VOL. 5, No. 2

BIOFEEDBACK

THE FISCHELL DEPARTMENT *of* BIOENGINEERING
A. JAMES CLARK SCHOOL *of* ENGINEERING

www.bioe.umd.edu

A NEWSLETTER FOR ALUMNI AND FRIENDS OF THE FISCHELL DEPARTMENT OF BIOENGINEERING AT THE A. JAMES CLARK SCHOOL OF ENGINEERING, UNIVERSITY OF MARYLAND, COLLEGE PARK.

IN THIS ISSUE:

Bioengineering Undergraduates Dominate National Bioethics Contest

For the second year in a row, bioengineering undergraduates, including three freshmen, edged out a national field of 184 other entrants to earn four of the five top spots in the Institute of Biological Engineering's (IBE) annual bioethics essay contest. Sophomore **Zachary Russ** won for a second year in a row, while freshman **Victoria Stefanelli** placed second and freshmen **Chris Dupuis** and **Laith Abu-Taleb** were first and second runners-up, respectively. As finalists, they presented their papers at IBE's annual conference in March, where the winners were decided.

Russ' first place essay, "Mapping the Moral Boundaries of Biological Engineering," argues that given a history of high-profile incidents in which scientific advancement or discoveries inadvertently led to disaster due to failures in safety protocols, the discipline of biological engineering must have its own specific code of ethics, not one borrowed from a parent field. This is because, he feels, biological engineering is a synthesis of disciplines that utilizes a wide variety of scientific techniques, presenting an array of potential dangers and moral issues. The essay presents suggestions as to what form such a new code of ethics could take.

Stefanelli's second place essay, "Bioethics: An Issue of the Future," takes an opposite stance, arguing that too many people's impressions of the possible negative outcomes of biological engineering draw too heavily from the realm of science fiction, and that many fears are "unreasonable or unwarranted." Stefanelli feels that a specific code of ethics would result in too many limitations, restrictions that are too broad, and too much bureaucracy, all of which would slow progress and possibly constitute a "violation of civil liberties by eliminating the [patient's] right to choose" new treatments for injury and disease.

Dupuis' essay, "Scientific Freedom Begins With Regulation," suggests a balance between sensible regulation and morality that would allow science to progress at a meaningful pace while not overstepping ethical concerns. Dupuis stresses humane animal research, respect for all people regardless of culture, and the right for everyone to know both the potential benefits and dangers of research. The paper advocates decoupling the objective work of scientists from subjective moral issues so we can first fully explore, and then make informed decisions about whether and how to use controversial means of problem solving such as stem cell research.

Abu-Taleb's essay, "Does the Field of Biological Engineering Need its Own Code of Ethics?" proposes the kind of discussion which must occur in order to determine the answer to that question. Moral issues that should be raised include the possibility of exploitation; the moral rights of stakeholders, regulators, researchers, and the public; and the tradeoff between social benefits and social costs. Abu-Taleb writes that we must analyze four specific issues: human culture, standards for rapid advancement, the need to save lives, and financial costs and allocations.

chair's MESSAGE

WILLIAM BENTLEY

WHAT BETTER WAY TO KICK OFF THIS ISSUE OF *BIOFEEDBACK* THAN WITH EXCITING NEWS—WE NOW HAVE AN OFFICIALLY ACCREDITED BACHELOR OF SCIENCE PROGRAM IN BIOENGINEERING!

You may recall that when we started the Fischell Department in 2006, we transitioned the Biological Resources Engineering B.S. program into the Bioengineering B.S. program. The agency in charge of engineering program accreditation in the U.S., the Accreditation Board for Engineering and Technology (ABET), viewed this as the creation of a "new" program and subsequently visited us in November for a full review. We passed through the process with flying colors and just received word that our accreditation is retroactive to October 2007, so everyone who has graduated or will graduate with a B.S. will earn their degree from an accredited program.

Speaking of graduation, I'm also excited to announce that we graduated our first cohort of students with bachelor's degrees in bioengineering in May 2009—just three years after we launched the department. You can learn more about their accomplishments and ideas in our annual Capstone Design Review (see pp. 14-15).

Talented students like these need your support. Now more than ever, even a few hundred dollars can make the difference between a student obtaining a Terp education or not. We can help you find creative ways to give—for example, we often find ourselves giving gifts to loved ones who tell us they really don't want or need anything. You can help our bioengineering undergraduate students with the cost of their education and create a unique, thoughtful gift by establishing a scholarship in honor of a family member or friend (see pp. 12 and 16 for details).

This spring, we had a fantastic Fischell Festival, highlighted by great talks from leading experts, a live laparoscopic bypass surgery using a da Vinci robot, technical breakout sessions, student research, a career and information fair, the announcement of the 2009 Fischell Fellow, and our inaugural undergraduate student design awards (see pp. 6-8 for details).

Our faculty, students and postdocs have continued to win prestigious grants and awards for their innovative work. Stories about many of these accomplishments make it into the pages of *Biofeedback,* but to read all of our news as it happens, please visit www.bioe.umd.edu/news.

This July, one of our most distinguished professors, Dr. **Art Johnson**, formally retired, but we convinced him to keep teaching two of the most demanding courses in the curriculum for a couple more years (see. p. 4 for details)!

Thank you for your continued support and interest in the Fischell Department of Bioengineering!

With Best Regards,

William E. Bentley
Robert E. Fischell Distinguished Professor and Chair
bentley@umd.edu
(301) 405-4321

researchNEWS

YU WINS NANOBIOTECH GRANT

Fischell Department of Bioengineering associate professor **Bruce Yu** (joint, School of Pharmacy) has been awarded a 2009 Maryland Nanobiotechnology Research and Industry Competition Grant of $250,000 from the State of Maryland. His winning proposal, "Force-Sensitive Nano Networks (FSNN)", will be carried out in collaboration with Dr. **Boualem Hammouda** of the National Institute for Standards and Technology (NIST).

The Maryland Technology Development Corporation (TEDCO) and the Maryland Biotechnology Center, Department of Business and Economic Development (DBED) announced the award, one of 12 statewide, on June 4.

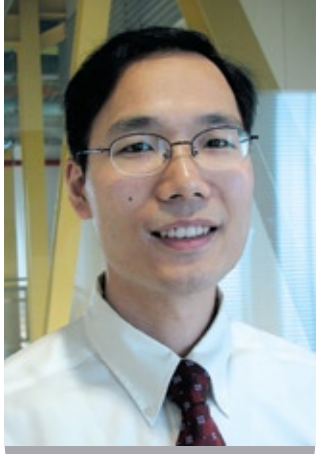
BRUCE YU

The research falls under one of Yu's major focus areas–the engineering of mechanosensors to aid the repair and rehabilitation of injured musculoskeletal tissues. Currently, mechanosensors made out of metals, ceramics and plastics are implanted in patients to provide doctors with information used to guide the treatment and repair of damaged ligaments, joints, and tendons. Yu and Hammouda are developing soft and wet force-sensitive nano networks (FSNN) that are comprised entirely of biocompatible materials, including peptides, proteins and polymers. Mechanosensors made out of FSNN could be injected into the body rather than surgically implanted, and are naturally and safely biodegradable.

"I'm particularly excited about this project because of my collaboration with Dr. Hammouda," says Yu. "NIST has the best neutron scattering resources in the world and Dr. Hammouda is a world-renowned expert in neutron scattering research." Neutron scattering, Yu explains, will be crucial in help-

ing them understand why FSNNs are sensitive to mechanical forces, which will in turn lead to improvements in their design.

In 2005, Yu earned a Presidential Early Career Award for Scientists and Engineers (PECASE) for his work with FSNN.



YU CHEN

CHEN WINS CANCER DETECTION RESEARCH GRANT

Assistant Professor **Yu Chen** has been awarded a 2-year, $80,000 grant to develop an improved biopsy technique for use in the early detection of breast cancer. Chen's collaborators on the project are research associate Dr. **Shuai Yuan**, Ph.D.; near-infrared fluorescent molecular imaging expert Dr. **Kristine Glunde**, assistant professor of Radiology and Oncology at the Johns Hopkins University School of Medicine; pathologist Dr. **Qin Huang**, assistant professor at the Brown Medical School and VA Boston Medical Center; and biostatistician Dr. **Tongtong Wu**, assistant professor of Epidemiology & Biostatistics at University of Maryland College Park.

The earlier breast cancer can be detected, the more likely it is to be treated effectively. According to Chen, only 61% of breast cancers are diagnosed in their early or curable stages. "Conventional needle-based biopsy techniques result in too many false negatives due to sampling errors," he explains. "Image-guided biopsies can improve sampling success rates, but currently those improvements are limited to lesions that are visible using conventional methods such as ultrasound or mammography. These techniques can only provide information about the outward appearance of the lesions. They can't adequately identify small lesions or show their full extent. There is a critical need for high-resolution imaging techniques that can accurately guide biopsy procedures to improve test results."

Chen's solution is based on an emerging technology called optical coherence tomography (OCT), which provides micron-scale imaging of tissue inside the body in real time, and is capable of performing three-dimensional subsurface imaging. When combined with fluorescence imaging, it also enables the visualization of molecular processes such as gene expression and disease-specific molecular interactions, allowing doctors to not only obtain a better picture of a cancerous lesion, but actually watch what it is doing. According to Chen, using OCT results, which can be obtained without having to remove a tissue sample, would be a major advance in cancer diagnostics. When combined with fluorescence molecular imaging (FMI), he says, the results become even more accurate.

