SPRING 2007

BU College of Engineering MAGAZINE

Material Gains

UNLOCKING THE PROMISE OF ADVANCED MATERIALS

- DEAN LUTCHEN ON ENG'S FUTURE
- SPECIAL FX

BU College of Engineering BOSTON UNIVERSITY

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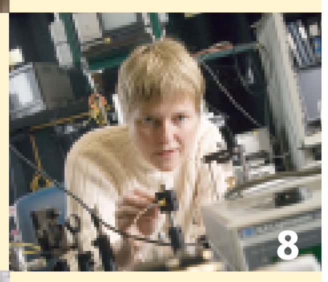

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COVER: Assistant Professor Elise Morgan studies the material properties of bones.

Out of Our Silos

By Kenneth R. Lutchen, Dean

We often note with pride that Alexander Graham Bell invented the telephone while he was a faculty member at Boston University. There was no College of Engineering at that time and Bell probably did not think of himself as an engineer, yet his invention stands as one of history's most important engineering achievements.

Of course, Bell fit the definition of an engineer; he used the scientific knowledge of his day to solve a real-world problem. In his effort to find new and better ways to educate the deaf, he devised his "telegraphy" machine, thereby using mechanical and electrical engineering principles to address a biomedical engineering problem.

In the century following Bell's invention, engineering grew and achieved maturity as an academic discipline. Like most engineering schools, Boston University divided its engineering program into a set of academic departments wherein faculty taught and conducted research. This resulted in numerous technological breakthroughs and trained generations of scientists and engineers who put man on the moon, created the computer and produced a host of achievements that stand as landmarks in human history. But this tightly focused approach may no longer be sufficient or competitive for addressing the engineering and scientific challenges of the future.

In a sense, we have come full circle to Bell's time. As engineering educators, researchers and practitioners, the time has come for us to poke our heads out of our silos and collaborate across disciplines inside and outside of engineering. We must combine the knowledge and perspectives of the individual disciplines to achieve new breakthroughs. For certain, we must insure that students acquire the core competencies in a chosen engineering discipline. But addressing the major challenges of the future will also require an educational and research structure that insures all engineers are able to work and communicate effectively with their colleagues in other fields—including those outside of engineering, such as the physical and life sciences—and the computational and statistical sciences.

Wireless networks, imaging, materials science, micro- and nano-technologies, and countless other emerging technologies of the 21st century require that multiple engineering sciences be brought to bear. As educators, we need to adapt to this changing landscape and produce graduates who are equipped to be leaders. We are moving in that direction at Boston University.

One of the College of Engineering's signature strengths is the innate collegiality among our faculty, not only within the College but throughout Boston University. We are capitalizing on that by beginning the process of organizing our research efforts around clusters of strength that represent areas where the College is poised to make the greatest impact on the technology of today and tomorrow, and where faculty from every department are involved: advanced materials, micro- and nano-technologies, networks and systems, and sensors and imaging. Overarching—and integrated with each of these clusters—are our world-recognized strengths in photonics, bioengineering and computational modeling.

As we develop this cluster model for research, I fully expect that education will benefit. As we involve more undergraduates in laboratory basic and applied research, they will gain a broader understanding of the engineering sciences beyond their individual major. Graduate students will also reap an extraordinary benefit.

I believe that this approach is the best way we can prepare our students for the world of the 21st century and produce the kind of signature innovations that will advance society. Somehow, I think Professor Bell would approve. ■

MATERIALS World

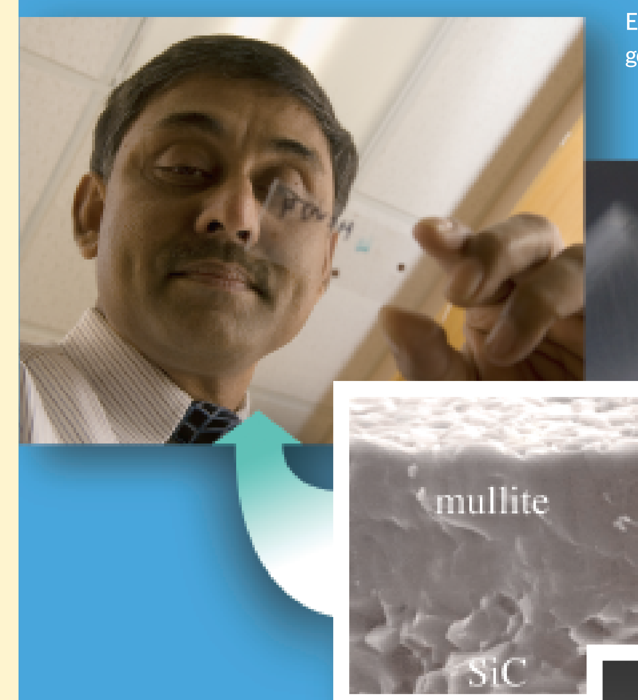
ENGINEERS CROSS DISCIPLINARY LINES TO CREATE AND HARNESS NEW MATERIALS

By Chhavi Sachdev

People have always defined their place in human history by the materials they have used to create their tools. From stone, bronze and iron to plastic and silicon, understanding materials and finding innovative ways to use them have propelled civilizations forward throughout the ages. Typically, evaluating the properties of new and existing matter came before applied use, making materials science one of the first branches of engineering.

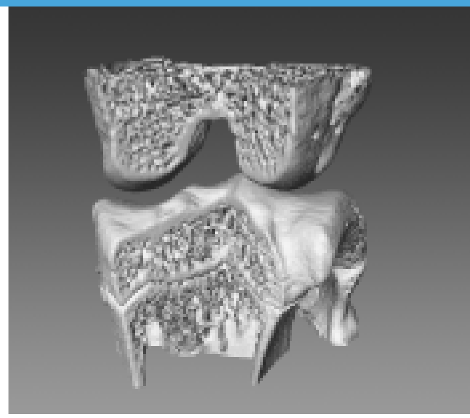
Today, materials science is a blossoming discipline focused both on enhancing the properties of known materials and creating new ones. Ancient areas like metallurgy continue to be explored, as do new frontiers in nanotechnology. At the College of Engineering, faculty researchers from all academic departments are engaged in the business of studying fundamental substances in order to understand, manipulate and improve them. Frequently, researchers are collaborating with colleagues in other engineering disciplines and in the natural sciences and medicine, taking their research beyond traditional bounds.

For instance, biomedical engineer Mark Grinstaff works with chemists and clinicians creating and perfecting biogels that could soon replace sutures in eye surgery. Elise Morgan in Aerospace and Mechanical Engineering partners with orthopedic surgeons to understand the structure and mechanics of bones, hoping to predict and reduce the risk of fractures. In the Manufacturing Engineering Department, Soumendra Basu cooperates with aerospace engineers on making an alloy resistant to thermal and environmental ravages, and in Electrical and Computer Engineering, Anna Swan teams with physicists to study single nanotubes to characterize them for semiconductor and possible medical applications.

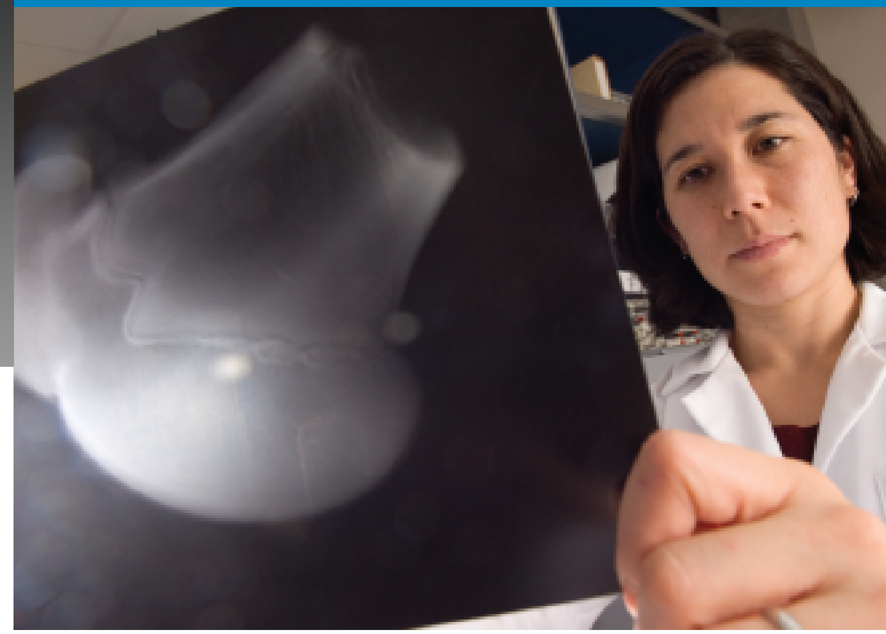


Professor Soumendra Basu (MFG), Assistant Professor Elise Morgan (AME), Associate Professor Anna Swan (ECE), Professor Mark Grinstaff (BME).

Boning up on mechanics



Courtesy Elise Morgan



Assistant Professor Elise Morgan examines a sample of the inner spongy mass inside bovine bone tissue (also in inset) in order to see the stresses from a fracture.

Pumping iron makes muscles grow stronger, but what makes bones strong or weak? What is it about their structure that makes them susceptible to injuries and disease regardless of calcium intake, age or exercise? Unlocking the answers to these questions would have wide ranging applications in surgery and rehabilitation as well as prevention of injury and diseases such as osteoporosis. Elise Morgan, an assistant professor of aerospace and mechanical engineering, aims to do precisely that.

Aging and time take their toll on everybody. "Quite drastic changes occur in the structure and mechanical properties of bone tissue with age and with disease," says Morgan. "It would be extremely helpful if we could detect changes in structure and know what these structural changes mean in terms of the mechanical competence. Then we could develop better diagnostics of someone's risk of suffering a bone fracture. And we could also figure out how best to modify the tissue's structure—maybe through exercise or a drug treatment—in order to decrease the fracture risk."

Morgan focuses on the structure and composition of tissues such as bone and how they are related to their mechanical properties.

Bones are composed of minerals, proteins and water. "But you can take the same amount of the components and spatially arrange them in different ways and get totally different mechanical properties."

In our bodies, bone and cartilage support walking, running, climbing, weight bearing and even impact from falling or jumping due to their combination of strength, toughness and relatively low weight. "These tissues have important biological functions, but they also have very critical mechanical functions," she says. "If they can't serve those functions, we're not able to go about our daily lives. We have to be able to stand up, walk and bend over to pick something up, all hopefully without pain."

Morgan's lab simultaneously combines 3-D imaging techniques—such as CT scans, MRIs and ultrasound—with mechanical testing to identify the structural characteristics of vertebrae that are most closely related to the strength of these bones. Spine fractures are the most common fracture resulting from osteoporosis, a disease that affects as many as 44 million Americans.

Today's clinical imaging tools measure bone density to screen for the risk of a spinal fracture, but data on the bone's microstructure, or how the bone tissue is distributed in space, are not studied.

"If we can provide simple quantitative links between measures of the structure and the strength of the vertebra, we can get more sensitive, specific predictions of fracture risk," Morgan says.

They can also use their techniques to literally watch these fractures happen. "We combine imaging with mechanical testing in order to characterize, for the first time, how the fracture process occurs—what are the first regions in the vertebra to actually fracture, and how that fracture propagates throughout the entire bone," she says. With this failure visualization method, Morgan hopes to provide doctors and health professionals with a more complete understanding of how spine fractures happen.

Morgan is also looking at ways to help regenerate tissue; she is focused on the deterioration of joint cartilage associated with arthritis. Once the deterioration is characterized, her next step will be to form a quantifiable continuum correlating structure with strength for prognoses as well as diagnoses.

"Since bone and cartilage have important mechanical functions it should be no surprise that they can respond to the forces that are applied to them," says Morgan. Just like muscles grow or atrophy in response to the work they do, the amount and type of force applied to a bone will change its structure accordingly.

This happens not just in healthy bones, but also in bones that are healing after a fracture. Cells that are initially present in the fractured region can become bone cells, cartilage cells, or any one of a variety of other types of cells. The path they choose depends in part on what forces they are experiencing.

It has been known for a while that breaking a bone and then stretching it with a pulling motion can stimulate bone growth, a procedure used even today for bone-lengthening in people with short bones or congenital deformities. Morgan has shown that bending a broken bone back and forth for short periods stimulates the formation of a tissue that behaves a lot like joint cartilage.

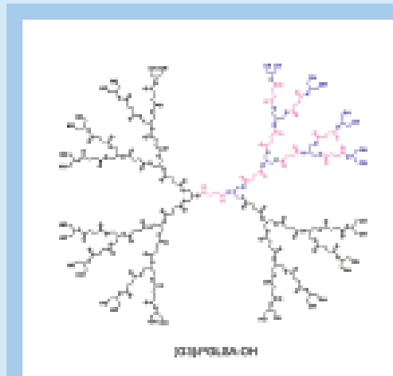
In collaboration with Boston University School of Medicine's Louis C. Gerstenfeld, a professor of orthopedic surgery and biochemisty, and Thomas Einhorn, a professor of orthopedic surgery, as well as graduate student researchers from the mechanical engineering and biomedical engineering departments, Morgan is characterizing the nature of this cartilage. The researchers are quantifying its structure, mechanical properties, molecular signature and how the mechanical stimulation is altering what genes are and are not being expressed.

