THE FULL SPECTRUM
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HAJIM SCHOOL OF ENGINEERING & APPLIED SCIENCES
UNIVERSITY OF ROCHESTER

The Full Spectrum

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BLUE NOISE MASK
Why is our University such a strong research institution? The proximity of the River Campus to the Medical Center is certainly a big part of the equation. When you consider that our Hajim School faculty and students are no more than a five-minute walk away from clinicians and medical researchers, all kinds of interesting collaborations are possible. We’ve seen that with the new Center for Medical Technology and Innovation, which was featured in our last newsletter. And you can certainly see it in the tissue-engineering research projects we write about in this one.

All three of the Department of Biomedical Engineering faculty members we talked with—Hani Awad, Danielle Benoit, and Mark Buckley—are engaged in research that will help advance treatment in one of our most vexing, costly areas of health care: when joints, bones, tendons, cartilage, and associated muscle deteriorate with age, become diseased, or suffer massive trauma.

All three of these faculty members belong to the Center for Musculoskeletal Research, among the top five programs of its kind in the United States. Based at the Medical Center, it gives engineers a chance to learn from their medical colleagues about the underlying pathology and biology of the problems they address. And the engineers, in turn, can offer their insights about the best way to build a scaffold to promote bone healing, for example, or deliver a therapeutic drug with pinpoint accuracy and timing.

This is what we mean when we use buzzwords like “synergy” and “multidisciplinary research.” As Danielle explains it: “Their work is better for it and my work is better for it. And it couldn’t be done if the Medical Center didn’t exist or was not in close proximity.”

Of course, this also benefits BME students. I am very proud of the way department chair Rick Waugh, his faculty, and staff have parlayed these collaborative opportunities with the Med Center into unique research experiences for graduate and undergraduate students alike. This helps explain why BME has the largest undergraduate population in engineering, just 13 years after it was established. Dottie Welch, who is also featured on these pages, has been an important part of that story, serving as the department’s undergraduate coordinator since its inception. Students have come to Dottie for more than just a signature on a form. When they’ve needed a word of encouragement or advice, Dottie has been there for them. Her example reminds us how much we owe to the people who, in so many ways, keep the Hajim School functioning as well as it does—our administrative staffers at both the department and school levels.

We are fortunate to have such a great community here at the University of Rochester and in the Hajim School of Engineering.

Meliora!

Rob Clark
The Ronald Rettner Hall for Media Arts and Innovation, a three-story, 18,900-square-foot building, opens to students this fall. It features an engineering fabrication lab, sound and video recording studios, a multipurpose digital media studies learning studio, group study areas, and more. These photos were taken in August 2013.

Designed as a hub for the arts, sciences, and engineering, Rettner Hall is where students pursuing new majors in digital media studies and in audio and music engineering can gain the skills they’ll need to excel in a fast-paced, digitally oriented world.

See for yourself. A ribbon cutting and open house will be held from 2–4 p.m., Oct. 11, as part of Meliora Weekend.

In the meantime, go online at www.rochester.edu/rettnerhall/about.html to learn more about the hall and how it came about.
When a surgeon uses a titanium rod or plate to hold fractured bones in place, or installs a total joint replacement, the chance of infection is small. But when it happens, it can be devastating.

The hardware must be removed. The bone must be debrided and washed with antibiotics. Gaps created by infection-related bone loss must be temporarily filled with antibiotic-releasing bone cement. The patients must be kept on antibiotics. And months later, when the infection is finally eradicated and the cement can be removed, the surgeon “has to come up with some real magic to reconstruct that missing bone,” says Hani Awad, professor of biomedical engineering and of orthopaedics.

“This multistep treatment is long and daunting, and the outcomes are generally not very good,” says Awad. Awad believes 3D printing can avoid much of this in a single step.

As part of a consortium of research projects funded by AOTrauma, Awad and his lab members are using the new printing technology to fabricate bone scaffolds made of biocompatible material to replace the original bone tissue lost to infection. As part of the “printing” process, the scaffolds can be “ink-jetted” with antibiotics to fight the infection and with growth factors to stimulate replacement bone growth. These therapeutics can be applied to the surface of the graft, or embedded uniformly in it, so they can be released gradually, as the graft dissolves, to ensure the infection is eradicated and to stimulate regeneration of the bone tissue.

“It’s a very exciting project,” says Awad. One of his PhD students, Jason Inzana, “has been just tremendous in identifying optimal ingredients for 3D printing of these scaffolds and moving the project forward.”