"The Clark School's investment in bioengineering for human health is beginning to take hold," says BioE Professor and Chair **William Bentley**. "Work like Yu's is key in getting the word out that we are engaged in this important field of research."

Founded in 1985 as the Cancer Research and Prevention Foundation, the Prevent Cancer Foundation is dedicated to the early detection and prevention of cancer through its support of cancer research and the education of the general public about cancer prevention. Since its inception it has raised over $106 million to fund research and outreach programs, and has supported 300 scientists nationwide.

HSIEH WINS NSF CAREER AWARD

Assistant Professor **Adam Hsieh** has received a $400,000 National Science Foundation (NSF) Faculty Early Career Development (CAREER) Award for a proposal titled "Engineering Cellular Mechanotransduction." The research will be conducted in Hsieh's Orthopaedic Mechanobiology Laboratory.

Hsieh's project involves the use of cellular engineering, specifically a form of genetic manipulation known as RNA interference, to modify the functionality of a cell. In this case, his goal is to customize mechanotransduction, the way that cells perceive and respond to mechanical stress, by either amplifying or reducing intercellular communication to achieve a desired result. The project investigates mechanotransduction at different levels: in the tissue immediately around the cell, at the boundary between the inside and outside of the cell, and signaling within the cell.

"Being able to control the way cells respond to mechanical stress could have a significant impact on tissue engineering-based treatments for chronic disorders such as degenerative disc disease and other kinds of back pain," Hsieh explains.

The award will also fund several educational objectives centered around Hsieh's research, including the introduction of new classroom and research opportunities for undergraduate and graduate students and the expansion of his current outreach program, which provides demonstrations at high schools and invites local pre-engineering students to campus to participate in bioengineering projects.

ADAM HSIEH

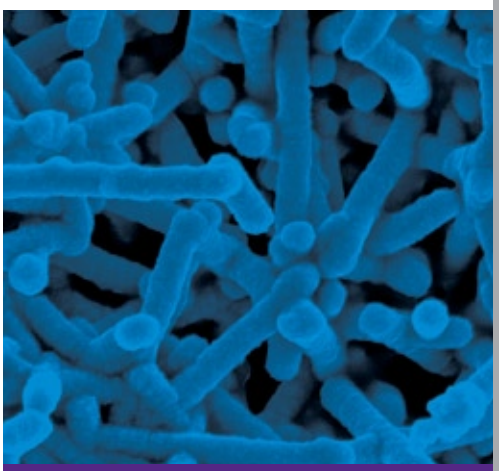
The NSF CAREER program supports the career development of outstanding junior faculty who most effectively integrate research and education within the goals and missions of their programs, departments, and schools.

JIM CULVER

CULVER PART OF WINNING NANOBIOTECH GRANT TEAM

Graduate Program in Bioengineering affiliate professor **James M. Culver** (professor, Center for Biosystems Research, University of Maryland Biotechnology Institute) will collaborate on a project that has been awarded a 2009 Maryland Nanobiotechnology Research and Industry Competition Grant of $250,000 from the State of Maryland. The winning proposal, "A Micro-Direct Methanol Fuel Cell with Nanostructured Platinum Catalysts Using the Tobacco Mosaic Virus," will be carried out in collaboration with P.I. Professor **Reza Ghodssi** (Department of Electrical and Computer Engineering and affiliate, Graduate Program in Bioengineering) and Assistant Professor **Chunsheng Wang** (Department of Chemical & Biomolecular Engineering and University of Maryland Energy Research Center).

The Maryland Technology Development Corporation (TEDCO) and the Maryland Biotechnology Center, Department of Business and Economic Development (DBED) announced the award, one of 12 statewide, on June 4.



▲ A SCANNING ELECTRON MICROSCOPY (SEM) IMAGE OF A TOBACCO MOSAIC VIRUS-ASSEMBLED NICKEL ELECTRODE SURFACE. PHOTO BY ADAM BROWN.

The project combines the professors' expertise in micro-electro-mechanical systems and microfabrication (Ghodssi), biology and protein engineering (Culver), and fuel cells and batteries (Wang) to design and develop high-performance, low-cost, portable micro-power sources using a simple and inexpensive biotemplate: the tobacco mosaic virus (TMV).

TMV has a high aspect ratio plant nanostructure which can be genetically modified to include functional groups that facilitate electroless metal deposition and self-assembly onto gold surfaces. This biotemplating process has been integrated with standard micro-machining for the development of micro-fabricated batteries. The result is a fuel cell with surface area nano-structured electrodes.

JOHNSON ANNOUNCES RETIREMENT

Although Professor **Art Johnson** has announced his retirement after 34 years at the University of Maryland, faculty, staff, students and alumni don't have to worry about missing their chance to say goodbye. With so much left he still wants to accomplish, the university community can expect to see him on campus as a Professor Emeritus for some time to come!

ART JOHNSON

"Goodbye, and thank you," he joked shortly after the announcement this summer, "…see you Thursday."

Although officially retired as of July 1, Johnson can still be found working in the Human Performance Laboratory, and is scheduled to teach an electronic design course this fall. "There are still too many things to do," he tells us. "There are students that I need to help turn into engineers, service to the University I want to perform, and my *Biology for Engineers* textbook will be coming out next February."

Seeing his most important research through also figures prominently in his decision to stay active on campus. Johnson has been working steadily on the development of his Airflow Perturbation Device (APD), a noninvasive tool that can be used to measure respiratory resistance in children, animals, and people who find other measuring devices difficult to work with. It can also be used to help diagnose respiratory problems. "The APD will soon be made available [to patients]," he says. "It looks like it will be able to help people with vocal cord dysfunction, asthma, and other conditions. That's very exciting!"

Reflecting on how he decided to spend his retirement—at least for now—Johnson makes the choice seem easy. "A few years ago I asked myself if there was anything I would rather be doing with my life," he explains. "I told myself that if so, I'd better start doing it because life is too short not to do what makes me happy. But I couldn't think of anything else I'd rather be doing. As long as life around here is exciting, I'm staying!"

JOHNSON ELECTED IBE FELLOW

PRIOR TO ANNOUNCING HIS RETIREMENT, PROFESSOR **ART JOHNSON** WAS ELECTED TO FELLOWSHIP IN THE INSTITUTE OF BIOLOGICAL ENGINEERING (IBE). THE IBE IS A PROFESSIONAL ORGANIZATION THAT PROMOTES RESEARCH AND INTEREST IN BIOLOGICAL ENGINEERING, EDUCATION, PROFESSIONAL STANDARDS, INTERACTION BETWEEN ACADEMIA, INDUSTRY AND GOVERNMENT, PUBLIC AWARENESS, AND RESPONSIBLE USE OF BIOLOGICALLY ENGINEERED PRODUCTS. JOHNSON IS A FOUNDING MEMBER AND FORMER PRESIDENT, AND WITH HIS ELECTION BECOMES THE INSTITUTE'S SIXTH FELLOW.

IBE FELLOWS ARE SELECTED BASED ON THEIR "RECOGNIZABLE AND DEMONSTRABLE RECORD[S] OF UNUSUAL AND EXCEPTIONAL ACHIEVEMENT AND ACCOMPLISHMENT IN A SPECIFIC SECTOR OF BIOLOGICAL ENGINEERING" THAT HAS ADVANCED THE FIELD AND PROFESSION.

THE CITATION ON THE AWARD, PRESENTED BY IBE PRESIDENT **CHRISTINA SMOLKE**, STATES "AS A CHARTER MEMBER AND SECOND PRESIDENT OF IBE, DR. JOHNSON HAS SERVED THE SOCIETY WITH DEDICATION AND PASSION. HE HAS PIONEERED NEW APPROACHES TO TEACHING BIOLOGICAL ENGINEERING. HIS RESEARCH IN RESPIRATORY PROTECTION, PULMONARY FUNCTION TESTING, AND EXERCISE BIOMECHANICS HAS BEEN RECOGNIZED AS UNIQUE AND VALUABLE."

One Urgent Problem, Two Innovative Solutions

TWO STARTUPS AND THEIR AWARD-WINNING APPROACHES TO CONTROLLING BLEEDING

In previous issues of Biofeedback, *we've told you about Fischell Fellow* ***Matt Dowling****'s award-winning, blood-clotting "nano-Velcro," and his startup company,* ***Remedium Technologies****, which is working to produce spray-on and "biobandage" versions of the product. Since our last issue, another startup based in the Fischell Department of Bioengineering,* ***Trauma Solutions****, has independently discovered and presented its own invention aimed at controlling heavy bleeding in emergency situations. Remedium's product is biologically-based, while Trauma Solutions' is synthetic. Each represents the particular expertise of our faculty and students. Together, they help demonstrate both the breadth of our research and our entrepreneurial spirit.*

"NANO-VELCRO" WINS OUTSTANDING INVENTION OF THE YEAR

"Nano-Velcro," the technology behind a hemostatic tissue sealant spray and a blood clotting "biobandage" also capable of drug delivery, was named the Outstanding Invention of the Year in the Life Sciences category of the University's Office of Technology and Commercialization's annual awards. Nano-Velcro was developed primarily in the Complex Fluids and Nanomaterials Group laboratory by bioengineering graduate student and Fischell Fellow **Matt Dowling** and his advisor, Department of Chemical and Biomolecular Engineering associate professor **Srinivasa Raghavan**. The pair collaborated with Dr. **John Hess** and Dr. **Grant Bochicchio** from the University of Maryland School of Medicine, where testing of the products is taking place.

