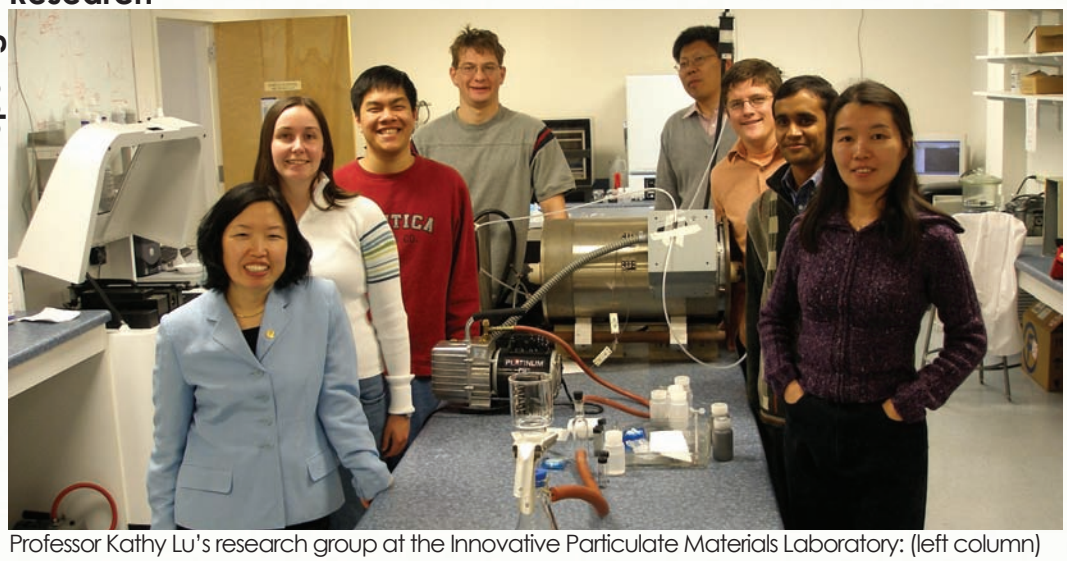
Exploring Materials at Virginia Tech

VirginiaTech Invent the Future

Spring 2007, Volume 10, Number 1

News from the Department of Materials Science and Engineering
Virginia Polytechnic Institute and State University

Spotlight **Research**



Professor Kathy Lu's research group at the Innovative Particulate Materials Laboratory: (left column) Kathy Lu and undergraduate students Elizabeth Logan, Kevin Yu, and Christopher Glomb; (right column) graduate students Xiaojing Zhu, Manoj Mahapatra, Chris Story, and Naili Yue.

Innovative Particulate Materials

Kathy Piezhan Lu

Particulate materials encompass extremely diverse ranges of chemical compositions and applications. From a materials point of view, processing of particulate based ceramic, metal, and/or polymer compositions is used to create a wide range of components with applications ranging from medical uses to electronics, to automotive, and to aerospace. Research on particulate materials is fascinating not only because of its complexity and versatility, but also because it allows one the means to independently organize microstructures on scales ranging from the single particle level to macroscopic components.

Conventional particulate-based material processing typically involves three steps: powder preparation (mixing, dispersion, etc), forming, and sintering. However, this approach usually suffers from non-uniform mixing, limitations to simple shapes, and difficulties associated with achieving fully-dense microstructures. In recent years, the fast advancement of nanomaterials and computing capabilities has brought unprecedented opportunities for particulate materials processing. At Virginia Tech, our efforts are focused on two areas: 1) nanoparticulate material assembly/patterning and 2) particulate material digital processing.

...Research Spotlight continued on page 14

What's inside

Discover what we're made of...
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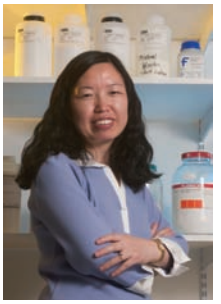
Border Image : Computer simulation of spinodal decomposition in a binary alloy.
Courtesy of Professor Yu Wang and graduate student Weifeng Rao

Research Corner



Meet Professor Kathy Lu

Professor Piezhan Kathy Lu, Assistant Professor of Materials Science and Engineering at Virginia Tech, begins this invitation to know her by quoting what her sister said of her not long ago: *"you are deeply rooted in who you are."*

Kathy came from a village, in Henan, China, where 85% of the population shares her last name. As the youngest child of five, she grew up in free spirit and was lucky enough to pursue whatever her interest was. With her good grades in math and chemisty, engineering seemed to be her natural career choice. But what truly won her over was the deep pride and spirit of serving people as an engineer, especially since she became the first engineer in her family.

With the freedom of having a relaxing family environment, and a father (her most influential person in her growing years) who had great admiration for knowledge and had unwavering support for whatever she did, Kathy had a wide range of options to explore her true interest. She did not feel any career limitation until she became a faculty member at Beijing University of Aeronautics and Astronautics after she received her first masters degree. Working in the same department with some of the renowned materials professors and many rising stars, it was very hard to envision that she could go much further without more advanced education and a new set of skills. The evaluation of her situation was an easy process; there was no place more fitting than getting a Ph.D. degree in the US. As a result, she enrolled into the materials Ph.D. program at Ohio State.

Professor Lu is proud to say that she is a materials veteran, "I have never changed my study, research focus, or working field in any fundamental way. Materials research is what I was trained for and what I love to do." The biggest change for her at that time was when she switched from ceramic systems to metal powder systems after joining Penn State for her post-doc work. However, she does believe in the importance of working in a slight different area. It offers a whole new perspective of addressing problems, designing materials, and improving performances. Materials is simply a fascinating field with endless possibilities. She says, "my fundamental belief is that there has never been a time in human history that does not rely on materials improvement to advance. It is like the air we breathe and the water we drink, we cannot live our dreams without up-to-expectation materials."

Currently, her research group focuses on nanomaterials and digital materials processing research. Her group mainly takes the advantages of advanced tools such as electron microscopes and computers to look at and manipulate things closer, as close as to nanometer scale, and to do things a bit smarter, as smart as directing the computer to do the things that our hands cannot get on. She adds, "As materials scientists and engineers, we are never short of 'recipes' or blueprints in materials selection and design, even though the guiding principles are just a handful. For me, that is the fascination of this discipline."

Kathy wants to share with everyone that we have to follow our passions. "This means that you find a passion first and then you follow it faithfully" she adds. Her first job was in academia, and it happened because it was the right decision at that time. After her post-doc work at Penn State, she gave herself the opportunity to say 'no' to certain prospects and took time to find her true passion; she took a job in industry, learned a lot, and met some very interesting people. But most of all, this job experience helped her find her true passion which was to come back to the academe.

