Exploring Materials at Virginia Tech

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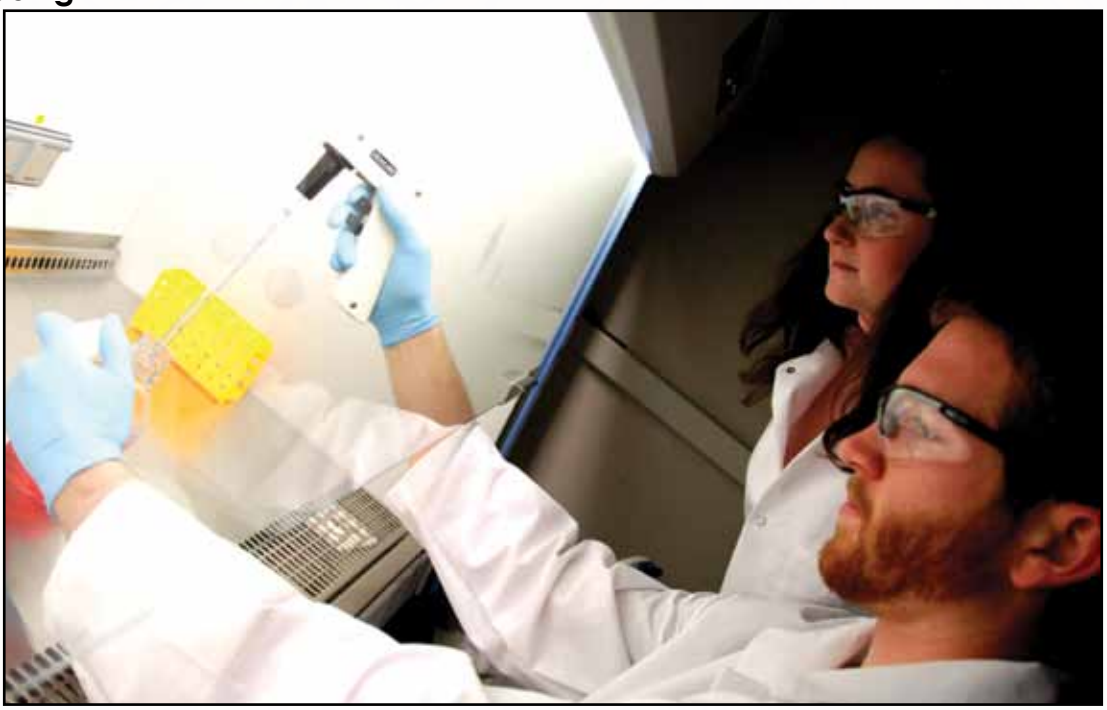
VirginiaTech
Invent the Future

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

Spotlight

Research



Professor Abby Whittington Morgan and graduate student, Kevin Sheets

Research to Design New ACL Replacement Tissue

by Abby Whittington Morgan

A major concern with current anterior cruciate ligament (ACL) implants is their inability to integrate from the ligament through the bone-ligament interface into the bone. The interface is characterized by a gradual gradient in mechanical, functional and biochemical properties from the bone to the ligament and presents a challenge to mimic. Electrospinning is a useful tool to fabricate polymeric scaffolds and has been used for many years in the field of tissue regeneration, especially that of bone and ligament. It has the advantages of low cost, ease of operation and functional tunability in the nature of scaffolds produced. Co-electrospinning is a technique that employs two polymeric solutions that spin nano-fibers onto the same ground target. This technique can be exploited to produce a gradient, using two polymers that have properties similar to the bone and the ligament. The aim of this project is to fabricate and characterize the mechanical and biological properties of co-electrospun graded meshes that represent the bone-ligament interface.

Polycaprolactone (PCL) and silk are the polymers chosen to represent the bone and ligament ends respectively.

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Image: Electrospun polymer mesh for ACL repair, Courtesy of Professor Abby Whittington Morgan

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Discover what we're made of...
www.mse.vt.edu

Research Corner

Meet Professor Abby Whittington Morgan

In January 2008, Dr. Abby Whittington Morgan joined the Departments of Materials Science and Engineering and Chemical Engineering at Virginia Tech after a short but productive post-doctoral experience at the National Institute of Standards and Technology (NIST). She is a member of the Controlled Release Society, and the American Institute of Chemical Engineers. Dr. Morgan has authored 1 book and several papers.

As a materials engineer, Abby attributes her interest in materials and tissue engineering to her mother. "My mom always encouraged us to notice the natural world and how things worked together from cells to tissues and orchids to trees," she says.

The youngest of three, Abby grew up in Homewood, Alabama. Her brothers, one a civil engineer and the other a small business owner, always pushed her to excel with a little bit of healthy sibling rivalry. Her mother was an elementary school teacher (now retired) and her father is a free-lance art director.

While working on her bachelor's degree in textile chemistry, Abby developed a taste for research. At Auburn University, she worked as an undergraduate research assistant for Dr. Giesla Buschle-Diller and Dr. Roy Broughton. There her interest in biomaterials began as she designed a natural antimicrobial finish for bedding. "I now make it a point to include undergraduate students in my research – in the hopes they catch the research bug as well," she says.

Abby worked as a process engineer for Shaw Industries in Dalton, Georgia, for one year as a cooperative education student. There she learned that the laboratory was where her passions lie after working in the analytic chemistry and quality control departments. A professor at Auburn encouraged her to apply to his alma mater, University of Illinois at Urbana-Champaign (UIUC), in materials science and engineering.

Abby says, "The structure-to-properties relationship that is the core of materials science and engineering really appealed to me. I enjoy learning the 'why' of which materials are useful, especially when placed in context with the body." At UIUC, Abby flourished under the direction of Prof. Russ Jamison. While there, she learned surgical techniques important to her research on drug delivery systems for bone regeneration. This took her to Kyoto, Japan to work for Professor Yasuhiku Tabata for five months.
Following completion of her doctorate, Abby spent the next year working at the National Institute of Standards and Technology in the Polymers Division within the Biomaterials Group. There she began her collaboration with Dr. Carl Simon that she continues to this day. Their work focuses on the development of gradient 3D scaffolds for tissue engineering applications.

Her research focuses on the use of natural polymers in the design of drug delivery systems and tissue engineering scaffolds. One current project is described in the Research Highlight article.

Most recently, her work has focused on the manipulation of natural materials to direct cell response through adjustment of crystallinity and modification of the surface chemistry.

Abby's research lab, Tissue Regeneration Laboratory, is home to five graduate students and five undergraduate students working on scaffold fabrication, materials characterization, and drug delivery device design. This 1200 sq ft lab is housed in the new ICTAS (Institute of Critical Technology and Applied Science) on the 1st and 2nd floors. The lab is a Bio-Safety Level 1 facility for mammalian cell culture and has scaffold fabrication equipment.

Outside the office, Abby enjoys cooking, yoga, and reading. "I feel to be a good biologist/chemist you need to be a good cook as well. Especially if you are a synthetic chemist, they're the best cooks I've known!" ❄

Professor Whittington Morgan with her graduate students, Kevin Sheets, Tyler Horseman, and Satyavrata Samavedi

2010 MSE Advisory Board Meeting

The MSE Advisory Board held their annual meeting on December 6-7, 2010 at the MSE Collegiate Square Suite. Attendees for this year's meeting were **Warren White, Catherine Baker, George Wicks, Diola Bagayoko, David Rice, Kathleen Richardson, Michele Holbrook, Claudio Caprio, and Paul Huffman**.

