MATERIALS SCIENCE AND ENGINEERING DEPARTMENT

IOWA STATE UNIVERSITY

MSE ELEMENTS

Vol. 11, No. 1

vertically ○ integrated ○ design ○ courses at Iowa State

As students begin to analyze the problem, a hierarchy of mentoring gradually takes shape.

Undergraduate courses bring industry research to classrooms

An innovative set of courses, implemented last fall semester in the MSE department, is introducing undergraduates as early as their sophomore year to the intricacies of industry workplace dynamics.

Vertically integrated design courses, developed by MSE faculty **David Jiles, Mufit Akinc, Kristen Constant, Bruce Thompson, Steve Martin,** adjunct ME faculty **Joseph Gray,** and Ames Lab scientist and adjunct MSE faculty **Bulent Biner** have sophomores, juniors, seniors, and graduate students working together in teams on industrially relevant research problems posed by companies like John Deere and Maytag.

Here's how it works. Students register for the integrated course appropriate to their level. They're then divided into teams with representation from each level. Each team is assigned a project, for example, researching John Deere's corrosion resistant alloy development or Maytag's new enamel formulation or solving a problem in breaking a component.

As students begin to analyze the problem, a hierarchy of mentoring gradually takes shape. Graduate students function as "coaches," while seniors take on leadership roles in establishing and maintaining effective communication between team members. Juniors learn to apply practical skills, contributing as working engineers. And sophomores get a first-hand look at juniors and seniors using their practical engineering know-how to complete advanced technical tasks.

All this is accomplished within the existing curriculum by adding three courses—starting from the sophomore through senior years. While working on the projects, students have direct contact with industry representatives, who communicate with their research team through weekly e-mail progress reports. At the end of the semester, students make final presentations.

A compelling reason to incorporate industry-related work dynamics into the MSE curriculum was a result of growing industry concerns, said MSE Chairman Akinc. Employers were very satisfied with the technical capabilities of students, but frequently complained about their limited communication skills and teamwork concepts.

Although the senior capstone design course in the MSE curriculum currently addresses this concern, MSE faculty and the department's Industrial Advisory Council partners were keen to expand its scope and outcome. "Our approach is to give students an early start in learning design skills instead of waiting till the end," said Akinc.

Moreover, senior design teams are comprised of students with similar skills and grasp of subject matter. A vertically integrated sequence of design courses, on the other hand, brings together a diverse range of skills and knowledge, challenging students to assume different roles and responsibilities, from apprentice to lead engineer, over a course of three years.

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Greetings from the MSE department!

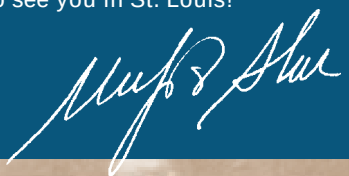
What an exciting and busy six months since the last ELEMENTS issue.

By the time you receive this newsletter, we will have just completed the MSE department's accreditation visit by ABET. As I write this letter in early September, we have completed our preparation and are anxiously waiting for the visit. As you may know, the ABET 2000 criteria are based on a continuous improvement philosophy and demonstration of outcomes. So even though the ABET visit and report will be completed this fall, we will be continuously working toward improving the curriculum using the feedback from the student forum that was held at the end of Spring '99 and the faculty retreat at the beginning of this fall semester.

The graduate studies committee under the leadership of David Cann, Director of Graduate Education for MSE, revised the graduate degree requirements. Although the restructuring process went smoothly and quietly, the implications of this change in our graduate program will be profound. Briefly, the new guidelines reduce the required coursework for the Ph.D., put the diagnostic qualifying exam at the front end of the program, and demand a more active role by the students in the whole process. I believe these changes will produce the following benefits: early diagnostics to guide the students properly, more time for research and hence shorter time-to-degree, increased research productivity, and improved efficiency in graduate course offerings. An interview with Professor Cann provides more detail on the graduate program changes on page 3 of this newsletter. As always, we welcome your comments on these changes in the graduate program.

Just a few weeks ago, Dr. Ralph Napolitano joined our department as a tenure-track assistant professor. We are delighted to have him join our faculty. Dr. Napolitano teaches in the metallic materials area. His research interest is in dynamics of experimental and computational solidification microstructures. Some consider him to be a protégé to Professor Rohit Trivedi. You can read more about Ralph on page 5 of this issue.