As a female professor, people sometimes ask her to share her experience as a female engineer. "The best advice I can give is to have 'gender unawareness' first," she says. While engineering requires logical thinking and making decisions based on hard facts, the discipline is not gender-specific. With that being said, Kathy is a strong advocate of female engineering education. She believes that "females represent a vast but untapped resource for our society. Not fully utilizing their intelligence is a huge waste for mankind." One of her passions is to share and show every and each female student that the engineering door is wide open to them and they are fully entitled to enter and stay if this is their passion and they have the faith to follow their dreams. For this, she devotes time to C-Tech^2, a residential camp that focuses on attracting high school women who are rising juniors and seniors into engineering, and Hypatia, a theme program designed for the first-year engineering female students at VT.

Professor Lu is a strong believer of maintaining balance even though she doesn't know much about 'yin' and 'yang'. Job and family are equally important to her. Her husband, Jim, is a chemist, "He balances me out by collecting things that I send on the way to our trash can," she says. She also has a five year old daughter, Maggie, who wants to become a home builder so she can build rainbow houses. ❄

Before Professor Kathy Lu joined MSE at Virginia Tech in August 2004, she was a Materials Development and Processing Scientist at Energizer Battery Company from 2001-2004. She was also the Director of Materials Processing at the Center for Innovative Sintered Products at Pennsylvania State University from 2000 to 2001.

Professor Lu's research interest includes particulate materials synthesis, forming, and sintering, especially the design of specific microstructures and compositions for performance requirements. Her most recent research interests involve nanomaterials, solid oxide fuel cell materials, composites, powder materials characterization, and material processing related simulations.

Professor Lu is widely published, and a member of The American Ceramic Society, Materials Research Society, APMI International, and American Society for Engineering Education.

MSE Welcomes and Congratulates New Faculty, Research and Committee Appointments

New Professors

Two new faculty members will soon be joining the MSE Department. **Professor Paul Gatenholm** and **Assistant Professor Abby Morgan** have both been appointed as part of a Provost's cluster hiring initiative in bio-based materials and technology. Including the MSE additions, at least nine new faculty members have been appointed within the Departments of Biological Systems Engineering (BSE), Wood Science and Forest Products (WOOD), and Chemical Engineering (ChE) as part of this cluster initiative.

Professor Paul Gatenholm will be joining the MSE Department in the fall of 2007. He received his Ph.D. in polymer technology at Chalmers Institute of Technology, Götenborg, Sweden in 1985. He held a post-doctoral position at the University of New South Wales in Sydney, Australia, and various positions within the polymer related industry. In 1991 he spent a sabbatical year at the Center for Bioengineering, University of Washington in Seattle. He became professor at Chalmers in 1995, and served as the head of the Biobased Materials Group there. He has been a visiting professor at the Naval Research Laboratory, and an Adjunct Professor in Biomaterial Engineering at Virginia Tech. His current research interests involve the engineering of biopolymer technologies with a focus on material surfaces.

Dr. Abby Morgan will be arriving at Virginia Tech in the spring of 2008 as a jointly appointed assistant professor in the MSE and Chemical Engineering Departments. She received her Ph.D. in materials science and engineering from the University of Illinois at Urbana-Champaign (UIUC) in October of 2006. Her dissertation focused on a protein delivery system for improved bone healing. Dr. Morgan will be joining MSE and ChE in January upon completion of a post-doctoral appointment at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD.

New Research Assistant Professors

Drs. Jeff Schultz and **Shuxiang Dong** have been appointed Research Assistant Professors in the MSE Department.

Dr. Jeff Schultz has been working with Professor Steve Kampe as a post-doctoral research associate since 2004. Jeff has served as a Co-PI on several research projects and with a variety of sponsors including Aerojet Corporation, Touchstone Research Laboratories, and Oak Ridge National Laboratories (ONR). Jeff received his Ph.D. in 2003 in MSE under the guidance of Professor Ron Kander.

Dr. Shuxiang Dong joined MSE in 2002, working as a post doctoral research associate with Professor Dwight Viehland. With Dr. Viehland, Dr. Dong has participated in a variety of research projects involving magnetoelectric composite materials and devices, magnetostrictive and piezoelectric composite materials, high-sensitivity magnetic field sensors, current sensors, hydrogen gas sensors, transformers, gyrators, and low-temperature piezomotors. Over the past five years, he published about 40 journal papers and is a co-inventor on three US patents.

Other New Appointments

Dr. Sean McGinnis, Senior Research Associate in the departments of MSE and Biological Systems Engineering (BSE), and Director of the Virginia Tech Green Engineering Program, has been appointed to serve as a respresentative on the Mayor of Blacksburg's Task Force on Climate Protection and Sustainability. In November, the Blacksburg Town Council adopted a resolution calling for the town to work in conjuction with ICLEI (International Council for Local Environmental Initiatives) and other appropriate organizations to track progress and implementation of the U.S. Mayor's Climate Protection Agreement.

For more info about the VT COE Green Engineering Program, visit

www.eng.vt.edu/green

Professor Alex Aning has been appointed as the Chair of the College of Engineering Diversity Committee. His responsibilities will include recruiting new members for the committee, setting goals and preparing the annual summaries of findings and progress. For the first half of the year, the committee's work focused on increasing the undergraduate application pool of minorities in the college. For this spring semester, the committee is set to discuss recruitment, retention, and other diversity issues related to minority graduate students and faculty. The committee also plans to discuss and evaluate the current diversity strategic plan of the college.

Department News

The Office of the Vice President for Research recognized MSE professors **Gary Pickrell, Levon Asryan,** and Engineering Education Assistant Professor **Marie Paretti** as **Faculty Scholars of the Week** for their excellent research contributions.

Assistant Professor **Gary Pickrell**, was recognized in November for his work in the development of novel optical fiber structures and for his research of NanoBiomaterials.

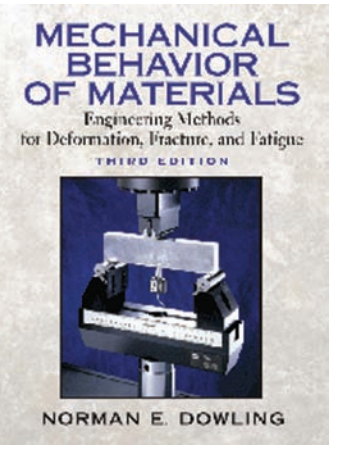
Levon Asryan, Associate Professor, was recognized in August for his theoretical research in optoelectronics and nanoelectronics, particularly on semiconductor lasers with a quantum-confined active region.

