



The Center for Adaptive Neural Systems presents a symposium on  
**“Adaptation and Learning in Neuro-Biomechatronic Systems”**  
*Supported by National Science Foundation SBE-0518697*  
Location: Biodesign Auditorium  
The Biodesign Institute at Arizona State University  
Tempe, Arizona  
March 22-23, 2007

## TITLES & ABSTRACTS FOR SPEAKERS

Page 1 of 2

1. Apostolos P. Georgopoulos

**TITLE:** TBD

**ABSTRACT:** TBD

2. Scott Frey

**TITLE:** “Neural representations of technology: Implications for rehabilitation”

**ABSTRACT:** The ability to manufacture and use technology to augment existing behavioral abilities is a hallmark of the human species. Understanding the neural mechanisms that support these behaviors and how they are affected by experience is critical for the development and optimization of rehabilitation protocols, as well as assistive and prosthetic devices. In this talk I will discuss research from the field of cognitive neuroscience concerning the neural bases of tool use behaviors in humans and other primates, and discuss the implications of these findings for ‘neuro-biomechatronics.’

3. David Fuller

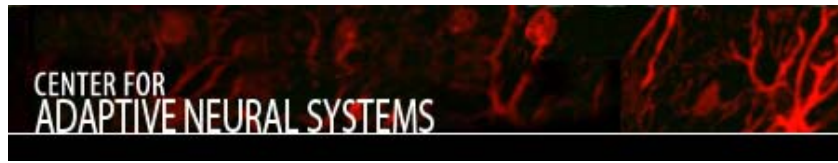
**TITLE:** “Neuroplasticity in biological systems”

**ABSTRACT:**

<sup>1</sup>D.D. Fuller, <sup>1</sup>N.J. Doperalski, <sup>2</sup>M. Lane, <sup>1</sup>K. Qiu, <sup>1</sup>M. Sandhu, <sup>1,3</sup>L.R. DeRuisseau, <sup>3</sup>B.J. Byrne, and <sup>2</sup>P.J. Reier. Depts. of <sup>1</sup>Physical Therapy, <sup>2</sup>Neuroscience, and <sup>3</sup>Pediatrics. University of Florida. Gainesville, FL. 32610.

Neural plasticity can be defined as a persistent change in the structure and/or function of neurons or neural networks due to experience. Thus plasticity is a fundamental property of neural systems, and occurs in both health and disease. An understanding of how to promote and harness plasticity is of paramount importance to rehabilitation following injuries to the central nervous system (CNS). For example, both experimental and currently accepted therapeutic strategies after CNS injury (e.g. cell transplant, physical therapy, brain-machine interface) should compliment endogenous neural plasticity and any associated natural repair mechanisms. My colleagues and I study plasticity in the neurons and networks that control breathing. Using data from our group at the University of Florida, and select examples from the literature, I will provide an overview of plasticity in neural systems, and will attempt to synthesize several general rules that relate to plasticity in the context of neural rehabilitation and repair. Topics to be addressed include: 1) stimulation paradigms to optimally induce plasticity, 2) gene therapy and plasticity, 3) enhancing endogenous mechanisms of neuroplasticity, and 4) sex hormones and plasticity. The intent is to stimulate thought and discussion regarding the mechanisms by which neural plasticity occurs, and how plasticity can be interfaced with emerging biotechnologies.

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Page 2 of 2

4. Arunava Majumdar

**TITLE:** TBD

**ABSTRACT:** TBD

5. Thomas Stieglitz

**TITLE:** “How can neural microimplants adapt to a changing biological system?”

**TBD**

**ABSTRACT:** TBD

6. Ralph Etienne-Cummings

**TITLE:** “Dynamic Generation and Control of Spinal Locomotion Signals and Its Application to Neural Prosthetic Devices”

**ABSTRACT:** For normal locomotion, the brain initiates and modulates the activity of spinal cord circuits that generate the basic motor pattern, called the central pattern generator (CPG). After severe spinal cord injury, patients are unable to walk because they cannot activate or control the CPG, although the local circuits may still be intact. One approach to restoring locomotion is to use phase-dependent electrical stimulations of the spinal cord or muscles, relative to either the underlining activity in the cord or sensory feedback, is required. Hence, work focuses on understanding how to generate signals required for locomotion and/or control the existing locomotion circuits in the spinal cord. We approach this problem from an instrumentation and neural signal processing by developing neuromorphic chips that may become implantable neural prosthetic devices. Ultimately, such a neuroprosthesis, which could be used in combination with regeneration or training methods and functional electrical stimulation, would have to initiate activity and dynamically modulate the rhythm of the CPG according to parameters or commands supplied by the user.

In this talk, I will show how CPGs spinal circuits from a lamprey are modeled mathematically and in silicon. I will then show these silicon CPGs being used to adaptively control walking/running in robotic biped.

The ideas gleaned from the robotics experiments lead us to conducting neuroscience experiments using lamprey spinal cords, to investigate how to interact with the biological locomotion controllers. Finally, I will show how we can use these neuroscience results and /neuromorphic/ VLSI chips to “replace” the spinal cord and brain signals in an anesthetized cat, and how this may lead to the development of the next generation controllers for prosthetic limbs for humans.