

## Influx of new faculty points to opportunity for MSE



Dr. Michael Rigsbee  
MSE Dept. Head

Dear MSE Alumni and Friends:

NC State's Department of Materials Science and Engineering (MSE) continues to evolve and grow, with new faculty, new areas of research and improved teaching infrastructure. In this letter, I highlight some of the ways in which the department has grown during the current decade.

In 1999 the 20 MSE faculty included only three associate professors and no assistant professors. Since then we have hired 11 faculty at the assistant or associate professor level, and nine faculty members have left the department, mainly through retirement. In the past two years six faculty members have joined MSE, significantly expanding our opportunity for future research programs.

Those joining the faculty in 2007-2008 were Dr. Yuntian Zhu, an associate professor whose specialty is deformation physics of nanoalloys and carbon nanotubes; Dr. Yaroslava Yingling, an assistant professor who specializes in molecular modeling and nanobiotechnology; Dr. Joe Tracy, an assistant professor who works with magnetic nanoparticles and composite magnetic materials; and Dr. Tom Rawdanowicz, a research assistant professor whose expertise is in electron beam analytical instrumentation and whose research centers on opto-electronic materials.

### Targeted growth areas

Joining the faculty at the opening of the current semester were Dr. Anatoli Melechko, an associate professor who specializes in synthesis and functionalization of nanostructured materials and in nanobiotechnology; and Dr. Doug Irving, an assistant professor who focuses on large-scale atomistic simulations of materials in extreme environments.

These new faculty members integrate well with the range of critical research areas targeted for growth by the College of Engineering. We are excited about the new capabilities for teaching and research that they bring to MSE.

I am also very pleased to announce that Dr. Don Brenner, Dr. Carl Koch and Dr. Zlatko Sitar will be honored this fall with endowed Kobe Steel Distinguished Professorships in Materials Science and Engineering. NC State received funding from Kobe Steel in 1988 to establish an endowed materials science and engineering professorship, which was held by Dr. Bob Davis until his retirement in 2004.

With growth of the endowment and the approval of Kobe Steel, we have been able to expand the number of Kobe Steel Distinguished Professorships and honor three of our most productive senior faculty. This brings the number of endowed and named professorships in the MSE department to five.

### Renewable energy research center

In recognition of the quality and potential of the faculty, students and staff in the NC State College of Engineering plus the vision and hard work of a core set of faculty and senior administration, the National Science Foundation announced its approval in September of an Engineering Research Center devoted to developing a Future Renewable Electric Energy Delivery and Management (FREEDM) system.

This is a five-year, \$20 million dollar grant, which can be renewed for an additional five years. Dr. Mark Johnson, an MSE associate professor, played a key role in securing the grant with his compound semiconductor research and with his leadership in assembling more than 50 companies who will participate in the center with the intent of transfer-

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New MSE faculty: Dr. Doug Irving (left picture) describes computers used in his research and Dr. Joe Tracy (right) works in his lab

## New NSF center to revamp power grid for green energy

With the skyrocketing cost of energy, putting solar cells on your roof may seem to make sense, but what if you want to sell your excess electricity back to the power company?

Dr. Mark Johnson, MSE associate professor, is helping to set up a new engineering research center (ERC) at NC State that will tackle this issue and others posed by the introduction of alternative sources of electricity into the power grid. The ERC, which will be devoted to developing the Future Renewable Electric Energy Delivery and Management (FREEDM) system, will be funded primarily by the National Science Foundation (NSF) and will be housed in a building to be constructed on Centennial Campus.

Connecting renewable energy sources to the conventional power grid can't be achieved by simply flipping a switch. Johnson says the process will require a "paradigm shift" similar to the one that hit the world of computing with the arrival of the Internet, when the centralized computing structure of the mainframe era evolved into today's PC-based distributed model. Instead of relying entirely on enormous fossil-fuel or nuclear plants, the power grid of the future will take a greater percentage of its electricity from wind turbines, solar cells and other decentralized renewable sources.

The ERC has attracted researchers in materials science, electrical and computer engineering, computer science, textile

Dr. Mark Johnson, MSE associate professor and director of innovation and industry of the FREEDM system NSF center, says reconfiguring the power grid to accommodate alternative energy will require a "paradigm shift."



engineering, physics, mathematics and business management from NC State, other U.S. universities and institutions abroad. Johnson's materials expertise will enable him to help develop the improved solid-state switching devices required for a smooth transition to renewable energy. The currently available silicon devices can't tolerate the high temperatures common to power applications and are less efficient than those made of materials such as silicon carbide and gallium nitride. Materials issues must also be addressed in the development of new batteries and other advanced storage devices necessary for optimal deployment of green energy.