This is one example of how tissue engineering research at the University of Rochester, much of which is conducted in preclinical models, is bolstered by the work of biomedical engineering faculty and graduate students in the Hajim School.
Danielle Benoit, assistant professor of biomedical engineering and of chemical engineering, and members of her lab are tackling the problems that arise when large sections of bone have been destroyed as a result of trauma, battlefield injury, or lost to cancer. There’s not enough viable bone material left to hold in place with a brace or rod. A bone transplant is required.

However, in order to reduce the chance of rejection, much of the biological material in transplanted cadaver bone is washed away, including stem cells that are essential for integrating the transplanted material with the patient’s own surviving tissue.

With support from a National Institutes of Health grant, Benoit’s team is exploring the use of hydrogels—Jell-O-like polymers—that can be seeded with the patient’s own stem cells and wrapped around the transplant. Benoit’s graduate student Michael Hoffman has demonstrated that as the hydrogel dissolves, the stem cells are gradually released and promote bone healing and integration. Benoit is exploring various ways in which this can all be orchestrated to maximize graft healing and integration.

“Another PhD student in my lab, Amy Van Hove, has developed hydrogels that are responsive to the enzymes that play a role in the body’s remodeling process,” Benoit noted, “so you can let the body decide when to degrade the hydrogel.”

Mark Buckley, who joined biomedical engineering as an assistant professor at the start of the year, is not directly involved in creating engineered tissue, but he is hoping one of his research projects will help those who are. Buckley is studying heat buildup in tendons as they are stretched during various activities and the extent to which this contributes to cell death and eventual deterioration of the tendon.

A key part of this research involves characterizing exactly what constitutes healthy tendon structure and function. “We have made enormous progress in designing clever ways to mimic some of these tissues. However, these tissues are incredibly complex. So it is important to be able to help define the standards for tissue engineers.”

The proximity of the Medical Center to the River Campus has contributed to the University’s strength in tissue engineering research.

Awad, Benoit, and Buckley, along with Amy Lerner, associate professor of biomedical engineering and of mechanical engineering (whose research involves computational modeling to study the biomechanics of the knee), are among 27 principal investigators of the University’s Center for Musculoskeletal Research. The center has been ranked among the top five NIH-funded musculoskeletal programs in the United States for nearly a decade.

The other principal investigators include faculty in orthopaedics, pathology, rheumatology, environmental medicine, and endocrinology.

Benoit says this brings her into contact with colleagues who can answer her questions about biology, pathology, and other subjects outside her expertise, even as they seek her advice about how to engineer a new way of delivering a drug or other therapy.

“It’s very synergistic. Their work is better for it and my work is better for it. And it couldn’t be done if the Medical Center didn’t exist or was not in close proximity.”
Ever since there’s been a Department of Biomedical Engineering, Dottie Welch has been the “go to” person for a steadily growing number of undergraduate students regarding everything that pertains to their academic lives.

With her retirement as BME’s undergraduate coordinator on July 31, that is no longer the case. However, the Hajim School wants to be sure her legacy and commitment live on long after her retirement. Beginning this year, the Hajim School will present an annual Dottie Welch Student Enrichment Award to a Hajim faculty or staff member “whose performance and dedication enriches the student experience in the tradition exemplified by Dottie Welch.”

Welch began working at the University 26 years ago in electrical and computer engineering. She moved to BME 13 years ago when Waugh was putting together the new department.

Beginning this year, the Hajim School will present an annual Dottie Welch Student Enrichment Award to a Hajim faculty or staff member “whose performance and dedication enriches the student experience in the tradition exemplified by Dottie Welch.” Welch’s retirement “is a milestone in the history of our program,” says department chair Richard Waugh.

BME graduated 10 students that first year. Now, BME’s undergraduate enrollment is more than 300. Each one has had at least two emails a year from Welch, indicating the student’s status, unmet requirements, and any problems or concerns. “It was important to them as well as to me,” Welch says, “because if I listed something they didn’t agree with or know about, we could work together to resolve it.”

Welch “was always two steps ahead of me in anticipating what students’ needs would be and then carving time out of her own life to make it happen,” Waugh said. The interaction with students by Welch and other BME staffers has paid off. As one PhD student acknowledged in his dissertation, “I could not have endured stringent requirements of the undergraduate program and the confusing formalities of the graduate program without the help of our program coordinators, Dottie Welch and Donna Porcelli. Thank you for your constant encouragement and unsurpassed patience.”

Giving encouragement to students who have been struggling and then seeing them accomplish something they never thought possible, such as landing a good job, “makes you feel like a proud parent,” Welch adds.

