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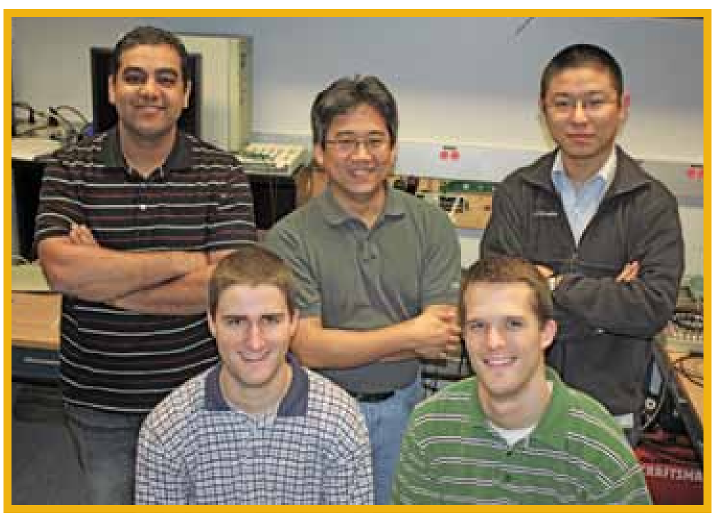
IUPUI - Purdue School of Engineering & Technology

THE BME NETWORK

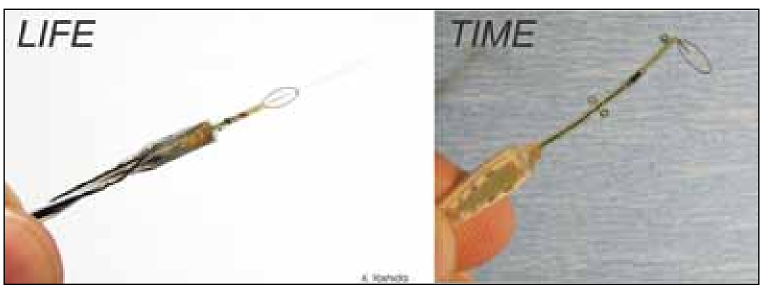
Newsletter of the **Department of Biomedical Engineering**

NEURAL PROSTHESIS: Interfacing the Body's Communication Pathways

Injury to the central nervous system (CNS) through trauma or disease can result in motor impairment, development of pathological motor activity, and bone, muscle mass or sensory loss. Similarly, the loss of a limb through amputation can lead to phantom limb pain. Common to these cases are the neural circuits and organs left intact but unreachable and unusable by the injury. If it were possible to reach, reactivate and control these latent neural circuits, they may be available to recover function or reverse pathological activity.



ABOVE – Front row – David Sempsrott, Kevin Mauser. Back row – Muller Soliman, Dr. Yoshida, Shaoyu Qiao. Dr. Yoshida's Bioelectronics Lab has been in operation since 2006. He received his Ph.D. in Bioengineering from the University of Utah in 1994.



Nearly all our interactions with the environment are mediated by the peripheral nervous system which transmits information from the body to the brain, and vice versa. If we can intercept, understand and manipulate these signals, we have a means to access and interact with the body's own communication pathways; a means to reach the isolated, latent neural circuits. The aim of neural prostheses is to rebuild some of the broken communication bridges and reach the non-functioning body part using implantable electrode structures. The development of such artificial nerves is the research conducted by Dr. Ken Yoshida and his group.

Neural prostheses work by manipulating the bioelectric phenomenon, the mechanism used by nerves and muscles to electrically communicate with one another. Devices placed within the nerve can detect these minute electrical signals. Conversely, they can place information into the body by injecting electrical impulses. But proximity to the nerve is critical, and the highest quality interface is achieved with the device implanted within the nerve tissue.

Thus, a requirement for artificial nerves is that they must be compatible with the nerve tissue, and not disrupt or injure the nerve fibers with which they interact. Additionally, they must be robust enough to survive for many years within the body, and stable enough for the users to rely on the interface for daily use. Yoshida and his co-workers have designed and implemented devices that aim to meet these

See [Neural Prosthesis] on p.3

Message from the Chair

Edward J. Berbari

Chancellor's Professor, Chair
Biomedical Engineering

The Biomedical Engineering Department continues to grow and develop as measured by our size and the accomplishments of our students and faculty. Some of these accomplishments are highlighted in the newsletter as we review Dr. Ken Yoshida's research and a number of our alumni from the first graduating class in 2008.