Discussions of the meeting included department overview status reports, faculty presentations, international activities, senior design project assessment, as well as reviews for the Graduate and Undergraduate Programs. **Professor Bob Hendricks** took the advisory board on a tour of the newly established VT-FIRE building. In addition, the advisory board members had the opportunity to interact with the MSE students. The two-day meeting concluded with **Dr. Richard Benson**, Dean of the College of Engineering joining a portion of the wrap up discussions. ❄

Professor Diana Farkas named Jefferson Science Fellow at the State Department

by Lynn Nystrom

Diana Farkas, Virginia Tech Professor of Materials Science and Engineering, has spent the past year as a Jefferson Science Fellow, working with the U.S. Department of State.

From Left: Angela Farkas, Secretary of State Hillary Clinton, and Diana Farkas

The Jefferson Science Fellows are tenured faculty in areas of science and engineering who are selected after a rigorous process by the National Academies of Science. Fellows serve in the State Department or the U.S. Agency for International Development (USAID) fulltime for one year and for an additional five years in a consultancy capacity.

Dr. Farkas worked in the Bureau of Oceans, Environment and Science, Office of Science and Technology Cooperation (OES/STC) and the Bureau of Western Hemisphere Affairs, Public Diplomacy, to promote scientific collaboration and student exchange programs with various countries, particularly Latin America. This initiative is considered as key to the improvement of the international aspects of science and engineering in the U.S., and to the cre-

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Department News

Team led by ESM Frank Maher Professor Norman E. Dowling

The team led by ESM Frank Maher **Professor Norman E. Dowling,** professor of materials science and engineering and engineering science and mechanics, which included ESM doctoral student Attilio Arcari, ESM BS alumnus Christopher A. Calhoun, and MSE undergraduate student **David C. Moore,** received the best structures and materials paper award at the American Helicopter Society International 65th Annual Forum and Technology Display that was held from May 27-29, 2009 in Grapevine, Texas. Professor Dowling and his group plan to update the paper, "Strain-Based Fatigue for High Strength Aluminum Alloys," for submission to the Journal of the American Helicopter Society. ❄

Dwight Viehland leads DARPA program on Magnetic Sensors, Arrays, and Imaging Systems

On September 12, 2009, a team led by MSE **Professor Dwight Viehland** was awarded an $8 million, 4-year DARPA (Defense Advanced Research Projects Agency) program. The program is comprised of six universities, two companies, and a national laboratory: Virginia Tech, University of Delaware, Oakland University, Universite DeCaen Basse Normandie & Ensicae, Northeastern University, Science Applications International Corporation and Passive Sensors, and the U.S. Army Research Laboratory.

Professor Viehland's team plans to focus on the development of ME sensors using state of the art multiphase materials with enhanced ME coefficients. These sensors will be designed to meet the demands for future generations of magnetic sensors, arrays, and imaging systems for Urban Threat Reduction. ❄

Department News

MSE Laboratory Updates

The MSE Department Upgrades Teaching Laboratories

With funding from the College of Engineering, two of our general service laboratories (***Optical Microscopy and Sample Preparation Laboratories)*** have been remodeled and upgraded with newer furniture and instrumentation. Both laboratories have a combined area of close to 900 square feet and are utilized for the ongoing teaching and research efforts within the MSE Department as well as by members of the larger University community.

Equipment presently residing in these laboratories include a chemical hood, various specimen mounting presses, an abrasive cutter and a low speed diamond saw, various grinding/polishing units, an optical stereoscope and high magnification microscopes with Nomarski optics, microhardness testers and a picnometer. These laboratories are thus suited for sample preparation (mounting, cutting, grinding, polishing and chemical etching) and preliminary micro structural characterization (optical microscopy and properties testing such as hardness via microhardness testing and density via picnometry testing).

Although specifically suited for teaching undergraduate laboratory classes, these laboratories are also extensively used by the various research groups in the Department. With the increase of the undergraduate and graduate enrollment to the MSE Department the facilities are literally in constant use and the renovations and newer equipment are very much appreciated by all. ❄

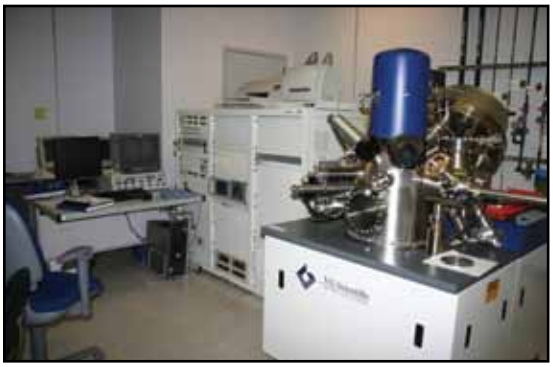
Research Laboratories on the Move

The Innovative Particulate Materials Laboratory led by Professor Kathy Lu has completed its move to 125 Holden Hall. The lab is equipped with the much needed chemical hoods for nanoparticle synthesis and templating research. A freeze dryer, a 3D printer, and several furnaces, including a controlled hydrogen atmosphere furnace have been relocated there. The floor is totally re-tiled and the lab layout is totally upgraded. This lab will serve as the important research lab for at least five graduate students and several undergraduate students in Professor Lu's group. ❄

MSE Laboratory Updates

New Equipment and Course Offering in NCFL

The Nanoscale Characterization and Fabrication Laboratory (NCFL) has new equipment additions this spring:



(1) A used VG 350 Field Emission Auger Electron Spectrometer (FEAES)

FEAES provides the capability for the surface elemental analysis of nanometer-size features. The Auger allows the capability of simple sample preparation (typically no additional preparation to several minutes), nm scale lateral resolution and excellent surface sensitivity (<5nm). The Thermo Fisher Scientific (formerly VG Scientific) Microlab 350 is a multi-purpose lab instrument with the capability for both Auger Electron Spectroscopy (AES) and XPS (X-ray Photoelectron Spectroscopy). The chamber is optimized for Auger analysis – using a field-emission electron source. Sample sizes are limited to about 15mm X 15mm X 7mm due to the sample holders used and the method of introducing samples into the analysis chamber. There is an ion gun for sputter depth profiling, although the ion gun is optimized for Auger and is not for depth profiling for XPS analysis due to the large spot required. The system has a motorized, 5-axis stage. The system has a standard ion pump for pumping the main chamber and is equipped with a turbo pump for pumping the load lock and differentially pumping the Ar gas line.

(2) A used Atomika 4100 quadrupole SIMS

Quadrupole SIMS provides very high depth resolution analysis of thin layers or shallow ion implants and is optimal for semiconductor devices. The Atomika quadrupole is specially outfitted with a high performance low energy floating ion gun, capable of achieving primary beam energies as low as 150eV. This low beam energy enables very high depth resolution measurements. Additionally, insulator analysis is greatly simplified with the quadrupole SIMS relative to the current magnetic sector instrument. The operation of the quadrupole is also much more straightforward than the current SIMS which would allow students to be trained in its operation. This equipment is an addition to NCFL's IMS 7f GEO, which is a magnetic sector Secondary Ion Mass Spectrometer for surface molecular or elemental analysis, trace element depth profiling, and secondary ion microscopy, optimized for mineral samples.