A five-year, \$20 million NSF grant, which can be renewed for an additional five years, will provide the principal financing. The NC State College of Engineering will be the lead institution for the ERC, and its director will be Dr. Alex Huang, NC State's Progress Energy Distinguished Professor of Electrical and Computer Engineering. In addition to his research activities, Johnson is recruiting industrial partners as the ERC's director of innovation and industry.

## Brenner, Koch and Sitar named Kobe Distinguished Professors

Three MSE professors—Dr. Donald Brenner, Dr. Carl Koch and Dr. Zlatko Sitar—have been appointed Kobe Steel Distinguished Professors of Materials Science and Engineering.



Dr. Brenner



Dr. Koch



Dr. Sitar

An endowment secured in 1988 led to the appointment of Dr. R.F. Davis as the first Kobe Steel Distinguished Professor, a position he held until his retirement in 2004. The endowment's growth since then was deemed sufficient to supplement the salary of more than one faculty member, enabling the appointment of Brenner, Koch and Sitar.

Brenner, whose specialty is computational materials modeling, joined the MSE faculty in 1994 as an associate professor and became a full professor in 2003. He holds a B.S. degree in chemistry from the State University of New York and a Ph.D. in chemistry from Pennsylvania State University. In

2002, Brenner won the prestigious Feynman Award for nanotechnology research.

Koch, who specializes in structural materials, joined the MSE faculty in 1983 as a full professor and has served as associate department head since 1990. He holds a B.S. degree in metallurgical engineering and an M.S. and Ph.D. in metallurgy, all from Case Western Reserve University. He is one of 100 materials scientists worldwide to be named a fellow of the Minerals, Metals and Materials (TMS) Society. In 2006 he received NC State's highest faculty honor, the Alexander Quarles Holladay Medal of Excellence.

Sitar, whose specialty is electronic materials, joined the MSE faculty in 1995 as an assistant professor, becoming an associate professor in 1998 and a full professor in 2002. He received B.S. and M.S. degrees in physics from the University of Ljubljana in Slovenia and a Ph.D. from NC State in 1990. He is currently director of NC State's Materials Research Center. Sitar has received the Entrepreneurship and Leadership Award as well as distinguished engineering awards from the Alcoa Foundation and the U.S. Office of Naval Research.

## New intro course designed to spur enrollment

**DR. MAURY BALIK**, DIRECTOR OF UNDERGRADUATE PROGRAMS



Dr. Maury Balik

Beginning this semester, we are offering an introductory course for freshmen that will help us persuade more undergraduates to choose MSE as their engineering major.

The course is listed in the catalog as "Engineering 101," which is the standard course that all freshmen considering an engineering major must take. With the cooperation of the College of Engineering, we have restructured one section of the course to focus on materials issues, which will allow us to show prospective engineers just how interesting and challenging a career in materials science can be.

I am teaching the first section of the introductory course, but I had plenty of help from other faculty members in designing a course that would pique the interest of the new crop of freshmen. Of course, we're also hopeful that some of them will decide to major in MSE and will spread the word to friends who haven't yet picked a major.

To keep things interesting, we're using plenty of demonstrations and some hands-on experiments that the students will do at their desks. For example, they're going to perform a stress/strain test on a rubber band from which they will calculate its crosslink density to learn about the molecular structure of the rubber.

In addition to offering this course for prospective majors, we are also in the process of overhauling our entire undergraduate curriculum. The first three courses in the new curriculum will be offered in spring 2009, and the rest will be phased in over the following two years. By spring 2011, all of the new courses should be available and all students matriculating at that point will be expected to fulfill the requirements contained in the new curriculum.

With the new curriculum, we are aiming for a more integrated approach in the teaching of materials science. A broader exposure to all materials will better enable our graduates to select the appropriate material for a particular application when they are working as materials engineers or conducting research in graduate school. Other undergraduate materials programs, such as the one at the Massachusetts Institute of Technology, have also adopted an integrated philosophy in developing their curricula.

### Letter from Dr. Rigsbee (continued from cover)

ring the technology to address our nation's expanding energy needs. The center will be based at NC State and will draw from the resources of multiple partnering academic institutions.