Marie Paretti, Assistant Professor of engineering education and the director of the MSE/ESM Engineering Communications Program, was named Faculty Scholar of the Week in February for her research on learning and teaching professional skills in engineering curricula, global virtual teams, capstone design classes, workplace communication in the curriculum, and assessment of engineering learning. ❄

The **Piedmont Chapter** of the **American Foundry Society (AFS)** held its annual meeting at the Virginia Tech Skelton Alumni Conference Center on November 16th. Several MSE students and faculty were present at the evening's dinner where AFS Student Chapter President Andrea Rojas and AFS member Devin Crawford were awarded scholarships. ❄

Virginia Governor Tim Kaine visited Virginia Tech on October 4th to attend the dedication ceremonies for the Micron Semiconductor Processing Laboratory. In addition to providing a grant that assisted in the completion of the laboratory, Micron Technologies of Virginia (Manassas, VA) sponsors yearly scholarships for students of MSE, ECE, and ChE with career interests in microelectronics. Micron presently employs several alumni from MSE at their Manassas, VA facility. ❄

(from l-r) Dr. David Clark, Dr. John Walz (ChE), and Governor Tim Kaine



Professor **Norman Dowling** has recently completed the 3rd Edition of his eminently popular **Mechanical Behavior of Materials** text (Prentice Hall, 2005, ISBN 0-13-186312-6). The text is presently used by over 50 departments nationally and many more internationally. Professor Dowling has a joint appointment in the Departments of Materials Science and Engineering and Engineering Science and Mechanics. ❄

THE MSE-VT STARS Connection Continue

For the second summer in a row, MSE hosted a group of high school students exploring careers in science and engineering. The Virginia Tech Training Academy for Rising Students (VT STARS) program invites qualified middle school students, many from Virginia's southside region, to campus to spend two weeks learning about professions that use science and mathematics. The MSE group performed a variety of hands-on experiments including metallography of cast irons (**Professor Steve Kampe**), metal casting **(Paul Huffman,** MSE Advisory Board member and president of Dominion Metallurgical Inc.), ceramics (**Diane Folz,** senior research associate), rapid prototyping (**Professor Kathy Lu**), biologically-derived micro- and nano-porous materials (**Professor Gary Pickrell**), and nanomaterials (**Andrea Hill and Dr. William Harrison of Nanosonics, Inc).** Also **Dr. Joerg Jinshcek**, (Research Assistant Professor), gave the students a guided tour of the Field Emission Scanning Transmission Electron Microscope (FEI Titan**)** Laboratory**.** These demonstrations were assisted by MSE graduate students, and facilitated by MSE senior, **Olisa Pinto**.

VT STARS students cast medallions in a metallurgy demonstration.

ICTAS Update: The Nanoscale Characterization and Fabrication Laboratory (NCFL) at Virginia Tech *by Bill Reynolds*

The Nanoscale Characterization and Fabrication Laboratory (NCFL) at Virginia Tech is beginning to take shape. Once only a concept advocated by MSE Department Head David Clark and others on campus to facilitate cutting-edge experimental research, the NCFL is now part of a new building located in the Corporate Research Center adjacent to Virginia Tech's campus in Blacksburg. Operated by the University's Institute for Critical Technology and Applied Science (ICTAS), the realization of a University-wide characterization laboratory has been one of the highest priorities of Dr. Roop Mahajan, the new ICTAS Director, whose vision is to provide researchers with the critical tools needed to work in bio- and nano-related technology. The building that houses the laboratory is nearing completion, and installation of the new instruments will start in April.

ICTAS A is currently nearing completion within the Virginia Tech Corporate Research Center. This building will house the Nanoscale Characterization and Fabrication Facility (NCFL).

The NCFL building is special; it includes 16,000 square feet of laboratory space on the first floor designed to house the sensitive instruments used to image, analyze, and manipulate materials and devices at the atomic level. To work at that extremely small size scale, the instruments must be protected from even very small changes in room environment.

courtesy of www.fei.com

Field Emission Transmission Electron Microscop(FEI Titan)

To this end, the NCFL rooms were planned to minimize interference from building vibrations, stray electromagnetic fields, and temperature fluctuations. Many of the instruments are accompanied by loud ancillary equipment like pumps and water chillers, so service chaises adjacent to the instrument rooms were constructed to house and isolate the noisy supporting equipment. The first floor also has chemical hoods, chemical storage, and waste marshaling facilities for hazardous materials, and a detached loading dock to keep heavy trucks away from the building foundation. The second floor will house computer facilities with instrument-specific software, offices for instrument scientists and visiting researchers, research clusters (for graduate students and post-docs), and a conference room for short courses, instruction, and presentations.

When fully operational, the NCFL will operate as a service center with a cost structure tailored to serve the needs of researchers from Virginia Tech and from the industrial community. The facility will be staffed with instrument specialists who will operate the equipment and train university researchers in their use.

State-of-the-Art Instrumentation

Some of the equipment for the facility includes instruments currently located in buildings around campus, but more than $5M of new equipment will be installed as well. In total, the NCFL will house research equipment valued at approximately $10M. Instruments that will move from campus to the NCFL include:

- a **field emission transmission electron microscope (FEI Titan)**, a state-of-the-art microscope capable of resolving features below a tenth of a nanometer and collecting structural and chemical information from the inside of thin samples
- a **multimode atomic force microscope and nanomanipulator** for probing the mechanical behavior of surfaces and devices smaller than the eye can resolve
- a **field emission scanning electron microscope** used to resolve surface features several nanometers in size.

courtesy of www.fei.com

Environmental Scanning Electron Microscope (Quanta 200)

New instrumentation that will be installed soon include:

- a **secondary ion mass spectrometer** capable of detecting trace elements with parts-per-billion sensitivity
- an **x-ray photoelectron spectrometer** for quantitative characterization of chemical elements and chemical states of the top few monolayers of the surfaces
- an **environmental scanning electron microscope** for investigating

...continued on page 15

Education Corner

Professor Kathryn Logan and Distance Learning Education in MSE

As the Virginia Tech Langley Professor, Professor Kathryn Logan advises graduate students in residence at the National Institute of Aerospace (NIA) in Hampton, Virginia. Her joint appointment as a professor advising undergraduate/graduate students on the Tech campus in Blacksburg requires her to be co-located both at NIA and on the Virginia Tech campus. She typically spends three weeks out of the month in Hampton and the remaining week on the campus in MSE. In order to teach and conduct research while maintaining the two geographically separate assignments, virtual communications is an absolute necessity.

NIA (www. nianet.org) is a non-profit research and graduate education institute formed by a consortium of research universities to ensure a national capability to support NASA's mission by expanding collaboration with academia and leveraging expertise inside and outside NASA. NIA performs research in a broad range of disciplines including air traffic systems, aviation safety, flight systems, materials and structures, space exploration, and atmospheric sciences. The institute's graduate program offers M.S. and Ph.D. degrees in the fields of engineering and science through its university partners: Georgia Tech, Hampton University, North Carolina A&T State University, North Carolina State University, the University of Maryland, the University of Virginia, Virginia Tech, Old Dominion University, and the College of William & Mary. Each university partner has established its presence on the NIA campus by appointing a Langley distinguished Professor. Professor Logan represents Virginia Tech in this capacity.

The MSE department immediately recognized the benefits of broadening the education and research opportunities that could be provided by NIA, but needed a way to make it happen. Professor Logan was appointed as the chair of the distance learning committee for the graduate program. This appointment gave her the responsibility to develop the department's virtual access to the numerous exciting opportunities being created by the NIA. At the same time, she took the additional responsibility of chairing the Langley Professor's Distance Learning committee at NIA.