Also in NCFL, **Drs. Jerry Hunter** and **Mitsuhiro (Mitsu) Murayama** taught courses on the "Fundamentals of Nanoscale Characterization," which is populated mostly by MSE students. Dr. Jerry Hunter is Research Assistant Professor in ICTAS and Affiliate Professor in MSE. Duties include operation and maintenance of a CAMECA IMS-7f Geo SIMS and Phi Quantera XPS tools. Dr. Hunter recieved his bachelor's in Chemistry from University of North Carolina, Charlotte, and his doctoral degree in Analytical Chemistry from University of North Carolina, Chapel Hill. Dr. Mitsuhiro (Mitsu)Murayama is Research Assistant Professor in ICTAS and Affiliate Professor in MSE. He is the first contact for the High Resolution Electron Microscopy (TEM and STEM).

An original concept that began in the Department of Materials Science and Engineering (MSE), NCFL was created to provide researchers with the tools to work in converging disciplines. Finally established in 2007, NCFL is currently equipped with more than $10 million in highly specialized equipment, more than half of which was made possible through funding provided by Commonwealth Research Initiative. It seeks to help researchers investigate novel phenomena and build transforming technologies that solve critical challenges. The facility is approximately 16,000 square feet of laboratory space with instrumentation for bio- and nano-characterization. Located in the Corporate Research Center adjacent to Virginia Tech's campus in Blacksburg,Virginia, the state-of-the-art facility is housed in a dedicated building designed to shield sensitive instruments from environmental factors such as building vibrations, stray electromagnetic fields, and temperature fluctuations. It operates as a service center with a cost structure tailored to serve the needs of researchers from Virginia Tech and from the surrounding industrial community. The facility is staffed with instrument specialists to train users and assist in the operation of the equipment.

For more information on NCFL, visit www.ictas.vt.edu/facilities/ncfl.shtml.❄

Education Corner

VT FIRE – Reigniting the Casting Industry

by LeeAnn Ellis

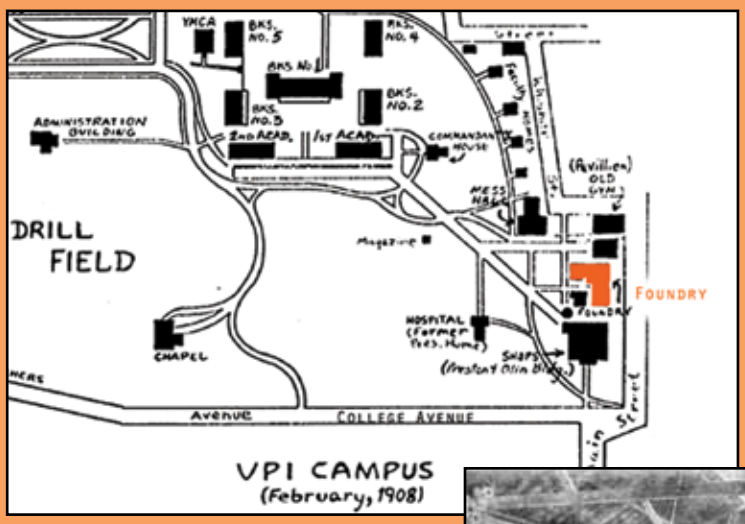
The Department of Materials Science and Engineering has teamed up with other departments and with members of the metal casting industry in an exciting endeavor to establish a world-class research and teaching foundry at Virginia Tech. The Virginia Tech Foundry Institute for Research and Education (VT FIRE) will support a growing interest in the area of foundry science and the metal casting industry. Locating the foundry on the Virginia Tech campus will offer an excellent teaching facility for our students and for the American Foundry Society's (AFS) Piedmont region.[1] VT FIRE has been designed with an emphasis on green engineering and industry best practices. This institute will serve as a greenhouse for new technologies, for the transfer of technology from research to production, and for developing methodologies for converting non-cast components to casting processes.

Metal casting in America dates back to 1642, making it among the earliest industries in this country, according to historical information on the American Foundry Society website. The process of metal casting involves melting metal and pouring it into a mold to create a component or a usable good. Over 90% of manufactured goods and capital equipment require castings as components or for use in the manufacturing process. Quoting from the AFS website, "…in 2008, more than 12 million tons of castings in the U.S. were valued at more than $31.5 billion. The U.S. is the world's second largest producer of castings (China is first)…." Furthermore, metal castings feature heavily in products for automotive applications and construction, for internal combustion engines, pumps, and compressors just to name a few, and they are essential to all sectors of the U.S. military.[2] Castings are also found in advanced technology products such as jet engine turbine blades. Locally, on our own college campus, MSE Professor Bill Reynolds states, "A foundry is something that would have broad use." He points out that the MSE department often receives requests from Virginia Tech student design teams who need various parts and components cast. Students in the College of Architecture and Urban Studies, the School of Visual Arts, and in the Industrial Design Program will also be able to make use of the foundry.

The Piedmont Chapter of the AFS has been instrumental in this initiative to establish a teaching foundry on the Virginia

Did you know...

Once upon a time there was a foundry at Virginia Tech. Early in this university's history, when agriculture and mechanical arts were the focus, a foundry/forge was built in 1882, located just behind the main building on the campus of what was then the Virginia Agricultural and Mechanical College (VAMC). It is interesting to note where these first buildings were located. Back in the late 1800s, if you stood at the intersection of College Avenue and Main Street, you would be standing at the entrance to VAMC, and Preston and Olin Hall would be in front of you. If you walked around the building, you would find the foundry and other shop buildings.[1]



[1]Tech Triumph: A Pictorial History of Virginia Tech, Thomas C. Tillar, Jr., ed., Blacksburg, Va., Virginia Tech Alumni Association, 1984. Many thanks to Bruce Ferguson for sharing valuable insight on this historical foundry, and for sharing his copy of Tech Triumph. Mr. Ferguson is the Associate Director for Planning, University Planning, Design, and Construction Services at Virginia Tech.

Tech campus. "The only way our industry is going to survive is to attract young engineers who will come up with innovative manufacturing techniques to compete with overseas sources," states MSE alum and AFS member, Paul Huffman, who has played a major role in raising awareness and igniting enthusiasm for this initiative.

Presently, there is a small casting facility located in Whittemore Hall where hundreds of engineering students participate in required manufacturing lab courses involving welding and casting, among other manufacturing processes. This facility is limited to pouring small quantities of aluminum in a strictly educational environment. "The difference between a real foundry," states Bill Reynolds, "and what we have had so far is that a real foundry has furnaces designed and optimized to melt a wide variety of metals, has a place to make molds, and has a way to break out molds at the end. A foundry incorporates all of the steps in the casting process under one roof. We have never had this capability."

Soon after returning to the MSE department in 2008, Professor Robert Hendricks joined the VT FIRE effort. He brainstormed new ways to raise funds, discovered partners to donate equipment, and created a senior design team who devoted an entire year to exploring equipment needs, researching engineering requirements, and designing a floor plan. They worked with Paul Huffman to determine necessary equipment, and they worked with architect, Derek Cundiff, who incorporated their floor plan into the final 4000 sq. ft. building design.[3] "They did a very good job," Professor Hendricks said. "They laid out the foundry; that was their task."