One of the issues at the forefront of Morgan's research is defining the key molecular and structural events that occur during the process of new cartilage formation. "If we know that, then we can identify whether these events are taking place naturally in degenerated joints, arthritic joints and joint injuries in general," she says. If they aren't, then Morgan would like to figure out how to make them happen and find a way to regenerate joint cartilage.

Gel in your eye?

Professor Mark Grinstaff works with orange solvent to make photo cross-linked, or light-activated, gels. A small amount added to the polymer (inset) will make the liquid orange mixture turn into a clear gel when light is shined on it.

While many researchers look into creating materials that will be inserted into our bodies for long-term use, Mark Grinstaff, a professor of biomedical engineering and chemistry, works on biodegradable polymers that will provide a temporary scaffold for tissue regeneration or facilitate drug delivery.



Courtesy Mark Grinstaff

"The whole idea is to synthesize, develop and characterize new materials and identify particular medical applications for them," says Grinstaff.

"For instance, we have a significant interest in designing, synthesizing and evaluating dendritic—or highly branched—polymers," he says. "We have found that you can modify them and mix them to form gels that are 80 percent water and 20 percent polymer." Dendritic polymers, or dendrimers, are so called because of their tree-like structure.

Dendrimers have been synthesized for over 20 years, but until recently they had not been explored for medical applications. Grinstaff's research bridges organic chemistry, biomaterials and clinical applications. "We are synthesizing dendrimers from materials such as amino acids, succinic acid and glycerol," he says, which occur naturally in the body.

The resultant biodendrimers not only have the characteristics of adhesion, viscosity and transparency, they are also biocompatible—which means the body does not reject them as foreign objects—and biodegradable.

(continued on page 7)

Leaner, greener turbines

Soumendra Basu's research is aimed not only at solving an intellectual jigsaw puzzle but also at addressing a problem with great societal impact. Applicable in both power generation and the aerospace industry, his research involves materials that will allow gas turbines to run more efficiently and in an environmentally friendly manner.

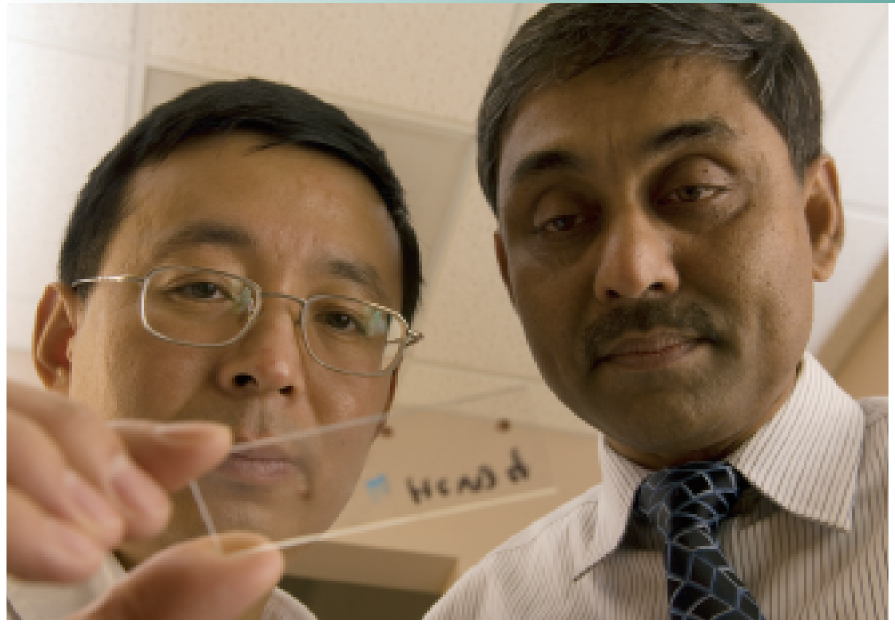
Basu's focus is on the relationship between a material's processing, structure and properties. "My expertise is studying the structure of materials and ascertaining how to modify the structure to improve the properties," he explains. "Then I go back and optimize the processing to obtain that modified structure and end up with a material with superior properties."

Basu works on several projects concurrently but at the fore is his work developing environmental barrier coatings (EBCs) for gas turbines for both energy and aerospace applications.

"There is a push to use ceramic components in micro-turbines for on-site power generation and in certain sections of gas turbines in manned and unmanned aircraft," says Basu. The use of ceramics would enable operation at higher temperatures, which would mean greater efficiency and cleaner byproducts.

The temperature in a gas turbine is typically over 1,100° C, which is near the limit of metallic nickel- or cobalt-based superalloys. To push the temperatures significantly higher, silicon-based ceramics will have to be introduced.

Silicon-based ceramics are not completely immune to these extremely hot and corrosive atmospheres either. They suffer from problems of recession, which is a repeated cycle of oxidation of the ceramic to form silicon dioxide and the vaporization of this silicon dioxide. This causes the surface of the ceramic components to recede inwards. The ceramic components also suffer from hot-corrosion, which is the formation of very corrosive liquids that lead to pitting of the ceramics.



Professor Soumendra Basu, right, and researcher Hengzhi Wang look at a sample of the mullite coating.

To protect the ceramic components, Basu is developing a novel, functionally graded environmental barrier coating system based on mullite, a silicon dioxide and aluminum oxide alloy with "excellent corrosion, recession and thermal shock resistance."

These mullite coatings have the added advantage of being significantly thinner than the current coatings being deposited by plasma spraying today. This is especially useful for aerospace applications in which weight is a huge consideration. Plasma sprayed coatings are typically a millimeter thick.

"We're trying to replace this with a 10-micron mullite coating," Basu says, which is about one-fifth the diameter of a human hair.

To be effective, EBCs have to be protective on the outside as well as adherent to the substrate. Working with Vinod Sarin, a professor of manufacturing engineering, Basu came up with the idea of grading the composition and properties of the coatings from the inside out. This allows the coating inside to simultaneously match the thermal expansion coefficient of the ceramic material of the turbine blade while being corrosion- and recession-resistant at the outside surface.

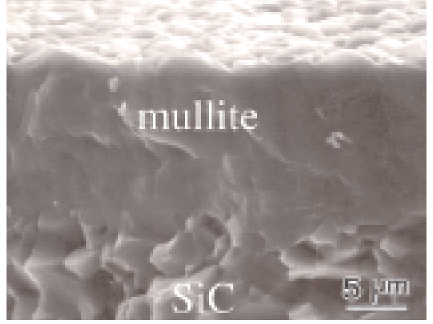
"The best part about this research is that not only are we developing a complex coating system for an exciting application, we are also producing some of the most aluminum oxide-rich mullite compositions ever to be reported in the literature," says Basu. "The atomic structure and defects in this phase are highly complex and understanding how such a structure evolves presents an excellent scientific challenge, in addition to the engineering challenge of designing the most effective coating system." The research has also fostered "Excellent interdisciplinary collaboration since we are working with [Assistant Professor] Todd Murray of Aerospace and Mechanical Engineering, who is interested in measuring the mechanical properties of the functionally graded coatings by nondestructive techniques." This work has been funded by the Department of Energy and the National Science Foundation.

Another area of Basu's research is developing thermal barrier coatings (TBCs) for gas turbine components. TBCs have very low conductivity and allow an increase in the combustion temperature of an engine without increasing the temperature of the turbine blades. For gas turbines used for energy generation, the TBCs are deposited by plasma spraying.

"You take ceramics powders, put them in a plasma gun where temperatures are thousands of degrees, heat them up, melt them and literally spray-paint the component," Basu says. "The trouble is that there is a very violent quenching process that occurs when the molten ceramic particles flatten on the substrate and solidify rapidly."

This leads to the formation of cracks in the coating. On one hand, these cracks are useful in reducing the thermal conductivity of the coatings; on the other hand, cracks near the interface of the coating and the ceramic subtrate can make the coating spall—or fragment and flake off—exposing the blades to higher temperatures.

Working with Michael Gevelber, an associate professor of manufacturing engineering, and Donald Wroblewski, associate professor of aerospace and mechanical engineering, Basu is researching processing techniques to engineer the density and structure of the microcracks in order to reduce the coating's thermal conductivity without spalling. This work is funded by the National Science Foundation.



Courtesy Soumendra Basu

A scanning electron microscope image of a 10-micron-thick environmental barrier coating on silicon carbide.

GEL IN YOUR EYE?

(continued)

While these biodendrimers can have applications in many areas—from drug delivery to healing arthritic joints—Grinstaff's patented biomaterials are being tested for use as hydrogel adhesives to repair eye wounds.

Suturing is a state-of-the-art treatment for repairing ocular wounds caused by trauma or surgery. However, the use of sutures causes additional trauma, explains Grinstaff—they leave scars and often produce astigmatism if uneven stress is applied at any point on the cornea.

Talking to clinicians about the need for a less invasive solution, Grinstaff became interested in the interface between medicine and designer materials. From these discussions, his team was able to create a list of design requirements and started experimenting with hydrogels.

Their solution was a novel extension of a common item: the contact lens. Composed mostly of water and some amount of plastic or silicone, a contact lens is the perfect example of a hydrogel.

Grinstaff's hydrogel functions as a type of viscous adhesive that can be applied to an eye wound to form a thin healing film, like a transparent bandage. In a few days the tissue underneath heals and the hydrogel sealant is gently sloughed off.

Hydrogels are more elastic than the cornea and have optical properties, explains Grinstaff. A few microliters placed on the eye can act as a physical barrier, reduce the chances of asymmetrical healing, and, as new cells grow, the patient "basically blinks it out."

Grinstaff's lab has produced two kinds of hydrogels: light-activated and self-gelling. Both types are liquid in their inactivate form and turn into transparent gel when activated, the former by exposure to a small light, the latter when the two components are mixed. In an emergency, a doctor could decide which is better depending on the site and type of wound.

In vitro studies have shown enough promise that Grinstaff has teamed with clinicians for in vivo studies. A company will take care of the clinical trials and FDA approval. "We will continue to provide guidance, assistance and improvements," says Grinstaff.

Even as they work on improving the hydrogels for eye surgery, Grinstaff's lab is also addressing their applications for drug delivery and arthritis.

"The translational component is exciting," says Grinstaff, who is one of two "site miners" at the University as part of the Wallace H. Coulter Foundation Translational Research Partnership Award. As a site miner, Grinstaff helps develop collaborations between engineers and clinicians to translate potentially useful technologies into better patient care.

"It is this type of interdisciplinary research that will enable us to investigate today's challenges which are at the crossroads of different disciplines," says Grinstaff. "The opportunity to collaborate and explore new research ideas with faculty and students from engineering, chemistry, biology, physics and the School of Medicine is exciting, and one of the strengths at BU."