(There will still be a chance to say a farewell to Welch in person. She’s working part time this school year, streamlining a BME alumni database and helping her replacement, Taimi Marple, ease into the position.)
Rebecca Berman and five other University of Rochester doctoral candidates dipped into their “optics suitcase” last summer to demonstrate the transformative power of sunlight to 70 students gathered outside a primary school in Chirapatre, Ghana.

“First, a lens was used to concentrate sunlight onto a piece of paper, which excited the children as they saw smoke rising from the paper where the light burned a hole,” related Berman, an optics student who visited Ghana as part of the IGERT (Integrated Graduate Education and Research Traineeship) program. “Students laughed as they watched a mini car race around on the dusty ground, stopping whenever it entered a shadow.”

It was a memorable “hands-on” learning experience for the students. And it was a memorable experience for Berman as well.

So much so, she willingly volunteered to help lead another group of Rochester IGERT trainees to Ghana this summer. The itinerary included exchanges with professors and graduate students there and teaching Ghanaian high school students how to build solar-powered cell phone chargers.

The IGERT program, funded by the National Science Foundation, is designed to train future global leaders in science and engineering. The Rochester IGERT program, one of 20 chosen for funding in 2010, focuses on solar energy. The $3.2 million grant is for five years. Each year, a new cohort of six PhD students in science and engineering are accepted for the program, which provides a $30,000-a-year stipend.

Of the 24 students selected so far, two-thirds are from the Hajim School. Matthew Yates, chair of chemical engineering, is the director; Vicki Heberling, administrative assistant for the Energy Research Initiative, is program coordinator.

Berman learned about the program from her advisor, Professor Duncan Moore, who suggested that IGERT would be a “good fit,” given Berman’s research interest in photovoltaics. “I jumped at the chance,” Berman said. She enjoyed studying abroad as an undergraduate and relished the opportunities for outreach and teaching. “IGERT has all of that. I wouldn’t have found that in a regular graduate program.”

Moreover, IGERT’s emphasis on additional training in entrepreneurship allowed her to earn a master of science degree in technical entrepreneurship and management through the University of Rochester’s TEAM program, in addition to a master’s in optics.

Berman says she is struck by the impact she and her IGERT teammates have had on the Ghanaians they meet.

“Some students (at Chirapatre) even approached us after class, enthusiastically expressing that they wanted to learn more and that they’d return with us to the United States if we could be their teachers.”

(Students at Chirapatre, Ghana, eagerly gather around an optics demonstration.)

(A final cohort of six IGERT trainees will be selected next spring. For more information about the program, go to www.rochester.edu/igert/.)
Zhiyao Duan
The momentum behind the new audio and music engineering major received another boost with the hiring of Zhiyao Duan, who joins the electrical and computer engineering faculty as an assistant professor. “Zhiyao is a wonderful addition to the Hajim School, both for the role he will be able to play in our new major as well as in the ongoing research programs in audio and signal processing in ECE,” chair Mark Bocko said.

Duan earned his PhD in electrical and computer engineering earlier this summer from Northwestern University. His research focus is computer audition. Bocko said applications range from making cell phone conversations in noisy environments more intelligible to converting a music recording into a written score.

“Zhiyao also will help to strengthen the ties to the Eastman School and our long tradition of multidisciplinary research at the intersection of music, engineering, and science,” Bocko added.

“Building a vibrant research group to perform computer audition research is my career dream,” Duan said. “I also enjoy teaching, mentoring, and working with students, both undercats and grads.”

M. Ehsan Hoque
Is it possible to interact with computers and robots the way we interact with each other? That’s the fundamental question underlying the research of M. Ehsan Hoque, who earned his PhD from the MIT Media Lab this spring and will continue to explore that question as an assistant professor in computer science.

The department “encourages research that makes real world impact. They provide resources for faculty members to take big risks and accept the failure as long as you fail spectacularly!” Hoque notes. “That particular risk-taking culture makes the computer science department an exciting place for a junior faculty member.”

Hoque’s research “provides foundations for computer systems that are capable of interacting with humans in a natural and fluid manner,” department chair Henry Kautz notes. “He created MACH (My Automated Conversation coach), a framework that is targeted to improve social skills by quantifying subtle human nonverbal behavior and providing feedback on improving them. The research has the potential to be used in many scenarios, including helping people with social difficulties (e.g., Asperger syndrome).

“Bringing Ehsan to URCS strengthens our research in human-computer interaction and artificial intelligence and builds new bridges for collaborations with faculty in psychology, brain and cognitive sciences, and linguistics,” Kautz said.