SECONDS AFTER A SMALL AMOUNT OF "NANO-VELCRO" WAS ADDED TO THIS TEST TUBE, THE BLOOD IT CONTAINED CLOTTED INTO A THICK GEL. NANO-VELCRO IS MADE FROM MODIFIED CHITOSAN, A NATURAL POLYMER THAT IS ANTI-MICROBIAL, BIOCOMPATIBLE, AND ABLE TO SAFELY INTERACT WITH HUMAN TISSUE.

Nano-Velcro is capable of providing nearly immediate, lasting, and cost-effective hemorrhage control for wounds ranging from simple cuts to surgical incisions to battlefield injuries. The product is created by attaching fatty grafts onto chitosan, a bipolymer found naturally in the shells of crustaceans. The grafts act as tiny "hooks"—much like the hooks in Velcro—that catch on blood and soft tissue, improving the adhesion and blood-clotting ability of the chitosan. The bond is strong enough to control bleeding but gentle enough to be removed from the patient without creating further damage. Nano-Velcro has also been found to prevent infection and allow the oxygen transfer required during healing. A patent application is pending.

Nano-Velcro and the startup created around it, **Remedium Technologies**, was launched in 2007 and in the past two years has received numerous prizes and awards, as well as mass media attention. For more information, visit:
www.remediumtechnologies.com

KOFINAS GROUP WINS 2ND BUSINESS PLAN COMPETITION, SUCCESSFULLY TESTS NEW SYNTHETIC HEMOSTATIC MATERIAL

For the second year in a row, a startup company and product proposed by members of the Fischell Department of Bioengineering (BioE) and Keystone Professor **Peter Kofinas**' research group and its collaborators have won the biotechnology division and $20K in start-up funding in the Maryland Technology Enterprise Institute's (MTECH) $75K Business Plan Competition. Team members represented startup company **Trauma Solutions** (formerly Heamechanics), which has developed the first and only synthetic hemostatic material capable of simultaneously inducing blood clotting and delivering therapeutics. The material is able to induce clotting as effectively as biologically based products at a fraction of the price.

Kofinas' Trauma Solutions teammates include undergraduate research assistant **Adam Behrens** (Chemical and Biomolecular Engineering); graduate research assistant **Brendan Casey** (BioE, advised by Kofinas); and Dr. **Bartley Griffith** (Professor of Surgery; Chief, Division of Cardiac Surgery; Director, Heart and Lung Transplantation, University of Maryland Medical Center). The young company's goal is to develop a commercial product that can be used in general surgery, emergency rooms, and especially on the battlefield, where suturing may not be possible and the patient may be a long way from an operating room.

IN THIS VIDEO, TRAUMA SOLUTIONS' HEMOSTATIC HYDROGEL IS APPLIED TO AN INCISION ON A SHEEP'S LUNG. TWO MINUTES LATER, THE GAUZE IS PEELED AWAY WITHOUT FURTHER INJURY, AND THE BLEEDING HAS STOPPED.

"Our research is very applied," says Kofinas. "Most things we do in my lab are targeted toward a product or a device. The Business Plan Competition, and particularly the coaching and support [provided] by MTECH and Venture Accelerator, is vital to transforming such research to market products. [My students'] participation in the Business Plan Competition has allowed them to pursue careers that are not typical for them. For example, **Dan Janiak**, the winner of last year's competition, is now an associate at a venture capital firm."

The group recently completed their first full-scale animal trial at the University of Maryland Medical School in Baltimore. The hemostatic polymer hydrogel was able to successfully stop bleeding from an induced lung incision in a sheep in approximately 2 minutes. Post-operative analysis showed that the material was able to induce the formation of fibrin (a blood-clotting protein) at the incision site, causing a natural suturing process, completely sealing the tissue, and preventing further blood loss. A liver experiment is planned for the near future.

The 3rd Annual Fischell Festival

A CELEBRATION OF BIOENGINEERING'S POTENTIAL TO IMPROVE LIFE FOR MILLIONS OF PEOPLE

On April 21, 2009, the Fischell Department of Bioengineering held its third annual Fischell Festival, featuring a variety of speakers and activities, including the presentation of a revolutionary new stent, live video of a completely endoscopic coronary bypass surgery, the announcement of the Robert E. Fischell Institute for Biomedical Devices, a demonstration of a robotic exoskeleton, the best of this year's senior design projects *(see related story for complete details and winners, pp. 14-15),* a poster session, and breakout seminars. It also featured the announcement of the Department's newest Fischell Fellow, **Deborah Sweet**, who was selected for her work on the development of an orally-delivered chemotherapy drug *(see related story, p. 13).*

FISCHELL INTRODUCES NEW STENT, "GETS DOWN TO BUSINESS"

The Festival kicked off with a presentation from department benefactor and namesake Dr. **Robert E. Fischell**, who introduced the audience to his latest medical device, the Svelte Stent.

Stents are used to reopen and keep open blocked coronary arteries, and they are considered effective alternatives to open heart surgery and balloon angioplasty. Fischell has a long history with stents—he is sometimes called "the father of modern medical stents"—but he has continued to find ways to improve them. After implantation, some patients eventually experience restenosis, a reblocking of the artery from scar tissue formed in reaction to the stent's presence. Stents containing timed-release anti-scarring drugs have reduced but not eliminated the problem. Stents are also sometimes misplaced in the patient because the surgeon must first open the artery with a balloon, then go back in a second time to insert the device. The Svelte Stent addresses both problems through the use of a new drug emitted from a new type of coating on its surface, and by providing the surgeon with an all-in-one method of opening the artery and placing the stent. It also has a longer shelf life than previous models.

In the second part of his presentation, Dr. Fischell reminded the audience that even the very best biomedical device won't help anyone if it can't get into surgeons' hands, and that inventors must be prepared to promote their work with a sound business strategy. Specifically, says Fischell, a device must be good for the patient, serve a large population, make money for the prescribing doctors, save both the hospitals and insurance companies money, and be fast and easy to implant or use.

ENDOSCOPIC BYPASS SURGERY PERFORMED USING DA VINCI ROBOT

For those patients who cannot be helped with a stent, there is an exciting new alternative to traditional open heart surgery: a fully endoscopic coronary bypass procedure using a da Vinci robot. The University of Maryland School of Medicine (UM-SOM) is fortunate enough to have on their faculty one of four people worldwide who can perform the procedure, and one of only two in the U.S., Dr. **Johannes Bonatti**—and Festival attendees were fortunate enough to see him in action! While Bonatti operated and commented, Dr. **Bartley Griffith**, M.D., Director of the Division of Cardiac Surgery and Cardiothoracic Transplantation and professor of the Department of Surgery at UM-SOM, narrated the procedure and fielded questions.

While using the da Vinci robot, Bonatti didn't need to touch the patient with his own hands. Instead, he guided its four arms—which enter the patient through four small incisions—with both of his hands and a foot pedal at a control console. Two of the da Vinci's arms are equipped with surgical tools, one helps stabilize the position of the patient's heart, and the fourth holds a camera, which transmits video back to the console. Viewers were able to see the patient's beating heart and Bonatti grafting an artery into place. Although robotic-assisted surgery takes longer to perform than a traditional bypass, the patient's sternum does not need to be opened, and the recovery time can be cut down by as much as half. The results are better and last much longer.

As amazing as the technology is, Griffith had a piece of advice for the audience: "It's really much easier not to smoke."

UPDATE: ROBERT E. FISCHELL INSTITUTE FOR MEDICAL DEVICES

Professor and Chair **William Bentley** reported on the progress of the Robert E. Fischell Institute for Biomedical Devices. The Institute's Formative Committee has been laying the groundwork for the Institute's major goals and services: to connect inventors and engineers with clinical practices, to serve as an accelerator for biomedical device creation, and to provide internships for students. "The overarching purpose of the Institute is to get devices out of the labs and into practice," Bentley explained, "using the 'Fischell Factors'—the

▼ DR. FISCHELL DISCUSSES THE SVELTE STENT

ENDOSCOPIC BYPASS, LIVE FROM BALTIMORE, WITH DRS. BONATTI AND GRIFFITH ▲

same development criteria Dr. Fischell uses for his own devices and business ventures." Bentley also offered guests his vision of bioengineering's future, in which ever-smarter medical devices would not just be implanted, but capable of monitoring their status and the status of the patient, and reporting back to doctors.

Members of the Formative Committee include Associate Professor **Elias Balaras** (Bioengineering [BioE]), Professor and Chair **William Bentley** (BioE), Dr. **Martha Connolly** (Director, Maryland Industrial Partnerships), Associate Professor **Jaydev Desai** (Mechanical Engineering), **Susan Fischell**, Associate Professor **John Fisher** (BioE), Professor **Reza Ghodssi** (Electrical and Computer Engineering/Institute for Systems Research), Dr. **Bartley Griffith**, M.D. (Department of Surgery, UM-SOM), **Sandra Huskamp** (Director of Operations, BioE), Professor **W. J. Lederer**, M.D., Ph.D. (University of Maryland Medical Biotechnology Institute), **Kevin Lepley** (Assistant Director of Finance, BioE), **Leonard Pinchuk**, Ph.D., D.Sc. (co-founder and President/CEO, Innovia) and **Mel Schatz** (President/CEO, Crux Biomedical).