#### Stepping down in 2009

Finally, in summer 2009 I will step down from my administrative role as department head. Over the past 10 years (time really does fly!) it has been my privilege to serve the department, working with the generous support of the faculty and staff to strengthen and enhance our educational and research programs.

I look forward to new opportunities for

continued contributions to the department through teaching and research.

Sincerely,

Mike Rigsbee

## MSE Scholarships 2008-09

### ARAI Manning

Joshua Harris  
Robert Wilson  
Gabriel Olivero

### William Austin

Benjamin Baker

### Boeing

Zachary Howard  
Robert Wilson

### John A. Boren

Brian Bender  
Patrick Wong

### Caterpillar

Jonathan Baker

### Comstock

Eric Jones

### Cummingham

Timothy Clark

### Gettes

Sharon Licata

### John Deere

Jeanelle Todd

### Barry M. Goldwater

Lauren Jackson

### Mitchell

Brandon Findley

### MSE Freshman

Allam Arsheen  
Joseph Brookes  
Alan Collier  
William Griffin  
Krystian Kozek  
John Leonard  
Matthew Molnar  
Lydia Paulk  
Kenneth Plunkett  
Weston Straka  
Andres Vargas  
Dane Wallin

### MSE Leadership

David Hook

### Hayne Palmour III

Marcus Moore  
Justin Greene

### Martin Parcel

Katrina Zmithrovitch

### Progress Energy

Jenna Puckett

### Ed Scott

Justin Railsback

### Hans Stadelmeier

Evan Keresi

### Robert F. Stoops

Lisa Moll

## New faculty members expected to boost graduate student opportunities

DR. RON SCATTERGOOD, DIRECTOR OF GRADUATE PROGRAMS



Dr. Ron Scattergood

The recent addition of seven new MSE faculty members has enabled us to significantly enhance the diversity and strength of our graduate program.

The influx of new faculty started in 2005 with the arrival of Dr. Mark Luo, whose specialty is the emerging and important field of biomaterials. Then, in 2007 we added Dr. Yuntian Zhu, noted for his carbon nanotube research; Dr. Yara Yingling, who specializes in computational materials modeling with an emphasis on biomaterials; Dr. Joe Tracy, whose research focuses on the properties of nanoscale materials, and Dr. Tom Rawdanowicz, director of our analytical training and education center. With the opening of the fall semester, we're welcoming Dr. Tolik Melechko, who came from the Oak Ridge National Laboratory, and Dr. Doug Irving, a former MSE postdoc.

Yuntian and Tolik joined the department as associate professors, Mark, Yara, Doug and Joe are assistant professors, and Tom is a research assistant professor.

At the spring 2008 commencement, Brian Biagini and Kevin Bockenstedt made history when they received the department's first master's of materials science and engineering degrees to be administered through the College of Engineering's Internet-based distance education program. The new degree program, which requires the completion of 10 courses (30 credit hours), is designed to allow students maximum flexibility in choosing materials science courses and courses in related disciplines.

In a previous column, I noted that most new MSE graduate students were enrolling in our Ph.D. program. That trend appears to be continuing. Of the 76 students currently pursuing graduate degrees, 67 are Ph.D. candidates.

About two years into the pursuit of their degree, we require our Ph.D. students to pass a qualifying exam in order to continue in the Ph.D. program. Until recently, the exam took the form of a written test with questions drawn from designated, but not required core graduate courses. In 2005, we began giving Ph.D. candidates the option of drafting and presenting a research proposal to a faculty committee instead of taking the written test. They are also now required to complete a set of designated core courses. This format has been well-received by both the faculty and the Ph.D. students.

## RESEARCH

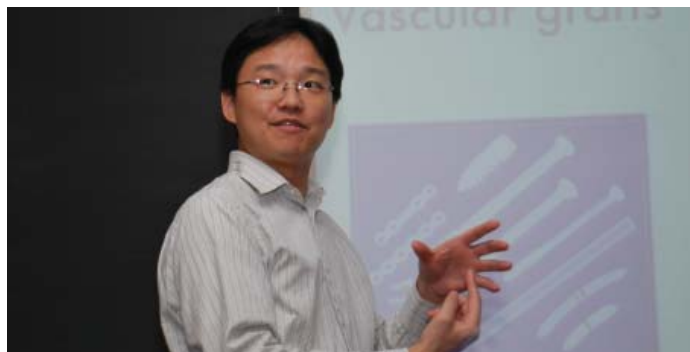
### Dr. Mark Luo's artificial bones may speed healing of fractures

To rejoin bone segments separated by severe fracture or the removal of diseased tissue, a surgeon has the option of inserting synthesized bone material in place of the temporary metal fasteners once commonly used.