As we have done for several years now, we will host a reception at the TMS/ASM annual meeting on October 9th from 6:00 to 7:30 p.m. in the Rose Garden, 4th level, Adams Mark Hotel. Come and join us—meet our future engineers. I hope to see you in St. Louis!



WEB brings microscopes to teachers

Each year, science teachers come to Iowa State during the summer for a look at materials science. This year, they got a closer look than usual.

The 39 participants at the Materials Science and Engineering Workshop for High School Teachers used a custom-made Web site to remotely operate a scanning electron microscope. Now that the teachers have returned to their classrooms, they and their students can use the microscope via the Internet for classroom activities.

Two grants from the National Science Foundation have made this remarkable tool available. The first helped pay for the microscope and the Web software. The second is providing funds to introduce the concept of scanning electron microscopy into science methods classes in the College of Education's Department of Curriculum and Instruction. Both have been co-authored by MSE Associate Professor **Scott Chumbley.**

Chumbley teaches the annual workshop, which he says "is part of our plan to get high school science teachers to know more about materials science." This year, he adapted the workshop to focus on the microscope as a classroom tool.

"We are coming up with lesson plans for teachers to use," Chumbley said, "and they will be posted to the Web site for teachers to download." Chumbley hopes to have 200 lesson plans on line. And it won't cost the teachers a penny.

"We won't charge them to use the microscope via the Web page," Chumbley said. "They can even download the Web browser." The MSE department, which charges researchers $35 an hour to use the microscope, will cover the costs.

The department has Assistant Engineering Dean **Loren Zachary** to thank for funding this year's workshop. Through an NSF grant of his own, Zachary teaches a five-day summer course in engineering mechanics to elementary and high school teachers. One of those five days was spent at Chumbley's workshop.

"The engineering mechanics course focuses on macroscopic properties, so it was an interesting switch to examine the microscopic," Zachary said.

The science of ART

When **Rohit Trivedi** gazes at a metal sculpture, he appreciates more than its aesthetic qualities. His eye discerns processing techniques handed down from generation to generation. Today's artists and artisans use these techniques with metals and ceramics, although many aren't aware of the science involved.

MATERIALS in ART and TECHNOLOGY

Trivedi, Anson Marston Distinguished Professor of Materials Science and Engineering and a senior scientist at Ames Laboratory, is trying to bridge that gap. He wrote ***Materials in Art and Technology***, a book describing the evolution of materials processing techniques dating back to the discovery of fire.

"Many of the techniques we use today were developed very early in civilization," Trivedi says. "Casting, joining, forging—all of these techniques were nicely developed by early artisans. We have only perfected these techniques."

Trivedi notes that craftsmen—not scientists—were the first to take advantage of the properties of metals and ceramics. He marvels at their ingenuity in learning to manipulate the materials. "In some cases, they did things that we could not reproduce," he says.

Rohit Trivedi

His book is based on a college course he taught for 20 years after listening to an Iowa State art teacher describe problems in producing metal castings on cloudy days. Trivedi explained that the problem wasn't the clouds—it was the hydrogen present in humid air, which caused bubbles in the metal. The teacher asked Trivedi to teach his students the basics of materials science; the class soon gained popularity throughout the campus.

"The challenge was to put together this course without using mathematics or complex science because the students hadn't taken those types of courses," he notes. "I tried to separate scientific concepts from mathematical equations so that they could learn science through the ideas rather than formulas, and that's what appealed to them."

Revised graduate program is broader and more flexible

The MSE undergraduate program recently added polymers and electronic materials to its traditional study of metals and ceramics. This fall semester, to complement the changes in the undergraduate curriculum, the graduate program is undergoing a similar reorganization.

By broadening the graduate program requirements and areas of emphasis, the department will better reflect the new research areas in polymers and electronic materials. At the same time, the graduate program will also attract non-MSE graduates in related disciplines, such as chemistry, physics, and chemical engineering.

Under the new guidelines, students will take a reduced course load, giving them more time to focus on research. To accomplish this, the program has been front loaded so that they will take all courses and exams during the first two years, followed by research leading to their thesis or dissertation.

"A change to the graduate program was primarily needed to make it easier for students to specialize in more areas of materials science," said **David Cann,** MSE assistant professor and graduate program coordinator. "We're trying to format our program to attract our students from a broader base," he said.

The new Ph.D. preliminary exam will have students taking a choice of 4 out of 5 components that cover all of the fundamental areas of materials science. "This added flexibility will attract students from nontraditional disciplines," said Cann, "while allowing them expanded options to choose within the field of materials science."