Getting to know nanotubes

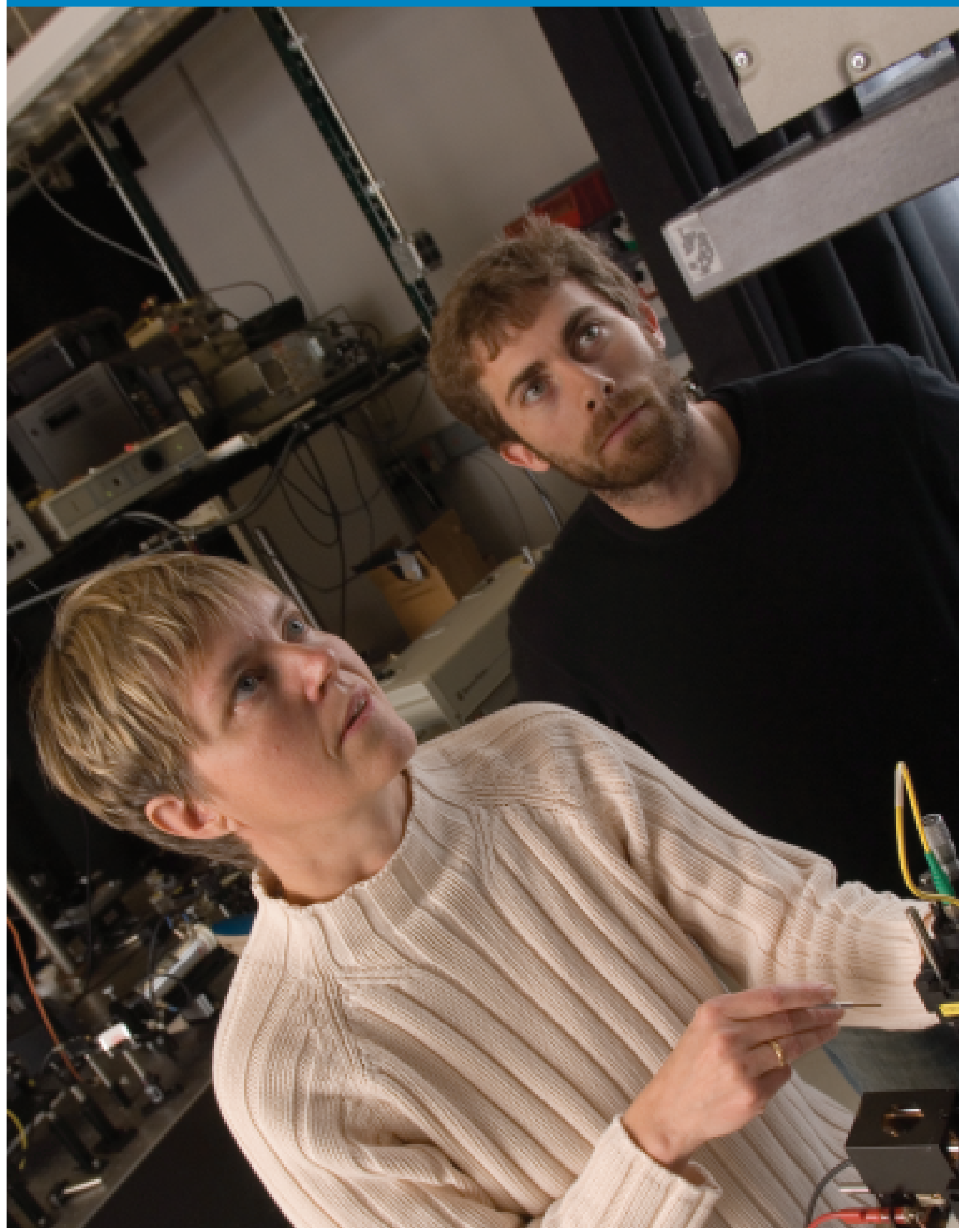
Carbon nanotubes have been hailed as the answer to everything from space travel to integrated circuits. And while researchers the world over are studying the tiny tubes of carbon that can conduct electricity, no one has yet figured out how to control their properties. Nanotubes are essentially rolled-up cylinders of graphene sheets. How they roll up dictates their properties; nanotubes can be metallic or semiconducting, single- or multi-walled, depending on simple geometry. Associate Professor of Electrical and Computer Engineering Anna Swan isolates single nanotubes to explore fundamental physics at the nano scale as well as potential applications in nanosemiconductor devices.

"Lots of people are studying nanotubes," says Swan. "Our niche in all this is determining and correlating the properties of a single particular tube and the role of the physical environment."

What interests Swan and her team is that nanotubes have unusual electronic properties. Nanotubes measure about one nanometer in diameter—or a millionth of a centimeter—which is the width of 10 hydrogen atoms. The nanotubes are nearly one-dimensional; by stringing them out one by one across minute trenches, "suspended like rope bridges in the air, we can look at them one at a time," says Swan.

Using resonant optical measurements, Swan's team first identifies the kind of nanotube and measures its properties. "It's like plucking a string on a guitar—the sound gets strong when there is a resonant box that can strengthen it," says Swan. "Only the nanotubes that resonate with the laser will respond with enough strength to be measured." After calibrating that, the researchers then change the physical environment around the nanotubes and see how that affects the properties.

"We have been changing the temperature, which changes the carbon's electronic energies," says Swan. "We have also been changing the medium it is in—from dry air to moist air and then to water to see how the interactions change."



Associate Professor Anna Swan and graduate student Nick Vamivakas look at nanotube reactions on a video monitor linked to a microscope.

Swan discovered that while the optical changes being measured are not very large, "We found enormous changes in the electronic properties that nearly cancel, which help us understand the physics behind it."

Understanding a phenomenon means being able to control it. Recently, says Swan, "We have been looking at how phonons, or vibrating atoms, in the nanotubes interact with electrons." People do not think of phonons in their daily lives, says Swan with a laugh, but they are quite important. Phonons are responsible for scattering electrons in a current. "When you have an electric voltage across something, say copper wires, you get a current, and—per Ohm's law—resistance, which is caused by scattering." As electrons move from electrode to electrode, some scatter, giving off heat. In a toaster, scattering is desirable but in a computer chip or transistor, scattering is waste. Energy is lost and most things lose efficiency when they overheat.

For any material, even for carbon nanotubes, the closer its geometry is to a crystalline structure, the less scattering occurs. Explains Swan, "The electrons don't scatter from the perfectly aligned ion cores, but the ions oscillate around their ideal positions when the temperature rises." This thermal motion is called a phonon. "Phonons are vibrations of the atoms in the lattice," says Swan. The fact that they are not in their best position makes electrons scatter from the ion motion. "If things cool down, there is less thermal motion and less scattering."

"Carbon nanotubes have the amazing property of having very low scattering even at room temperature," says Swan. This characteristic makes them ideal components for tiny circuits, where they can bridge microscopic distances and conduct current quickly and efficiently. However, Swan explains, "If the field is high enough, electrons will gain enough speed—or kinetic energy—to generate phonons." The outcome of the interaction is that electrons transfer their energy to phonons and lose all their speed, causing resistive heating.

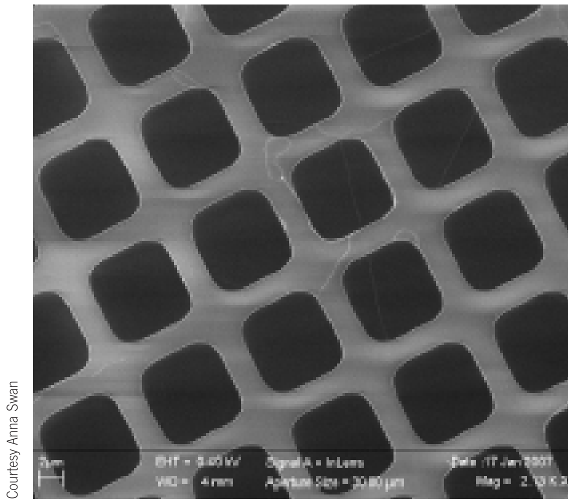
Swan's research tests nanotubes to see which kinds are more efficient. Depending on the type of tube, they have found some types of nanotubes with strong electron-phonon interaction and some with zero interaction. Based on this characterization, researchers may someday pick tubes with zero electron-phonon interaction, which would reduce the problem of scattering and increase efficiency.

Swan is also looking at how carbon nanotubes could be used for targeted drug delivery within the body. Working with Rama Bansil, a professor of physics, Swan is connecting the fields of nanomaterials with biology and imaging. Bansil—an expert on biological and light scattering experiments—studies a glycoprotein called gastric mucin, which is produced in the lining of the stomach.

Together, they are coating the outer layer of nanotubes—which are hydrophobic—with gastric mucin. "We've been looking at using mucin to separate the nanotubes and make them hydrophilic, and it turns out we can. This is just a very early experiment we have done, and now we are looking into where we can we go with this," says Swan.

One possibility is attaching a marker cell that is attracted to a particular target, such as a cancer cell, to a nanoparticle. Piggy-backed on the marker, the loaded nanoparticle would either stick to, or even enter, the target cell.

Courtesy Anna Swan



Scanning electron microscopy image of carbon nanotubes grown across voids 7 micrometers across.

Since nanotubes strongly absorb infrared light—which our bodies do not—the cancer could be pinpointed by imaging and even destroyed without damaging the surrounding healthy cells. "You could kill cancer cells by having heat absorbed locally in the cancer cell but nowhere else," says Swan. "I don't think the last word has been said on the mucin experiment. We are in the really early stages, but it's a direction I'm very excited to enter into."

With their collaborators within their fields and beyond, these and other researchers at the College are working to understand and develop materials to make ours a better world. "Being in an environment like BU where it's so easy to collaborate is wonderful," says Swan.

Morgan agrees. "The University has fantastic computational resources, experimental facilities and world-class researchers, and is really well positioned for expansion of interdisciplinary materials research." ■

Special Effects Wizard

ALUM CHRISTOPHER MILLER MAKES ANIMATION WORK IN SOME OF HOLLYWOOD'S BIGGEST FILMS

By Chhavi Sachdev

When Christopher James Miller (AME '95) lived on Bay State Road, he never dreamed that some day his AutoCAD classes would lead to a business card that reads "London-Sydney-Los Angeles."

As a student, he was gearing up to be an aerospace engineer at NASA. Today Miller—with his company, Duke Visual Effects—has successfully transitioned from working with networks and cables to doing high-end, 3-D special effects for Hollywood.

Miller's work with rendering technology and lighting is on display in many movies. Every time the lion Aslan came out of his tent in *The Chronicles of Narnia: The Lion, The Witch and the Wardrobe,* Miller's invisible hand was involved. His other recent projects have included *Scooby-Doo,* M. Night Shyamalan's *Unbreakable* and the Warner Bros. animated feature *Happy Feet,* which took him to Australia for eight months. This year, he is in London working on the fifth Harry Potter movie.

Christopher Miller

From formulas to fiction

The start of Miller's career in movies can be traced to a less exotic locale and films with more modest budgets. Growing up in Pittsburgh, he spent Saturday mornings in front of the television watching old "B" monster movies. "They always played the Bella Lugosi and Abbott and Costello monster movies and then we got this channel over the air antenna from Ohio that played a two-cheesy-movies-marathon in the afternoon."

During his childhood he designed a few computer games but his parents encouraged him to focus on a more traditional career. "Design courses were always my favorite," says Miller, who studied aerospace engineering at BU and remembers well his AutoCAD, 3-D modeling and introduction to computer graphics classes.

"There were a couple of professors who taught me that innovation comes from imagination and encouraged me to think beyond the box," he said.

After graduation, Miller—who showed prospective students around campus as a President's Host during his senior year—moved to Los Angeles and found work in information technology at DreamWorks. His next job was something the industry calls "render wrangling" at Disney. Essentially, that means "Watching large machines that render farm, or chug out computer-generated images." Every 100-frame sequence in an animated movie needs 100 images for characters and props; each second of a movie comprises 24 frames. "The artists send it in and the render farmers wait to see if the code works, which commands are bad and whether there's a bug," Miller explained.

As soon as the opportunity arose, Miller, who was training new hires in the technology, moved from the checking to the doing of lighting and rendering. He became one of the first people to move from the technical to the creative side at Disney. His first movie was *Long John Silver,* which combined live action and computer-generated—or CG—animation.

As lighting director, "When a scene comes to me—whether it is for a live action movie or a completely computer-generated feature—the computer elements are a flat gray," Miller explains. "What I do is set up computer-generated lights to 'light' the computer-generated elements to either mimic the lighting already present in a real set we are adding to—or, if it's a completely CG feature, set up the time and day and mood or tone the director is going for based on an art director's notes."

In live action, where the set and actors are real and have been filmed under set lights, the CG parts have to match or the eye will notice the discrepancy. Another job of the lighting director is a subtle *trompe l'oeil.* "Sometimes you can add or take away light to hide or draw attention, or even distract the eye to certain areas based on the director's view."

Once the scene has been lit, Miller renders the elements, which means that for each piece of the new CG set, character or scene, textures are attached to the gray models. Finally, based on "The positioning of the lighting, the look, shading and textures attached to a piece of geometry, a picture is created with shadows, light and dark areas which eventually make up the final frame of film," Miller explains.

Reel life

"I had no idea I'd end up with a highly artistic technical career," Miller says. When he won the contract for *Harry Potter and the Order of the Phoenix,* his 18th project, he sent his nephews a text message to say he was going to Hogwarts, the fictional school for wizards. "They think that I am the absolute coolest uncle there is," he laughs.

In addition to movies, Miller has worked on two video games and 16 features. "If you ask me where I will be in five or ten years, I want to be enjoying myself as much as I am now," he says. His future definitely holds more movies and video games and an expansion of the Duke Visual Effects brand to employ more people and also take on larger, team-oriented projects.

"Sometimes, I sit back in disbelief and think, How did I get here? Is this really me?" he says. "Standing back from it all, it is just really awesome to be able to do this and get paid to do it." ■

Christopher Miller's work is invisible but in view in this still from *The Chronicles of Narnia: The Lion, The Witch and the Wardrobe.*

Getting Started

THE CAREER DEVELOPMENT OFFICE HELPS STUDENTS AND ALUMNI FIND JOBS

By Chhavi Sachdev

Career Development Director Michael Walsh (left) and computer systems engineering senior Jimmy Ng.

Perhaps no other office in the College of Engineering gets as much traffic as the Career Development Office. Thousands of students have passed through the corridors of the CDO since it was created under the deanship of Carlo De Luca in 1988 to help graduating seniors find jobs.

Today, undergraduate students and graduate students alike drop in looking for guidance and information about internships and job openings. "On average, we see about 135 students every month," says Holly Adorno, assistant director of the Career Development Office.

