University of Minnesota
Department of Biomedical Engineering
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University launches Center for Neuroengineering

The University launched a new Center for Neuroengineering (CFN) aimed at strengthening neuroengineering research among faculty in neuroscience and engineering. The CFN is part of the new Institute for Translational Neuroscience (ITN), a campus-wide initiative. The primary mission of the CFN is to accelerate interdisciplinary research in neuroengineering across the University and to increase interactions with companies with neuromodulation products. The major research strengths of the CFN faculty include neural interfacing, neural modulation, neural control, neural imaging, and neural computation. The CFN has currently 24 core faculty members whose home departments include biomedical engineering, neuroscience, electrical and computer engineering, mechanical engineering, neurosurgery, psychology, and radiology. A search for up to five tenure-tracked faculty members is ongoing, made possible by ITN's Translational Neuroscience Scholars Program. More CFN information can be found at www.cne.umn.edu.

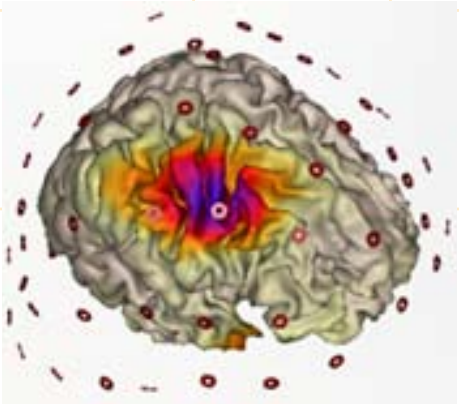
"Neuroengineering is an emerging field bridging neuroscience and engineering, translating the research discoveries in neuroscience into technologies that can provide important means for diagnosis and treatment of disorders of our neural systems. This is an extremely exciting time for neuroengineering in the field and the University. We expect the CFN will become an important catalyst fostering collaborations among basic and clinical neuroscience and engineering at the University, and we are optimistic that it will become a center of excellence in neuroegnineering research," said Bin He, Professor of Biomedical Engineering and CFN Director.

One exciting example of CFN's research is from Professor He's lab where he and his students are developing high-resolution spatio-temporal functional imaging methods for studying brain activity and connectivity and for aiding management of brain disorders. This team has pioneered the development of multimodal functional neuroimaging by integrating blood oxygenation level dependent (BOLD) MRI with

Prof. Bin He aims to harness the power of the human brain.

electrophysiological imaging. A novel theoretical framework has been developed to quantitatively correlate the BOLD signals with neuronal synaptic currents, upon which a high-resolution time-varying multimodal neuroimaging methodology has been established. Human studies using simultaneous fMRI-EEG recordings during a visual task revealed significant enhancement of spatio-temporal imaging ability.

Another exciting example from Professor He's lab is the investigation of brain-computer interfaces that sense and interpret the "thoughts" of a human subject using noninvasive EEG signals. Innovative methods are being developed in an attempt to develop highly reliable and fast brain-computer interface in controlling a computer cursor.



Imaging of brain activity during movement imagination in a human subject.

Continued inside

Head Lines

The University's initiative in translational neuroscience with its neuroengineering focus fits squarely with the department's vision for its future. It may translate into hiring additional faculty members beyond Dr. Hugh Lim, the first hire into the CFN, who has pioneered auditory mid brain implants to restore hearing, and it will complement the efforts of several existing faculty members with neural interests (Akkin, Netoff, He, and Odde). Another major University initiative featured in the last year's newsletter, medical devices, led to the hiring of two more faculty members this year, Profs. Shai Ashkenazi (photoacoutstic and optoacoustic imaging) and Alena Talkachova (cardiac electrophysiology and arrhythmias). The full-time faculty size now has double digit status at 12, and counting.

Our academic programs continue to grow as well, with 80 seniors expected to graduate this year, up from 66 last year. The ABET accreditation review this year was successful, leading to continued accreditation of our degrees, and our students can now participate in a year-long co-op program between their junior and senior years. Our graduate program is also growing, with over 110 students now enrolled. As evidenced in the News Lines inside, our graduate students and postdocs, as well as our faculty members, continue to be recognized for their research achievements. We look forward to more talent joining our department this year!

student spotlight

Erica Delin

With 11 scholarships to her credit, including those from Tau Beta Pi, SWE, and Boston Scientific, along with the Lynn Otten scholarship awarded by the Department, we wanted to ask BME senior Erica Delin about her experiences.