As one of her first priorities towards establishing virtual contact between NIA and Virginia Tech, Professor Logan developed two new graduate level courses that are open to all disciplines, as well as to exceptional seniors: MSE 5624 Design of Materials and MSE 5634 Design with Materials. The classes originate wherever she is located. Whether at NIA or on the campus, the link is made by using videoconferencing which is bridged together by the facilities at NIA and Virginia Tech. Both the NIA and campus classrooms are occupied by students and Professor Logan is facing both "live" and "remote" students real-time depending on her location during the particular class. All students, whether in the virtual or live location, can see and hear Professor Logan, the other site's students, and any on-screen presentations that are used during course delivery. Students can register for the courses through the campus timetable of classes, via VT OnLine (www.vto.vt.edu) and/or at NIA.

Both Virginia Tech and NIA have been very proactive in identifying and implementing state-of-the-art distance learning software and hardware. Nonetheless, Professor Logan is constantly seeking to improve it. For example, she is initiating an effort to increase the availability of distance learning in materials related courses in all departments in the College of Engineering by coordinating the development of a five-year plan of courses that will be offered at a distance. This initiative will open more opportunities for students to complete a Virginia Tech degree completely off-site, as well as providing campus students with access to NIA resources.

Research is also a major component of education. Professor Logan's research interests include the design of, and the design with, multifunctional aerospace materials. She operates research laboratories both at LaRC and Virginia Tech and conducts group meetings as well as lab sessions at a distance. Her six graduate and two undergraduate students interact with her and each other synchronously between NIA and VT on a weekly basis. She has also established a mechanism where students can set up a laboratory webcam to allow Professor Logan to observe their labwork and communicate with them virtually. At one point, she was able to link Virginia Tech's Associate Dean for Research Edmund Henneke from his campus office with students conducting an exciting lab experiment in the Applied Research Laboratory of Jefferson Labs in Newport News. Professor Logan, herself, was also off-site in Georgia during the demonstration. She was able to coach the students at a distance, Dean Henneke was able to view the interesting experiment and

the students could share the excitement of their research, despite all being geographically separated.

While the added dimension of distance learning can be a challenge for instructors, Dr. Logan sees the benefits of distance learning. "I see a strong potential to increase the depth of learning experiences by using the distance learning media," says Professor Logan. "I'm an action person; I take advantage of the available resources and use them with an objective of making the distance learning classroom as similar to the traditional classroom teaching environment as possible. Many resources exist; they simply need to be implemented." Through distance learning, Professor Logan sees ample opportunity for the sharing of resources, such as the way NIA is sharing expertise among its members and affiliates, in classrooms and in laboratories.

Professor Logan currently has a number of plans to implement more Distance Learning opportunities in education and research. For example:

- make the Friday MSE seminars available to NIA students, as well as make the NIA seminars available to the campus.
- develop working group websites to allow ongoing communication and sharing of documents, such as that already established for the Multifunctional Aerospace Materials Research Group (MAMRG), the main Logan research group; the Multifunctional Materials Working Group (MMWG), an MSE-based working group co-chaired with Professor Steve Kampe; and the Center for Multifunctional Aerospace Materials (CMAM), a national working group with members from academia, government and industry.
- seek more opportunities for virtual laboratory experiences.
- continue to strive to make the Distance Learning environment as "real" as possible.

Meet Kathryn Logan

Kathryn Logan began the process of becoming an engineer when she entered Georgia Tech fresh out of high school. She was one of 100 female students amongst 5000 males in the student body. Kathryn met her husband Steve (ME'70/GIT) on the Saturday before the first day of classes. It was an interesting sojourn where women were expelled if they wore slacks when the weather was above 32°F. She majored in Ceramic Engineering and actually received one of the last Bachelor of Ceramic Engineering degrees. Her diploma was printed on sheepskin (one of the last times before diplomas were printed on paper).

After receiving her bachelor's degree, Kathryn was offered a job at the Engineering Experiment Station (the forerunner of the Georgia Tech Research Institute). In her job interview, one remarkable question was "Can you type?" Her answer was "No" (and she still can't type). Kathryn got the job and began her professional career as an "Engineer--with a capital E." She conducted research in a number of interesting areas: ferrites, bio-ceramics, high temperature diffusion, materials characterization.

Her career has included an exciting 32 years at Georgia Tech where she obtained her Master of Science in Ceramic Engineering and Ph.D. in Civil Engineering (Mechanics of Materials). She held a number of positions in the Georgia Tech Research Institute during her tenure. When she retired from Georgia Tech in 2002, she became President of the American Ceramic Society (member since 1967). She had previously served as President of the National Institute of Ceramic Engineers (NICE) and is Fellow of both organizations. In fact, she is a very "NICE Fellow."

Professor Logan has served on a number of National Research Council Committees and Boards. One significant memorable experience occurred when she was a member of the Board on Army Science and Technology (BAST). "It has been my fervent desire to drive a tank since my research involves the development of ceramic tank armor." The opportunity came when several of the Army generals who also served on the BAST overheard Professor Logan make the statement to a colleague. It was then arranged, to the surprise of Kathryn, for her to learn how to drive an M1A1 tank at Aberdeen Proving Ground. She now has a signed certificate that proclaims "Certified driver of an M1A1 Abrams Tank."

The offer to be the Virginia Tech Langley Professor came one month after completing her term as President of the American Ceramic Society. "They made me an offer that I couldn't refuse." It's my capstone job; a job where I can use the culmination of my entire career experiences in a unique teaching and research environment."

Kathryn has two children: Stephanie, formerly a Mission Control Specialist at Johnson Space Center who is now a stay-at-home mom taking care of Kathryn's three beautiful grand children; and Bill, a Fireman Lieutenant Emergency Medical Technician. Kathryn has many hobbies: gardening, sewing (quilting and machine embroidery), and jewelry making (lampworking, metal working findings and cabochons). She has also dabbled in caving and artistic roller skating (she won first place in a dance competition). She and husband Steve also "collect" MGs. Steve is in charge of keeping the sports cars mechanically sound, and Kathryn is in charge of unit beautification.

Student News

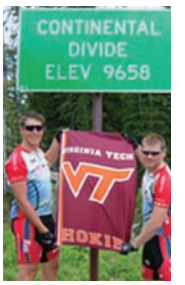
MEPS Receives Awards at the 2006 Materials Science and Technology Conference

In October, the VT-MSE Materials Engineering Professional Societies (MEPS) group received one of five Outstanding Materials Advantage Chapter Awards at the 2006 Materials Science and Technology (MS&T) Conference held in Cincinatti, Ohio. The Awardees are selected based on the content of a yearly chapter report that summarizes the chapter's activities and accomplishments over the previous year. The VT report highlighted MEPS activities that included assisting the department with recruiting, hosting the COE/MSE football tailgates, participating in the publication of the *Journal of Undergraduate Materials Research* (JUMR), outreach activities, and winning Virginia Tech's E-week for the third straight year. This is the second year in a row that MEPS has been awarded one of these highly competitive awards.