EXOSKELETON DEMONSTRATION

Dr. **Craig Carignan** (Research Associate Professor, Georgetown University; adjunct faculty, Aerospace Engineering) gave a demonstration of a robotic arm exoskeleton developed by the Space Systems Laboratory to treat shoulder injury. The Maryland-Georgetown-Army (MGA) Exoskeleton has five powered joints connected by adjustable linkages and is strong enough to be used for both orthopaedic and neuro-rehabilitation. A variety of standard shoulder exercises used in physical therapy were demonstrated as well as a functional task for stroke patients in which the exoskeleton was used to replicate forces from a virtual wall during a simulation of painting. MGAXOS is slated to begin clinical trials at the National Rehabilitation Hospital in Washington, D.C. later this year, and future plans include producing a commercial version within the next 2-3 years.

▲ EXOSKELETON DEMO

AFTERNOON SEMINARS

We were pleased to host four seminar speakers who spoke on a variety of bioengineering trends and discussed current research:

"Imaging Physics and the Assessment of New Medical Imaging Technologies"

Aldo Badano, *Imaging Physics Laboratory, Division of Imaging and Applied Mathematics, Office of Science and Engineering Labs, FDA Center for Devices and Radiological Health*

Establishing the benefits of new imaging technologies is a critical part of the process of invention, development, and commercialization of new product concepts. In his talk, Dr. **Aldo Badano** highlighted recent imaging research at the Division of Medical Imaging and Applied Mathematics (OSEL/CDRH/FDA) where advanced computational methods are used to create virtual models of human anatomy and disease for performing *in silico* studies of new imaging modalities. The methods developed as part of this research are used by academic and industry R&D laboratories to speed up the design and development of detectors and techniques for the next generation of medical imaging systems.

ALDO BADANO

"Image-guided Surgical Robotics: From Macro-scale to Meso-scale"

Jaydev P. Desai*, Associate Professor, Director—RAMS Laboratory, Department of Mechanical Engineering, University of Maryland*

Professor **Jaydev Desai** described two of his current research projects, in which he and his group are working to develop a robotic system that operates under continuous magnetic resonance imaging (MRI). These two projects are in the areas of 1) breast biopsy (Bx) and radiofrequency ablation (RFA) of breast tumors; and 2) the design of a meso-scale robot for neurosurgery. The preliminary prototype of the Bx/RFA system provides realtime imaging and haptic (touch) feedback to the user as the biopsy needle is inserted into the tissue, while the prototype of the meso-scale robotic device developed for applications in neurosurgery consists of a multi-degree of freedom device with joint actuation provided by a shape memory alloy.

"Developing Trends in Tissue Engineering & Regenerative Medicine"

John Fisher*, Associate Professor, Director—Tissue & Biomaterials Engineering Laboratory, Fischell Department of Bioengineering, University of Maryland*

Professor **John Fisher** spoke on the development of the field of tissue engineering, as well as the current state of the tissue engineering industry. He identified angiogenesis, stem cell science, molecular biology, and systems biology as areas that require increased, strategic attention from the tissue engineering community, and discussed current projects in his Tissue Engineering & Biomaterials Laboratory, including the engineering of articular cartilage and craniofacial bone.

continues on page 8

◀ POSTER SESSION

FEST PHOTOS: LUISA DIPIETRO

FESTIVAL, continued from page 7

PETER SWAAN

"Drug Targeting and Imaging Approaches Using Nanotechnology"

Peter Swaan, *Professor, Department of Pharmaceutical Sciences and Center for Nanomedicine and Cellular Delivery, University of Maryland School of Pharmacy*

Professor **Peter Swaan** discussed two of his current research projects in drug delivery. In one study, Swaan and his team are using high-pressure microfluidics to form liposomes (biocompatible capsules made of phospholipids, fatty molecules found in cell membranes) at precise sizes. Liposomes can carry therapeutics in their hollow centers, and Swaan's collaborator, Professor **Don DeVoe** (Mechanical Engineering), has found that his technique greatly increases the successful encapsulation rate of a drug in the liposomes during manufacturing, something very important when the drug in question is costly. In another study, Swaan is creating porous silicon wafer particles designed to cling to cells on the intestinal wall and emit the drugs they carry on the cell-side only. This increases the concentration of the medication delivered and reduces the amount lost to digestion. Its greatest potential could be in the oral delivery of insulin.

FINEBERG LOOKS INTO THE FUTURE OF HEALTHCARE

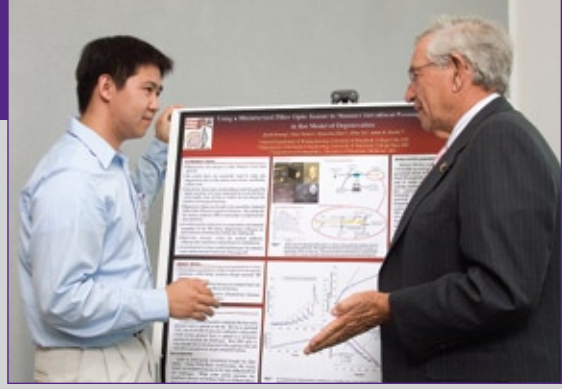
The Fischell Festival concluded with a Whiting-Turner Business and Entrepreneurial lecture delivered by **Harvey V. Fineberg**, M.D., Ph.D., president of the National Academies' Institute of Medicine. The presentation, titled "Innovation in Medical Technology," asked whether it was possible to enjoy the benefits of new advances in health care while maintaining an affordable health system, particularly within the context of the comparative-effectiveness of our research and policy-making agencies. The most notable challenges, he told the audience, were the depersonalization of medicine and distance between doctors and patients caused by overuse, underuse, or misuse of technology in medicine. He advocated working smarter and more efficiently. "We carry over our expectations of the previous technology," he noted, and as an example cited electronic records, expressing the need for them to move beyond simply scanned documents and become the basis for automated research. Forward thinking like this, he feels, would enable Federal agencies to be proactive rather than engaging in "repeated response to disaster."

HARVEY FINEBERG

BIOTECHNOLOGY CAREER FAIR AND INFORMATION EXPO

Sixteen companies and organizations were on hand to demonstrate products and discuss careers in bioengineering, biomedical engineering, and biotechnology with interested students, faculty and guests:

- Amethyst Technologies
- APC Biotechnologies, Inc.
- Atlantic Technology Group
- Biomedical Engineering Society
- CC Biotech
- Chesapeake PERL
- Fisher BioServices



DR. FISCHELL DISCUSSES RESEARCH WITH GRADUATE STUDENT DAVID HUANG. ▶

- FDA Office of Regulatory Affairs
- FDA Center for Devices & Radiological Health
- Henry M. Jackson Foundation for the Advancement of Military Medicine
- Igene Biotechnology
- MedImmune, Inc.
- Medtronic, Inc.
- Perinatronics Medical Systems
- SAIC (Science Applications International Corporation)
- University of Maryland School of Medicine

The Fischell Department of Bioengineering would like to thank the Clark School's office of Engineering Co-op and Career Services for organizing the career fair and information expo, as well as all of the companies and organizations that participated.

THANK YOU!

The Fischell Department of Bioengineering would like to thank the Fischell family, all of the Fischell Festival's speakers, participants, presenters and guests; and University of Maryland students, faculty and staff, for a wonderful and informative event. We hope to see you all next year!

BIOMEDICAL ENGINEERING SOCIETY ▶

▲ L-R: BIOE PROFESSOR AND CHAIR WILLIAM BENTLEY, DR. BARTLEY GRIFFITH, MRS. SUSAN FISCHELL, DR. ROBERT E. FISCHELL, AND CLARK SCHOOL DEAN DARRYLL PINES.

ALUMNA FOUNDS ENVIRONMENTAL CONSULTING FIRM

Alumna **Michele E. Gehring** (B.S. '98, biological resources engineering) is one of the two principals of Coterie Environmental LLC, a new consulting firm specializing in environmental services for industrial and government clients who operate combustors, solid waste incinerators, and boilers. The company helps organizations comply with regulatory requirements by providing services including trial and risk burns, test oversight and reports, permit development and negotiation, operating plans, employee training, and dispersion modeling.

According to the company's web site, since graduating from the University of Maryland, Gehring has worked in the combustion industry, becoming an expert in regulations, permitting, hazardous waste incineration, multipathway risk assessments, and OSHA requirements. Prior to founding Coterie with principal **Heather McHale**, she worked for the Franklin Engineering Group and RMT, Inc. Coterie Environmental LLC is located in King of Prussia, Pa.

GIFFORD ACCEPTS SR. NUCLEAR ENGINEER POST

IAN GIFFORD

Ian Gifford, advised by Department of Materials Science and Engineering Professor **Mohamad Al-Sheikhly**, has recently accepted a job offer from the Uniformed Services University of Health Sciences (USUHS) as a senior nuclear engineer at the Armed Forces Radiobiology Research Institute (AFRRI) at the National Navy Medical Center in Bethesda, Md.

Gifford will serve as both a senior reactor operator for the AFRRI's 1 MW TRIGA nuclear reactor and as a research investigator in the Radiation Sciences Department. The position builds on his experience on campus as a senior reactor operator for the 250 kW TRIGA University of Maryland Training Reactor. His dual role at AFRRI will allow him to continue pursuing his graduate research in mixed-field radiation of biological systems while serving the AFRRI mission to preserve the health and performance of U.S. military personnel, and to protect humankind through research that advances our understanding of the effects of ionizing radiation.