Helping new graduates launch their careers is just one of the tasks of the office, according to Michael J. Walsh, CDO's director. The staff's primary function is helping seniors and graduate students find permanent positions, but they also help place students in co-ops and internships. Additionally, to help maximize students' options, the office conducts two on-campus engineering career fairs each year along with some smaller events like job blitzes and an exclusive online job bank for "e-recruiting."

"BME placement is our fourth big task," says Walsh. One staff member is dedicated solely to building relationships with biomedical, biotechnology and pharmaceutical companies as well as hospitals. This outreach nets internship, co-op and full-time opportunities for biomedical engineering students, who make up the largest major in the College. Finally, the Career Development Office conducts on-campus recruiting. "That's probably one of the most important features that we offer to students here and to employers," Walsh added.

Of the 136 members of the Class of 2006 who had work lined up within six months of graduation, "Eighty listed the CDO as their primary way of getting a job," said Walsh.

In the fall semester, the staff—Walsh, along with Assistant Director Sarah Goldfine, who oversees on-campus recruiting, career fairs and permanent placement; Assistant Director Holly Adorno who runs the co-op and internship program; and David Brown, who does the BME placement—mainly see students looking for co-op opportunities and seniors who have started looking for jobs.

In the spring, they most often advise students who are looking for jobs and summer internships.

One frequent visitor this academic year has been Jimmy Ng, a senior majoring in computer systems engineering. Ng's two-year relationship with the CDO—and especially Walsh—started when he went to a seminar on internships.

Ng found out about the CDO's e-recruiting online database for engineering jobs and went by the office to sign up. He also picked up the office's guides to job hunting, résumé writing and interviewing. "I had never had a résumé before," he says. "I made a résumé based on their guides at the end of my junior year and then called and asked for a review." The staff talked to him about wording and taught him how to emphasize certain things as well as what *not* to emphasize. "That was really helpful since I didn't know anything about résumés and jobs," says Ng, who landed a summer internship with Sun Microsystems that continued through the fall semester.

Michael McManus, a senior majoring in aerospace engineering, had been hearing about the CDO since he was a freshman. In his junior year, he signed up for access to the e-recruiting database. The staff made a few phone calls and in May McManus started his co-op at Lockheed Martin.

In the fall of his senior year, McManus got his résumé critiqued and went for some mock interviews, which he found "One hundred percent useful—it's always good to get practice and it's a great networking opportunity." By the end of the semester, he had met recruiters from several local companies and interviewed with both General Electric and Raytheon for a job. "I'm nervous, but I'm sure it will all work out," he said.

Walsh is quick to note that his office's services are available to alumni as well as to current students. He hears from many former students looking for help finding their next job or in filling vacancies. "We are seeing many more students contacting us saying, 'Mike, remember me? You helped me get a job. Right now, I have a couple of positions that my boss is looking to fill. Can you help us?"

Erika Sutherland (AME '06) is a former student now on the other side of the hiring divide. "My company is looking for co-ops, so I e-mailed Holly and Mike for résumés," she says. "They got back to me within hours."

Walsh has many such success stories. Not only do alumni call and e-mail looking to fill positions, they also attend career fairs, do on-campus recruiting and conduct mock interviews. They also send the CDO exclusive job openings for the e-recruiting database that will not be posted on job sites such as Monster.com.

Their resources are wonderful, says Ng. "They'll help you in every way and encourage you."

All of Sutherland's friends frequented the CDO, she says. "They're all very accessible and ready to spend one-on-one time with you."

McManus concurs: "They have great suggestions. If you put the effort in, they'll match it."

Bruno Tapia (MFG '01) found this was the case even after he graduated. He established a relationship with the staff early in his junior year: "They helped me enhance my interview skills and presentation." Tapia got a job after graduation through the CDO, but then got laid off. "I went back and they still helped me," he says. That company folded, too, and once again, Tapia found himself talking to Walsh. For a third time, the CDO helped him get a job.

Tapia, who has now worked at Amgen for nearly four years, has put ENG students in internships, reviewed their résumés, attended career fairs and recruited BU students into the company.

Over these interactions, the staff at the CDO become like extended family for many. Students frequently bring them mementos from overseas travel and knickknacks from their companies.

"You know how your dad teaches you how to ride a bike, just pushes you to do it? I needed that push from Mike and a lot of students do, too," says Ng.

Re-Energized Rocket Team

A LAUNCH PAD FOR AEROSPACE ENGINEERS

By Chhavi Sachdev

Members of this year's Rocket Team include, from left: Jonah Zimmerman, Aaron Colby, Eddie Walton, Nick Doucette, Seth Cohen, Chris Calvitto and Jenna Grapensteter.

Six years ago, an aerospace engineering major thought it would be cool to build a rocket. The future propulsion engineer got some of his classmates together at the College of Engineering and wrote proposals to General Electric and National Instruments to start a rocket club.

By his senior spring, Luke Colby (AME '03) and the BU Rocket Team had built a 15-foot rocket, obtained data acquisition materials and done a static test. They also made inroads into testing a nascent engine technology—designing and building an aerospike engine—and were among the first students to flight-test one.

Although that motor did not turn out to be powerful enough for the rocket, the team did launch the vehicle in 2003 using a prefabricated motor. The single-stage rocket flew for about three minutes and "was pretty awesome," according to Aaron Colby, Luke's younger brother, who came up from his high school to see it happen.

After Luke Colby—who now works at Scaled Composites, an aerospace and specialty composites development company in Mojave, California—left for graduate school, the Rocket Team lost some steam. This past year, however, it has seen a dramatic relaunch with younger brother Aaron (BME '08) at the helm.

The team—which plans, designs and constructs everything from start to

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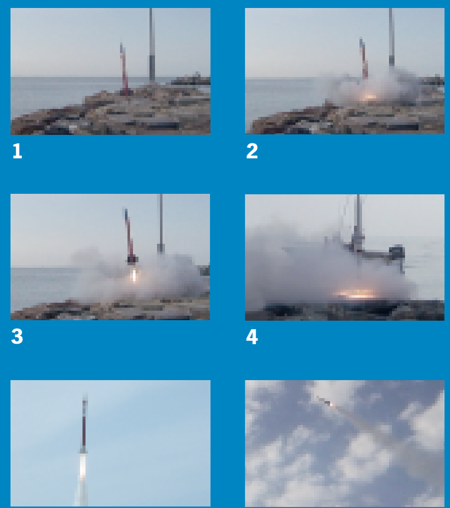
Rocket Team



Courtesy Rocket Team

The test launch of the rocket in 2003.

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finish—has evolved into a larger entity. Today, there are more than 20 members and the team is now an official BU student organization.

Their project list has expanded, too. "We meet about once a week and are working on a smaller rocket, about one meter tall," says Aaron Colby. The team gives them a place to put their classroom knowledge to use. "To do something where you can apply it is a lot of fun," he said. "It's beneficial for everyone."

The officers say they are gaining a lot of leadership and problem-solving skills, because they have to find projects for everyone and incoming freshmen don't have a lot of technical know-how. "We're trying to strike a balance between getting them involved and going right over their heads with a lot of technical jargon," says Seth Cohen (AME '05), a graduate student at the College who has been part of the Rocket Team since he was a freshman.

"We wanted, as Luke did, for all of us to get some actual hands-on experience," says Colby.

"We're trying to give the freshmen something they can get involved in, whether it's to start learning about working in the machine shop, making the parts, helping out with designs or data testing."

A handful of the more seasoned members worked on designing and building the new, smaller rocket. "None of us were on the big rocket from the design process to the actual launch phase," explains Cohen, "so we want to get some experience with that but not do the whole thing over again."

The team is building a solid propellant motor for the small rocket. "We have prior experience in casting these so it shouldn't provide the same level of difficulty as the hybrid motor," says Colby. When casting, the teams pours a viscous propellant mix into a mold and then dries or cures it before using it, he explains.

"Another four or five of us are working on the large rocket, based on what my brother built," says Colby.

The team is also making changes and improvisations on the engine Luke Colby had chosen to work on. The aerospike engine—so called because it uses an aerospike, or altitude compensating nozzle—had been used in aircraft as far back as World War II but only recently applied to rockets. Most rockets use a bell nozzle—which is slightly more efficient than the aerospike nozzle at a single altitude, but the aerospike nozzle is more efficient at a range of altitudes. The aerospike nozzle is also significantly smaller in size, says Nicholas Doucette (AME '08), an aerospace engineering major and the team's vice president.

This is important because for a single-stage rocket that doesn't drop any payload, the thrust must put the entire structure into orbit and the structure must weigh as little as possible.

In an aerospike engine, there's a "plug" inside the engine bell that forms a barrier between the combustion chamber and the exit below. The term "aerospike" originally referred to the innovation of the plug nozzle's somewhat conical, tapered design. Since the plug doesn't have a tail, there is some gas injection to form an "air spike."

Though the aerospike has performance advantages over the traditional bell nozzle, it is also more expensive. Additionally, the flight experience for the aerospike is limited, so finding relevant information is difficult. The prospect of researching and applying this type of technology will allow the Rocket Team to be part of the small group of engineers involved in forging forward with aerospike technology. "We wanted to use the aerospike because that's what the team originally designed the rocket engine for," says Colby.

A normal rocket motor runs on solid fuels that burn as one. "Because the fuel has some oxidizer in it, you just light it and it goes by itself," explains Colby. For this rocket, they are using the aerospike with a hybrid motor, which uses both liquid and solid fuels and keeps the fuel separate from the oxidizer. The two are then combined under high pressure and ignited, after which the rocket engine goes off and thrust is produced. "Solid and liquid motors have been used with an aerospike nozzle but there is not much data on using a hybrid one with the aerospike and we're trying to do that," says Cohen.

"We wanted to incorporate the hybrid because it's a new technology with a lot of potential. There's a lot of promise for that technology in the industry," adds Colby.

The complication, he explains, is that "You have to keep the pressurized gas in your rocket and of course that means you need tanks and plumbing." High-pressure tanks and plumbing require correct geometries for introducing the oxidizer to the propellant so that it burns but doesn't burn through the side of the casing, or burn faster on one side than the other. To calibrate this, the team did a static test late last year and anticipates a few more in the fall.

They are expecting a successful launch for the small rocket in mid-spring. For the Rocket Team, the sky's the limit. ■

New Directions

Ken Lutchen talks about his plans for the College's future

By Michael Seele

Kenneth R. Lutchen became dean of the College of Engineering on August 1, 2006 after serving as a faculty member in the Biomedical Engineering Department for 22 years, where he rose through the ranks to full professor and was named chairman in 1998. During his eight years as chairman, BME grew dramatically in size and national stature; it was ranked 7th in the nation by *U.S. News & World Report* at the time Lutchen assumed the deanship.

Lutchen's energetic personality rippled through the College almost immediately. Upon taking office, he set about the business of meeting with faculty and soon formed ad hoc groups to take hard looks at the College's programs and potential as he planned for the future. After a semester on the job, Lutchen sat with *BU Engineering Magazine* Editor Michael Seele to talk about what he has learned and how he sees engineering research and education developing in the new century. The setting was the dean's office, personalized with Lutchen's books, family photos and an array of artifacts that convey an affinity for Elvis (several photos), the New York Yankees (a 1938 team photo) and caffeine (an espresso machine).

BUE: You have been a faculty member in the BME Department for more than 20 years, but when you became dean you took an in-depth look at the College as a whole. Did anything surprise you?

Lutchen: Several things surprised me. The first thing I did was to make it my business to meet many different faculty members individually and talk to them about their research goals, their ambitions and their perspectives on education. Of course, I knew those in Biomedical Engineering, but I didn't know the faculty in other departments well. What surprised me—or energized me—is the talent pool throughout the College; the tremendously talented faculty at all levels, from junior to senior, the creativity that spans all those levels and the College, and the ambition to start cross-disciplinary initiatives rather than keep research siloed in individual programs. They are reaching out and wanting to build more bridges and more connections, which I was really excited about because that is part of my vision as well. Their desire to go after large-scale initiatives was at a much higher level than I would have guessed in advance, so all that excited me.

Another thing that excited me was that a substantial number of them were very dedicated to education connected to research. I didn't know what to expect; I thought I would get faculty who wanted to be left alone to do their research, but they very much wanted to make sure that there were education initiatives and enhancements they could link to their research and I think that energized me because it's always been high on my agenda.

BUE: During your eight years as BME chairman you presided over a rapid rise in that department's national stature. What was your secret?

Lutchen: Good looks *(laughs)*. No, really, it's not a big secret; it's faculty, students and ambition—you add to those ingredients a commitment to excellence and then you stir up the pot. I don't know if it's a secret; it's more of a style of approaching how to exploit all those resources in a team-like environment. I think what we did early on is say that we're all in this as a team. We've got constituents: faculty; students; we've got great alumni; we've got a great industrial base here. What do we want to do? What do we want to go after and how are we going to do that? We're going to do it by working together and we've got to do it by recognizing that everyone has something to offer. Once I felt we engaged that talent pool and that commitment to excellence with an inclusive everybody-is-important type of attitude, everyone jumped in and realized we can do something very exciting here, and I think that same approach is going to work for the College as a whole. It's going to work with my style and it's going to work by engaging the chairs of the departments to permeate that approach to the entire College.