Also during conference, MEPS president **Jennifer Mueller** was awarded second place in the highly-competitive Materials Advantage student speaking contest (formerly sponsored by ACerS). She presented results from her graphite foam research conducted at Oak Ridge National Labs during her recent summer internship there.

MSE senior Jennifer Mueller was one of three students recognized for "best poster presention" at the 2006 Virginia Tech Symposium for Undergraduate Research in Engineering on 13 October 2006. The symposium, sponsored by the Virginia Tech's Department of Engineering Education and the National Science Foundation, provides undergraduate students who have participated in research to present their results to peers and faculty from the College of Engineering. Jenny presented a poster entitled, "Characterization of Nano-particles in Mesophase Pitch Derived Graphite Foams" based on research conducted over the summer at Oak Ridge National Labs. ❄

Three MSE graduate students were recently named Citizen Scholars in ceremonies hosted by the Graduate School. **Christelle Julian, Carlos Folgar, and Susan Holt** were recognized for their continuing efforts in sustaining the highly acclaimed *Journal of Undergraduate Research* (JUMR) project. Cris, Carlos, and Susan join 2005 recipients **Ben Poquette, Navin Manjooran, Davis Eichelberger**, and **Morsi Mahmoud** in representing MSE in the VT Citizen Scholar program that seeks to recognize students who donate their time and skills in service to the community, state, nation, and world. ❄



This summer, **Matthew Widders** (right), an MSE senior, was one of four VT students who participated in the Journey of Hope, cross country bicycle trip undertaken as an annual public service fund raising event sponsored by the Pi Kappa Phi fraternity. Matt began his trip in Portland, OR on May 31st and finished up at the U.S. Capitol in Washington, D.C. on August 15th. On August 5th, Matt was recognized at the main stage of Blacksburg's annual Steppin' Out festival. ❄

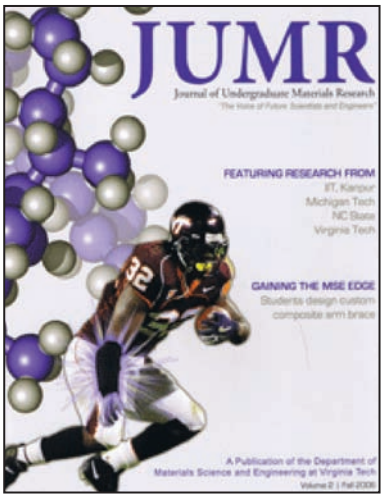
MSE graduate student **Navin Manjooran** has been inducted into the Order of the Gavel, a Leadership Honor Society of Virginia Tech, the Division of Student Affairs, and the Department of Student Activities. Navin was also cited for his numerous activities, including for his role as the Board of Visitors student representative during the 2005-06 academic year, and as a member of the founding board of JUMR. He has recently defended his dissertation and has accepted employment in Florida with Siemens Power Generation Group. ❄

In January 2007, nine undergraduate MSE students attended the 31st Annual Conference on Composite Materials and Structures held in Daytona Beach, Florida. At the conference, several students networked with professionals and distributed resumes in hopes of getting a summer internship. Additionally, MSE senior **Jenny Mueller** presented results from her graphite foam research conducted at Oak Ridge National Laboratory last summer. Also, MSE alumnus, **Ashley White** (MSE '05) gave a presentation entitled "Carbon Nanotube-Reinforced Hydroxyapatite Nanocomposites" at the nearby 31st International Cocoa Beach Conference & Exposition on Advanced Ceramics and Composites.

Journal of Undegraduate Materials Research (JUMR) News

The *Journal of Undergraduate Materials Research* (JUMR) is a cross-disciplinary partnership between the Departments of Materials Science and Engineering and English, and brings graduate and undergraduate students and faculty together to publicize undergraduate research in materials.

In November, the editorial board of JUMR held a reception celebrating the release of Volume 2 of journal. The reception was held at the Virginia Tech Graduate Life Center. Attendees included Graduate School Dean Karen DePauw, Associate Dean Ron Daniels, COE Dean Richard Benson, COE Associate Dean for Research Edmund Henneke, VT Honors Director Dr. Charles (Jack) Dudley, English Department Head Dr. Carolyn Rude, members of the JUMR editorial board, and several MSE faculty and students. At the reception, the editorial board was pleased to present VT Chemistry student Joe Zadrozny with the JUMR Best Paper Award, selected and supported by a grant from



the American Ceramic Society (ACerS). This year's edition features original research contributions by students from ITT-Kanpur (India), Michigan Tech, NC State, and Virginia Tech. Over the past year, JUMR has received recognition and support from several national professional societies, including TMS, ASM International, ACerS, AIST, and MRS.

This year, JUMR will sponsor a symposium for undergraduate presenters at the MS&T meeting in Detroit, September 16-17, 2007. MS&T, hosted by TMS, ASM, AIST, and ACerS, is the largest materials conference every year. Ben Poquette, outgoing editor says, "here we plan to invite past JUMR undergraduate authors to speak, and also leave several spots open for undergrads to submit abstracts through the MS&T website. JUMR's advantage here is that it will be the only symposium at the conference specifically geared toward undergraduate students; there are only a handful of undergrads who typically speak at these conferences."

The journal's new editorial board for 2007 will consist of Davis Eichelberger as Editor-in-chief, Jessica Pritchard as Production Editor, Christelle Jullian as Finance Manager, Steven Kyriakides as Public Relations Manager, and Susan Holt as Communications Manager

Please visit the journal's website **www.jumr.mse.vt.edu** for more information.

The Fun Part of Materials Science and Engineering

In December, MSE students visited three Blacksburg High School classes to teach students about MSE. The VT students first gave a general overview of MSE followed by several demonstrations; these included a solar powered car, a shape memory alloy, a space shuttle tile, and a superconductor.

These demonstrations were presented to AP physics classes. By the end of the day, over 60 Blacksburg High School students learned about MSE. The school's science department also benefited through a donation from MEPS of over $800. The money was earned last year from events during Engineer's Week and will be used towards science laboratory equipment at the high school.

MSE Senior Jenny Mueller demonstrates how superconductors work to Blacksburg high school students.