The most important news item in the past year was obtaining our initial accreditation from ABET. As noted by new Dean, David Russomano, "*Accreditation of our undergraduate biomedical engineering program is an assurance that the program has met quality standards set by the biomedical engineering profession. To employers, graduate schools, and licensure and registration boards, graduation from an accredited program signifies adequate preparation for entry into the profession. ABET accreditation is an important indicator of our program's commitment to quality.*" I want to personally thank the students, alumni, and our external advisory board members who participated in this process.

Our fourth class of 28 BSBME students graduated this year and is our largest to date. Despite a rather stagnant economy we are finding that our students are landing jobs in their discipline. In addition we see a high percentage of our graduates going forward with advanced education. We ask all of you to keep us informed as your career progresses. The faculty and staff are always pleased to hear from you.

Plans are now being finalized to begin construction on a new building to be shared between our school and the School of Science. BME will have a good "footprint" in the building with new research lab space, a shared teaching lab with Biology, and access to the animal facility. We expect construction to begin in the Spring of 2012 and completion sometime in late 2013.

We had another very productive year in research with annualized funding of about $4.0 million and over 50 peer reviewed journal publications; many with student co-authors. Speaking of students! Did I mention that over 25% of the BME undergraduates are in our newly established Honors College, six of our students were in the IUPUI top 100 and that Asad Raza was named the top male student for the year? It's clear that achieving excellence is indeed part of the BME culture.

The Class of 2011

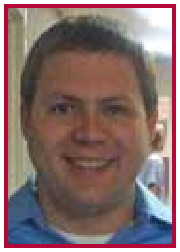
Congratulations to our students who earned their bachelor's degree this year.

BME 2010-11 Award Recipients

- *Charles H. Turner Award for Oustanding Achievement in the Senior Year* Alisa Beal
- *Bepko Award for Outstanding Achievement in the Junior Year* Perez Agaba
- *Bepko Award for Outstanding Achievement in the Sophomore Year* Arika Kemp and Jeremiah Ayers
- *BME Exemplary Internship Award* ChiaLei Ang
- *BME Outstanding Service Award* Han Shih
- *Medtronic Outstanding Senior Design Team* Tanya Barlow, Todd Dodge, Danielle Gowin, Haili Theriac, Kyle VondenBenken
- *Outstanding EDDP Student* Paula LeBlanc

NEWS FROM OUR ALUMNI

We asked alumni from our first graduating class in 2008 about their careers and how they are using their BME degrees today.



MARK WILLIAMSON

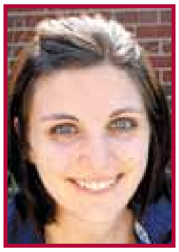
I am a Senior Reporting Engineer for FujiFilm's Medical Informatics division, specifically Synapse CardioVascular product, which is a Cardiovascular PACs (Picture Archiving and Capture system). Cardiologists and other hospital personnel consult with me to determine what clinical needs they have as compared to the stock offerings for their software package and how best to meet those needs. I then build customizations into the software for the customer.

EDDIE SHMUKLER

I am currently a fourth year medical student at Indiana University School of Medicine hoping to become a combined hospitalist and primary care physician. BME was very valuable because it gave me the necessary background in biology and chemistry to be successful in the pre-clinical years of medical school. It also taught me how to work in teams and how to present information effectively. Most importantly, it taught me to be a problem solver, which is a crucial part of being a good physician.

RACHEL MEYER

I'm in the Quality Regulatory Leadership Program at GE Healthcare which develops future leaders for the company. My first rotation was in Healthcare Systems in the Ultrasound, Diagnostic Cardiology, and Interventional Cardiology modalities working on usability regulations and testing as well as global Ultrasound Acoustic Output standardization. My second rotation was in Global Quality Operations where I worked with chief officers, executives, and subject matter experts to identify operating mechanisms based off of analytics. My final rotation is in the Medical Diagnostics business at a site which manufactures Radiopharmaceuticals and Nuclear Seeds. My education helped me develop critical problem solving, time management and leadership skills, and a strong work ethic.