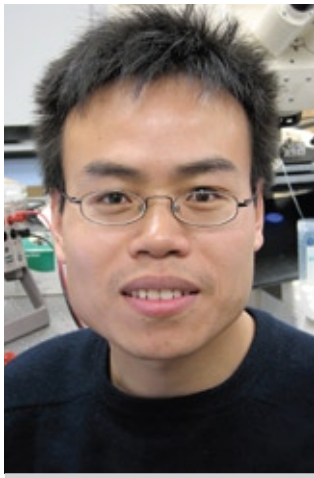
While at Maryland, Gifford's research focused on adapting boron-neutron capture therapy for the treatment of prostate cancer. The first half of his research concentrated on encapsulating therapeutics in a package the prostate cancer cells–but not healthy ones–would find tempting to absorb. The second half involved the use of finely focused irradiation to cause the drug molecules to "explode" once inside the cancerous cells, killing them. The overall result would be a more accurate style of treatment requiring less radiation therapy and with fewer side effects.

Gifford was also part of the team that retrofitted the university's nuclear training and research reactor for work in nuclear medicine, and took the lead in establishing the new Biophysical and Polymer Radiation Laboratory.

LUO WINS MRS SILVER AWARD

Postdoctoral research associate and alumnus Dr. **Xiaolong Luo** (Ph.D. '08) won a Graduate Student Silver Award at the Materials Research Society (MRS) Spring 2009 meeting this April. He was recognized for his paper titled "Biofabrication and Enzymatic Functionalization of Free-standing Chitosan Membranes in Microfluidic Network." The paper's research for was initiated during his graduate studies under his advisor, bioengineering affiliate professor **Gary Rubloff** (Materials Science and Engineering/Institute for Systems Research). Luo received a $200 prize and a certificate.

The paper demonstrates the formation of enzymatically active semi-permeable membranes in bioMEMS (microelectromechanical systems) exploiting the pH-responsive solubility of the amino-polysaccharide chitosan (a natural polymer found in the shells of crustaceans). The chitosan-based porous membrane they created during the study was shown to have expanded functionality as a versatile biointerface to enable site-specific, electrode-free, enzyme immobilization for metabolic engineering applications in bioMEMS.



XIAOLONG LUO

Luo continues to work on the project in his role as a research associate at the University of Maryland Biotechnology Institute, collaborating with former advisor Rubloff and Fischell Department of Bioengineering Professor and Chair **William Bentley**. The group is pursuing more complex microfluidic networks, flow recipes, and control systems that are promising for various applications of the free-standing chitosan membrane.

The MRS Graduate Student Awards are designed to honor students who show promise for significant future achievement for their excellence in materials research.

FISCHELL WINS PRESIDENT'S DISTINGUISHED ALUMNUS AWARD

Fischell Department of Bioengineering benefactor and namesake Dr. **Robert E. Fischell** (M.S. '53, physics) was named the recipient of the 2009 President's Distinguished Alumnus Award, which was presented at the 10th Annual Alumni Association Awards Gala this April.

The University of Maryland Alumni Association's President's Distinguished Alumnus Award recognizes an alumnus or alumna "for achieving national recognition for excellence, both personally and professionally." Fischell was nominated for the honor by former Clark School interim dean Dr. **Herbert Rabin**.

UNDERGRADUATES PRESENT PAPER AT NORTHEAST BIOE CONFERENCE

Fischell Department of Bioengineering undergraduates **Anik Duttaroy**, **Andrew Paek**, and **Bobak Shirmohammadi** presented a research paper at the 2009 Northeast Biological Engineering Conference (NEBEC), held this April at Harvard University. The three students, advised by Assistant Professor **Yu Chen**, discussed their work on human kidney imaging conducted over the past year in Chen's Biophotonic Imaging Laboratory.

One of the challenges surgeons face when performing kidney transplant surgery is the lack of an objective means to evaluate the donor organ's viability in cases where it comes from a deceased patient. In the time it takes to remove the kidney and transport it to the recipient, its structure may deteriorate, resulting in potentially fatal complications. The long-term goal of the Chen Group's study is to develop an imaging system that surgeons can use to assess the viability of the donated kidneys they receive. Currently, Chen explains, "They [can] only rely on the freshness of the organ."

Duttaroy, Paek and Shirmohammadi, working with Chen and in collaboration with Dr. **Peter Andrews** from Georgetown University Medical School, have been involved in the preliminary stages of the project. Duttaroy and Shirmohammadi performed the segmentation of human kidney images they received from Andrews, a process in which the kidney's tubule structure (part of its filtering system) is selected and enhanced in an image data set to allow for further analysis. Paek developed a MATLAB program to quantify the samples. Previous research has shown that understanding the tubule structure is important in determining the viability of a kidney.

The trio originally submitted their abstract, titled "High-Resolution Optical Coherence Tomography (OCT) Imaging of Human Kidney *Ex Vivo,*" as a poster, but were excited to learn that the NEBEC review committee wanted them to do an oral presentation instead.

"One of my goals when I began participating in undergraduate research was to publish my research and participate in a conference," says Duttaroy. "We were fortunate to have extensive support from Dr. Chen, the Fischell Department of Bioengineering, [Professor and Chair] Dr. **William Bentley**, [Director of Operations] **Sandra Huskamp**, and SOBE [the Society of Bioengineers]."

"The [NEBEC] conference was a great experience for all three of us," he says. In addition to learning about a variety of research projects from presenters ranging from undergraduates to professors, he adds, "It was great that we were able to correlate the theory we learn about in class to the advanced research being done around the country…the conference has provided us with a motivation to continue to be involved in research in the future. The cutting edge technology being developed in the field has lots of potential and we want to be part of that."

UNDERGRADUATE PUBLISHES IN TOP POLYMER SCIENCE JOURNAL

Rising senior **Omar Ayyub** is the second author of a paper he co-wrote with recent alumnus and former Fischell Fellow **Dan Janiak** (Ph.D. '09, materials science and engineering), and Professor **Peter Kofinas**. The paper, titled "Effects of Charge Density on the Recognition Properties of Molecularly Imprinted Polymeric Hydrogels," was published in *Macromolecules* (2009, 42 [5], pp 1703–1709), the highest cited journal in the field of polymer science.

Kofinas is proud of the accomplishment. "Not that many undergraduates who do research end up with their name in a high-impact publication," he says. "It's a commendable achievement for Omar and Dan."

◀ OMAR AYYUB

AIDIKOFF AMONG MARYLAND'S TOP WOMEN

Senior **Jenna Aidikoff** was selected to receive the *Maryland Daily Record*'s 2009 Circle of Excellence Scholarship, part of the Maryland's Top 100 Women awards program. She was among the winners honored at a public ceremony at the Baltimore Symphony Hall, where she also provided remarks. The award includes a $3000 unrestricted gift.

Since 1996 the *Maryland Daily Record* newspaper has honored high-achieving women throughout Maryland. Each four-year college and university in the state has the opportunity to nominate only one of their juniors or seniors to be considered for the Circle of Excellence Scholarship, which is awarded to those who possess the same qualities as the professional women named among the state's Top 100.

Criteria for the award include outstanding scholarship, leadership, and mentorship. Aidikoff was selected for her exceptional scholarship in engineering, education, and at the Kennedy Krieger Institute in Baltimore, where she conducted research on Down Syndrome. She was also recognized for her deep commitment to the University of Maryland community through her leadership in the Student Government Association, as a Resident Assistant, as a member of the Omicron Delta Kappa Leadership Honor Society, and for her leadership with the O.N.E. UMD Student Leaders Conference. Aidikoff has mentored countless students on campus and at Camp Pals, a community for those living with Down Syndrome.

"Jenna is a bright young lady," says Professor Adel Shirmohammadi. "Besides her outstanding academic achievements, she is a kind individual with a passion for the well being of others. Her performance in my Senior Capstone Design Course was outstanding. She always showed leadership qualities and had a smile on her face regardless of the challenges of the day."

"Jenna's ability to mentor others, create sustainable long-lasting change, and be an

accomplished scholar make her the perfect recipient for this honor," says **Ramsey Jabaji**, the university's Coordinator for Leadership Development Programs. "Jenna is a wonderful testament to the University of Maryland and its commitment to multiculturalism, scholarship, and community engagement. Her ability to mentor her peers to be social change agents is remarkable and I have met only a few students who approach her level of character, maturity, and intellect during my time as an educator."

RUSS WINS GOLDWATER SCHOLARSHIP

ZACHARY RUSS

Rising junior **Zachary Russ** was awarded a 2009-2010 Goldwater Scholarship, the premier national award granted to undergraduate students majoring in mathematics, natural sciences and engineering who are interested in research careers.

Created by the United States Congress in 1986 to honor Senator **Barry M. Goldwater**, Goldwater Scholarships are designed to ensure the nation has a source of highly qualified scholars and researchers. Recipients are chosen based on academic merit, research experience and career objectives.

Russ, who is double majoring in mathematics, intends to pursue a Ph.D. in bioengineering, conduct research in cellular engineering and bionanotechnology, and design micro- and nanoscale devices for medical application.