Astronaut addresses MSE scholarship recipients at awards ceremony

More than 30 Iowa State University students were honored at the annual Materials Science and Engineering Awards Program, held last spring at the Iowa State Center. The students received a total of nearly $110,000 in departmental scholarships.

The ceremony included the presentation of two special awards. Andrew Schultz, now a graduate student at Penn State University, received the Outstanding Senior Award. Laura Keehner, a senior from Monona, Iowa, earned the Student Leadership Award for her outreach and student organizations activities.

More than 100 people attended the event, which included a special program on the international space station by NASA astronaut Dr. Sandra Magnus. Dr. Magnus, who earned a Ph.D. at the School of Materials Science and Engineering, Georgia Institute of Technology, is working on space station projects while awaiting a flight assignment.

The honorees included 10 National Merit/Achievement Scholars who receive full or partial tuition and board as long as they maintain a certain grade point average.

Materials Engineering Alumni Scholarship Recipients:

($500, sponsored by the general MSE alumni scholarship fund)

Adam Buckalew, Hamburg, IA
Matt Cambronne, Finlayson, MN
Bryce Campbell, Omaha, NE
Kristin Johannsen, Rockford, IA
Meagen Marquardt, Boone, IA
Chad Martindale, Ottumwa, IA
Carlson Schindler, Ottumwa, IA

National Merit/Achievement Scholars:

(full or partial tuition, room, and board)

Brent Andrees, Farmington Hills, MI
Brynne Kriegermeier, Woodstock, IL
Jeffrey Leib, Maryland Heights, MO
Richard Lewis, Omaha, NE
Nathan Lubbs, Oswego, IL
Justin Peters, Council Bluffs, IA
Colleen Prosser, Florissant, MO
Amber Schneeweis, Grand Rapids, MI
Alan Tkaczyk, Carmel, IN
Paul Tomlinson, Eagle Grove, IA

Additional scholarships:

Frank S. McCutcheon III Scholarship — **Justin Riney**, Keokuk, IA
(Full in-state tuition to a junior or senior student from Iowa with a metallurgy emphasis)

David R. Wilder Scholarship — **Andrew Manning,** Waterloo, IA
(Full in-state tuition for students in Materials Engineering)

Deere & Company Scholarship — **Stephanie Connor,** Willmar, MN
($2,500, open to all engineering majors who are women or minorities)

Murray Gautsch Scholarship — **Gabriel Weigelt,** Blair, NE
($1,900, open to all students in Materials Engineering)

Clarence H. Ford Scholarship — **Jonathon Goldie,** Omaha, NE
($1,700, open to all engineering students)

David C. Moll Scholarship — **Rachel Neuendorf,** Tripoli, IA
($1,500, open to all junior and senior engineering majors)

E-Week Scholarship — **Kevin Sutherland,** Cedar Rapids, IA
($1,500 recognizing leadership and participation in campus organizations)

Roderick Seward, Flossie Ratcliffe, & Helen M. Galloway Scholarship
($1,300, open to all engineering majors with financial need who graduated from an Iowa public high school) **Cara Taylor,** Cedar Rapids, IA; **Joseph Schramm,** Dyersville, IA

Otto & Martha Buck Materials Science & Engineering Scholarship
($1,000, open to all students in Materials Engineering) **Amy Palecek,** White Bear Lake, MN

Paul E. Morgan Scholarship — **Michael Krashin,** Overland Park, KS
($1,000, open to all engineering majors who are women or minorities)

Frank Kayser Memorial Scholarship — **Jon Ihlefeld,** Muscatine, IA
($750, open to all students in Materials Engineering with a metallurgy emphasis)

David T. Peterson Memorial Scholarship — **Darrel Enyart,** Postville, IA
($750, open to all students in Materials Engineering from Iowa or Minnesota)

Samuel Walker Beyer Scholarship — **Bryan Baker,** Ottumwa, IA
($500, open to all students in Materials Engineering)

MSE student is first woman to win award

The first female recipient of the annual $20,000 Catron Fellowship is an MSE student who used her experience in a fast-food restaurant as the springboard to a career in teaching and research.

Jane Clayton, who will graduate in May with a combined B.S./M.S. degree, began her studies at Iowa State in '95 as a part-time student following eight years as general manager at a McDonald's in Iowa City. Her decision to study engineering was a logical one, she says.