BUE: Biomedical Engineering has led the College in terms of research for some years now. How can the College broaden that and bring other departments up to prominence?

Lutchen: We have tremendous strength among our faculty in every department but to fully capitalize on that, we need to get people thinking beyond their department. When we do that, we can leverage our expertise to its full potential and position ourselves to go after the major initiatives that can make a huge impact on society.

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When I came in as dean, the very first part of my agenda was to go after what we call the cluster model. We have a large talent pool of engineering scientists and a variety of clustered strength areas that span multiple departments, but the College hadn't yet figured out how to leverage that strength to identify exciting challenges and go after them.

We identified the cluster areas as advanced materials, sensors and imaging, micro- and nano-technologies, and distributed network systems. All of these are integrated with our pillars of strength in bioengineering, photonics and computational modeling. As we speak, we have faculty working together to identify how to leverage that strength, add excellence to it, and bring the quality of all the other departments up to the same level as bioengineering. This is going to take a lot of effort.

BUE: What makes the cluster areas you mentioned signature areas of strength for the College?

Lutchen: The quality of the faculty working in those areas. I'm particularly impressed with the extraordinary quality of the junior faculty and the way they've embraced this kind of interdisciplinary approach and the way they embrace the interface between basic and applied sciences. While they're advancing basic science's understanding of how the world works—how nature works—they're also looking for new technologies that have an impact on society. We also have tremendously talented students at both the undergraduate and graduate levels and we will continue to identify ways to leverage that intellectual firepower.

BUE: What areas of improvement do you see as needing particular attention?

Lutchen: The College has been the same four departments since it began its commitment to being a world-class college of engineering. We're looking at ways to potentially restructure it to take advantage of some of the new directions that these fields are going in. We're realigning some programs so that we can leverage the faculty's strengths. When you put people of similar research and educational interests together, the whole becomes greater than the sum of the parts. If you isolate them within the different silos and don't get them to communicate with one another, you don't take advantage of those resources. That's one issue we're looking at.

Over the last eight or 10 years we've developed a lot of strength in the area of materials science and engineering in virtually every department, so one challenge is to leverage all of that and perhaps create a new program in that area. Another challenge is systems engineering, which is highly interdisciplinary. We want to make that program more visible because we've attracted some world-caliber faculty in systems engineering.

Another big challenge for me as dean is to help engage our alumni to be partners to help the College of Engineering move forward and achieve its potential. We've got a great faculty; we've started some exciting educational initiatives; we've built some new buildings; we're attracting very high caliber undergraduate students and we're getting more quality graduate students in each of the departments—but we haven't done a great job of energizing and engaging our alumni in the process. We need to figure out how their experience at BU and how their work out in the real world can make us a more high-powered college of engineering in the future.

We have other challenges, too. If we're going to grow or add some exciting new programs, we're going to need more space. We can only do so much and no more with our existing space, so one of our big pushes will be to try to identify how we can partner with our alumni and friends to bring in the resources to create new space for research and for research coupled with education.

I also firmly believe that we need to continue to enhance our educational programs so that we're doing more than just training a narrowly defined engineer. Our graduates enter an increasingly multidisciplinary, multicultural world and they require an education that prepares them for that. One of our jewels is our engineering study-abroad program, which started only five years ago in Germany and has since expanded to Mexico and Israel. Students know they will enter a global economy and they recognize the importance of a semester abroad. We need to keep up with their increasing demand for this experience. We also need to increase the cultural, ethnic and gender diversity of our student body. We need to reach out to these potential students while they're in high school and show them that if they're good at the sciences, good at math, and they like doing things that can really have a positive impact on society, then engineering can be a very rewarding career for them.

If we can address these issues successfully, we will have achieved our potential.

BUE: The College adheres to a traditional academic structure. We have a set of departments within which faculty conduct research and teach courses. Is that structure still relevant today?

Lutchen: That's a very good question and one that's being asked throughout the nation, not just in colleges of engineering but throughout other sciences and even the liberal arts. I believe that departmental structures remain relevant and important, primarily at the undergraduate level. It also provides pillars upon which you can build cross-disciplinary approaches to research at the graduate level.

At the undergraduate level, there are some core competencies which you can address programmatically in specific engineering disciplines. Departments in each of the disciplines allow you to make sure the curriculum provides the underlying principles upon which each discipline is based. Those departmental constructs become the pillars upon which you build graduate research programs; you include those individual disciplines and reach out across them. You can identify ways in which one discipline touches the others. More and more science is becoming interdisciplinary. You can't build a sensor without talking to materials people, without talking to systems engineering people, without talking to applications people, which might include biology, imaging, weather, and so on. So you take advantage of the departmental structure and you build cross-disciplinary approaches to graduate education.

BUE: Do you see a change in the way we educate our undergraduate students in the new century and, if so, how is the College positioned to meet that challenge?

Lutchen: I definitely envision a change. There are two aspects to your question. One is, content-wise, What are we trying to achieve as we educate undergraduates? The other one is, technically, How do we do the teaching? Let me speak to the second one first.

There is a continued drive to try and use all of the new technologies that impact—or potentially impact—how you teach: PowerPoint; web-based interactions; chat rooms; and all kinds of ways to enhance communication or visual presentation of information. Those are all good, but they need to be used in a very responsible fashion or we run the risk of decreasing human contact; personal contact between students and professors. That is the pillar of an effective education and of learning how to interact with society, which is a part of what we're trying to accomplish. We need to make sure all of those technologies enhance the ability of a professor to convey the essence of the material to students and the student's ability to get excited about the material, absorb it, internalize it, and use it down the road for some other application. I'm a little concerned that some of the technologies are subtly used to move us in the other direction, where there's less interaction between the student and the professor. I'm going to push very hard for professors to recognize the sanctity of interacting with students in and out of the classroom, and that teaching and learning is an interactive process. Students need to watch the professors develop the concepts, interrupt the professor when they're not understanding the flow of logic or information, engage the professor in the discussion of how it might relate to some other application, and have the professor bring research or other applications into the classroom. Any technology that enhances that communication is positive, but it needs to be used wisely.

As far as the content of the undergraduate education goes, we have an obligation to provide the core competencies in engineering and make sure we graduate a solid engineer who knows engineering principles and is able to apply them. But we're also graduating a human being who needs to be a productive member of society. Now, society, as you know, is becoming increasingly dependent on technology and science and quantitative principles. Yet, despite that dependency, a huge segment of society is technologically and quantitatively illiterate; they don't understand how all these wonderful things work. The engineering student is going to graduate with a deeper understanding of what drives those technologies—that's a huge responsibility and an exciting opportunity for them to be extraordinarily important contributors to society, whether or not they stay in engineering as a profession. They may go to marketing, they may go to medical school, they may go to law school, business school—whatever it may be—but our job is to make sure they carry with them the ability to integrate with all these other disciplines in a constructive way and in a leadership way. So we have to make sure that our education doesn't provide them just the courses but also the experiences that allow them to appreciate how their engineering knowledge can impact society in a positive and responsible fashion. That means we have to make sure that our programs offer ways for students to interact outside the classroom, whether it be as undergraduate research assistants, interning in companies, applying engineering in the community, or studying abroad so they can feel comfortable when they have to interact with people from other societies. And we have to make sure that our engineers are able to communicate effectively, both in writing and orally, by synthesizing fundamental communication skills with their engineering quantitative knowledge base. That's a high commitment by me, as dean, to be sure that our programs and all of the extracurricular activities and experiential activities provide students that leverage. If we do that, BU students will continue to be leaders of society.

BUE: The College has more than 11,000 alumni. How do you plan to engage them?

Lutchen: There's nothing I want to do more as dean than engage our alumni as part of the process. The College of Engineering is not just the faculty; it's not just the students—it's a family of constituents of which our alumni are a major

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element. To this point, we haven't done a good job at creating concrete, effective, active relationships with our 11,000 alumni. If you look at our peer institutions—the ones we are competing against for reputation and the ability to attract resources—the big difference between them and us is the degree of alumni participation. The average giving rate of alumni to the College of Engineering—and Boston University as a whole—is fairly small: under 10 percent. Other universities that have colleges of engineering of our size and caliber—schools such as Duke or Johns Hopkins or the University of Pennsylvania or Case Western—have alumni giving rates as high as 30 or 40 percent. Now, there are all kinds of potential reasons for this, but I think the big challenge I have as dean is to engage our alumni and try to educate them on the joys and the personal fulfillment associated with giving back to the University, both through their time and as part of their resources.

Most universities can become so good and no better without substantial amounts of investment back from their alumni to do specific things that are important to alumni. We're talking about scholarships for students to participate in research fellowships in faculty laboratories, or in internship programs and so forth. We're talking about graduate student fellowships that allow certain areas to thrive at Boston University. We're talking about ways to attract and retain absolutely top-quality, exciting professors committed to education and connected to research, the kind of professors alumni remember when they were here as students. We need our alumni to create endowed professorships because other universities have them and use them to recruit our professors away. We need the resources to create and sustain new facilities for education and research, resources that can only come from alumni.

Now, I don't want just money. I also need the alumni's thoughts and advice. How are we doing? What kinds of facilities and new faculty members and new kinds of scholarships do you think will make the biggest impact on Boston University and in society in the future? I have to get out there and meet a lot of alumni and talk to them. I've got to get out there and invite them to talk to me, to come back to the University and meet with me and with the faculty. I want them to understand that they can invest their time and resources in what excites them and that their contribution can help us get to the goal.

BUE: Have you noticed any sort of a difference in the students of today compared to those you taught in your early years here?

Lutchen: They are a lot faster than they used to be, but maybe I am just getting older *(laughs)*. Actually, there are more similarities than differences. One of the things that I loved most about teaching was how incredibly well my students did when they were challenged. What hasn't changed is that year in and year out, our students want a challenge and when they are given one, they respond well beyond what you might think any student is capable of. The quality of their work is extraordinary and I would put it up against any university in the nation. I used to think that this may have just been bioengineering students. Now, in finding out more about the students in the other departments, I discover that this is across the board in the College of Engineering. We attract an extremely high caliber student and have for many years.

What's different? The students coming in are a little more engaged in, "What's going to happen to me when I finish?" They are a little more engaged in understanding that their education is a stepping stone to a wide variety of potential career paths, and so even early on they are looking at positioning themselves for not only employment, but for graduate school, business school, law school and other disciplines that might couple with an engineering background. I think students are coming in more aware of the need to have a more experiential background and more and more of them—I think perhaps more than there were 15 years ago—want to be engaged in these experiential components of education. Early on in the process, I get an increasing flow of students that come by and say, "How do I get involved in a professor's laboratory?" or, "Is there an internship available for me?" or, "Is there a summer job available for me?" or, "Can I do study abroad?" They are initiating this interaction as opposed to us just telling them about the opportunities.

Today's students are also incredibly capable of juggling huge amounts of information in parallel, so they can speak on their phones and play on their computers and listen to a lecture simultaneously. We shouldn't be afraid of using technologies and tasking the students with what appears to be a highly complex set of parallel technical tasks. They can handle this as long as they feel that the professor is engaged in the education process and part of the learning experience.

BUE: Spring is in the air and hope springs eternal, again, for the Red Sox. Are we going to see you around Fenway Park this year?

Lutchen: Only if the Yankees are in town *(laughs)*. I am a born-and-raised New Yorker, and one of my great pleasures in life every year is to be a Yankees fan living in Boston. ■

BU, Fraunhofer Gesellschaft Form Alliance to Accelerate Biomedical Innovation

Fraunhofer USA Center for Manufacturing Innovation

By Michael Seele

Seeking to accelerate the delivery of biomedical engineering advances to the medical care of patients, Boston University and its College of Engineering are joining the German research and development organization Fraunhofer Gesellschaft to create the Boston University-Fraunhofer Alliance for Medical Devices, Instrumentation and Diagnostics. BU and Munich-based Fraunhofer will jointly fund the five-year, $5 million initiative.

Combining the innovation and translational technology development experience of Boston University and Fraunhofer, the alliance will allow for the accelerated translation of advanced biomedical research into products that can be manufactured and used in clinical applications. The alliance will leverage the most promising research innovations in labs throughout Boston University, particularly in its College of Engineering, said Andre Sharon, a BU engineering professor and director of the BU-based Fraunhofer Center for Manufacturing Innovation.

Boston University Provost David K. Campbell said, "Boston University has enjoyed a long and productive collaboration with Fraunhofer Gesellschaft and this alliance will raise that collaboration to the next level."

Hans-Jörg Bullinger, president of Fraunhofer Gesellschaft, Europe's largest applied R&D organization, noted, "Based on Professor Sharon's outstanding track record and the excellent results from our long-standing collaboration with Boston University, we are confident that this initiative will be very successful and will lead to the development of new medical technologies."