Russ has already received national attention for his back-to-back first place wins in the Institute of Biological Engineering's annual bioethics essay contest in 2008 and 2009 *(see p. 1)*.

student AWARDS

Congratulations to the following students, who were recognized at the Clark School's 2008-2009 Honors and Awards Ceremony held this spring. They have all demonstrated outstanding academic and research performance, and have made contributions to the Department and field.

THE ASABE, AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS' STUDENT HONOR AWARD

Presented by the American Society of Agricultural and Biological Engineers (ASABE) on the basis of academic achievement, service to the department, student branch participation, and other extracurricular activities.

Awarded to Monica Machado

THE WASHINGTON, D.C.–MARYLAND SECTION OF ASABE, AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS' SCHOLARSHIP

Presented to outstanding students based on academic achievement and contributions to the department and student ASABE branch.

Awarded to Katie Farhang, Jennifer Lei, and Pratiksha Thakore

THE FISCHELL DEPARTMENT OF BIOENGINEERING'S OUTSTANDING JUNIOR AWARD

Presented by the Chair on the basis of outstanding academic achievement and contributions to the department.

Awarded to Steven Graff and John Lin

THE FISCHELL DEPARTMENT OF BIOENGINEERING'S OUTSTANDING SENIOR AWARD

Presented by the faculty on the basis of academic achievement and contributions to the profession and the department.

Awarded to Anthony Awojoodu and Devang Sharma

THE DINAH BERMAN MEMORIAL AWARD

Presented to an engineering student who has combined academic excellence with demonstrated leadership or service to the Clark School as a freshman and sophomore.

Awarded to Allon Meizlik

THE A. JAMES CLARK SCHOOL OF ENGINEERING LEADERSHIP AWARD

Presented to an engineering student for outstanding leadership in the Clark School.

Awarded to Tracey Epstein

THE KEYSTONE DESIGN CHALLENGE AWARD

Presented to the freshman engineering design teams that build an autonomously controlled hovercraft that completes a specified course in the minimum amount of time.

Awarded to Kelliann Wachrathit and Ayo Adekoya

EVEN MORE AWARDS!

Please see these related stories to learn more about students who won local, national, and professional honors:

"Bioengineering Undergraduates Dominate Bioethics Contest" *(p. 1)*

"Russ Wins Goldwater Scholarship" *(at left)*

"Aidikoff Among Maryland's Top Women" *(p. 10)*

the gift of EDUCATION

HAVE YOU EVER THOUGHT IT WOULD BE GREAT TO CREATE YOUR OWN SCHOLARSHIP FOR STUDENTS YOU THINK DESERVE SOME HELP ON THEIR WAY TO SUCCESS, BUT ASSUMED YOU COULD NOT AFFORD TO DO IT? WOULD YOU LIKE TO HONOR AN ALUMNA/US, FRIEND OR FAMILY MEMBER BY CREATING A SCHOLARSHIP IN HIS OR HER NAME?

IF YOU ANSWERED YES TO EITHER OF THESE QUESTIONS, YOU MIGHT BE EXCITED TO LEARN THAT **FOR AS LITTLE AS $250 A YEAR, YOU CAN CREATE YOUR OWN NAMED SCHOLARSHIP** FOR UNDERGRADUATE STUDENTS IN THE FISCHELL DEPARTMENT OF BIOENGINEERING.

YOU CAN NOW CREATE A GIFT TO BE DONATED EACH YEAR FOR FOUR CONSECUTIVE YEARS THAT WILL BE AWARDED TO A STUDENT BASED ON ACADEMIC MERIT, NEED, AND/OR SERVICE TO THE DEPARTMENT. THESE AWARDS CAN BE MADE IN INCREMENTS OF $250, $500, $1000, AND $5000/YEAR, AND CAN BE OFFERED TO CURRENT STUDENTS OR DESIGNATED TO HELP RECRUIT NEW ONES. SCHOLARSHIPS CAN BE IN YOUR NAME, OR WE CAN HELP YOU MARK A SPECIAL OCCASION BY LETTING SOMEONE WHO APPRECIATES ENGINEERING OR EDUCATION AS MUCH AS YOU DO KNOW THAT AN AWARD HAS BEEN ESTABLISHED IN THEIR NAME.

WE CAN ALSO PROVIDE ASSISTANCE IN CREATING AND BUILDING A PERMANENT ENDOWED SCHOLARSHIP OR PROFESSORSHIP.

ANYONE INTERESTED IN CONTRIBUTING TO A GENERAL FUND OR EXISTING SCHOLARSHIP, OR ESTABLISHING A SCHOLARSHIP OR ENDOWMENT, CAN CONTACT PROFESSOR AND CHAIR **WILLIAM BENTLEY** AT (301) 405-4321 OR BENTLEY@UMD.EDU; OR MS. **PAMELA SIEMER**, CLARK SCHOOL DIRECTOR OF DEVELOPMENT, AT (301) 405-8289 OR PSIEMER@UMD.EDU. GIFTS CAN ALSO BE MADE ONLINE AT **www.greatexpectations.umd.edu/make_a_gift.html**.

IN THE FUTURE, WE'LL BE RECOGNIZING BOTH THE NAMED SCHOLARSHIPS AND THE AWARDEES IN ISSUES OF *BIOFEEDBACK* AND ON OUR WEB SITE.

FOR THE COMPLETE STORY, INCLUDING INSPIRING EXAMPLES OF NEW SCHOLARSHIPS STARTED BY OUR OWN FACULTY AND STAFF, PLEASE VISIT OUR WEB SITE AT **www.bioe.umd.edu/alumni/scholarships.html**.

BRADBERRY WINS WYLIE FELLOWSHIP

Graduate student **Trent Bradberry**, advised by Associate Professor **José Contreras-Vidal** (Kinesiology), has been awarded an Ann G. Wylie Dissertation Fellowship. The fellowship, created for students who are in the final stages of writing their dissertations, includes a stipend of $10,000, candidacy tuition remission and financial assistance toward the cost of health insurance.

Bradberry works in Contreras-Vidal's Movement Disorders Lab, part of the Cognitive Motor Neuroscience Lab at the University of Maryland College Park School of Public Health, where he studies brain-computer interfaces (BCI), specifically those that are non-invasive. Devices that make use of the brain's direct interaction with a computer—often known as neuroprosthetics—have the potential to make life easier for people with limited or lost mobility due to injury or disease. For example, a neuroprosthetic could take the form of a robotic arm that reaches, picks up objects, or manipulates other devices by interpreting the electrical activity in its user's brain. Bradberry's research focuses primarily on helping those with spinal injuries, where the brain is healthy but the body cannot respond to its commands.

Bradberry, a former Raytheon signal processing specialist, plans to pursue an academic career after graduating.

BERLIN TAKES 2ND IN DEAN'S M.S. THESIS COMPETITION

Graduate student and new alumnus **Dean Berlin** (M.S. '09) took second place and a $1000 prize in the inaugural Dean's Master's Student Research Award competition for his thesis titled "Enzyme Inhibition in Microfluidics for Re-engineering Bacterial Synthesis Pathways." Berlin is advised by bioengineering affiliate professor **Gary Rubloff** (Materials Science and Engineering/ Institute for Systems Research [ISR]/ Director, Maryland NanoCenter).

The competition is a companion to the Dean's Doctoral Research Award competition, also launched this spring. Both awards are designed to confer special recognition that will be valuable in launching the careers of our graduate students, and to show all students the importance of high quality engineering research.

Berlin focuses on how bacteria use the exchange of small molecules to coordinate changes in group response, such as the onset of virulence or film-formation, when their population reaches a threshold. His thesis describes the use of a bio-microfluidic device that inhibits the production of these communication molecules in order to prevent this behavioral change. Berlin also outlines design optimizations implemented in the device that improve its performance, allowing for greater control and less influence of background signals. The work represents part of the progression of a larger, collaborative research project on bacterial signaling currently underway in the research groups of professors **William Bentley** (Chair, BioE), **Reza Ghodssi**

RECENT DISSERTATIONS: MAY 2009

M.S.

Dean Berlin: "Enzyme Inhibition in Microfluidics for Re-engineering Bacterial Synthesis Pathways" Advisor: Gary Rubloff (Materials Science and Engineering).

Ph.D. (Bioengineering)

Martha Wheaton Betz: "Orbital Floor Regeneration Using Cyclic Acetal Hydrogels Through Enhanced Ostegenic Cell Signaling Of Mesenchymal Stem Cells." Advisor: John Fisher

Ph.D.
(Biological Resources Engineering)

Lei Qin: "Prospective Head Movement Correction for High-Resolution MRI Using an In-Bore Optical Tracking System." Advisor: Yang Tao

Derya Coursey: "Respiratory Mechanics of Flow Limitation and Characterization of Resistance Measurements with a Non-Invasive Device." Advisor: Arthur Johnson

Fenghua Jin: "Machine Vision Technology for Food Quality & Safety Inspections." Advisor: Yang Tao

BRADBERRY DOWLING THOMAS

(Electrical and Computer Engineering/ISR), **Gregory Payne** (University of Maryland Biotechnology Institute; Director, Center for Biosystems Research), and **Gary Rubloff**.