"In my previous role, I fixed a lot of equipment, which intrigued me," says Clayton. "But when I couldn't fix something, I called in a service person—the guy we used just happened to be an ISU engineering graduate. I was really jealous of his expertise and I wanted to be like him. For me, it wasn't enough just to troubleshoot a problem. I wanted to understand the entire problem—how something worked, what made things go wrong, what were the best solutions."

Clayton became a full-time pre-engineering student in the fall of '96. By spring '97, she had decided on MSE as her major area of study; she entered the combined B.S./M.S. program in the fall of '99.

Clayton plans to pursue a doctoral degree in MSE. Her ultimate goal is to teach and do research at a major university, where she hopes to encourage women and under-represented minorities to pursue engineering careers. Her research area is transparent conducting oxides, which are used in solar cells and other devices that convert energy from the sun. Her research was key to her eligibility for the Catron Fellowship.

The fellowship has been awarded annually since 1987 to students researching practical ways to use solar energy. The late William (BSEcon'31) and Lenore Catron, formerly of Sunland, California, established the grant. Clayton is the 11th recipient of the prestigious award, which is administered by the Institute for Physical Research and Technology.

"It's something really great to put on my resume," Clayton says. "I'll also be able to attend at least two important conferences, and that's something that most students don't normally get to do."

Napolitano joins MSE faculty

Ralph Napolitano is the newest member of the MSE faculty but he's hardly new to the Iowa State campus.

Napolitano has been an associate scientist at Ames Lab since October 1998. In August, he became an MSE assistant professor. Prior to his arrival in Ames, he was an NRC post-doctoral fellow at the National Institute of Standards and Technology in Gaithersburg, Maryland.

In his new role, Napolitano advises four graduate students and teaches one class. He also does research in physical metallurgy and solidification with a special emphasis on understanding the dynamics of microstructural transformation.

Napolitano has received numerous honors for professional and academic service. Most recently, Georgia Institute of Technology named him to the Council of Outstanding Young Engineering Alumni. He has served as chair of the central Iowa chapter of ASM International, co-organizer of a TMS symposium on defects in solidification processing, and organizer of a NIST-CTCSM workshop on processing of wrought iron alloys. He has contributed to seven publications and given numerous presentations.

A 1989 graduate of the University of Florida, he earned his master's and doctoral degrees at the Georgia Institute of Technology. He worked as a nuclear engineer at Charleston Naval Shipyard, Charleston, South Carolina, and as a research engineer at Lynchburg Research Center, Lynchburg, Virginia.

His family includes wife Dawn and their 10-month-old daughter Anna. They reside in Ames.

Accepted a courtesy appointment with MSE

Surya Mallapragada, **assistant professor of chemical engineering, joined the MSE faculty this summer.**

The appointment came as MSE expanded its curriculum to offer more options. Students may now earn a materials engineering degree while specializing in two of four areas: polymers, semiconductors, metallurgy, and ceramics.

Mallapragada works extensively with polymers in her ChE research. She helped develop the polymer curriculum in MSE and will be available to work with MSE graduate students who wish to focus on that area.

Continued from page 1

Undergraduate courses with industry research

In fact, these courses also have the potential to be continued as senior design projects, added Akinc, where students will benefit from continuity and knowledge they have acquired as sophomores and juniors.

A central component of a vertically integrated course is the involvement of industry. This fall semester, supported by a $440,000 National Science Foundation grant, MSE faculty will move to the next phase by partnering with Iowa State's Center for Nondestructive Evaluation to include a combined research curriculum development component to the integrated courses. Students will get hands-on experience with design problems, using advanced computer simulators developed by CNDE that assist in design, development, and inspection of components and materials.

The thought processes in NDE add an extra dimension to research problems, according to Jiles, MSE professor and principal investigator of the grant. "In approaching a design problem, most of our students think in a linear fashion as they stack up all properties necessary for a performance," he said. "When working with computer-aided software, however, they'll have to think beyond initial design and development, venturing into issues of inspectability, detection, and analysis."

"This type of learning involves taking a fresh approach to teaching for what is a vital part of the MSE curriculum," said Jiles. A vertically integrated sequence of courses through three levels offers this unique opportunity for faculty to not only teach design early, but give it a practical emphasis supported by active industry involvement.