Douglas Kelley
Douglas Kelley joins the faculty of mechanical engineering after a year of postdoctoral work at MIT, where he worked on the measurement, simulation, and control of mixing in liquid metal batteries.

Mixing “transports ions, and therefore governs the performance and efficiency of liquid metal batteries, which could be a game-changing technology for renewable energy,” Kelley explains.

That fits nicely with ongoing work here on batteries and energy storage devices, says mechanical engineering chair John Lambropoulos—as does Kelley’s interest in how the dynamics of flow in ocean currents can be applied to climate change.

Kelley’s breadth of postdoctoral experience, strong publication record, and his extensive teaching experience as a grad student and postdoc are also positives, Lambropoulos added. “Kelley’s commitment to involving undergraduates in his research is a great sign of a dedicated teacher,” Lambropoulos said.

Wyatt Tenhaeff
Wyatt Tenhaeff, a staff scientist at Oak Ridge National Laboratory since 2009, says he’s looking forward to undergraduate and graduate teaching as a new faculty member in chemical engineering—and to the opportunity to “develop an important and respected research program.”

At Oak Ridge, his research focused on developing solid-state lithium batteries, in particular new solid electrolyte materials, which offer greater safety, higher energy densities, and easier packaging than liquid electrolytes. They are also important for such advanced concepts as Li-air and Li-sulfur batteries. He also will work on problems in lithium ion batteries.

That will complement existing efforts in materials science and energy research here, says department chair Matthew Yates. “We feel that his work has the potential to aid the commercial development of battery technology in New York State promoted through the efforts of organizations like New York BEST,” a battery and energy storage technology consortium.

Tenhaeff says he was drawn to Rochester’s strong reputation for both research and engineering education, the smaller size of the college, and Hajim’s impressive record of research funding. “I value collaborative efforts, and the collegial, tight-knit nature of the faculty was also important to me.”
Govind Agrawal, professor of optics and of physics, received the 2013 William H. Riker University Award for Excellence in Graduate Teaching.

Miguel Alonso, associate professor of optics, received the Edward Peck Curtis Award for Excellence in Undergraduate Teaching.

Diane Dalecki, professor of biomedical engineering, associate professor of electrical and computer engineering, and director of the Rochester Center for Biomedical Ultrasound, was named a Fellow of the American Institute for Medical and Biological Engineering.

James R. Fienup, Robert E. Hopkins Professor of Optics, professor of electrical and computer engineering and the Center for Visual Science, and senior scientist in the Laboratory for Laser Energetics, received the Emmett N. Leith Medal from the Optical Society of America.

Eby Friedman, Distinguished Professor of Electrical and Computer Engineering, received the Charles A. Desoer Technical Achievement Award from the Institute of Electrical and Electronics Engineers (IEEE) Circuits and Systems Society.

Lane Hemaspaandra, professor of computer science, was awarded the 2013 SIGACT Distinguished Service Prize. SIGACT is the special interest group for Theoretical Computer Science of ACM, the professional organization of the computing profession.

James C. M. Li, Albert Arendt Hopeman Professor of Mechanical Engineering and professor of materials science, was announced as the 2015 recipient of the Gold Medal of ASM International, the materials information society, “for his elucidation of the mechanical properties of materials through the application of thermodynamics and kinetics to the understanding of microstructural phenomena and for his mentoring of students and colleagues.”

David Meyerhofer, deputy director, experimental division director, and associate director for science at the Laboratory for Laser Energetics; professor of mechanical engineering and of physics and astronomy; and a coprincipal investigator of the Fusion Science Center, was selected to receive the 2013 Leadership Award from the Fusion Power Associates Board of Directors.

Kevin Parker, William F. May Professor of Engineering, dean emeritus of the School of Engineering & Applied Sciences, and professor of electrical and computer engineering, of biomedical engineering, and of radiology, was named a Fellow of the American Institute for Medical and Biological Engineering.

Scott Seidman, associate professor of biomedical engineering and of neurobiology and anatomy, was named the Undergraduate Engineering and Applied Sciences Professor of the Year by the University of Rochester Student Association.

Kevin Thompson, visiting scientist in the Institute of Optics, received the A. E. Conrady Award from SPIE.