Because production of these synthetic materials is still in its infancy, the artificial bone fragments used in surgical reconstructions are constantly being refined. Dr. Mark Luo, assistant professor of MSE, is currently developing a bone-graft material that would be more malleable, would promote faster healing and would cost less than currently available materials.

In addition to these benefits, the artificial bones developed by Luo would not need to be removed at the end of treatment. "They would be a sort of filler that would become integrated into the bone," says Luo.

A natural bone is principally composed of hydroxyapatite, which is a form of tricalcium phosphate, and collagen. The two principal components of Luo's synthetic bone material are hydroxyapatite and gelatin, a cheaper substitute for collagen. To



Dr. Mark Luo

this liquid solution, amino silane is added as a hardening agent.

Hardening of the solution occurs at room temperature, allowing the introduction of heat-sensitive antibiotics or other drugs during the manufacturing process. Luo is currently focusing his research on altering the non-porous material that results from the hardening process to a material that is more sponge-like. Increasing the porosity eases the integration of the synthetic bone into the body and enables greater absorption of beneficial additives.

Luo is conducting the research in collaboration with Dr. Ching-Chang Ko, a professor at the University of North Carolina School of Dentistry. Funding is from a \$200,000, two-year grant from the North Carolina Biotechnology Center in Research Triangle Park.

## MSE unit plans expansion as new opportunities open

The MSE department's Institute for Maintenance Science & Technology (IMST) is poised for a significant expansion as it moves much of its operations to Research Building II on NC State's Centennial Campus.

When the move to new quarters is completed, the IMST will occupy about 6,000 square feet of additional office and laboratory space while retaining most of its current space in Engineering Building I, also on Centennial Campus. One of the new labs is a two-story high-bay area, which will allow engineers to bring in equipment too large for the current labs.

This expansion comes at a critical juncture, says Roger Sanwald, an IMST co-director. Among IMST's clients are two major facilities for overhauling military aircraft - the Naval Air Depot at Cherry Point and the Coast Guard Aircraft Repair and Supply Center in Elizabeth City. The Army is now planning to expand operations at Fort Bragg, a development that Sanwald calls "not only a huge economic opportunity for the state but also an opportunity for the IMST."

Established in 2005, the IMST helps military and commercial clients maintain and upgrade aging equipment no longer supported by the original manufacturers. The IMST grew out of consulting work for Cherry Point by the multidisciplinary research team headed by Dr. Jerry Cuomo, Distinguished University Research Professor of Materials Science and Engineering and IMST co-director. Dr. John Strenkowski, associate dean in the College of Engineering and professor of mechanical and aerospace engineering, is also an IMST co-director.

The research conducted by IMST engineers leads to immediate solutions for prolonging the functional lifespan of



From left, IMST co-founders and co-directors Cuomo, Strenkowski and Sanwald examine a part taken from an aging military aircraft (Photo by Roger Winstead)

aircraft and land- and sea-based equipment owned by military and civilian clients. IMST engineers use next-generation technology and advanced processes and materials to produce urgently needed parts faster and cheaper than would be the case with traditional methods. They also provide characterization and testing to support the development of new materials processes and use the latest tools to simulate and characterize the mechanical behavior of parts and systems.

Though "Maintenance" is IMST's official middle name, it is apparent that the "M" could also stand for "materials" process development, improved "manufacturing" processes, "mechanical" characterization of parts and systems and of course, the "military," reflecting the IMST's longtime support for vital defense operations.

A parallel mission of IMST is to promote economic development by supporting military and commercial endeavors in eastern North Carolina. This matches the goals of the Golden Leaf Foundation, which awarded the College of Engineering a five-year, \$4.7 million grant, much of which has supported IMST in its startup phase.

## MSE team develops heat-resistant nano-iron alloy

The research team headed by Dr. Carl Koch, MSE professor and associate department head, and Dr. Ron Scattergood, MSE professor and director of graduate programs, has developed a nanocrystalline iron-zirconium alloy that is far stronger and harder than conventional iron and that retains these properties under extremely high temperatures.