Both Jiles and Akinc stress the crucial role that industry plays in sustaining these courses. "We're always looking for exciting projects and industrial involvement," said Akinc. So far, enthusiastic responses this semester from industries like Rockwell Collins, Sperry, Siemens Westinghouse, 3M, and RD Tech in Toronto, Canada, to name a few, will allow students to work on a broad range of projects from designing portable electromagnetic inspection units for inspecting rail heads to ultrasonic classification systems that detect gas pipeline weld defects.

"From the students' perspective," said Jiles, "the knowledge and experience that these projects bring will be just as invaluable as the contacts they establish with industry early in their academic career."

MSE engineering professor elected Fellow

Iowa State University Professor **Thomas D. McGee** was honored with the title of Fellow of the National Institute of Ceramic Engineers at the group's annual meeting, held recently in St. Louis, Missouri.

McGee, who has a joint appointment in the department of materials science and engineering and the department of biomedical engineering, was cited for his sustained service in representing the institute on the Accreditation Board for Engineering and Technology, where he was a board member for six years.

The citation also recognizes McGee's leadership as director of the American Association of Engineering Societies and his service as president of the institute. McGee has served on Keramos (Ceramic Engineering Honorary/Professional Fraternity) for over 25 years, first as an advisor to the Iowa Chapter and later as General Secretary of the organization, a position he filled for several years.

Currently, McGee is editor and chair of the engineering publication committee of the American Ceramics Society. He conducts pioneering research on ceramics for orthopedic surgery repair. He is also involved in collaborative research with Veterinary Clinical Sciences at Iowa State University.

Gschneidner honored for career in science

Karl Gschneidner, Jr., Anson Marston Distinguished Professor of Materials Science and Engineering and a senior metallurgist at Ames Laboratory, was named Science Alumnus of the Year 2000 by the University of Detroit Mercy's College of Engineering and Science.

Gschneidner received a bachelor's degree in chemistry at the University of Detroit in 1952 and earned his Ph.D. at ISU in 1957. He is a leading expert in rare-earth metals and alloys, the theory of alloy phase formation, and magnetic refrigeration. He has published nearly 300 journal articles and 115 book chapters and has written or edited 33 books.

In 1997, Gschneidner received a Materials Sciences Award from the U.S. Department of Energy for the advancement of magnetic refrigeration research. He has also received the William Hume-Rothery Award for contributions in the science of alloys; the Frank H. Spedding Award for distinguished contributions in his field; the Russell B. Scott Memorial Award for best research paper; and the ISU David R. Boylan Eminent Faculty Member Award in Research.

Gschneidner is a Fellow of two materials science societies—The Minerals, Metals & Materials Society and ASM International.

Honors and Awards

Nicole Cavanah
Graduate student, industrial advisory council member
BSCerE'93
Engineer of the Year Award for Rockwell Collins
For distinguished contributions in the development and implementation of advanced manufacturing technology in microelectronics.

Stephanie Connor
Undergraduate student
Delegate to the Leadershape Institute
Selected as one of six ASM International Foundation student delegates for demonstrated academic abilities, campus activities, and community service.
Outstanding Scholar Award
Received one of the three awards given by the ASM International Foundation.

Kristen Constant
Associate professor
Superior Engineering Advisor Award
Was recognized for her excellent advising skills in helping more than 100 students make important academic choices. Also served as a member of the college's advising committee and in 1997 helped restructure the MSE advising system.

Alan Russell
Associate professor
Superior Engineering Teacher Award
In a teaching career that spans 23 years, Russell has touched more than 2,000 students, who consistently gave him the highest student evaluations in the MSE department.

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Working with Cummins Engine Company as an advanced materials engineer in the Fuel Systems Division.

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Jeffrey G. Greiman
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Involved with the design and development of thin-film magnetic tape heads for future DLT tape drives. Current work includes developing giant magnetoresistive (GMR) thin-film stacks for read sensors. Also involved in developing thin high moment magnetic films and structures for shields/poles, which are used in the write process. Areas of interest include physical vapor deposition of magnetic and dielectric thin films, ion beam etch processes for defining microstructures, and the metrology of thin films.

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Alumni Reception at the TMS Fall Meeting

Monday, October 9, 2000

6:00 - 7:30 p.m.
Rose Garden, 4th level
Adam's Mark Hotel

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2000 FALL CONFERENCE

Iowa Science Teachers

Thursday, October 26, 2000

Polk County Convention Complex

ISU Family Weekend

October 6-8, 2000

Homecoming

October 19-21, 2000

IOWA STATE UNIVERSITY