In support of VT FIRE, three engineering departments have been developing a minor in foundry engineering, and to that end, Professor Reynolds (MSE) reintroduced a metal casting course last fall, something that has not been taught for about five years. Professor Reynolds taught this as a metallurgy of casting course, addressing the theory behind casting, and he described it as a problem-based learning course where the students worked as a group to solve a series of problems. "All of the learning is from the bottom up," Reynolds explained. "They are seeking information rather than having it provided." Students worked collaboratively in teams, without competition, and they worked well together. Some of the problems the class tackled involved reducing coring and macro segregation in a specialty nickel alloy and designing a gating system for a submarine propeller.

The second course for this new minor focuses on solidification modeling under the direction of Professor Hendricks (MSE). Students in this course receive hands-on experience with ProCAST, a professional industrial modeling environment for casting. A third course in rapid prototyping is being taught by Professor Chris Williams in the Department of Mechanical Engineering. In addition, Professor Bob Sturges in the Department of Industrial and Systems Engineering is developing a course in manufacturing operations for the metal casting industry.

There has been a lot of interest and support for VT FIRE not only from the university but also from industry. Precision Castparts Corp. (PCC) has donated time and financial support for the development of the foundry. "We are excited about the foundry," said

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Meet Paul Huffman

by LeeAnn Ellis

Spend only a few minutes in Paul Huffman's presence, and you will begin to absorb his contagious enthusiasm not only for metallurgy but for life. It quickly becomes clear how he has achieved so much. He possesses an instinct for making things happen, and he understands the meaning of hard work and perseverance.

It seems that Paul was destined for work in metallurgy and metal casting. He can trace his foundry roots all the way back to the Civil War, to a relative on his mother's side, General Joseph Anderson, who managed Tredegar Iron Works in Richmond, Virginia, where most of General Robert E. Lee's cannons were produced. Then there is his paternal grandfather, who owned the Virginia Foundry Company, a three-man foundry. When Paul's father, Paul Sr., was 19 and in college, he was called home to help in the foundry. When Paul Sr. took over the operation, it grew to a 40-man company, where, incidentally, the first Virginia Tech Skipper cannon was cast back in 1963.

With such a family history, it's no surprise that Paul arrived at Virginia Tech in the mid 1970s knowing exactly what he wanted to do. "Most students knew they wanted to be engineers," Paul said, "but weren't sure what type. I knew I wanted to study metallurgical engineering and wanted to go to work in industry, specifically metal casting." When he discovered the cooperative education program, he paid a visit to Roger Hedgepeth in the co-op office and announced that he wanted to co-op at the Lynchburg Foundry. He was not deterred when he learned that Lynchburg Foundry did not have a co-op program with Virginia Tech. His response to Mr. Hedgepeth was, "Well, let's get a program!" He was adamant about his choice because he knew he would be able to work among the movers and shakers in the metal casting industry. And through perseverance, he succeeded in becoming

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Student News

MSE Graduate Students Receive Clevinger Award

This year, five graduate students received the MSE Clevinger Award. The scholarship is designed to benefit graduate students pursuing materials-related disciplines who also received a B.S. in materials from Virginia Tech. Each student is selected based on "scholastic achievement, good character, and demonstrated leadership potential."

Niklas Floyd received his Master of Science in MSE this May 2010. He worked with Professor Diana Farkas on atomistic simulations of various metals used in pressure vessel steels, structure property relationships of materials, and energetics and crack behavior of random tilt grain boundaries.

David Gouldey received his Master of Science in MSE in the summer of 2010. He was also an exchange student in TU-Darmstadt, Germany under the supervision of Professor Doctor Wolfram Jaegermann and Professor Doctor Dimitris Pavlidis. His advisors in Virginia Tech were Professors Bob Hendricks and Bill Reynolds. David's research topic is on cadmium telluride solar cells.

Kevin Sheets received his Master of Science in MSE this May 2010. He has been working on tissue engineering and bone scaffold materials under the supervision of Professor Abby Morgan.

Charles Sprinkle received his Master of Engineering in MSE this May 2010. He has been working on fiber optics under the supervision of Professor Gary Pickrell.

Matthew Hiser Receives College of Engineering Outstanding Senior Award and ACC Undergraduate Research Scholars Award

MSE student **Matthew Hiser** was named the 2010 Outstanding Senior in the College of Engineering in recognition of his exemplary academic record. Matthew is the fourth MSE student to win this award since 2003, following Michael Willeman (2006), Ashley White (2005) and Erik Herz (2003). The award is sponsored by the Virginia Tech Alumni Association.

Matthew also won one of eight ACC Undergraduate Research Scholars Awards for the 2009-10 academic year. The ACC Undergraduate Research Scholarship program recognizes highly talented undergraduate students who are pursuing ambitious and unique research projects. Students selected as ACC Undergraduate Research Scholars receive a $2,000 award that can be used as a stipend and/or direct support of research expenses such as supplies, travel, and the use of specialized research services.

"One of the unique aspects of a Virginia Tech undergraduate education is to offer undergraduate students access to research experiences," said Bob Jones, professor and head, Department of Biological Sciences and chair of the ACC Undergraduate Research Scholars Awards committee. "As a result, we see many exciting collaborations between our faculty and students that one cannot find at other universities. The ACC Undergraduate Research Scholars program further supports and encourages these partnerships."

Matthew is using his award to support research expenses including supplies and the use of Virginia Tech's Nanoscale Characterization and Fabrication Laboratory (NCFL). His research project is titled "Processing of Tungsten-2 wt% Iron Alloy for use in Kinetic Energy Penetrators." He plans two presentations in October 2010 at the MS&T conference and at the ACC Meeting of the Minds Conference. His faculty mentor is Professor Alex Aning of the MSE Department. ❄

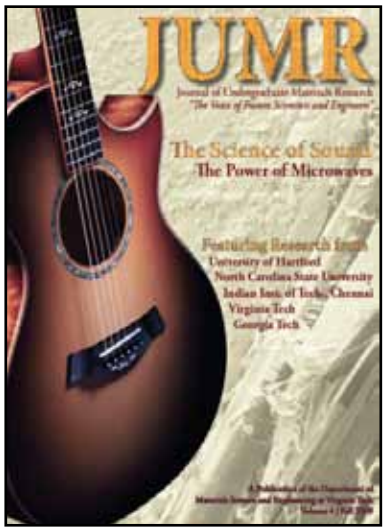
Andrea Rojas is currently a doctoral student under Professor Alex Aning (MSE) and Professor Rafael Davalos of the School of Biomedical Engineering and Sciences. Her research work is focused on studying the motion of bacteria through applied electric fields to produce scaffolds for bone and cartilage growth. ❄

MSE Students Inducted into Phi Kappa Phi

On Tuesday, December 1, 2009, MSE undergraduate students **Matthew Glazer**, **Karen Kokal**, and MSE research associate **Diane Folz**, were inducted into the VT Chapter of Phi Kappa Phi. Founded in 1897 at the University of Maine, Phi Kappa Phi is the nation's oldest, largest, and most selective honor society for all academic disciplines. Its chapters are on more than 300 campuses in the United States, Puerto Rico, and the Philippines. Each year, approximately 30,000 members are initiated. ❄

Volume 4 of Journal of Undergraduate Materials Research Released in Spring 2010

by Raghu Thridandapani



This year, the fourth volume of the **Journal of Undergraduate Materials Research (JUMR)** features a music-inspired project that connects the fields of engineering and art through a collaborative learning effort between two universities and industry. Volume 4 also features research from universities in the United States and India, including: Virginia Tech, University of Hartford, Rose Hulman Institute of Technology, North Carolina State University at Chapel Hill, South Dakota School of Mines, Georgia Institute of Technology, and Indian Institute of Technology in Chennai, India.