Dr. Carl Koch

Their discovery opens the door to a wide variety of potential applications, such as engine components that are exposed to high stress and high temperatures.

The enhanced strength and hardness exhibited by earlier forms of nanoscale iron have been compromised by the fact that

the nanocrystalline structure breaks down at relatively modest temperatures. The iron-zirconium alloy developed by Koch's team can withstand temperatures above 1,300 degrees Celsius – approaching the melting point of iron.

Kris Darling, a Ph.D. student on the team, led the project to develop the material. He said the stability of the nanocrystalline structure under high temperatures will allow for the material to be produced in bulk using conventional manufacturing methods that rely on heat and pressure. Darling also said the material's stability at high temperatures will make it easier to fashion the alloy into tools or use it in structural applications such as engine parts.

The new alloy is also economically viable, since "it costs virtually the same amount to produce the alloy" as it does to create earlier versions of nano-iron, Darling said.

## Researchers' goal: boost solar cell efficiency

Dr. Nadia El-Masry, MSE professor, and Dr. Salah M. Bedair, professor of electrical and computer engineering, have won a \$1.4 million grant to conduct research aimed at boosting the energy yield of multijunction solar cells made of gallium arsenide.

They will collaborate on the research with Spectrolab, a subsidiary of Boeing that manufactures high-efficiency solar cells for the space program. Spectrolab scientists have developed a multijunction solar cell with an efficiency rating of 40.7 percent, according to company officials. The NC State research team aims to boost the efficiency rating of the Spectrolab cells to 45 percent.

Multijunction gallium arsenide solar cells are far more efficient than silicon cells, which have yet to reach 20 percent efficiency. Silicon cells, however, are much cheaper to produce, and this cost differential is the main reason multijunction gallium arsenide cells are used mostly in space. El-Masry said the efficiency gains achieved through this research project are expected to lower the energy costs sufficiently to make the gallium arsenide cells more competitive for earth-bound applications.



Dr. El-Masry

To increase the efficiency of the cells, El-Masry said, the research team will seek to develop a fourth layer for three-layer Spectrolab cells. Each layer of a multijunction cell is tuned to convert specific wavelengths of the solar spectrum into electricity. The extra layer to be developed by the team would receive the now unused 1.0 to 1.4 electrovolt portion of the spectrum.

Most of the money for the research grant is from the U.S. Department of Energy's Solar America Initiative to improve solar cell technology. The department is funding 11 solar cell projects around the country totaling \$13.7 million.

### Here's how to honor a favorite professor

If you would like to pay tribute to a favorite teacher in the MSE department, you might consider donating a brick in his or her honor for the memorial walkway in front of Engineering Building I, MSE's headquarters.



An MSE alumnus has already donated a brick honoring Dr. Tom Hare, a senior MSE lecturer who passed away in 2006 (see inset photo).

Each brick requires a \$150 donation, the proceeds from which go toward furthering the MSE department's educational and research missions. For further information, send an email to [mse-alumni@ncsu.edu](mailto:mse-alumni@ncsu.edu), subject line "Brick."



### Recognizing MSE benefactors

Dr. Tom Rawdanowicz, director of the MSE department's analytical training and education center, holds a plaque honoring the center's corporate contributors: Exxon-Mobile Chemical Co., Materials Analytical Service Inc., Shell Research, PPG Industries and Eastman Chemical Co. The center gives graduate and undergraduate hands-on experience in using such analytical tools as the transmission electron microscope.

## FACULTY & ALUMNI

### Narayan named to inaugural class of MRS Fellows

The Materials Research Society (MRS) has recognized Dr. Jay Narayan's career contributions to materials science by selecting him for the inaugural class of MRS Fellows. Narayan is the John C.C. Fan Family Distinguished Chair Professor of MSE and director of the NSF Center for Advanced Materials Science and Engineering. MRS is limiting each class of fellows to 0.2 percent of MRS membership, which now stands at 14,000.



Dr. Narayan

### Dr. John Russ puts intro course materials on CD

Dr. John Russ, MSE adjunct professor, has updated the course materials he developed more than a decade ago for introductory MSE courses. The updated materials, which feature video clips, graphics and animation, are now available on CD for Windows and Macintosh computers. Teachers of introductory materials science courses are invited to request a copy of the CD by emailing Russ at [john\\_russ@ncsu.edu](mailto:john_russ@ncsu.edu).