2007 Materials Science and Engineering Bachelor of Science Degrees (Expected)

David Berry (Fall 2006)

Michael Modica (Fall 2006)

Vincent Caluori

Bradley Cline

Brian Costello

Daniel Etter

Gabrielle Farrar

Matthew Fisher

Jennifer Mueller

Kristine Obusek

Kristin Patterson

Stephanie Petrina

Olisa Pinto

Benjamin Sandbrook

Alexander Scott

Matthew Widders

2006 Materials Science and Engineering Undergraduate Awards and Scholarships

Dean's Scholarship
Chelsey Zacherl

Alfred E. Knobler
Meredith Fotta
Erica Hartsell Moore
Thomas Johnston
Elizabeth Logan
Jennifer Mueller
Kristine Obusek
Kristin Patterson
Stephanie Petrina
Andrea Rojas
Alexander Scott
Chelsey Zacherl

John H. Kroehling
Mark Briguglio
Vincent Caluori
Kathleen Campbell
Bradley Cline
Brian Costello
David Gouldey
Joseph Norman
Kevin Yu

Thomas G. Stroyan Memorial
Christopher Dykema
Daniel Etter
David J. Gloekler
Kevin Sheets

Ronald S. Gordon
Matt Fisher
Daniel Martin

MSE Faculty
Olisa Pinto

Presidential Campus Enrichment Grant
Kristine Obusek
Alexander Scott

Micron Foundation
Derek Gordon

William C. McAllister Leadership Scholarship
Kristine Obusek

Gilbert and Lucille Seay
Mark Briguglio
Chelsey Zacherl

William B. Belchee
Meredith Fotta

Charles and Mildred Carter
Bradley Cline
Kristin Patterson

Ray and Violet Frith
Erica Hartsell Moore

Gordon W. Jones
Daniel Martin

Bruce and Dorothy Pauly
Vincent Caluori
Kathleen Campbell
Brian Costello
Christopher Dykema
David Gouldey
Stephanie Petrina
Alexander Scott

Peter and Phyllis Pruden
Mark Briguglio

MSE Undergrads Work in Undergraduate Research, Internships, and Co-ops during Summer 2006

Several MSE undergraduate students spent the summer working and participating in internships, undergraduate research, and co-ops in industry, universities, and at research and government laboratories across the country.

Stephanie Petrina

"I did not have any prior semiconductor background when I interned at BAE, but I came out knowing a great deal! Overall, it was a great experience. It was good enough that I took a fulltime job with them."--**Vincent Caluori**, Intern, BAE Systems, VA

Alex Scott

"At Duke, I was given the option to design and create my own project from start to finish. With this freedom, I chose to investigate the aggregation characteristics of gold nanoparticles in the presence of salt and algae."--**Kristine Obusek**, REU, Duke University, NC. *Kristine was recently accepted to Duke's graduate school.*

Kristin Patterson

Internships

Daniel Barb
ECS
Charlotte, NC

Rusty Beckner
Progressive Design, Inc.
Richmond, VA

Vincent Caluori
BAE Systems
Manassas, VA

Brian Costello
Engineering Consulting Services
Chantilly, VA

Daniel Etter
Micron Technologies
Manassas, VA

Matthew Fisher
TOSOH SMD
Grove City, OH

Chris Glomb
IS&S Lockheed Martin
Gaithersburg, MD

Jill LeBlanc
Naval Research Lab
Washington DC

Dan Martin
Datacom Systems
Syracuse, NY

Erica Moore
Joseph Norman
CP Films
Fieldale, VA

Kristin Patterson
TIMET
Henderson, NV

Bradley Shevock
Danaher Motion,
Radford, VA

Lado Tonia
Internship, MIT, Lincoln Labs
Lexington, MA

Chelsey Zacherl
Knolls AtomicPowerLab
Lockheed Martin
Schenectady, NY

Undergraduate Research

Gabby Farrar
Dave Gloekler
Clemson University
Clemson, SC

Jennifer Mueller
Oak Ridge Natl Lab, TN

Kristine Obusek
Duke University
Durham, NC

Stephanie Petrina
UC Santa Barbara, CA

Alex Scott
Stanford and UC Davis, CA

Travis Church
Virginia Tech, VA

Olisa Pinto
Virginia Tech, VA

Co-ops

Andrew Smith
Brenco, Inc
Petersburg, VA

Tom Johnston
Honeywell
Petersburg, VA

Bradley Cline
Michelin
Anderson, SC

2006 Materials Science and Engineering Graduate Awards and Scholarships

Name	Advisor	Thesis/Dissertation Title	Present Position
Doctorates			
Feming Bai	*Viehland*	*Structure-Property Relationships of Multi-Ferroic Materials: A Nanoscale Perspective*	*Post-Doctoral Assistant, University of Rochester*
Douglas Crowson	*Corcoran / Farkas*	*Stability of Nanoporous Metals*	*AREVA, Novi, MI*
Navin Manjooran	*Pickrell*	*Van Der Waals Interactions Based Rheological Analysis for Electrosterically Stabilized Nanosized Alpha Silicon Carbide - Lactobacillus 99 Dispersions*	*Siemens Power Orlando, FL*
Master of Science			
Somadatta Mohanty	*Farkas*	*Tensile Stress and Thermal Effects on the Grain Boundary Motion in Nanocrystalline Nickel*	*Lockheed Martin, New Orleans, LA*
Joseph Butler	*Kampe*	*In-situ Fiber Strength Distribution in Nextel™ 610 Reinforced Aluminum Composites*	*ATI Allvac Richburg, SC*
Chris Kessler	*Lu K*	*Freeze Casting of Aqueous PAA-Stabilized Carbon Nanotube- Al_2O_3 Suspensions*	*U.S. Patent Office Arlington, VA*
Adam Maisano	*Kampe*	*Cryomilling of Aluminum-based and Magnesium-based Metal Powders*	*Dominion Metallurgical, Inc., Roanoke, VA*
Matthew Lynch	*Clark*	*The Effect of Microwaves on Aqueous Corrosion of Glass*	*PhD Student, Georgia Tech*
Elizabeth Jeffers	*Kampe*	*Reaction Synthesis of Titanium Aluminide/Titanium Diboride in-Situ Composites*	*Special Metals Division of Precision Cast Components, New Hartford, NY*
Jonathan Lok	*Logan*	*Acid Leaching of SHS Produced MgO/TiB_2*	*ExxonMobil Research Labs, Fairfax, VA*
Satenik Harutyunyan	*Reynolds*	*Magneto-Elastic Interactions in a Cracked Ferromagnetic Body*	*Ph.D. Student, MSE-VT*

2006 Materials Science and Engineering Graduate Honors and Recognitions

Gary S. Clevinger Memorial Scholarship

Susan Holt

Citizen Scholars Awards-VT Graduate School

Susan Holt
Carlos Folgar
Christelle Jullian

Paul E. Torgerson Graduate Student Research Excellence Award

Navin Manjooran
Guofeng Bai

Engineering Excellence for MSE Alumnus, Professor Richard Sission

(from left: Dr. David Clark, Dr. Richard Sisson, Dean Richard Benson)

Dr. Richard Sisson, Professor of Mechanical Engineering at Worcester Polytechnic Institute and a 1969 graduate of the VT Metallurgical Engineering Department, was inducted into the VT College of Engineering Academy of Engineering Excellence during ceremonies on April 27th, 2006.

Membership in the Academy is reserved for individuals holding an engineering degree from Virginia Tech's College of Engineering who have made sustained and meritiorius engineering and/or leadership contributions during their careers. Initiates have reached the pinnacle of their professional achievements and will normally have been alumni for 40 or more years.