As part of the publication, JUMR showcases undergraduate research by organizing an annual symposium at the Materials Science & Technology Conference (MS&T). In October 2009 in Pittsburgh, Pa., sixteen undergraduate students from universities across the country presented their work at MS&T'09. Due to a prodigious amount of interest in the JUMR symposium (compared with previous years), a second session was added to accommodate all of the submissions. We anticipate the same enthusiastic response for the MS&T'10 JUMR symposium. The keynote speaker, Dr. Daniele Finotello, Director of the NSF-DMR Office of Special Programs, emphasized the importance of higher education and research opportunities for undergraduate students. He said, "Graduate education is a long term investment and the students should seriously consider pursuing their higher education."

JUMR is an annual publication from the Department of Materials Science and Engineering (MSE) at Virginia Tech. The published work is gathered from all over the country and the world. JUMR only publishes undergraduate research papers that are selected based on a rigorous peer-review process. The first volume, the Alfred Knobler Inaugural Issue, was released in October of 2005. Since its inception, this journal has been organized and run by graduate students in MSE, with the assistance of undergraduate students from MSE and the Department of English.

The editorial board for this year's Volume 4 includes: Raghu Thridandapani as Editor-in-Chief, Manoj Mahapatra as Associate Editor, Kristen Zimmermann, Niklas Floyd, David Berry as Peer-Review Organizers, Andrea Rojas as Public Relations Manager, Tongan Jin as Treasurer, Susan Holt as Data Manager, Charles Sprinkle and Katelyn Webster [English Department] as Design Editors, Diane Folz as Faculty Advisor, Ben Poquette as Industry Advisor.

More information about JUMR can be accessed at http://jumr.mse.vt.edu or by emailing the board at jumr@mse.vt.edu.❄

MSE Biomaterials Team awarded Outstanding Senior Design

The 2008-2009 MSE Outstanding Senior Design Prize was awarded to the biomaterials team composed of **Kristen Zimmermann**, **Jill LeBlanc**, **Kevin Sheets**, and **Robert Fox**. These students were advised by Professor Paul Gatenholm, and the project was titled "Biomimetic Design of a Bacterial Cellulose/Hydroxyapatite Nanocomposite for Bone Healing Applications." Their research goal was to investigate a new approach for the development of a mineralized bacterial cellulose scaffold to be used as a bone healing graft. The group's research was accepted to be published in Materials Science and Engineering: C, a journal published by Elsevier.

The Capstone Design in MSE is a year-long course in which students work in teams under the guidance of expert faculty to define, plan, and conduct an open-ended project that draws on all the knowledge and skills developed throughout the curriculum. The Senior Design course is taught by Professor Marie Paretti, Assistant Professor in Engineering Education, and Director of the Materials Science and Engineering Communications Program.

MSE Students Inducted into Tau Beta Pi

MSE undergraduate students **Peter Evans**, **Matt Glazer**, and **Calvin Lear**, and graduate students, **Prabhakaran Munusamy** and **Tyler Williams** were inducted into the VT Chapter of Tau Beta Pi on December 1, 2009. Tau Beta Pi, the national engineering honor society, was established in 1885 at Lehigh University to honor those engineering students who distinguish themselves both by their scholarship and exemplary character. Notable members of Tau Beta Pi at Virginia Tech include former President Paul Torgersen and Dr. F. W. Stephenson, former Dean of the College of Engineering. ❄

Record Number of MEPS Students Attend Materials Science and Technology 2009

In November 2009, a record 23 **MEPS student members** attended the Materials Science and Technology Annual Conference in Pittsburgh, Pennsylvania. Students were given the opportunity to attend lectures, network with professionals, and represent Virginia Tech during this international event. Several MSE students participated in conference proceedings. Niklas Floyd competed in the Undergraduate Student Speaking Contest, and Charles Sprinkle competed in the Undergraduate Student Poster Contest. Connor Edsall and Dennis Hollich participated in the Chapter Leadership Workshop.

Virginia Tech was in charge of the JUMR symposium, which offered undergraduates an opportunity to present their research to conference attendees. MSE students Matthew Hiser, Gordon Waller, and Andrew Kulp were three of the presenters whose research is in the latest JUMR publication. ❄

MEPS Students go to Cocoa Beach, Florida

In January, fourteen **MEPS students** attended the 34th Annual Conference on Composite Materials and Structures – ITAR Sessions in Cocoa Beach Florida. The students worked as pages, security, and registration while being given an opportunity to attend lectures on the most cutting edge evolutions in ceramic and composite engineering. The students played an important role in running the conference while gaining experience and networking with professionals.❄

MSE Students International Experience Update

In the summers of 2009 and 2010, MSE undergraduate students traveled outside the United States to participate in the MSE International Program's collaborations with the Department of Materials and GeoSciences at the Tecnische Unversitat Darmstadt (TU-Darmstadt), Germany, and the School of Materials Science and Engineering at Tianjin University, China.

In July 2009, **Calvin Lear,** a junior, and **Brian Allik**, a senior participated in Darmstadt's summer cultural program. The cultural program runs for six weeks and the students get six transfer credit hours, three for a foreign language and three for humanities. Calvin stayed an additional three weeks to work with Professor Alba on computational materials science.

On a more extensive collaboration, we had **David Gouldey**, who was enrolled in our 5-year BS/MS degree, going to Darmstadt in the fall 2009 to finish his master's degree thesis research. He participated in a 6-week German course in September and October and then took engineering courses, some in German, in mid-October. His thesis (written in English) was advised by Professor Wolfram Jagermann, Dean of the Department of Materials and Geosciences at Darmstadt and Professor Dimitris Pavlides in Electrical and Computer Engineering at TU-D.

For Tianjin, China at the end of July 2009, **Professor G.Q. Lu** and **Professor Lou Guido** accompanied three undergraduate students for a three-week cultural visit. **Amanda Krause, Nathan May**, and **Dennis Hollich** were introduced to the Chinese language and culture. They spent time with faculty and students, visited several materials-oriented industries, and of course, other places of cultural significance. This past July 2010, two MSE students, **Matthew Hiser** and **Annie Ellis** participated in the same program.

From March 21-July 5, 2010, MSE junior, **Matthew Glazer**, spent his spring semester in Tianjin University. In the Materials Science and Engineering Department, he took four classes, all taught in Chinese: Mechanical Behavior of Materials, Physical Properties of Materials, Polymer Physics and Dynamics of High Temperature Inorganic Materials. Matthew worked with MSE Professors Lianyong Xu and Dr. Fang He in Tianjin.