Sharon said, "The alliance will leverage other independently funded research activities at Boston University as a continuous source of medically relevant innovations. In conjunction with Fraunhofer, the selected research will be efficiently developed into deployable technologies in a time-efficient and cost-effective manner."

The alliance seeks to take advantage of the two institutions' respective strengths. Advanced biomedical engineering research being conducted throughout BU's College of Engineering, College of Arts and Sciences, and School of Medicine generally proceeds to the laboratory bench level. Fraunhofer hopes to take these innovations and convert them into working medical devices and instruments that can be licensed to existing companies or created by new, spin-off ventures.

The shop floor of the Fraunhofer Center for Manufacturing Innovation.

The alliance is expected to use another recently funded initiative as a wellspring. Last year, the Wallace H. Coulter Foundation awarded a $4.9 million grant to Boston University to enhance collaboration between researchers in Biomedical Engineering, and clinicians and researchers at the BU School of Medicine. The Coulter program shares the goal of accelerating translation of biomedical innovations to patient care.

"This alliance with Fraunhofer will add fuel to our translational research program in biomedical engineering," said BU College of Engineering Dean Kenneth R. Lutchen. "Indeed, throughout the College are world-class and top-ranked faculty working at the interface of engineering and medicine and this initiative will further accelerate our most promising research in this area so improved medical care can be delivered to patients as soon as possible."

"The BU-Fraunhofer Alliance for Medical Devices, Instrumentation and Diagnostics embodies, amplifies and

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ENG NEWS

College Adds Study-Abroad Program

By Chhavi Sachdev

The burgeoning interest among students for a study-abroad experience has prompted the College to open a third international program specifically for engineering students in Tel Aviv, Israel, this spring. It joins established programs in Dresden, Germany and Guadalajara, Mexico, as destinations for second-semester sophomores.

"Students understand that the international perspective they gain from a semester abroad rounds out their education and gives them an advantage in the global economy," said Solomon R. Eisenberg, associate dean for Undergraduate Programs. "We are expanding the menu of choices for what students correctly view as a life-changing experience."

Boston University's Dresden program was one of the first offered by an American university specifically for engineering undergraduates when it was opened in 2001. Last year, the Mexico program opened; these and the Tel Aviv program offer students cultural immersion and the opportunity to take required technical courses there instead of in Boston at no added cost and without delaying graduation.

BU engineering students at the Technische Universität in Dresden, Germany, the Instituto Tecnológico y de Estudios Superiores de Monterrey in Guadalajara, Mexico, and now Tel Aviv University in Tel Aviv, Israel, take three technical courses, a language course, and a liberal arts elective.

"The beauty of this program is that the classes they take are equivalent to BU courses," said Joanne Cornell, the director of the Office of Undergraduate Programs. "These schools offer the courses students need and they teach them in accordance with the way the curriculum is taught here."

Julia Delogu (AME '09) during her semester in Mexico.

Classes are taught in English, so fluency in the local language is not required although students learn enough German, Spanish, or Hebrew in their language course to integrate into local society. Time is built into the program to allow students the opportunity to experience the country's culture and do some traveling.

A handful of BU engineering students is in Israel this spring, though the number is expected to increase in subsequent years as it has in Guadalajara and in Dresden, which is at its capacity this year. The College and the University are also exploring the possibility of additional engineering study-abroad programs elsewhere in the world. ■

FRAUNHOFER GESELLSCHAFT ALLIANCE

(continued)

lends cohesion to some of the best biomedical research in physics, chemistry and engineering on Boston University's Charles River Campus," said Engineering Professor Charles DeLisi. "Along with clinical colleagues the participating faculty are poised to make important contributions to research and translational medicine."

Fraunhofer Gesellschaft is also very active in biomedical research. Current activities include plant-based vaccine development, medical imaging, array-based diagnostics, surgical micro-tools development, and other novel devices and instrumentation.

The Fraunhofer Center for Manufacturing Innovation was established at Boston University in 1994. Working with BU faculty, students and international interns, the center scales up basic research into advanced industrial technologies that meet the needs of client companies. Clients represent a range of industries both locally and globally.

Among the promising innovations under consideration for initial support by the alliance are efforts to create disposable diagnostic chips that can detect disease at the molecular level, an optically guided colon cancer detection and treatment system, and an array-based medical diagnostic tool. ■

Uday Pal Named MFG Chairman *ad interim*

By Chhavi Sachdev

College of Engineering Dean Kenneth R. Lutchen has appointed Professor Uday B. Pal as chairman *ad interim* of the Department of Manufacturing Engineering.

Pal's appointment comes after Professor Thomas Bifano stepped down as MFG chairman and became director of the Photonics Center. Bifano had been serving as interim director of the Photonics Center.

"Uday [has] an extraordinary record of accomplishment in materials science and engineering coupled to the manufacturing of materials for structural and new energy applications," said Lutchen in announcing the appointment. "It is important that the department has an interim chair with a local, national and international pulse of how the current manufacturing curriculum and department relates to these areas."

Pal, who has six years of industrial experience and 16 years of experience in academia, started at the College of Engineering as an associate professor of manufacturing engineering in 1995 and was promoted to professor in 2000.

He has authored or coauthored over 100 publications and holds 20 patents in the areas of electrochemical processes, fuel cells, sensors, membrane separation and metals processing, and has taught courses ranging from materials thermodynamics and kinetics to manufacturing processes. He received The Minerals, Metals & Materials Society's Extraction and Processing Technology Award in 2000 and 2003 and is the principal editor for the *Journal of Materials Research.*

Prior to joining the BU faculty, Pal served as an associate professor in the department of materials science and engineering at MIT and as a senior scientist at Westinghouse Science and Technology Center in Pennsylvania. He also was a senior engineer at Allegheny Ludlum Steel Company Research Center in Pennsylvania.

Uday Pal

The next year will bring "a simultaneous bottom-up and top-down approach to defining the future mission in education and research of Manufacturing Engineering," said Lutchen. Pal has "firm links to the faculty's core research strengths of materials, systems and MEMS."

Pal received his doctoral degree in material science and engineering from Pennsylvania State University in 1984 and has a bachelor's degree in metallurgy from the Indian Institute of Technology. He is a member of Tau Beta Pi, the national engineering honor society, and Alpha Sigma Mu, the national materials science and engineering honor society. ■

ENG NEWS

Former ECE Chairman Kincaid Retires

By Chhavi Sachdev

Thomas Kincaid

Thomas Kincaid's association with the University started with an advertisement. Before joining BU as chairman of the Electrical, Computer and Systems Engineering Department, Kincaid spent 18 years in industry. "I'd always wanted to teach and I saw this as the opportunity," said Kincaid. "I answered the ad looking for the department chair."

Kincaid started at the College of Engineering under the deanship of Louis Padulo and retired last fall after 23 years on the faculty.

Originally from Canada, Kincaid had a previous association with Massachusetts; he earned his doctoral degree in electrical engineering at MIT. In 1965, he moved to Schenectady, New York, to work for General Electric on early projects involving sonar and signal processing. At GE's research and development center, he became a manager of "a nondestructive evaluation program for building new equipment to inspect manufactured components, primarily aircraft engine parts."

At the College, Kincaid taught undergraduates circuit theory, signals and systems, and introduction to logic design. He also taught beginning computer programming in Pascal.

His tenure here has been "very interesting," he said. "The whole College started at 110 Cummington Street—now it's grown and every department practically has its own building." During the same time, the College has transformed from a teaching mission to a teaching and research mission, he added.

Kincaid remained the chair for ECS—now ECE—for 11 years, during which time he saw the department grow from 16 faculty members to over 30. "Rapid growth of faculty in the early years was matched by a rapid improvement in the undergraduate class as well," said Kincaid.

SAT scores of incoming students rose dramatically and the research funding "grew from almost nothing to over $2 million" during his tenure, he recalled. "It was very exciting."

In 1995, Kincaid became the associate dean for undergraduate programs. "My heart is for undergraduates," he said. "I relate to them easily." Kincaid oversaw recruitment, counseling, academic discipline and the co-op program, working with the Career Development Office which operated under his purview.

His research interest remained signal image processing applications—primarily for nondestructive testing—which include x-ray, ultrasound and electromagnetic methods for testing components. "Nondestructive testing means that if it's a good part, you don't make it bad by testing," he explained.

Early this year, Kincaid and his wife moved to Florida, where he plans to enjoy the weather and golfing. "I also hope to be tutoring high school mathematics and physics," added Kincaid. "I've been doing it for friends and relatives but not officially. After you retire there's a lot to do."

"I am pleased to have been able to do both of the things I wanted to do: industrial and academic. To be part of something that was growing and see the development was exciting," said Kincaid. ■

Emerging Technology Seminar Highlights Biomaterials Advances

By Chhavi Sachdev

In the spirit of multidisciplinary collaboration, the Department of Manufacturing Engineering held its 11th seminar in the Emerging Technology series around the theme of biomaterials. The day-long seminar, "Biomaterial for Sensors, Implants and Regenerative Medicine," attracted about 150 students, professors and industry members from the greater Boston area on October 20.

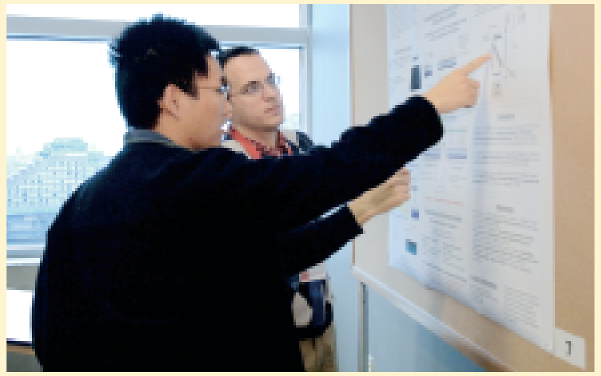
"This Emerging Technology symposium emphasizes and operates at the interface of several areas of Boston University's excellence in the highly interdisciplinary area of advanced materials and their applications to biology and medicine," said Kenneth R. Lutchen, dean of the College of Engineering.

"Biomaterials means more than just artificial skin and artificial tissue," said event host Catherine Klapperich, an assistant professor of manufacturing engineering with a joint appointment in the Department of Biomedical Engineering. "There are a lot more applications. Even as it's settling in as an academic field, it's still a new area," she said.

"Since we just got the Coulter Translational Grant, which funds this kind of interface between academy and industry, this was a good opportunity to put these speakers together and show our partners how we're doing," Klapperich added.

The event featured two BME faculty members: Associate Professor Amit Meller and Professor Mark Ginstaff. Meller gave a talk about his research into using nanopores—or miniscule holes—to analyze DNA and DNA-protein interactions [see story on page 27]. Grinstaff presented his research on fabricating a new class of polymers with wide medical applications [see story on page 5].

Besides two speakers from BU, the seminar featured Jeffrey T. Borenstein, the director of the Biomedical Engineering Center at Draper Laboratory who addressed the applications of biodegradable microfluidics in tissue repair.



Graduate student Mehmet Dogan (right) talks to a visitor about probing DNA surfaces with optical interference techniques.

Scott Manalis, an associate professor of biological and mechanical engineering at MIT, spoke about microdevices for biomolecular and single cell detection. Frederick J. Schoen, a professor of pathology and health sciences and technology at Brigham and Women's Hospital and Harvard Medical School, discussed novel biomaterials that could be used in heart valve replacement.

Arthur J. Coury, the vice president of biomaterials research at Genzyme Corporation and a member of the BME Industrial Advisory Board, addressed orthopedic applications of new hydrogels. David Mooney, the Gordon McKay Professor of Bioengineering at Harvard University, presented research on angiogenesis, or growing new blood vessels from existing ones.

As evidenced by the varied backgrounds of the speakers, "The areas of translational bioengineering and translational material science are growing into a College-wide initiative," said Klapperich.

Dean Lutchen agreed. "One of the major challenges for the research community is to translate the science behind biomaterials to patient care, be it targeted to molecular therapy or tissue replacement," he said. "This symposium attracts industry and science leaders from national laboratories as well as academy, many of whom have collaborated with the College already."

The seminar was co-sponsored by the Department of Biomedical Engineering and the College of Engineering. ■

EK 301 Tutoring Center Is New—Again

By Chhavi Sachdev

Back in the days before AutoCAD, it used to be a drafting room, but with a little imagination, reconfiguration and some alumni funding, the old EK 301 tutoring center at 110 Cummington Street has undergone a facelift.

Last summer, room ENG 205 was renovated and divided into two separate spaces. A portion was used to create a lab for Professor Katherine Zhang; the rest became the new tutoring center, which until then had simply taken up residence in the larger, mostly unused drafting room.

"We refinished, repainted and refurnished the space," said James Langell, director of the Department of Aerospace and Mechanical Engineering.

Improvements include audiovisual capabilities, a new LCD projector, whiteboards, multiple outlets and Ethernet boards, along with better tables and leather stools.

"It's a brighter and better environment," said Richard W. Lally, assistant dean of administration at the College of Engineering.