The College of Engineering and its Advisory Board anticipate inducting no more than ten individuals as members of the Academy of Engineering Excellence annually. This selection is made from some 40,000 living alumni of the College of Engineering

Professor Sisson continues his distinguished career at WPI as a notably effective and popular educator, and as an advocate of the application of environmentally-benign manufacturing for materials processing and heat treatment. He is a both a Fellow of ASM and an ASM Trustee.

Meet David Berry: B.S. Materials Science Engineering, Virginia Tech, December 2006

You know you are from the MSE Department at Virginia Tech if you know David Berry. It's as simple as that. You probably know him in many different ways: as the classmate in Ceramics Lab, as the fixer of those high temperature furnaces, as the person who got coffee every morning...You know that when you need him, he will be there to help you out when equipment breaks, or even you are looking for something as mundane as a white board. You would not have graduated without having David Berry pass through your academic life--or even just to pass by him through hallways of Holden Hall.

Well, David is graduated now too. And it's his time to tell his story on how he made it.

I started with the MSE department in 1997. At that time, I took advantage of the tuition waiver and took classes as soon as I could.

I was really impressed with MSE and the diverse range of its specializations. I have always enjoyed art and enjoy looking at architecture. I was also interested in metalwork and particularly interested in past metalwork like smithing. Materials science seemed to be the bridge that joined all those fields and many more.

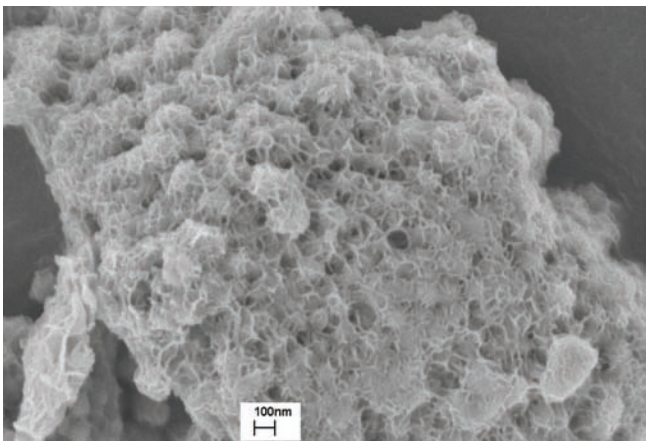
Combining a full time job with engineering courses was hard. Every semester I would spend days talking myself out of quitting school. It was hard to see the light at the end of the tunnel; I thought that if I stopped and counted classes and hours then I would have surely stopped but I chose to just look far enough ahead to get me to the next summer. It was easy at first because I was not much older than the students around me. As time went on, the students got younger as I got older and the gap increased. I was living life as well as taking classes and most of the people around me where just beginning. College was taking a place alongside my other responsibilities and it was harder and harder to socialize because priorities were so different. While working on my degree I had a son, Christian (who is now 6), went through a divorce, and have just been recently remarried. It was difficult to maintain a certain standard in school while attending to my home and work responsibilities.

In my senior year I chose to do a design project with Dr. Kampe on TiAl-TiB_2 intermetallic composites. I have to admit, I enjoyed the research more than the subject

...David Berry continued on page 15

Lu research highlight continued from p.1

On the nanoparticulate material assembly and patterning front, we are tapping into the vast potential of nanoparticles. Our research in this big arena is driven by the desire to create nano-scale structures, devices, and systems that can be used and manipulated at macroscopic scale. Nanoparticle synthesis is a well studied and relatively mature field. However, constructing unique 3D nanostructures using nanoparticles as fundamental building blocks is a fascinating area that waits to be explored. The tremendous push in nanotechnology around the globe also serves as a vital driver for the numerous opportunities of organized nanoparticle design at the nanoscale. Our efforts in nanomaterials involve controlling nanoparticle behavior by modifying their surface properties through dangling surface bonds, and through adsorbed ions and polymers. With well controlled surface charge characteristics, we assemble ions or polymers onto nanoparticles or assemble nanoparticles onto other surfaces. More importantly, we are directing these modified nanoparticles and organizing them into unique 3D nanostructures. For example, we are coating metal nanolayers onto ceramic particles through electroless coating. The nanolayer exhibits unique net structures at nanometer level as shown in the figure, above. This phenomenon deviates drastically from the well established fully dense film concept and serves unique roles in ceramic processing and consolidation. Another on-going effort is using carbon nanotubes (CNTs) as templates for nanoparticle assembly. The CNTs can be "chopped" from long, endless bundles into ~ 200 nm pipes. We are using electrostatic interaction to grow nanoparticles onto these pipes. Along with the 3D construction of nano-assemblies, we are also addressing the preservation and immobilization of these specially designed nanostructures. We have been developing freeze casting techniques in an attempt to form complex and micron size features with 3D nanostructures. Freeze casting offers the capability of forming complex shapes while converting the 3D nanostructures from a liquid system into the solid state. Shaping of nano-units into large ensembles and bulk particulate components with multifunctionalities differentiates our work from other efforts. Our ultimate objective is to make things lighter, faster, and more energy efficient. The applications range from solar cells, bio-sensors, neutron absorbers, to catalysts.



Nanoscale net nickel coating (5-10 nm thick) formed on two micron sized boron carbide particles by electroless coating.

On the particulate material digital processing front, we are focusing on three dimensional printing of complex 3D shapes. The three dimensional printing technique starts with dry powders and creates parts in layers from a CAD model. The solid model, formatted into standard triangle language (stl), is converted by a slicing routine into a compilation of two-dimensional slices representing the three-dimensional part. The slice file is further formulated into instructions that control the movements of the three dimensional printing machine. During the part forming process, each layer begins with the distribution of a thin layer of powder spread over the surface of a part-build bed. Then a print head, containing an array of fluid jets, rasters across the layer of powder and deposits binder droplets in those locations defined by the current two-dimensional slice of the solid model. The build platform indexes upward by one layer thickness and a new layer of powder is spread, which is then printed by the printhead. This procedure is repeated layer after layer until the three-dimensional part is completed. The minimum feature size that can be printed is determined by the binder droplet size and is typically 50 μm for the thickness and 200 μm for the disk diameter. Three dimensional printing can create parts of any geometry; the support gained from the powder bed enables open pores, meshes, channels, or any combinations of these features. It can also create very well controlled "unmachinable" geometries such as overhangs, undercuts, and internal volumes, or stack and nest multiple parts within the build chamber. Multiple parts with the same or different configurations can be built simultaneously, and this unique feature makes three dimensional printing very efficient in productivity. This solid freeform technology has demonstrated the capacity of fabricating tools and parts from a variety of materials, including ceramics, functionally graded materials, and tool steels with an array of unique geometries, including intricate internal passages similar to the cooling passages in turbine blades. The other distinctive advantage of the process is near-net-shaping. For many complex-shaped components, unique composition designs, or small scale devices, the existing particulate processing techniques cannot meet these requirements. One application of the three dimensional printing technique being pursued in our laboratories deals with the creation of self-healing seals for fuel cell applications. We are using three dimensional printing to create very unique 3D mesh structures which will be embedded within a brittle matrix. The resultant composite is expected to offer the multifunctionality of self-healing, low cost, and long term high temperature stability.