In addition, MSE senior, **Gordon Waller** went to Tianjin from May to August 2010 as a participant of the International Research and Education in Engineering program (IREE) organized by Purdue University and sponsored by the NSF. Gordon elected to go to Tianjin University's Materials Science and Engineering department because of the relationship between our MSE program and theirs. Professor GQ Lu from Virginia Tech, Dean Zhenduo Cui, Drs. Fang He and Lianyong Xu from Tianjin University were instrumental in helping with Gordon's arrangements. Gordon worked under Dr. Xiwen Du's research group on nanomaterials for solar cell applications. His work focused on the fabrication of novel Pb doped ZnO nanostructures using long pulse width, low energy pulsed laser ablation. ❄

Spring 2010 Materials Science and Engineering Bachelor of Science Degrees

Roberta A. Acken

Brian D. Allik

Adwoa S. Baah-Dwomoh

Jaclyn Brennan

Connor W. Edsall

Annie R. Ellis

Luke J. Golladay

Matthew M. Hiser

Lindsay Hockensmith

Dennis P. Hollich

Andrew B. Kulp

Nathanael H. May

Eric L. Miller

Eric T. Moffatt

David C. Moore

Thomas L. Murphy

Laura A. Patrick

Chandler T. Slate

Gordon H. Waller

Mark L. Yoo

Michael D. Zachar

Summer 2010 Materials Science and Engineering Bachelor of Science Degrees

Christin D. Alleyn

Fall 2009 Materials Science and Engineering Bachelor of Science Degrees

Mark G. Briguglio

Kathleen M. Campbell

Anne C. Coppa

Jill M. LeBlanc

2009-2010 Undergraduate Awards and Scholarships

Michael Stuback Memorial Scholarship
Elizabeth Belcastro
Matthew Hiser

Thomas G. Stroyan Memorial Scholarship
Karen Kokal

John H. Kroehling
David Brock
Annie Ellis
Paul Croasdale
Jessica Piness
Dennis Hollich
Carolyn Tucker

Peter and Phyllis Pruden
Paul Croasdale
Eric Moffatt

Thomas L. Leivesley, Jr.
Dennis Hollich

William McAllister
Jill LeBlanc

Eleanor Davenport
Karen Kokal
John Sions

Dean's Scholar
Matthew Hiser

Ronald S. Gordon
Eric Moffatt

Pratt Scholarship
Matthew Hiser
Tyler Williams

Gary S. Clevinger Memorial
Niklas Floyd
David Gouldey
Andrea Rojas
Kevin Sheets
Charles Sprinkle

College of Engineering Scholarship
Amanda Krause

Gilbert and Lucille Seay
Aaron Blomberg
Adam Blomberg
Tyler Corley
Akash Jain
Laura Patrick

William B. Belchee
Eric Miller

Alfred E. Knobler
Casey Berding
Aaron Blomberg
Adam Blomberg
Tyler Corley
Amanda Krause
Eric Miller
Laura Patrick

2009 Materials Science and Engineering Graduate Degrees

Doctor of Philosophy

Name	Advisor	Dissertation Title
Zengping Xing	Viehland	Magnetoelectric Device and the Measurement Unit
Junyi Zhai	Viehland	Magnetoelectric Laminated Composites and Devices
Xin Zhao	Corcoran	Electropolishing of Niobium in Sulfuric Acid-methanol Electrolytes: Development of Hydrofluoric Acid Free Electrolytes
Weifeng Rao	Wang	Computer Modeling and Simulation of Morphotropic Phase Boundary Ferroelectrics
Dae-Seob Han	Asryan	Theory of Tunneling-injection Quantum Dot Lasers
David Gray	Kampe	Characterization and Modeling of Friction Stir Fabricated in-situ Metal Matrix Composites
Manoj Mahapatra	K. Lu	Study of Seal Glass for Solid Oxide Fuel/Electrolyzer Cells
Li Yan	Viehland	Two Phase Magnetoelectric Epitaxial Composite Thin Films
Xiaojing Zhu (Rec'd, 2008)	K. Lu	Processability of Nickel-boron Nanolayer Coated Boron Carbide

Master of Science

Name	Advisor	Title
Bassam Alfeeli	Pickrell	Ionizing Radiation Resistance of Random Hole Optical Fiber for Nuclear Instrumentation and Control Applications
Eric Faierson	Logan	Influences of Reaction Parameters on the Product of a Geothermite Reaction: A Multi-Component Oxidation-Reduction Reaction Study
Gabrielle Farrar	Morgan	Creation of Ovalbumin Based Scaffolds for Bone Tissue Regeneration
Michael Hunt	Logan	Pressureless Densification of SHS Produced Alumina - Titanium Diboride Ceramic Matrix Composites
Reza Montazami	Heflin	Fabrication and Characterization of Layer by Layer Assembled Single and Dual-Electrochrome Electrochromic Devices
Brian Scott	Pickrell	Fabrication and Characterization of a Porous Clad Optical Fiber Gas Sensor
Chun-Hsien Wu	Reynolds	Microstructure of Flash Processed Steel Characterized by Electron Backscatter Diffraction

Alumni News

Virginia Tech Honors Engineer Tom Cox for his Career Achievements

by Lynn Nystrom

Thomas B. Cox of Boulder, Colo., who earned his bachelor's and master's degrees in metallurgical engineering from Virginia Tech in 1966 and in 1968, respectively, is a 2009 inductee into Virginia Tech's College of Engineering Academy of Engineering Excellence, joining an elite group of 90 individuals out of more than 50,000 living engineering alumni.

This Academy of Engineering Excellence honors the truly exceptional among its tens of thousands of alumni, according to F. William Stephenson, past dean of the College of Engineering who created the Academy in 1999.

Cox came to Virginia Tech in 1961, funded by a co-op program with National Steel Corp., the only way he could afford college. Virginia Tech operated in academic quarters at the time, and he alternated college with working at the mills at home.

Cox finished his bachelor's degree in 1966, and launched directly into a master's degree at Virginia Tech in the same field, finishing in 1968. At the David W. Taylor Naval Ship Research and Development Center, in Annapolis, he helped develop new compositions of matter and processing for high strength steels, including HY-180, and new titanium alloys. During his career at Annapolis, Cox earned his Ph.D. in materials science and engineering from Carnegie Mellon University in 1973.

From 1976 to 1979, he worked with the U.S. Department of Energy in Washington, D.C., managing alloy research programs for coal gasification technologies. His career then took him west to the Lawrence Livermore National Laboratory, near San Francisco, where he managed a plutonium technology program and facility, including plutonium alloy research, and the design and fabrication of hardware for weapons tests.

In 1981, he went to work for Amax Corp.'s Climax Molybdenum research and development division in Ann Arbor, Michigan. In 1989 Cox joined the General Electric corporate research center in Niskayuna, N.Y. There he managed metallurgical research and development in support of GE's businesses before being promoted to technical director of the giant's Global Research Center. He played a leading role in the establishment of GE research and engineering laboratories in Bangalore, India, and Shanghai, China, in the late 1990s before retiring at the end of 2001.