Why did you choose BME for your major?

I have many interests and like to think of myself as well-rounded, which makes biomedical engineering a perfect fit for me. It not only incorporates medicine, mathematics, chemistry, and design, but also produces diverse ideas and products. The further I have gone in my academic and professional career, the more my passion for this field has grown.

What was the most exciting aspect of your directed research?

I have conducted two directed research projects. The first one was assessing involuntary skeletal muscle force over time. The second was exploring the use of center-of-pressure recordings as a means of evaluating fatigue in athletes. The most exciting aspect of both projects was using my knowledge from my coursework and applying it to my very own clinical studies. In addition, I am an athlete and I enjoy studying muscle and biomechanics, so these projects were very much in line with my interests.

Was your study abroad experience "way cool"?

Of course it was! I took advantage of a 3-week seminar in Italy this past May and I would go back in a heartbeat! What I enjoyed most was seeing the differences in culture, landscape, food, people, and especially the architecture. What made it even more beneficial was traveling with a group of engineers who could discuss differences across cultures, as well as time, in terms of engineering design - Italy is one of the most exciting places to do it!

How have your industrial internships connected with your BME education?

Both of my internships have allowed me to apply my education to solve design-related problems and to better understand the medical device industry. Beyond providing challenging projects, they enhanced my education by directing the path I wish to take for my career: working for a company focused on rehabilitation engineering.

What advice do you have for BME students that will graduate after you?

I was a campus tour guide for new students; I told them three ways to get involved and to prepare for a career in engineering: 1) join at least one engineering student group; 2) conduct research; and 3) do an internship. Getting involved in a student group is especially helpful to establish camaraderie and to get help with classes. Research and internships provide hands-on experience and help solidify what you have been learning in your classes and guide career choices. Be proactive with your

news lines

Faculty:

Professor **Victor Barocas** has been promoted to a full professor, joining professors Bischof, He, Odde, Siegel, and Tranquillo as a full professor in the department.

Professor **Bin He** has been appointed Director of the Center for Neuroengineering, part of the University's new Institute of Translational Neuroscience.

Professor **David Odde** has been selected as the 2008 recipient of the Medal of Excellence Award for Distinguished Young Alumni of the Rutgers University School of Engineering. He received his Ph.D. from Rutgers in 1995.

Professors **Chun Wang** and **Taner Akkin** received the University of Minnesota's McKnight Land-Grant Professorship. The purpose of this highly competitive Professorship is to nurture the careers of the University's most promising junior faculty members in order to strengthen the faculty for the future.

Professor **Wei Shen** received the Coulter Foundation Early Career Translational Research Award. This award is designed to support biomedical engineering research that is translational in nature, and to encourage and assist new investigators. Her successful proposal is titled, "Targeted Nanocarriers of Retinoic Acid for Cancer Treatment."

Research Trainees:

Ed Sander, a post doctoral researcher advised by Prof. Barocas, was awarded an NIH NRSA post-doctoral fellowship for the project entitled, "Image-Based Modeling for Improved Functionality in Tissue Engineered Constructs."

Melissa Gardner, a post doctoral researcher advised by Prof. Odde, has been selected as a recipient of a Whitaker Foundation postdoctoral fellowship to support her research in Europe. She will conduct her research at the Max Planck Institute of Molecular Cell Biology & Genetics in Dresden, Germany starting in 2009.