Half of the cost of the renovation came from alumni contributions to the College's Annual Fund. "Our alumni donors are eager to make an impact on the educational experience of today's students," Lally said. "This upgraded tutoring center certainly accomplishes that."

The center will cater to all students in EK 301, Engineering Mechanics I. "All engineering students have to take this class, which is generally taught by AME faculty," Langell said.

Since EK 301 is a required class, approximately 300 students take it in the fall and about 60 in the spring semester. "For most students, EK 301 is the first engineering course they are taking," said Langell. "A lot of them have difficulties with it, so we've established the tutoring center."

The center is open from 4 p.m. until 10 p.m. on Mondays, Tuesdays and Wednesdays. A graduate teaching fellow supplements lectures and conducts review sessions.

For the rest of the engineering students at the College, the Undergraduate Programs Office runs a separate tutoring center in room ERB 105 from 5 p.m. until 11 p.m. Mondays through Thursdays. ■

Mechanical Engineering PhD student Henri Aguesse (left) helps BME sophomores Anoli Shah and Mohit Butaney with EK 301, Engineering Mechanics, in the tutoring center at 110 Cummington Street.

Underrepresented Students Get Primer on Grad School

By Michael Seele

Dozens of undergraduate science and engineering students from underrepresented groups learned about the possibilities offered by graduate schools around the country at the Getting Ready for Advanced Degrees Lab '06 held at the College of Engineering on September 30.

The event was sponsored by the Massachusetts Coalition of Science, Technology, Engineering and Math Programs (CSTEMP), a partnership of area schools that are members of the national GEM Consortium. GEM encourages graduate education in engineering and science among Native Americans, African-Americans, Mexican-Americans, Puerto Ricans and other Hispanic-Americans and offers financial support. Boston University spearheaded the formation of CSTEMP and is one of six member institutions in this regional consortium.

Some 74 Boston-area students attended the event; representatives from 20 institutions offering graduate programs in science and engineering were also on hand. Local universities including BU, Harvard and MIT were represented, as were more distant institutions like the University of California at Berkeley and the University of Minnesota.

Students heard remarks from ENG Dean Kenneth Lutchen and a keynote address from National GEM Consortium Executive Director Michele Lezama. Panel discussions included topics such as "Why Graduate School?" "How to Prepare for Graduate School," "Understanding the GEM Fellowship and Other Funding Opportunities," and "Voices from the Field—Real Life Research and Internship Experiences."

> "We hope this event will help us to increase the number of graduate students from underrepresented populations."
>
> *—Associate Dean Mark Horenstein*

Tomalei Vess of Duke University (left) talks to a student during the GEM lab.

Afterward, the students had the opportunity to visit with representatives from each of the institutions to learn more about their specific graduate programs in science and engineering.

ENG Associate Dean for Graduate Programs Mark Horenstein said, "In sponsoring this annual event, Boston University has made a commitment to the mission of the National GEM Consortium, namely to enable outstanding students from the United States and Puerto Rico to obtain graduate degrees in engineering, the natural and physical sciences, and mathematics from the nation's top universities and research institutions. We hope this event will help us to increase the number of graduate students from underrepresented populations." ■

Medical School Dean and Provost Karen Antman, University of Washington's Eve Riskin, University Provost David Campbell and NRL's Debra Rolinson at the WISE panel discussion

WISE Symposium Mulls Report on Women in Science and Engineering

By Chhavi Sachdev

On the heels of a report released by the National Academies on barriers and biases against women scientists and engineers in academia, Boston University's Women in Science and Engineering (WISE) held a symposium, "Transforming the Culture of Academic Science and Engineering," on November 13.

Though more women are matriculating in the fields of science, technology, engineering and mathematics, very few are moving into academia after graduation—a trend that the National Academies have noted and investigated in the report.

Forty years ago, only 3 percent of America's scientists and technicians were women. In 2003, the percentage was closer to 20. Still, the number of women is much lower than that of men, and governmental reports and congressional committees have noted that this is of significance to both the economy and the national security of the nation.

At the College of Engineering women make up 13 percent of the faculty, said Assistant Dean of Administration Richard Lally. In the last five years, seven out of 41 new hires were women, as compared to two out of 28 hires in the five-year period before that.

The ratio of arrivals—or new hires—to departures among the male faculty between 2001 and 2006 was 2.6, while at 2.3, it was only slightly lower for women. "Both factors indicate positive trends for female recruitment and also retention," Lally said.

"We are trying to incorporate the best practices to ensure that the College is a highly attractive career choice for women," said Dean Kenneth R. Lutchen.

At the symposium, Lotte Bailyn—a professor of management at the Massachusetts Institute of Technology and one of the coauthors of the report—was a featured speaker, as were Deborah Cotton, a professor at the School of Medicine, and Eve Riskin, a professor of engineering at the University of Washington. Debra Rolinson, head of the advanced electrochemical materials section at the Naval Research Laboratory, also spoke.

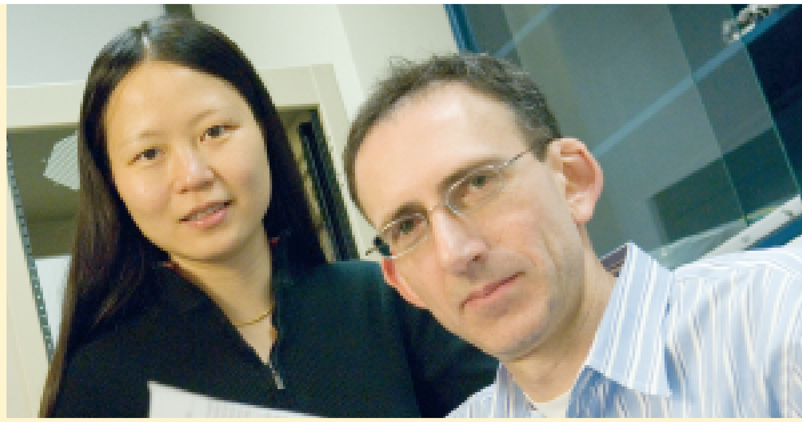
The symposium concluded with a panel discussion featuring University Provost David Campbell, Medical Campus Provost Karen Antman and the invited speakers.

Others in the audience included co-chairs of the recently formed Council on Faculty Diversity and Inclusion, whose mission is to make BU a more attractive, supportive employer of women and minority candidates.

According to Campbell, a former dean of the College of Engineering, the University has seen a fivefold increase in tenured women faculty in recent years. "The best practices for women also benefit men," he said, adding that BU science and engineering departments are moving in the right direction. ■

Bioengineers Win Major NIH Grant to Reduce Cost of DNA Sequencing

By Michael Seele



BME associate professors Zhiping Weng and Amit Meller.

Two Boston University biomedical engineers have won a major National Institutes of Health grant to continue groundbreaking research aimed at sequencing individual human genomes for about $1,000.

Associate Professor of Biomedical Engineering and Physics Amit Meller was among nine researchers chosen nationally for the NIH's "$1,000 Genome" award; he received the second-largest grant. Meller and coprincipal investigator Zhiping Weng, a BME associate professor, won $2.2 million over the next three years for their research in addition to some $600,000 Meller has already received from NIH for this work.

Meller is employing novel methods to decode the sequence of bases on a DNA strand at the molecular level. Using beams of electrons, Meller punches tiny holes in thin silicon films, then pulls strands of DNA through these "nanopores" using an electric current. Each base is identified by an attached florescent marker, which allows the researchers to record the sequence of bases as the strand emerges from the nanopore. Meller has devised a system of lasers and highly sensitive detectors that greatly increase the process' resolution. He is the only researcher in the world using this method, which he calls "Opti-Pore."

Weng's involvement centers on bioinformatics—using computational methods to organize the large amount of data collected.

Meller said he is grateful for the grant, which validates his approach to DNA sequencing. "We are very close to a proof of principle that we can read a small number of these bases, perhaps six or eight—using this method," said Meller. "From there, it is a small step to reading tens, and later hundreds, at a time. That would produce an orders-of-magnitude reduction in the price of sequencing individuals' DNA."

According to NIH, sequencing the 3 billion base pairs on a human genome using current technology costs about $10 million. Reducing the cost to $1,000 or less would bring DNA sequencing into the realm of routine medical care, enabling doctors to diagnose and treat patients more effectively based on their individual genetic profiles. ■

Grad Student Wins Elite Award

By Brittany Jasnoff

Sophie Desbiens (BME '09) was one of six PhD students in America to win a recent predoctoral fellowship in pharmacology and toxicology from the Pharmaceutical Research and Manufacturers of America Foundation.

"It's very nice to have my research recognized," said Desbiens, who is studying in ENG and at the School of Medicine. Desbiens will use her award to explore molecular-level changes in the brain following cocaine addiction. The research may lead to a new treatment option for drug addiction.

"It's appealing research to fund because it increases our understanding of basic mechanisms, but it also leads to possible new therapeutic targets," Desbiens said. ■

Castañón Named to Air Force Scientific Advisory Board

David Castañón

By Michael Seele

The Air Force has asked Professor David Castañón (ECE) to bring his expertise in signals and systems to bear as a member of the service's Scientific Advisory Board.

Castañón said his area of expertise is of particular interest to the Air Force.

"In the long term, the Air Force wants 25 percent of its aircraft to be robotic," he said. Although the Air Force has robotic aircraft now, operating them requires detailed programming and teams of humans on the ground to evaluate the torrent of information streaming from the aircraft's sensors. Sifting through the data and deciding what, if any, action is needed can take days.

"There is a great interest in developing systems that can process and evaluate information autonomously," Castañón said. "We have an increasing capability of instruments to measure things accurately, but we don't have the commensurate science that allows us to use them to their full potential."

The 50-member board advises Air Force leadership on scientific and technical issues that may help the service accomplish its mission. The board includes members of the military as well as scientists and engineers working in other areas of government, industry and academia.

Castañón and the Air Force envision a day when a single human could supervise—rather than operate—a network of autonomous aircraft from the ground. By developing artificial intelligence capability in the aircraft and linking them together, the aircraft could identify items of interest on the ground and relay only essential information to the human supervisor. The Air Force has an immediate use for such capability in Iraq, where roadside bombs pose a major hazard. ■

Klapperich Garners Award

(Michael Seele photo)

Catherine Klapperich

By Katelyn Boller

Catherine Klapperich, an assistant professor in the Departments of Manufacturing Engineering and Biomedical Engineering, received a Seed Funding Award from the Tilker Medical Research Foundation in recognition of her work to create realistic environments for the growth of stem cells.

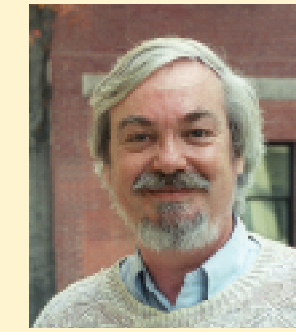
Klapperich, who arrived at ENG in 2003, is the director of the Biomedical Microdevices and Microenvironments Laboratory and a member of the Center for Nanoscience and Nanotechnology. She was one of three researchers to receive a $25,000 grant from the Tilker Foundation in 2006.

"From a wide pool of highly talented applicants, Dr. Klapperich stood out, not only for her already demonstrated research results but also for the direct promise [her] work holds for advancing treatment opportunities for some of today's most devastating diseases," said Marvin Tilker, president and CEO of the Tilker Medical Research Foundation. "The Tilker Medical Research Foundation is extremely pleased to be supporting such revolutionary research."

Klapperich was granted the award to support her research with the development of stem cells and nanomaterials. By simulating the stem cell's natural environment, her research allows the stem cells to produce therapeutic lineages which can be used for transplantation, according to Klapperich. She is working on reproducing the microenvironments of the breast, cochlea and motor neurons.

"Dr. Klapperich is rapidly establishing herself as an expert in the use of micro- and nano-technology for diagnosis and treatment of disease," said John White, chair *ad interim* of the Department of Biomedical Engineering. ■

Voigt to Lead International Organization



Herbert F. Voigt

By Katelyn Boller

Herbert F. Voigt, a professor of biomedical engineering, was recently voted president-elect of the International Federation for Medical and Biological Engineering (IFMBE), a nongovernmental agency that brings together national and international medical and biological engineering organizations to encourage research and collaboration.

While Voigt will not be inducted as president until the 2009 World Congress in Munich, Germany, he will act as vice president under the current president, Makoto Kikuchi of Japan.

"My role is to support his vision for the next three years while I hone my vision," said Voigt.

He will be serving on several committees and traveling across the globe for officer meetings, including a trip to Venezuela next year.

While working with an international organization is new to Voigt, he has a great deal of similar experience in the United States. He is president of the American Institute for Medical and Biological Engineering and Alpha Eta Mu Beta, the biomedical engineering honor society; and has been president of the Biomedical Engineering Society. According to Kenneth Lutchen, dean of the College—who also serves as a vice president at-large for AIMBE—serving as president for all of these organizations may be unprecedented in the field.