Cox also showed leadership in innovative research and development approaches, including partnering with the former Soviet Union to commercialize fundamental metallurgical process technologies such as high-gradient casting.

Cox holds five U.S. patents for composition of matter and the processing of metallic alloys. He also has authored 20 papers for referred technical journals and was elected to membership in Tau Beta Pi and Sigma Xi. ❄

Diana Farkas named Jefferson Science Fellow
continued from page 3

ation of more international experiences for students and scientists. The fellowship is also considered a tool of public diplomacy.

As a major part of this effort, Farkas spent the past year presenting lectures at many universities abroad, including locations in Brazil, Argentina, Uruguay, Mexico and Hungary. These lectures have been specifically on the topics of exchanges of faculty and students and the mechanisms of transferring scientific innovation from universities to industry.

Farkas also worked in the area of science diplomacy, promoting the idea that scientific endeavors help bring different cultures together and help build diplomatic bridges. She has continued the ongoing work of the Bureau of Western Hemisphere Affairs. For example, she worked with the "Science Corners" program, a public diplomacy effort from the Bureau of Western Hemisphere Affairs. Farkas also participated with OES/STC in the organization of joint commission meetings with countries with which the U.S. has Science and Technology Cooperation Agreements.

The materials science and engineering professor also participated with the Organization of American States on its "Engineering for the Americas" educational program, an initiative to improve engineering curricula in Latin American countries.

Farkas continues to work on the organization of a US-Brazil innovation forum that will discuss best practices for transferring scientific and technical innovation from the universities to industry, in a lab to market process. She also participated in the development of the 2010 strategic plan for the National Nanotechnology Initiative, and is involved in the activities of the Pan-American Nanotechnology Network, with the goal of increasing collaboration in the area of nanotechnology in the hemisphere.

In a ceremony held this past summer in the George C. Marshall room at the U.S. Department of State, Secretary Hillary Rodham Clinton honored the ten 2009-10 Jefferson Science Fellows and thanked them for their service in the various bureaus of the State Department and the USAID. In her remarks, Secretary Clinton congratulated the fellows, emphasized the need for scientific and technical expertise in government, and inquired about the most significant experience and contributions the fellows made to the missions of the U.S. Government foreign policy establishment. ❄

Research Spotlight continued from page

PCL is bio-compatible, biodegradable, can be easily processed and has previously been used in the literature in the area of bone tissue regeneration. Silk is a naturally occurring polymer that has found applications in a wide variety of tissue regeneration applications, especially that of ligament. The PCL-silk system will thus function as a robust, self-sustaining scaffold that will help regenerate ligament whilst allowing newly formed ligament to anchor into the bone due to the presence of mechanical, mineral and biological gradients.

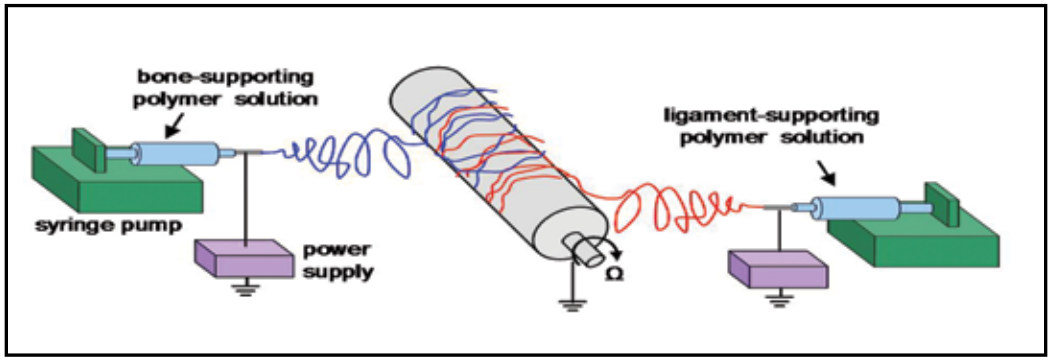


Figure 1: Dual electrospinning system with offset spinnerets. Separate polymers (blue, red) are electrospun simultaneously onto slowly rotating drum to form a gradient parallel to drum axis

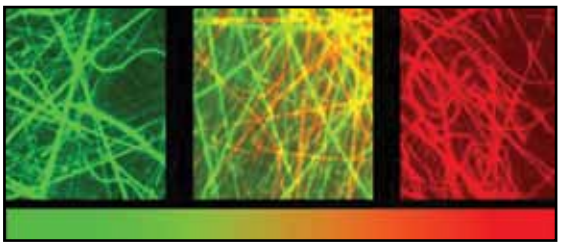


Figure 2: Graded electrospun polymer mesh with 100% green dyed polymer on left, 50/50 blend in the middle, and 100% red dyed polymer on right. Color scale from green to red indicates direction of the gradient from left to right spun simultaneously onto slowly rotating drum to form a gradient parallel to drum axis

The first gradient of interest is the mechanical gradient. This gradient is formed by co-electrospinning two different polymers as shown in Figure 1. To this end we are currently co-electrospinning PCL and silk. A proof-of-concept study with dyed PCL demonstrates how such a gradient will be fabricated (Figure 2).

The second gradient, made of mineral, will be generated by immersing the co-electrospun mesh in simulated body fluid (SBF 5x). This solution of ions deposits calcium phosphate onto the surface of the mesh, hopefully only on the PCL. To ensure mineralization of the PCL only, nano-hydroxyapatite crystals were seeded in the fibers of the PCL to act as nucleation sites for the calcium phosphate mineral. Mineralized meshes appear grainy with increased fiber diameter after immersion in the SBF for 12 hr (Figure 3).

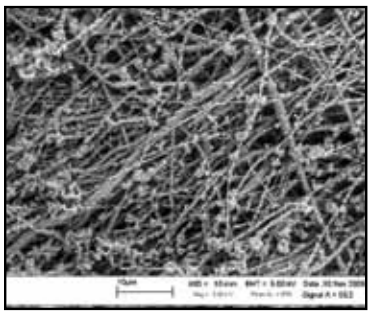


Figure 3: : In situ mineralized PCL electrospun mesh. Note grainy mineral deposits on fibers. Scale bar 10 microns

The current goal is to focus on creating a mechanical gradient by co-electrospinning PCL and silk. The fact that such a gradient can be created has been established (Figure 2) and PCL and silk have been individually shown to electrospin well under optimal conditions. The other goal is to create a mineral gradient by selectively mineralizing nHAP-PCL fibers. The rationale is that the hydroxyapatite particles present in/on PCL fibers will act as nucleation sites and help deposit carbonated hydroxyapatite from 5x SBF (Figure 3).

Subsequently, mechanical testing will be performed on these graded meshes to determine how well they behave under tensile stress. The ultimate goal would be to seed a mixture of osteoblasts and fibroblasts on these meshes and study cell response. ❄

Reigniting the Casting Industry from page 6

Jack Hyzak, the director of Corporate Technical Development for PCC. One of PCC's primary competencies is casting, and they hope to foster interest among students in metals research. "Hands-on experiences are the best education," Hyzak states. "This lab will be a great step in that direction. It will aid not only graduate students, but just as importantly, undergraduate students."

