrite materials." Co-inventors on McCallum's patent are Adjunct Assistant Professor **John Snyder** and Professor **David Jiles**.

MSE *to launch redesigned Web site*



Maybe you've seen Web sites that haven't been updated since the millennium ("Y2K" disclaimers are dead giveaways). MSE hasn't been that negligent, but we think we can do better. The department has therefore taken a proactive approach to Web site design and maintenance, including hiring an employee responsible for the site.

Josh Klesel, systems support specialist, worked with **Matt Wills** (Mat E 4) to design our new site, to be launched this spring. Klesel believes one key to any successful Web site is participation, so he conducted focus groups to make the site more user friendly. Innovations feature high interactivity, including message boards, online forms, and the ability to customize site format for individual use.

The new site also allows alumni to create and/or update personal information online, as well as search for other alumni in the database. This feature will replace the Cyber-contacts that have been previously printed in *Elements*. Alumni may access this feature through the MSE homepage via the People or Outreach pages, or by linking directly to **http://www.mse.iastate.edu/alumni/**.

Klesel plans continuous maintenance of the site, and, along with departmental secretary Krista Briley, will be able to add, edit, and delete materials instantaneously, ensuring the accuracy and timeliness of information.

Be sure to check out the new homepage later this spring at **www.mse.iastate.edu**, and let us know what you think!

Your help matters . . .

The MSE department also welcomes alumni donations. Your contributions help fund student facilities and projects, scholarships, lab equipment, faculty teaching and research, and department activities.

Name _____ E-mail _____

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Send your information to: MSE Department, Iowa State University
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Fax: (515) 294-5444
Web site: www.mse.iastate.edu/alumni

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JOIN US IN NASHVILLE!

ACerS MSE Alumni and Friends Reception

Monday,
April 28, 2003
6:00–7:30 p.m.

Gaylord Opryland Nashville Resort
Checkwood A Room
Nashville, Tennessee

The American Ceramic Society

MSE ELEMENTS

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The Newlyweds:

Tom and Dottie McGee were married on March 15, 2003. We wish the happy couple all the best in their new life together.

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