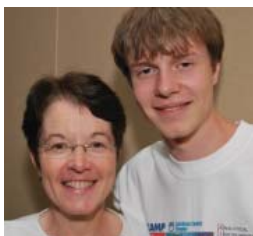
### Alumnus endows scholarship for MSE students

Tom Cunningham of Wilmington, an MSE alumnus, and his wife, Mimi, have endowed a scholarship for MSE students. The first recipient is Timothy Clark. The Cunninghams have also announced a \$1 million bequest to support various College of Engineering activities.

## Fourth Materials Camp draws 26 of best and brightest

This summer's Materials Camp, the MSE department's fourth annual weeklong outreach program for high-achieving high school students, gave 26 prospective materials engineers a chance to get their hands dirty and find out first-hand what materials science is all about.

A memorable moment was the second edition of the Great Silly Putty Drop, wherein a 30-pound ball of the malleable substance plummeted from the roof of the nine-story D.H. Hill Library. Though it might appear to have been a stunt (after all, the media were on hand for the occasion), the event did have a serious purpose from a materials perspective. It showed how a significant level of stress and strain—such as that resulting from a nine-story plunge—affects the behavior of a substance.



Two-time camper David Johnson with his mother, Sue Johnson

In this case, the giant ball of Silly Putty broke into much smaller chunks on impact. "The stresses were high enough that the Silly Putty shattered like a piece of glass," explained Roger Russell, an MSE staff member who supervised the drop and helped coordinate other Materials Camp activities.

The overall coordinator for the camp was Roberto Garcia, a researcher in the College of Engineering's Analytical Instrumentation Facility.

Other activities included an opening-day overview of materials science by Dr. Joe Fahmy, whose breezy style and enthusiasm also brightened the three previous Materials Camps. Following his usual practice, Fahmy eschewed the jargon of science and academia as he extolled the numerous materials-related career opportunities.

During the camp, participants got to observe the procedures and use some of the equipment typically encountered by materials engineers. For example, they analyzed their own hair with

### Would you like to attend Materials Camp '09?

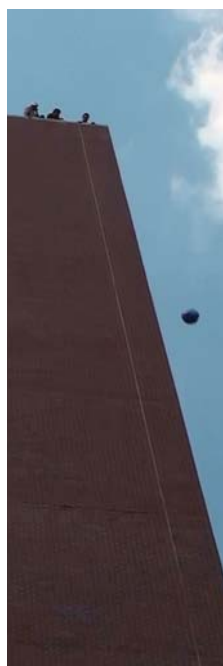
The MSE department and the NCSU College of Engineering are already laying plans for the fifth annual Materials Camp, which will be held in the summer of 2009. Like the earlier programs, the 2009 edition will be a weeklong residential camp for high school students considering a career in materials science and engineering.

If you are now a high school sophomore or junior who is interested in attending next summer's camp, please consider applying for a spot. The College of Engineering will begin accepting applications sometime in the spring of 2009.

The MSE department's Web site (<http://www.mse.ncsu.edu>) will provide details about the application process as they become available.



Roberto Garcia (right) assists Dr. Joe Fahmy with a demonstration; below, Silly Putty takes plunge; bottom, camp instructor Andy Newell shows camper Megan Kinneberg of Plymouth, Minn., how to operate transmission electron microscope



a scanning electron microscope, used a transmission electron microscope (TEM) to analyze gold particles and toured the State Bureau of Investigation's crime lab, Progress Energy's metallurgical lab and the university's "clean room," which is used in the development of semiconductors.

What did the campers get from their experience? David Johnson of Chapel Hill, who returned this year after also participating in 2007, said he picked up valuable knowledge at both camps. "Last year, they had us work on a project, and we focused on the tools required for that task," he said. "This year we learned a little bit more about materials as a program. We were exposed to stuff that wasn't covered last year."



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Please update your contact information. We would like to get e-mail addresses from all alumni. Please send this form to [mse\\_alumni@ncsu.edu](mailto:mse_alumni@ncsu.edu) or Campus Box 7907 NCSU, Raleigh NC 27695-7907.

Name \_\_\_\_\_ Degree & Class Year \_\_\_\_\_

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City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

E-Mail Address \_\_\_\_\_

Home Phone \_\_\_\_\_ Cell Phone \_\_\_\_\_

Company Name \_\_\_\_\_ Company Phone \_\_\_\_\_

Company Address \_\_\_\_\_



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