MSE alum and advisory board member, John Kroehling and his wife, Joan, have made a substantial donation toward the building. Other key donors for VT FIRE include the AFS Piedmont Chapter; industry support, lead by PCC and ETA Engineering Inc.; the College of Engineering, including the Departments of MSE, ISE, ME, and Engineering Education; the College of Architecture, including the School of Visual Arts and the Industrial Design Program. Together, this group has committed $1.6 million to this project in funds, equipment, and design work.

Groundbreaking began on March 29. The vision of reigniting metal casting at Virginia Tech is well on its way, and students will be pouring metal in the new Kroehling Advanced Materials Foundry by spring 2011.

Endnotes

[1]VT FIRE: Conclusions and Recommendations, by Mark Briguglio, Anne Coppa, Tobin Gibert, MSE Senior Design Project, Virginia Tech, May 2009.

[2]American Foundry Society website: http://www.afsinc.org/content/view/62/122

[3]*VT FIRE: Conclusions and Recommendations,* ibid.

[4]Historical Photos and Map: The Col. Harry Temple Collection, Ms88-039, t12-012, ht489, t102. Digital Library and Archives, University Libraries, Virginia Tech. VT ImageBase (http://imagebase.lib.vt.edu/), housed and operated by Digital Imaging, Learning Technologies, Virginia Tech.❄

Meet Paul Huffman continued from page 7

the first of many co-op students to train in the Lynchburg Foundry.

After completing his degree in materials engineering in 1978, Paul went to work for Pangborn in Hagerstown, Maryland, a company that manufactured shot blast and descaling equipment. Paul was hired as the sole metallurgical engineer to help with plans to modernize their foundry and create a quality control lab. "It was an absolutely wonderful first job out of school," Paul says, but it was also intimidating. Because he was a Virginia Tech graduate, and a metallurgical engineer, Paul recalls, "I was expected to know a lot more than I actually knew." Besides working on the foundry side, he also helped with engineering the product line and with sales. He did whatever it took to learn what he needed to know, including taking classes, visiting other foundry operations, and joining the American Foundry Society.

Five years later, he went to work as a foundry superintendent for Graham-White Foundry in Salem, Virginia, where he quickly moved into the position of plant manager. "I recognized we had a wonderful foundry operation that not only could make castings for our own product line, but we could sell castings to outside industry." Under his direction, the foundry expanded from a one-shift operation, where 80 percent of their production went into their own product line, to a three-shift operation, where 80 percent of the production went toward product for primary manufacturers outside of Graham-White. During his tenure with Graham-White, Paul volunteered to design and build the second Virginia Tech Skipper cannon in 1984 to replace the original, which had been damaged a few years earlier.

In 1992, after much soul searching, Paul left Graham-White to start Dominion Metallurgical (Domet), a company that serves as a supplier of metal castings, based on his initial idea that, "wouldn't it be great to have a company that, no matter what type of metal casting was required, we could say yes, we could do it." He set up shop in his basement and began searching for the best available foundries that could cast parts ranging from an ounce to a ton, searching for customers who needed castings, and the orders started coming in. In the early days, Paul says, he became a road warrior, wearing out multiple sets of tires delivering patterns to foundries and delivering completed castings to customers. Domet quickly outgrew Paul's basement and now has offices in Valleypointe Industrial Park in Roanoke. It's no surprise that Paul has been involved in starting more companies, such as Safety Step, LLC, based on ideas and needs discovered out in the field.

Paul serves as the Education Chairman and a Director for the American Foundry Society, and he is a Trustee for the Foundry Education Foundation. He is also a member of the American Society for Metals. He maintains strong ties with Virginia Tech and with the MSE Department, serving on the MSE Advisory Board, and he is heavily involved with the VT FIRE initiative to build a teaching and research foundry at Virginia Tech. He can often be found in a classroom performing metal casting demonstrations for various MSE outreach programs and student organizations. ❄

Heads Up continued from page 16

in Materials Characterization; and, one in Nuclear Materials (joint with Mechanical Engineering)

- The new Kroehling Advanced Materials Foundry will be dedicated in 2011.

As always, we thank our alumni for their continued support and loyalty. Please e-mail us, stop by the department for a visit or join us for one of our pre-game tailgates. Just stay in touch!

Exploring Materials at Virginia Tech

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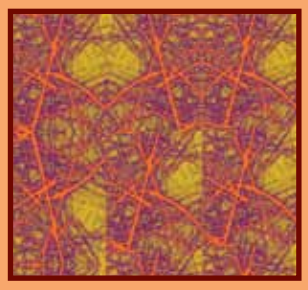

Image courtesy of:
Professor Abby Whittington Morgan

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Heads Up!

David Clark

MSE Department Head

It's great to be a Hokie – especially a Hokie in the College of Engineering. The COE's ranking in the U.S. News & World Report continues to rise with its undergraduate program ranked 13th (MSE ranking is 17th) and its graduate program ranked 25th (MSE ranking is 22nd.) Recently, the National Science Foundation ranked VT's COE 10th in the nation in terms of research expenditures and the Wall Street Journal ranked the College 5th with respect to where corporate recruiters like to hire engineers. Even with increasing tuition, the College's undergraduate enrollment continues to increase together with the quality of students that we are accepting.

Presently, we are among the top 5 engineering colleges in the United States with respect to enrollment and the number of students that we graduate. Why am I telling you all of this? Two reasons: first, MSE can be proud of the role that it has played in helping the College to achieve its national and international stature. Second, when the College does well, MSE reaps many benefits that help it to maintain a world-class program. Two examples of MSE's success are the Nanoscale Characterization and Fabrication Laboratory (NCFL) that was first conceived and spear-headed by MSE and then implemented by the Institute of Critical Technologies and Applied Science (ICTAS); and the Virginia Tech Foundry Institute for Research and Education (VT-FIRE) to be dedicated in April 2011. Neither of these initiatives would have been possible without the strong support of the College and both have contributed to increased research funding, and attracting new faculty and graduate students into the department and college as well as the rest of the University.

As I look back over the last 10 years, it's interesting to see how the department has grown. For example, our undergraduate enrollment in 2001 was 69; presently, it is 109 and I predict that in 2012, it will be over 140. Similarly, our research expenditures have grown from $1.5 million/year to $5.2 million/year during this same period, well over 10% year on average. While our space allocation has not grown, the new engineering fee has been instrumental in renovating several of the labs in Holden Hall as well as buying much needed equipment. With the dedication of the VT-FIRE building in April, we will add another 4000ft^2 bringing our total to about 30,000ft^2. Although this will help our immediate space constraints, one of our greatest challenges over the next 5-10 years will be additional space. To stay competitive with our peer institutions, we will need an additional 10,000 – 15,000ft^2. Based on Dean Benson's success in acquiring a new 150,000ft^2 building for the College, we are confident that by working with the College, we will acquire the space needed for MSE to continue to grow its faculty, student body and research program.

In closing, I would like to mention a few additional highlights.

- MSE student, Matt Hiser, was named the College of Engineering Outstanding Senior. This was the 4th time in 8 years that an MSE student has received this distinction.
- In 2009/10, we published 98 papers in refereed journals and conference proceedings, submitted 13 patent disclosures and received 2 patents and over $7 million in new research funding.
- The department is searching for 3 new faculty positions: one in metallurgy to serve as Director of VT-FIRE; one

continued on page 15