Office of Emerging Frontiers in Research and Innovation (EFRI)
Planned Topic Areas for FY 2011

Two new topic areas were announced for the FY 2011 EFRI Solicitation at the Directorate for Engineering Advisory Committee's Spring 2010 meeting on April 14, 2010. The tentative titles for and preliminary information about these topics are as given below. The EFRI Office intends to develop a solicitation around these topical areas for release in Summer 2010. These are planned for multidisciplinary teams of three or more investigators. You may find more information and updates on the EFRI Office by accessing ENG Advisory Committee website: http://nsf.gov/eng/advisory.jsp .

1. Multicellular and InterKingdom Signaling (MIKS)

Key Idea: Use molecular tools (synthetic biology, microfabrication, epigenetics) to gain fundamental knowledge in multicellular and inter-kingdom signaling and develop novel paradigms to sense, control and drive signaling and engineer new multicelluar systems to solve problems in energy, health, food safety and environment.

The importance of multicellular signaling, either between populations of the same species of organism or between species or kingdoms is becoming increasingly evident. Within bacterial communities quorum signaling can lead to epigenetic changes in the bacteria resulting in changes in growth patterns or virulence of the entire population. Coordinated signaling within multicellular organisms is responsible for differentiation, cell migration, and immune response. Between species/kingdoms, signaling behavior is more complex and less well understood. Inter-kingdom signaling is involved in infectious disease/disease transmission and also important in ecology, plant biology, and food safety. Signaling pathways within cells are highly non-linear reaction networks, thus complex dynamic inputs that are controlled both with spatial and temporal accuracy are required to discriminate between different mechanisms of signal transduction. As such, methods from control theory and/or other engineering tools are needed to gain fundamental knowledge of these complex reacting systems. Phenotypic change is often accompanied by not just changes in protein expression, but also epigenetic changes that may require novel engineering/technology advances such that they can be examined and appropriately managed. Up until now, the research community has lacked sufficient tools to do more than observe multicellular signaling. However, with the advent of the development of microfabrication technologies, synthetic biology, mass spectrometry-driven advances in omics, and advanced sensing, researchers are at the crossroads of being able to probe and engineer new technologies based on these complex phenomena.

2. Mind, Machines and Motor Control (M3C)

Key Idea: The central theme of M3C is to establish experimentally verified, quantitative, mathematical theories of human sensory-motor control that can serve as predictive tools for the design of machines that involve forceful, physical interaction and cooperation with humans.

Very little is understood about the way humans control their own bodies, and even less about how they manipulate even the simplest objects or tools. A fundamental theory of physically-interactive motor control will transform the engineering of machines that work in physical contact with people. This will come from transformative research in M3C which is at the intersection of brain and cognitive sciences with physics, engineering, and statistics. It will also transform sensory-motor neuroscience because it will enable an accumulation and refinement of knowledge. These two developments will catalyze each other: (1) machines that interact intimately with people will provide new context-based knowledge to improve neuroscience; and (2) better predictive mathematical models of human sensory-motor performance will accelerate the development of superior machines.