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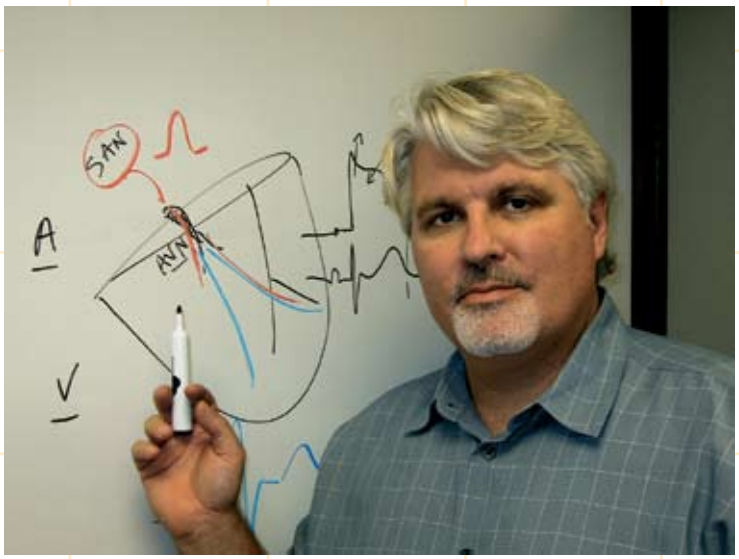
alumni achievement

Bruce H. KenKnight, Ph.D.



Bruce received his Ph.D. in BME at UMN in 1997. He is currently the Vice President of Research and Business Development for Boston Scientific-Cardiac Rhythm Management. Bruce led the research for cardiac resynchronization therapy, currently generating over $3B in annual worldwide revenue. He is an author of 45 peer-reviewed manuscripts, reviews, and book chapters relating to cardiac electrophysiology and heart failure. He is named as an inventor on 167 U.S. patents. In 2007, Bruce was elected as a Fellow of the American Institute for Medical and Biological Engineering. Beyond these accomplishments, Bruce has played a pivotal role as Adjunct Professor in the UMN BME department, organizing the first senior design course and playing a key role in it every year since.

How did you manage to complete a PhD while working full time?

The short answer is a lot of hard work and a confluence of good fortune. As you might imagine, this process was rather challenging. I needed to concentrate on my professional career while at the same time, spending nights and weekends on coursework, research, and writing publications. It was both challenging and rewarding. I had learned to work hard and be persistent as a kid. My parents instilled a strong value system and disciplined approach to life. I started working outside the home when I was 11. The "confluence of good fortune" arose from my curiosity, my company's desire to begin conducting more basic research, and the University's willingness to structure a flexible program.

What advantages do you see at UMN for BME research?

UMN has a unique combination of strong programs in engineering, biological sciences, medicine and business. Cross-disciplinary teams can form to address important unmet clinical needs. The quality of faculty and students in BME is excellent.

What is the most rewarding aspect of your involvement in the BME Senior Design Course?

Simply to watch the transition from Fall to Spring Semester! In the Fall, students are full of passion. The complexity of biomedical system design is humbling. Students soon discover that design isn't as easy as it looks. However, by Spring, the students figure it out and always amaze the judges at the Design Show with tremendous creativity and infectious levels of enthusiasm as they present their projects.

What advice do you have for students aspiring to careers in the medical device industry?

I always start with 1) work hard and 2) never give up. You not only need to work hard, but you need to work harder than your peers. Most companies select candidates that are flexible, adaptable, curious, and systematic, that have well developed technical skills and are good communicators. These skills are not present at birth; you really need to develop these skills. It's also really important to identify and develop alternatives. Rarely does one pursue a path that is predictable and uncomplicated. At any point in your academic and professional career you need to be prepared to take advantage of unforeseen opportunities and to minimize the potential damage of unexpected obstacles. So, always have a Plan B, always.

For ways to stay involved as an alumnus, please visit www.it.umn.edu/alumni. Mentors for students majoring in biomedical engineering are always needed. Alumni can also send news to share with other BME alumni by visiting www.umn.edu/bme/alumni.html.

News Lines *(continued)*

BME graduate students **Katie Ahmann**, **Rouzbeh Amini**, and **Eric Richardson** were awarded University of Minnesota Doctoral Dissertation Fellowships. They are advised by Profs. Tranquillo, Barocas, and Iaizzo, respectively.