Particulate materials will continue to play a critical role in materials research due to its potential benefits to microstructural design, net-shaping capabilities, and its potential value to a wide array of disciplines. I believe that it will continue to

fascinate future materials scientists and engineers by its complexity and endless possibilities. There has never been a more exciting time for particulate materials research. We invite you to learn more about our on-going efforts. For more information regarding our group activities, please visit

www.lu.mse.vt.edu.

ICTAS Update continued from p.5

samples that are difficult or impossible to image in conventional high vacuum systems — for example, organic materials, hydrated materials, biomaterials, and in-situ observations of materials heated as high as 1000 C

- **a dual-beam (electron and focussed ion) instrument** for imaging, depositing, and dissecting structures and devices a few nanometers in size
- **a multiphoton confocal scanning laser microscope** for imaging the structure of cells.

The new equipment was purchased with funding provided by Virginia's Equpment Trust Fund (ETF) and the Commonwealth Research Inititative (CRI) for nano- and bio-technology. What will all these instruments be used to do? Check the NCFL web site: http://ictas.vt.edu/NCFL for examples and more details.

ICTAS is a major campus initiative that seeks to tie traditional, fundamental-based university research to applied technology and development through aggressive multi-disciplinary teaming. The project will eventually include the construction of three new major laboratory facilities: "ICTAS A" is nearing completion within the Virginia Tech Corporate Research Center adjacent to campus; "ICTAS I "is presently under construction at the corner of Stanger and Old Turner Streets (behind Holden Hall) with a spring 2008 completion goal; construction of "ICTAS II" is anticipated sometime in 2009 or beyond at an exact location yet to be determined.

David Berry continued from p.13

of the research. In my time here I have come to know the operation of just about all the equipment we own but knowing the operation and using it for research are very different items. In the senior project I was able to run samples and look for results rather than simply operate the machine. It was a much different experience to use the equipment for analysis and I would love to continue down that path.

As for future plans, I am still unsure of where I want to go and what I want to do. I feel there is still tons of knowledge to gain in many different areas. I have had hundreds of good opportunities arise in the last ten years and felt that I had to turn them down to keep focused on my bachelor's degree. Now I am free to go wherever I can, and to see all that I have been missing in the materials world.

I honestly felt that I would never get the B.S. degree and am still worried something will happen before I receive the diploma as proof. It felt good to tell my son that I was--am an "engineer." Up to a month ago, I didn't know what to call myself. I have actually been an electrician for eight years but haven't applied that knowledge as often as I would have liked so I never felt I had a descriptive title. I have to say, the closer I got to the end of the climb, the more it felt like the respect or lack thereof was not a function of my education or the paperwork to back it up. Respect is built and earned and the education doesn't change it at all.

I also take great consolation in knowing the education I received over the last ten years is by far better than any other undergrad has received. I have learned as much out of the classroom as I have learned in the classroom. The MSE faculty and staff have taught me more over the last ten years than they could possibly know and they never realized they were doing it.

David is now continuing his part-time studies as a graduate student in the MSE Department at Virginia Tech.

Heads Up continued from p.16

ambitions.

Following my five-year personnel review, the Dean has asked me to continue to serve as Head of MSE, and I have accepted. I am excited about the future of the department and the opportunities/challenges that we will encounter, I look forward to working with the faculty, staff, students and alumni to make these next five years even more successful. I intend to focus on maintaining our excellent undergraduate program, improving our graduate programs, strengthening the green engineering component of the department, building international collaborations and making VT-FIRE (Virginia Tech – Foundry Institute for Research and Education) a reality. You do not need to wait until football season to visit us. Contact Tracey Keister (tkeister@vt.edu or (540) 231-9469) to arrange a visit.

Exploring Materials at Virginia Tech

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Send us a note or send an email.

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Professor Steve Kampe

Heads Up!

David Clark

I am grateful to have had the opportunity to serve as head of MSE for the last six years. In fact, I can honestly say that these years have been among the most rewarding for me professionally. The department has grown its faculty and student body, and we have experienced significant improvements in our processing and analytical capabilities. This past year has been no exception. Under the leadership of our new Dean (Dick Benson), we continue to add new faculty, update/improve our facilities and work toward increasing our research expenditures and the number of Ph.D. students.

One of our major achievements has been the creation of the Nanoscale Characterization and Fabrication Laboratory, NCFL (formerly known as the Advanced Materials Characterization Facility). This user facility will open in Spring 2007 with over $5M in new characterization equipment. Originally proposed by the MSE department and its Advisory Board under the leadership of its Chair (Warren White), the NCFL has been championed as a core capability for the new Institute for Critical Technologies and Applied Science (ICTAS) by its Director, Dr. Roop Mahajan. We expect the NCFL to be a world-class facility serving the needs of Virginia Tech, Virginia, and the nation for many years to come.

MSE continues to provide leadership to, and participation in, materials initiatives across the University. We are searching for a new faculty member with expertise in materials/energy who will be jointly appointed in Mechanical Engineering. We are also pleased to be a partner in the newly formed Biomaterials and Bioprocessing cluster that includes faculty from three colleges (Engineering, Agriculture, and Natural Resources) and four departments (Biological and Systems Engineering, Chemical Engineering, MSE, and Wood Science). We recently hired two new faculty members, Paul Gatenholm and Abby Morgan (joint with Chemical Engineering), as part of this initiative.

As you can see from the contents of this newsletter, our faculty, students and staff have been very active. Our students were recognized at the Materials Science and Technology (MS&T) Conference in Cincinnati for their creation of the *Journal of Undergraduate Materials Research* (JUMR), and for winning a Materials Advantage Chapter of Excellence Award for a second year in a row. These students are providing many services to MSE such as recruiting in K-12, participating in TMS-sponsored Congressional Visit Day, hosting speakers from industry and providing food/entertainment to alumni during tailgates at home football games. Seven of our graduate students have been named Citizen Scholars by The Graduate School over the past two years, primarily for their notable service on the JUMR Editorial Board. Academically, our student body is among the best – having produced three College of Engineering Outstanding Senior awards, two Goldwater Scholars, one Marshall Scholar and two Fulbright Scholars in the past five years. In addition to winning top honors in the VT undergraduate research symposium, Jenny Mueller (President of MEPS and an MSE senior) took second place in the national student speaking competition sponsored by Materials Advantage and the Ceramics Education Council. We are particularly proud of one of our recent graduates: David Berry graduated in December with a B.S. in MSE. David started his course work in 1997. What is noteworthy about this is that David worked full time as a MSE staff member maintaining equipment, keeping our laboratories operational, and helping all of our students achieve their educational

Heads Up continued p.15

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