David Williams, William G. Allyn Professor of Medical Optics; dean for research in Arts, Sciences & Engineering; professor of optics, of brain and cognitive sciences, of ophthalmology, and of biomedical engineering; and director of the Center for Visual Science, received the Edridge Green Medal from the Royal College of Ophthalmologists in London.
Sheophano Mitsa did everything right to prepare herself for a career in her native Greece. She scored high on college entrance exams. She graduated near the top of her class in electrical engineering at Aristotle University of Thessaloniki.

But in Greece in the 1980s, that was not enough.

Theo, a single child whose parents were of modest means, “had no connections in any political party, which was the surest way of getting a job in Greece then. No close relative in a bank, utility company, or government office who would put in a good word for me. To put it simply, I was toast.”

So she took a six-hour bus ride to Athens with her mother to apply for a Fulbright scholarship. She was accepted to one of her top choices: the University of Rochester, primarily because of its imaging processing program.

That’s how Theo Mitsa came to the River Campus as a PhD student. Her involvement in the invention of Blue Noise Mask here is one of the reasons she is this year’s winner of the Hajim School’s Distinguished Alumni Award.

Initially, Mitsa studied codes and signal processing in what was then the Department of Electrical Engineering. She knew that would be excellent preparation for work in the “Star Wars” missile defense program promoted by the Reagan Administration. However, after a “chance discussion with friends about job prospects,” Mitsa realized her status as a foreign national would preclude her from working in government labs on that project.

She talked to professor Kevin Parker, liked what he was doing with medical imaging, and asked to work with him.

Parker says he “knew from the start” that Mitsa “was a special person capable of doing notable work.” Parker was grappling with the misleading patterns that often appeared when halftone medical images were printed from the laser and desktop inkjet printers then available. The printers, still in their infancy, were only capable of 100 to 150 dots per inch.

“The University of Rochester gave me the best and most important educational experience in my life,” says Theo Mitsa. “It was much more than a degree. It defined a lot of my fights, a lot of my successes, a lot of who I am today.”

“Even the negatives in life can be positive.”

Kevin Parker
Initially, Mitsa recalls, she and Parker planned only to determine the best existing halftoning techniques for medical images. But eventually they decided to create their own halftoning algorithm. One day, Mitsa recalls, “Kevin came into my office and told me about an idea he had the night before. He started drawing on the board, and that became the main body of the Blue Noise Mask.”

For her thesis, Mitsa built the Blue Noise Mask program on computer, and she also provided the mathematical proof that the algorithm would produce high-quality results.

The coinvention of Blue Noise Mask with Parker was both a “direct blessing and an indirect blessing disguised as a curse,” Mitsa says. It gave her a great sense of accomplishment; it also provided her with the financial wherewithal to endow a scholarship at the University and with the financial independence to pursue her interests “without worrying about budgets, deadlines, and grumbling bosses.”

It also seemed like a curse at times. During litigation over Blue Noise Mask patent rights, some big-name professors in her field were engaged as technical experts for the other side. “It was not a great environment for the publishing activities of a budding assistant professor,” she says.

Mitsa switched the emphasis of her research to pattern recognition. The “curse” turned out to be a blessing in disguise. Mitsa collaborated with researchers at the University of Iowa on new techniques for the detection of emphysema and was awarded several patents in medical imaging and a prestigious Whitaker Foundation award.

A negative turned out to be positive after all. “As I like to say, my friends and family taught me how to walk, but it was my enemies’ kicks that made me fly. Be thankful for your friends but also for your enemies—they might just be your greatest benefactors.”

Now, Mitsa is an independent data mining/machine learning consultant with a focus on Big Data. She is also working on a book, contributes to analytical community blogs, and writes one of her own.

“The University of Rochester gave me the best and most important educational experience in my life,” she adds. “It was much more than a degree. It defined a lot of my fights, a lot of my successes, a lot of who I am today.”

We would like to hear from you!

We want to share news of you, our alumni and friends. So please, take a moment to send us a quick note on what you are doing today and your field of interest, along with your contact information, to Eric Brandt (ebrandt@alumni.rochester.edu). Check out our updated Alumni and Friends page online at www.hajim.rochester.edu/alumni.html.
FAST FACTS

- The number of master’s students enrolled in the Hajim School increased from 61 in fall 2004 to 215 in fall 2012.
- The number of graduate degrees conferred by the Hajim School has increased from 104 in FY 2006 to 179 in FY 2013.
- Advantageous undergraduate student to faculty ratio of approximately 11:1
- The Hajim School STEM Gems program helped retain 95 percent of first-generation, low income and racial minority freshman engineering students during the 2012–13 academic year.
- The percentage of Hajim students studying abroad has increased from 10.1 percent in 2007 to 18.0 percent in 2013.