"These types of leadership positions bring much pride to us here at Boston University," said Lutchen. "They are yet another recognition and reflection of the respect that the outside community has for our excellent faculty. Dr. Voigt has been actively engaged in taking on leadership positions in the bioengineering community for over 15 years now. He is passionate about the discipline and highly dedicated and effective in these organizations." ■

Ünlü Elevated to IEEE Fellow

Selim Ünlü

By Mark Morabito

An ECE professor with a joint appointment in the Physics Department, M. Selim Ünlü has been named a fellow of the Institute of Electrical and Electronics Engineers (IEEE).

ECE Chair Bahaa Saleh, who nominated Ünlü, said, "Selim has done a fantastic job fulfilling multi-disciplinary work in photonics. He has established an excellent reputation for work with photonics devices as well as near-field imaging."

This prestigious appointment was granted for Ünlü's contributions to optoelectric devices. Ünlü's research focuses on improving the hybridization efficiency of DNA; by combining complementary single strands of DNA to form a double helix—or hybridization—Ünlü gleans information about the conformity of DNA to microarray surfaces.

Through the pioneering use of spectral self-interference fluorescence microscopy (SSFM), each DNA strand's fluorescent marker is located within 0.2 nanometers, while each strand of DNA is approximately 0.3 nanometers. Ünlü's process of SSFM allows for a better determination of the shape, length and amount of hybridization of DNA with a high degree of accuracy.

This investigation into microarrays—which combines biology and electrical and computer engineering—holds great importance in genomics. Ünlü's research is done in collaboration with Bennett Goldberg, a professor of physics, and study investigators Charles R. Cantor, a professor of biomedical engineering and co-director for the Center of Advanced Biotechnology at BU; Anna K. Swan, associate professor of electrical and computer engineering; and Lev Moiseev, an electrical and computer engineering research associate. ■

Alum heads up IEEE Signal Processing Society

— Chhavi Sachdev

Alfred C. Hero III (CSE '80), a professor of electrical engineering and computer science at the University of Michigan, Ann Arbor, visited campus last fall shortly after being elected president of the IEEE Signal Processing Society. Hero led an ENG seminar and discussed ongoing collaborations with researchers in the College and in the Mathematics Department.

One of the research interests that led him back to BU is a Multi University Research Initiative (MURI) grant on target recognition. The MURI is between the University of Michigan, Ohio State University, Florida State University, MIT and two researchers at BU: David Castañón, a professor of electrical and computer engineering; and Clem Karl, a professor of electrical and computer engineering as well as biomedical engineering.

Together, they are studying automated target exploitations for the Air Force. "A few years ago, one of the biggest issues in being able to ensure safety and invulnerability for troops was automated target recognition—identifying a person or a vehicle approaching in an unexpected manner," according to Hero. "We are trying to exploit different types of information to distinguish someone running for a bus from someone with a bomb strapped on." Essentially, the researchers are trying to efficiently make a model of anomalies—rather than relying simply on detecting an anomaly—with cameras, microphones and a network of mobile sensors.

"To isolate behavior and look at it in context, we need an enormous amount of information," says Hero, whose role is looking beyond the physical model to develop non-parametric tools that are purely inductive.

"Signal processing is the glue that pulls all this together," he said.

"In this field, we are the ones who are able to apply physics, models, apparent noise in the measurement process and applied mathematics to understand abstract notions to build general frameworks for many phenomena," says Hero of signal processing. "Being at the interface makes this field exciting and challenging, for one has to teach students to be adept at operating in this space."

Hero joined the IEEE while at BU and was elected a fellow of the 300,000-strong organization shortly before being elected president of the Signal Processing Society, which has about 17,000 members worldwide. It is the fourth largest society in the IEEE and "second in terms of impact and number of journals, conferences and workshops," he said. "It's the fastest growing field." ■

Alfred C. Hero III

CLASS NOTES

1954

DAVID LOWRY (AME)

Newton, Massachusetts

In the fall, David was interviewed for a national television show as a retiree and member of the Danbury Railway Museum. The program "Retirement Living TV: The Art of Living" was broadcast October 16 on Comcast TV and was available online at *www.c8.tv*.

1956

SILAS K. BAKER, JR. (AME)

Rockledge, Florida

Sy has been appointed to the Space Florida Board of Directors by Governor Jeb Bush. Space Florida houses the state's existing space and aerospace entities and coordinates all space-related issues in Florida. E-mail Sy at *silasbaker@aol.com*.

1962

KATHLEEN JOAN (BREADY) PELLEGRINO (BS)

Springfield, Massachusetts

Kathleen Pellegrino has been professionally busy for the past four years as principal of LivingStone, LLC, consultants and expediters in finance, construction, construction management, historic rehabilitation, charter schools and a myriad of other business endeavors. Previously she served as executive director of the Springfield Parking Authority for four years and a professor of accounting and management operations at Westfield State College for 20 years—8 of them as chairperson of the department of economics and business—and has been a forensic accountant and certified public accountant for 27 years. Pellegrino has been married for 44 years to Joseph A. Pellegrino, retired justice of the Massachusetts Trial Courts, is the mother of four children and has 11 grandchildren, the eldest of whom is currently attending Colgate University and the youngest of whom is three years old.

She is not sure she will ever really retire but does travel regularly abroad and enjoys their beach home in Sandwich, Massachusetts. Pellegrino would love to hear from her classmates—mainly from those who graduated from '61 to '63 at *kpellegrino@livingstonellc.com*.

1963

WILLIAM A. COX (BS)

Tucson, Arizona

William works in missile systems at Raytheon Company; while working at Raytheon in the late 1950s, William won a scholarship to attend BU and has worked for the company ever since. E-mail him at *wacox@comcast.net*.

1978

PETER E. LENK (BS)

Foxboro, Massachusetts

"It is great to see the school really thriving and growing. I have such fond memories of my time at BU and the education was so valuable in my career." Lenk retired out of High Tech Electronics Manufacturing about five years ago after reaching the vice president level and now is happy working in his own businesses. "I am now primarily a professional cabinetmaker, but do some real estate projects and am starting an eBay philately business as well." His children are all grown and doing well. "My best regards to all my classmates and friends at BU!" E-mail Lenk at *RRoller123@aol.com*.

1991

KEVIN TSENG (ECE)

San Diego, California

Kevin is a civilian computer engineer for the Navy's Naval Surface Warfare Center. He performs land-based functional operability tests on combat system elements before installation on board ships. E-mail Kevin at *krtseng@aol.com*.

1992

JASON KOLB (MFG '92, '97)

Somerset, New Jersey

Jason and his wife, Ana, had their second child, Kyle Parker, on February 6, 2006. Their daughter, Taylor, is two. Jason is the business management system manager for Andrew Corporation, a telecommunications company. E-mail him at *jkolb@alum.bu.edu*.

1994

JOHN MCNEILL (ECE)

Stow, Massachusetts

John and his coauthors received the Lewis Winner Outstanding Paper Award at the 2006 International Solid-State Circuits Conference of the Institute of Electrical and Electronics Engineers. John is an associate professor of electrical and computer engineering at Worcester Polytechnic Institute.

HOCK M. NG (ECE '94, '97, '00)

Westfield, New Jersey

Hock was awarded the inaugural North American Molecular Beam Epitaxy Young Investigator Award at the NAMBE conference at Duke University in October. Hock was also awarded the Charles W. Tobias Young Investigator Award of the Electrochemical Society at the society meeting in Cancun, Mexico in November. E-mail *hmng@lucent.com* if you'd like to get in touch.

1995

JOSHUA CHEONG (ECE)

Singapore

Joshua left Hewlett Packard's global operations division to pursue a regional customer relationship manager role at Mercury Interactive. He writes, "Hope everyone from the class of '94/'95 is doing well—it seems like the last 10 years flew by in a rush!" E-mail him at *joshuacheong@hotmail.com*.

1998

REUBEN FISCHMAN (ECE)

Rehoboth, Massachusetts

Reuben is a senior systems engineer with General Dynamics C4 Systems. He is a lead engineer in the company's R&D organization and is engaged in work on transformational communications. He may be reached at *rfischman@alum.bu.edu*.

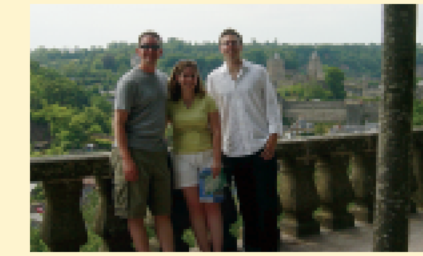
2000

NATALIE (DUARTE) HURLEN (BME)

Phoenix, Arizona

Natalie Hurlen and her husband Erik have completed their doctoral degrees at the University of California, San Diego. They recently moved to Phoenix, Arizona, where Natalie started work as an engineer at Exponent in January. E-mail her at *ncduarte@aol.com*.

2001



Fougères, France, June 2006
Left to right: Pete Cirak ('01), Erika Cirak and Dan Charbonneau ('01) at a park overlooking the 14th-century fortress in Fougères, France.

DAN CHARBONNEAU (AME)

Paris, France

Dan is a field engineer for GE Aviation in Paris, France.

PETER CIRAK (AME)

Malden, Massachusetts

Cirak graduated with a degree in aerospace engineering. He is currently a senior quality engineer at Palmer Manufacturing Company in Malden, Massachusetts.

2004

JESSICA GREENBERG (BME) and Gary Sonnenfeld (CAS '02) were married on February 17 in Florida.

PASSINGS

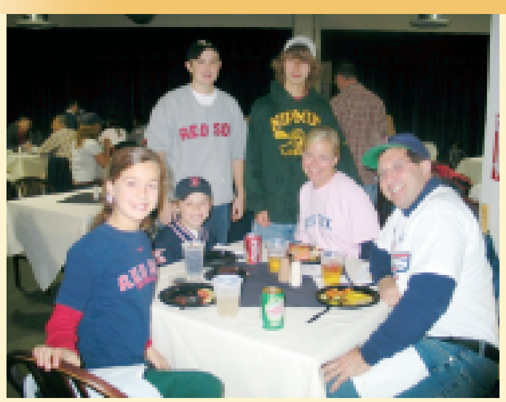
ARMAND F. SANSOUCY ('47), on June 1, 2005
ROLAND A. JEAN ('55), on October 7, 2005
PETER R. VECKERY ('64), on June 14, 2004
KENNETH F. MANCHAK ('67), on June 29
RICHARD M. NEWMAN ('70), on January 6
THOMAS J. WAINWRIGHT ('74), on June 25
CHARLES H. ZIMMERMAN ('82), on September 29, 2005
KEVIN M. VOSBURGH ('88), on February 7, 2005

GOLF TOURNAMENT



Alumni and friends of the College gathered for the Excellence in Engineering Golf Classic and Fundraiser on September 25 at Woodland Golf Club in Newton, Massachusetts. Among those at the event were Kyle Richards ('86), Dean Ken Lutchen and host Al Muccini ('62).

RED SOX VERSUS ORIOLES



Alumni, students and their families braved the elements to attend the final game of the 2006 Red Sox season. Among those spending a long rain delay in the comfort of the Players Club inside Fenway Park were the Kelleher family, left; the Fraser family, center; and Dave Lancia ('02, '04), Vik Vajada ('02, '04, MET '06) and friend Brittany.

GING S. LEE ('70)

Endowed Gratitude

Ging S. Lee ('70) never forgot what his Boston University engineering education did for him. While achieving success in his career, Ging remained dedicated and connected to the College of Engineering; he served on the Alumni Board for many years and generously supported the College throughout his life. The College recognized his commitment in 2003 with its Distinguished Award for Service to Alma Mater.

After Ging S. Lee's untimely passing, his wife Barbara and her family established an endowment to honor his memory with an award for community service. The Ging S. Lee Memorial Award will be presented each year to a graduating senior who has made outstanding contributions in the area of community service. But more can be done.

Mrs. Lee, her family and the College are asking alumni to add a total of $40,000 to the fund, which will allow for the creation of an endowed scholarship for deserving students in need of assistance.

To recognize Ging's memory and his contributions to the College, please consider making a donation to the Ging S. Lee Memorial Award Fund.

For more information, please contact the College of Engineering's Alumni and Development Office at *engalum@bu.edu* or call 617-358-2806.

Bright Light

Encouragement, facilities and funding shared center stage with inspiration and research in Ted Moustakas' pioneering work in developing the world's first blue light emitting diodes (LED) and, now, white LEDs.

BU is very supportive of this work, says Moustakas, whose expertise is in wide-bandgap semiconductors. "The field was completely young; we were not even sure it would become a field. But today, our group is very distinguished. The labs at BU are among the best labs in the country.

"The problems scientists and engineers are interested in today are beyond the reach of a single investigator. The only way to address them is with sophisticated analysis from people of different disciplines and skills. The University realizes this and encourages multidisciplinary work across departments and across colleges."

THEODORE MOUSTAKAS
PhD, Columbia University
Professor of Electrical and Computer Engineering

To learn more, visit:
www.bu.edu/eng

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