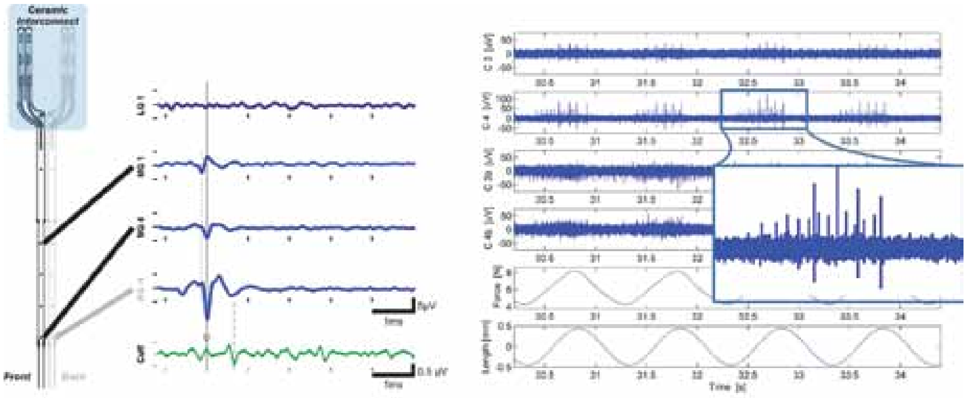
MEGAN SMITH

I am the Director of Clinical Research and an Orthotist for Midwest Orthotic and Technology Center. We work with pediatric patients supplying orthotic bracing from head to toe. I do research on some of our SureStep products using a gait analysis mat, called GAITRite Electronic Walkway to track a patient's progress. My BME degree taught me how to apply engineering concepts to the human body.

[Neural Prosthesis] Continued from p.1

criteria. The structures developed in his lab, named the thin-film Longitudinal Intra-Fascicular Electrode (tfLIFE) and Transversely Implanted Multielectrode Array (TIME), are implemented using MEMS (micro electro-mechanical systems) similar to the techniques used for microchip production. These microfabricated structures of micropatterned thin film electrodes on a micropatterned polymer substrate are extremely flexible, and have 8-12 well defined, distributed microelectrode contacts; each of which serve as selective neural interfaces.

The lab and co-workers have demonstrated the function of these prototype devices. Now the group is seeking to decode the neural information stream the structures access, non-destructively monitoring the status of the implant, and applying the devices to the multi-joint control problem of monitoring and controlling movements of the paralyzed limb.



ABOVE – Electrodes like the tfLIFE are able to pick up nerve signals. Signals from one nerve fiber appear as a deflection whose shape changes depending upon the relative position of the nerve fiber to the electrode, as demonstrated in the left panel where the signal from a single nerve fiber is viewed from 3 different sites of the tfLIFE. The shape of the waveform is used to distinguish different fibers, so that a single site can relay the information from around 8 different fibers. What sets the tfLIFE apart from current techniques is its ability to be implanted for relatively long periods of time, and to view the nerve from multiple locations even with the limb moving [right]. If each of the 8 channels of the tfLIFE is able to capture and track the activity of 8 nerve fibers, then a good sample of the activity in the entire nerve can be taken.

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BME Seminar Schedule 2011-12

Sep 16	Jiliang Li	IUPUI Biology
Oct 21	Jason Meyer	IUPUI Biology
Dec 1	Doug Weber	Univ of Pittsburgh Physical Medicine & Rehabilitation
Jan 20	Chongli Yuan	Purdue Chemical Engineering
Feb 10	Russell Main	Purdue Vet School
Mar 9	TBA	
Apr 13	TBA	

Research Areas of BME Faculty

BIOMATERIALS
Dong Xie, Ph.D., *Associate Professor*
Chien-Chi Lin, Ph.D., *Assistant Professor*

BIOMEDICAL INSTRUMENTATION
Edward Berbari, Ph.D., *Professor and Chairman*

CARDIOVASCULAR ENGINEERING
Ghassan Kassab, Ph.D., *Professor*
Julie Ji, Ph.D., *Assistant Professor*
Bill Combs, MSEE, *Clinical Assoc. Professor*

MECHANOBIOLOGY
Joseph Wallace, Ph.D., *Assistant Professor*
Sungsoo Na, Ph.D., *Assistant Professor*
Hiroki Yokota, Ph.D., *Professor*

NEUROENGINEERING
John Schild, Ph.D., *Associate Professor*
Ken Yoshida, Ph.D., *Associate Professor*
Karen Alfrey, Ph.D., *Instructor*

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