RESEARCHFEST 2009 WINNERS ANNOUNCED

Graduate students **Peter Thomas** and **Matthew Dowling** took second and third place, respectively, in the 2009 ResearchFest poster contest. Their work was selected by a panel of judges including Professor **Mohamad Al-Sheikhly** (Department of Materials Science and Engineering [MSE]), Assistant Professor **Sang Bok Lee** (Department of Chemistry and Biochemistry), and W. R. Grace and Company Senior Process Research Engineer **Stuart Nolan**.

Thomas, advised by Department of Chemical and Biomolecular Engineering (ChBE) associate professor **Srinivasa Raghavan**, took second place with his poster titled "Thin Film Oxygen Sensor for *In Vitro* Cell Culture." Dowling, also advised by Raghavan, took third place with his poster titled "Multi-Photon-Absorption-Induced-Luminescence (MAIL) Imaging of Tumor Targeted Gold Nanoparticles."

ResearchFest was sponsored by the Fischell Department of Bioengineering, ChBE, and MSE, and was organized by ChBE graduate student **Aaron Fisher** and ChBE associate professor and graduate program director **Sheryl Ehrman**. About two dozen students gave two-minute overviews and presented posters of their work to the large audience at the annual event, which highlights the best graduate- and undergraduate-level research from the three departments. It allows students to share their work in a casual setting with faculty, staff and students from other research groups.

fischell FELLOW

DEBORAH SWEET

DEBORAH SWEET: A More Convenient Chemotherapy

What if, instead of spending hours several days a week at the hospital undergoing chemotherapy treatment, a cancer patient could take a pill in the comfort of his or her own home?

Bioengineering graduate student and alumna **Deborah Sweet** (B.S. '06, chemical engineering) hopes her research will one day answer that question. Her proposal, "Anionic PAMAM Dendrimers for Oral Delivery of 5-Fluorouracil," which described the development of an oral delivery system for chemotherapy drugs that are traditionally administered intravenously, earned her the 2009 Fischell Fellowship in Biomedical Engineering.

Sweet is co-advised by Graduate Program in Bioengineering adjunct faculty members Professor **Hamid Ghandehari** (Department of Bioengineering, University of Utah) and Professor **Peter Swaan** (Department of Pharmaceutical Sciences and Center for Nanomedicine & Cellular Delivery, University of Maryland School of Pharmacy). She conducts most of her research in Swaan's laboratory on the University of Maryland–Baltimore campus.

Typically, an ingested or intravenous drug travels all over the body and treats what it encounters, whether it needs to be treated or not, resulting in increased side effects and patient discomfort. Targeted drug delivery tries to solve these problems.

Oral drug delivery can be particularly challenging. An oral chemotherapy drug would not only have to survive the harsh environments in the stomach and intestines, but also be able to pass through the intestinal wall, find its target, and treat a tumor as effectively as an intravenously-delivered drug could. Many chemotherapy drugs, including 5-Fluorouracil (5-FU), which Sweet uses in her work, cannot overcome these obstacles on their own.

Sweet's strategy is to use dendrimers—nano-sized, highly branched synthesized polymers with defined, controllable structures—as carriers for modified 5-FU molecules. Dendrimers are capable of crossing biological barriers in the digestive tract and heading out into the rest of the body, taking their chemotherapy cargo with them. At the ends of the dendrimers' molecular branches, Sweet attaches not only 5-FU, but also targeting and imaging molecules that can help guide them to a tumor site and allow doctors to track their progress visually using a technology such as magnetic resonance imaging (MRI).

That's when things get tricky. "You can't just load up the dendrimer with 5-FU and send it off into the body," says Sweet. "With every molecule you add, you're changing the physical properties of the dendrimer, so it might act differently than you'd expect, and may not be able to be able to pass through the intestinal barrier anymore." There are so many possible combinations of dendrimers, 5-FU, and linking, targeting, and imaging molecules that a major research effort is required to find one that could be as effective in treatment as intravenous drug delivery.

Sweet's work is only the beginning of a long journey toward an effective oral chemotherapy solution. "Through the Fischell Fellowship competition, I learned so much about the FDA approval process and everything you need to get a drug from the lab to commercialization."

While a single bioengineer may not be able to introduce a new drug on her own, Sweet's work is no less important because it creates a knowledge base that might ultimately end up in a pharmaceutical company's toolbox. Her experiences in the Fischell Fellowship competition, her research, and an internship at MedImmune are preparing her for her ultimate goal: conducting pharmaceutical or biotech research and development in industry.

To learn more about the Fellowship, including how to apply, visit:

www.bioe.umd.edu/fischell-fellowship/

2009 Capstone Projects

DEVICES FOR DOCTORS, CAREGIVERS, PATIENTS AND PUBLIC HEALTH

In May, bioengineering seniors gathered for the final presentation of their Capstone projects, showcasing their own engineering designs from concept to product, including working prototypes. This year the event held special significance for two reasons: our seniors represented the first full graduating class of bioengineering majors; and, for the first time, Mrs. **Susan Fischell**, spouse of department benefactor Dr. **Robert E. Fischell**, proposed, sponsored and inaugurated a new aspect of the Capstone experience: Each year the top three project teams, as selected by a panel of judges, will now win monetary prizes donated by Mrs. Fischell, and will also be invited to present their work to the public at the Fischell Festival. *(See related story, pp. 6-8.)* The teams may also have the opportunity to have their inventions put on track for development at the new Robert E. Fischell Institute for Biomedical Devices.

Our seniors would like to thank their on- and off-campus mentors, the department's lab and administrative staff, the faculty, our judges, and friends in outside academia and industry for the advice and supplies they donated that helped these projects succeed.

TEAM 1: SENSOR-EQUIPPED DEVICE TO DETECT HEAD IMPACTS

Team: *Anthony Awojoodu, Nick Ciccarelli, Tracey Epstein, Himali Fernando, and Timothy Sy. Mentor: Assistant Professor Ian White.*

Head injuries sustained while playing sports, from a fall during a seizure, and from compulsive self-injurious behavior by people with autism are often either unnoticed or misdiagnosed in their severity. Using ideas outlined in a 1984 patent by Dr. Robert E. Fischell, Team 1 designed a comfortable, sensor-lined hat capable of wirelessly transmitting alerts and impact data to caregivers or coaches, and to signal-processing software (also designed by the team) capable of analyzing whether or not a head injury requires more substantial medical attention. The sensors used are made of a piezoelectric material which, when deformed by an impact, generate a voltage that becomes the transmitted signal. If the force of an impact exceeds a certain threshold, an alarm is issued. A collection of signals can be saved over time, allowing doctors to review the times, locations and intensities of the impacts. Although the prototype demonstrated was in the form of a baseball cap, the team explained that the system could be built into any kind of close-fitting hat, helmet, or headgear.

TEAM 2: NOVEL SLEEP APNEA HOOD

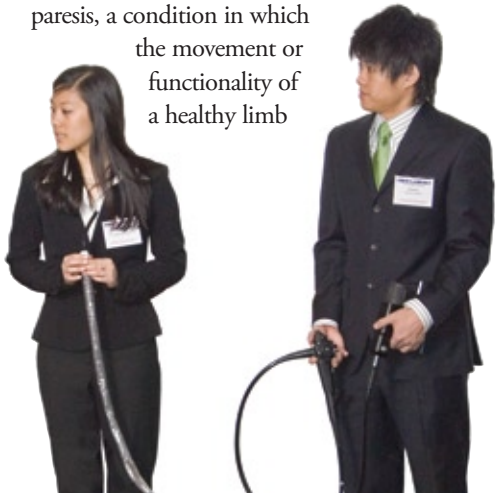
Team: *Shaza Abnouf, Jenna Aidikoff, Gunja Dave, Monica Machado, and Johnnie Shablack. Mentor: Professor Art Johnson.*

Sleep apnea, a condition in which a person temporarily stops breathing while asleep, affects millions of people, resulting in poor sleep, headaches, problems with memory and concentration, cardiovascular disease, and even death. Team 2 chose to focus on treating obstructive sleep apnea (OSA). Currently, people suffering from OSA may use a CPAP (continuous positive airway pressure) device, which uses a small air compressor and a mask to keep the throat tissues from collapsing. The CPAP is an unpopular and often abandoned solution, because it may cause discomfort or skin irritation and be difficult to adjust and fit. Team 2 designed a soft, pressurized, inflated hood that does not touch the face, gives the wearer more freedom of motion, and features an exhaust port and permeable fabric to maintain safety should the compressor stop working. The hood could be produced for significantly less than the cost of a CPAP system. Five out of six of the group's test users (all of whom have OSA) reported that they would be willing to use it regularly, and all reported an increase in comfort versus the traditional CPAP.

TEAM 3: MUSCLE CONTROL DEVICE

Team: *Harding Hall, Thomas Mountain, Tim Muruvanda, Brett Norton, and James Shee. Mentor: Associate Professor Hubert Montas.*

Team 3 created a device to assist patients with paresis, a condition in which the movement or functionality of a healthy limb is impaired or weakened following a stroke or a nerve injury. The device, designed to aid in recovery or restore functionality, is similar in concept to a myoelectrically-controlled prosthetic limb: it uses an electrical impulse generated by another muscle in the body to signal the target muscles to contract. A non-invasive sensor is placed on a healthy muscle, while a non-invasive electrode is placed on the problem limb—Team 3's example focused on the hand. When the healthy muscle (in this case the bicep) is flexed, the signal it generates is filtered, sent to a microcontroller, amplified, and carried to the electrode, which stimulates the hand to move. The team's signal processing software is capable of differentiating between large and small movements. The device could be used with a variety of muscle/limb combinations, and is also battery-powered, safe, easy to use, wearable, and economical.