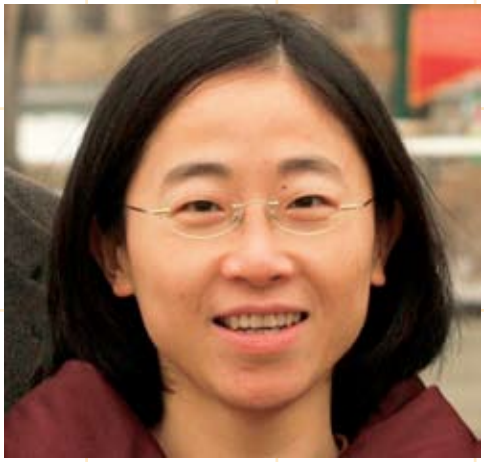
Archived news can be found at www.bme.umn.edu/news.html.

Center for Neuroengineering, cont.

Functional imaging in human subjects revealed accurate localization of cortical tissues being activated while controlling a computer cursor using motor imagery. These neuroengineering methods may have important clinical applications in early diagnosis of neurological and mental disorders, aiding surgical planning in epilepsy patients, and restoring neural functions in disabled patients. Professor He's work has been featured in various TV programs and newspaper reports, including a "Harnessing Brainpower" video featured by the National Science Foundation, which can be viewed at www.discover.umn.edu/viewCampaign/televisionNew.php.

faculty profile

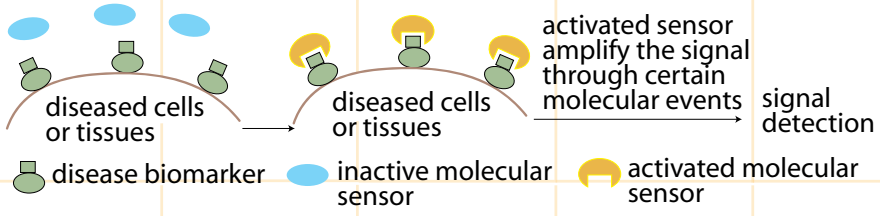
Professor Wei Shen



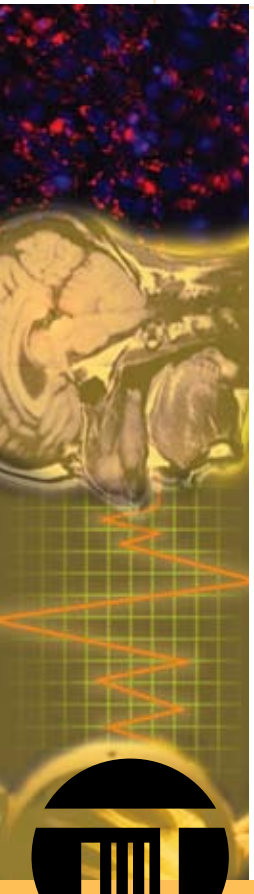
Proteins play diverse and critical roles, from simply serving as structural components to regulatory machineries and delivering bioactive chemicals. Such highly complex and dynamic functions rely on their precisely controlled hierarchical structure and highly selective molecular recognition. Inspired by these smart molecules in Nature, Professor Wei Shen and her students are harnessing naturally derived protein domains, in combination with protein engineering and chemical approaches, to develop novel biomaterials for applications in tissue engineering, drug delivery, and disease diagnosis.

Professor Shen and her team are using protein domains as various types of building blocks to confer desired physical, chemical, and biological properties of biomaterials: self-assembling domains are used as structural components to provide mechanical strength of hydrogels; polypeptide domains that bind to drugs are exploited to engineer drug nanocarriers for controlled delivery; bioactive polypeptide motifs are immobilized into polymer to elicit particular biological responses and guide tissue formation; and proteins activated in response to disease biomarkers are harnessed to develop molecular sensors for diagnosis.

In one project, depicted below, a protein-based molecular sensor capable of detecting a disease biomarker with high specificity and sensitivity but low background is engineered through rational design and molecular evolution approaches. When the molecular sensor recognizes and binds to its target, it changes its structure from an inactive form to an active form, which further amplifies the signal through prescribed molecular events, such as enzyme-catalyzed reactions, to enhance detection sensitivity.



Design of a protein-based molecular sensor that detects a disease biomarker and amplifies the signal.



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