MEMBERS OF TEAM 4 WITH THEIR MODIFIED COLONOSCOPE ▶

TEAM 4: NOVEL MODIFIED COLONOSCOPE TO REDUCE LOOPING IN COLONOSCOPIES

2ND PLACE (TIE), 2009 CAPSTONE AWARDS

Team: *Katherine Bail, Jeffrey Gair, Michael Gu, and Jennifer Uy. Mentor: Assistant Professor Yu Chen.*

Colonoscopes, the instruments used during colonoscopies to examine the patient's colon, are susceptible to looping (especially in the sigmoid area of the colon), which causes them to buckle instead of advance. This results in more discomfort for the patient, longer test times, the need for more anesthesia, and sometimes the inability to complete the procedure. Team 4 designed a double-layered, biocompatible sheath for colonoscopes that uses air pressure to vary and control the stiffness of the device, allowing it to move more easily through the patient, particularly around sharp turns. The sheath is made of a material with high tensile strength that can be sterilized and reused.

TEAM 5: QUICK RELEASE SELF-CONTAINED MEDICAL ELECTRODE

Team: *Ayo Adekoya, Mohamed Aziz, Lee Considine, Artem Dementyev, Nick Olivares, and Jordan Rustad. Mentor: Professor Adel Shirmohammadi.*

Many emergency room and hospital patients require heart monitoring using an electrocardiogram (ECG, EKG), the data for which is collected by electrodes placed on the skin. Current products involve a multi-step process

▼ THE CLASS OF SPRING '09 WITH FACULTY AND STAFF

▲ TEAM 8'S INSULIN POTASSIUM SENSOR FOR HEMODIALYSIS MACHINES

that uses adhesives and solvents for application and removal, may unexpectedly detach, leave a residue, and may be painful to remove from the sensitive or damaged skin encountered in newborns and burn victims. Team 5 created an improved product with increased adhesive strength and less residue, is gentler to the patient's skin, and which features an all-in-one design containing both the adhesive and solvent. Their prototype electrode contains a conductive plate, a new hydrogel adhesive they designed, and a bubble-like packet filled solvent, all in a GORE-TEX® package. When the electrode is ready to be removed, a doctor or nurse squeezes the solvent bubble until it ruptures. The solvent breaks down the hydrogel in place and the electrode can then be lifted away.

TEAM 6: THE SANSTAT SANITARY STATION

Team: *Anik Duttaroy, Alejandro Mendez, Pallavi Nadendla, Andrew Paek, and Devang Sharma. Mentor: Professor Adel Shirmohammadi*

How many times a day do you use a pen? In how many places? And how many people have used it before you? These small, mundane objects can be covered in bacteria or viruses that are easily spread through hand contact. Anti-microbial pens are uncommon and not very effective, and hand sanitizer is not always available. Team 6 designed a compact system that can be used to quickly sanitize shared pens, pencils and styluses without the wetness or waste of hand gels and prepackaged wipes. The device takes the form of a stainless steel container that exposes the entire surface of writing utensils to a germicidal UV light, which kills a wide variety of bacterial and viruses. For safety, the device features a sealed lid and sensors that indicate when its 30-second cleaning cycle is over and the UV light is off.

TEAM 7: MONITORING SUGAR CONTENT IN FRUIT: A PERSONAL SOLUTION

Team: *Richie Booth, Mike Carey, Lindsay D'Ambrosio, James Love, and Samar Sarwat. Mentor: Professor Yang Tao*

Team 7 designed a portable device that can be used to quantify the sugar content—and therefore relative sweetness, tartness or ripeness—of a piece of fruit, information which could appeal (no pun intended) to growers, grocers, bakers, shoppers, and even diabetics monitoring their blood sugar. A piece of fruit is placed in a light-sealed "funnel sensor head," which takes the form of a small, padded cone. From below, the fruit is exposed to infrared light which passes through the skin and flesh and is picked up by a sensor. A refractometer—a tool that measures how much the light is bent as it travels, which will vary by the amount of sugar present—in the device is then used to calculate the fruit's Brix number, an industry-standard measurement that defines sweetness.

TEAM 8: MECHANIZATION OF THE IN-LINE POTASSIUM SENSOR IN A NOVEL HEMODIALYSIS MACHINE

2ND PLACE (TIE), 2009 CAPSTONE AWARDS

Team: *Ajay Alkondon, Matt Dempsey, Adam Pfannenstein, Bobak Shirmohammadi, and Sarah Tostanoski. Mentors: Professor Adel Shirmohammadi and Dr. Gary Briefel (Johns Hopkins University Bayview Medical Center).*

When a patient with kidney disease has toxins filtered from their blood using hemodialysis, an unknown quantity of potassium is also removed. The accidental removal of too much potassium can cause muscle weakness, seizures, arrhythmia, and even sudden death. Team 8 has designed a device capable of real-time monitoring of blood potassium levels, including safety checkpoints and built-in delays to allow for recalibration as potassium levels change. More effective dialysis means fewer lab and technician costs, and a reduction in the time required for treatment. The team hopes to eventually fully automate the device, which would allow it to run while the patient is sleeping, and to make it an add-on component to existing home dialysis products.

TEAM 9: G.I. GO: GRIP IT & GO

1ST PLACE, 2009 CAPSTONE AWARDS

Team: *Sona Chaudhry, Bryan Hofferbert, D.T. Howarth, Tanya Saleh, and Kim Ziegler. Mentor: Assistant Professor Adam Hsieh.*

The G.I. Go is a lightweight, cost-effective device for the therapeutic or rehabilitative treatment of the hand. The patient uses the device by slipping his or her hand into a comfortable glove attached to a series of spring-loaded plastic bars, pushing against them using prescribed finger and hand movements. The resistance is adjustable. The G.I. Go allows the patient to keep his or her fingers straight, achieve 90º rotation (full contraction), and exercise individual fingers, intrinsic (finger) and extrinsic (forearm) muscles, and the whole hand. No products currently available address all of these important physical therapy requirements in a single device.

Our panel of judges included Professor **Leigh Abts** (College of Education/BioE), Senior Lecturer **Glenn Rahmoeller** (affiliate faculty, UGST-Honors Program/ BioE), and Dr. **Jafar Vossoughi** (President, Biomed Research Foundation and adjunct faculty, BioE).

The Department would like to express its deep appreciation to Mrs. **Susan Fischell** for her generosity and vision in promoting and forwarding our students' work, as well as our judges for their time.

A MEMBER OF TEAM 9 DEMONSTRATES THE "G.I. GO" ▶

A. JAMES CLARK
SCHOOL OF ENGINEERING

The Fischell Department of Bioengineering
2330 Jeong H. Kim Engineering Building
University of Maryland
College Park, MD 20742-2835

ABOUT THE COVER IMAGE

THE PURPLE IMAGE USED ON THE COVERS, FROM THE LAB OF ASSISTANT PROFESSOR SILVIA MURO, SHOWS POLYMER PARTICLES (LIGHT SPHERES) TARGETED TO MARKERS EXPRESSED ON THE SURFACES OF PATHOLOGICALLY ALTERED ENDOTHELIAL CELLS OBTAINED FROM THE WALLS OF HUMAN BLOOD VESSELS. THE PARTICLES ARE TAKEN UP BY THE CELLS AND RESIDE CLOSE TO THE NUCLEI (DARK MASSES), WHERE THEY CAN DELIVER THERAPEUTIC AGENTS FOR CARDIOVASCULAR TREATMENTS. YOU CAN LEARN MORE ABOUT OUR RESEARCH STARTING ON P. 2.

BIOFEEDBACK is published for alumni and friends of The Fischell Department of Bioengineering at the A. James Clark School of Engineering, University of Maryland.

Alumni news and comments are welcome! Please contact us at:
Fischell Department of Bioengineering,
2330 Jeong. H. Kim Engineering
Building College Park, MD, 20742
(301) 405-7426 / bioe@umd.edu
http://www.bioe.umd.edu

Department Chair: Dr. William Bentley
Editor: Faye Levine

scholarSHIPS

HOFFMAN WINS WOLF SCHOLARSHIP

Junior **Joshua Hoffman** has been awarded the 2009-2010 Seymour & Faye Wolf Endowed Scholarship in Bioengineering. Established in 2001 with a gift of $10,000 made by the **United Jewish Fund** on behalf of donors **Seymour** and **Faye Wolf**, the scholarship provides annual support for an undergraduate studying bioengineering in the A. James Clark School of Engineering at the University of Maryland. Students selected to receive the Wolf Scholarship are chosen based on GPA, a personal statement regarding their reasons for pursuing Bioengineering, extracurricular activities, academic achievements, and need.

"Josh Hoffman is a wonderful student who is excelling in the demanding bioengineering curriculum," says Undergraduate Program Director and Associate Professor **John Fisher**. "We have high hopes for his future career."

If you've ever wondered how you could make an affordable or creative gift within your budget, **please see our story on page 12 about named scholarships**. A variety of meaningful and fun ideas for supporting our students and programs can also be found online on the Clark School's Creative Ways to Give page: **eng.umd.edu/giving/giving_creative.html**. Possibilities include funding new courses, buying books for a student, sending a prospective engineer to one of the Clark School's summer camps, and supplying Engineers Without Borders with tools.