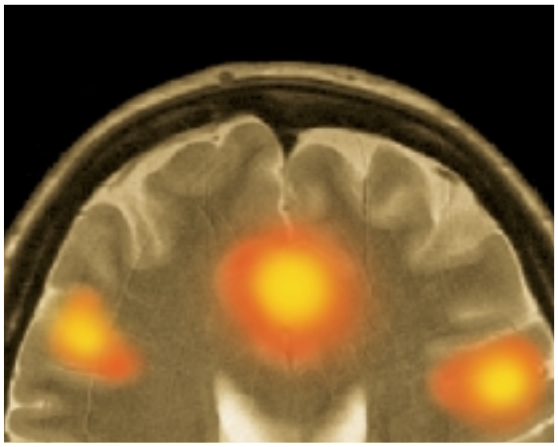
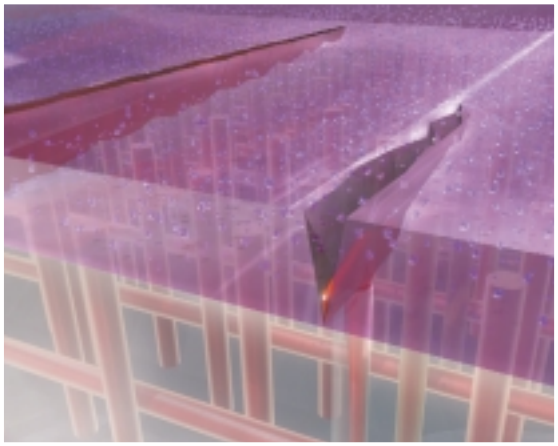




ANNUAL REPORT 2006-07

BECKMAN INSTITUTE
AT THE UNIVERSITY OF ILLINOIS

TABLE OF CONTENTS

30

At the Beckman Institute we are proud to host hundreds of researchers from more than 30 different departments.

7

Number of Initiatives that are central to our strategic plan.

DIRECTOR'S MESSAGE

This past year we were pleased to open our doors to visitors from all around the world. We hosted the Beckman Foundation Board, guests of the University of Illinois Foundation, thousands of people who came to experience the biennial Beckman Institute Open House, and numerous dignitaries from around the world. Having the opportunity to give visitors a firsthand look at the research and showcase our fantastic facility is truly a pleasure.

We were especially pleased to welcome back a long-standing, strong supporter of the Institute, the Beckman Foundation Board. Their April 2007 visit was their first trip to our facility since 1999. While our time with them was brief, we hope they enjoyed meeting the researchers, touring labs, and getting an updated perspective on the lines of research within the Beckman Institute.

Another group we were happy to welcome back was the University of Illinois Foundation. The Beckman Institute was a highlighted tour destination for their September 2006 Foundation Weekend. More than 100 guests came for an afternoon of discovering and learning about research on aging, autonomous materials, stretchable silicon, bioimaging technologies, human-computer interactions, and much more. Our faculty, students, and staff put a lot of effort into preparing for their visit and they should be extremely proud of their efforts.

I am also pleased to report that the Beckman Institute Strategic Plan is moving forward and we continue to work closely with campus administrators to make sure our plans mesh well with the campus strategic plan. Our strategic plan includes seven key initiatives that are most critical:

- to continue to grow bio- and neuroimaging research to increase translational research and encourage the development of multimodal imaging capabilities for research ranging from cancer biology to neuroscience;
- to promote "vitality in aging" by supporting world-renowned, novel research in exploring cognitive abilities as people age;
- to integrate research in human and machine language, speech, and vision to provide solutions to today's challenges in human-computer interactions;
- to continue developing modeling, computation, and multi-institutional initiatives in nanobiology;
- to acquire new characterization techniques to expand research opportunities in 3-D macro, micro, and nano assemblies;
- to continue support of research on autonomous systems and the development of new techniques and technologies for creating self-healing materials;
- to foster synergies between Beckman-based research and other medical and academic institutions to further our reputation as a leader in the repair, replacement, and augmentation of neural systems.

These initiatives are ambitious and aggressive, yet necessary to make sure we remain a top public interdisciplinary research institute devoted to world-leading basic and applied research. We are already making progress on our initiatives and we will continue to assess our efforts to reach our lofty goals.

We continue to lead the campus in the promotion and encouragement of cross-campus collaboration. Beckman Institute faculty and staff were instrumental in securing a 3-T whole-body MRI scanning system that will be located at Beckman's Biomedical Imaging Center. This new magnet, which is expected to be up and running in the Fall of 2008, will allow for research in high-demand areas, including cardiac imaging, animal imaging, and neural activity related to language and speech processing, just to name a few.

Our faculty members continue to be extremely active and have again attracted millions of dollars in funding from public and private agencies. One of the notable grants includes a $4.5 million grant for the establishment of the IMPACT Center for the Advancement of MEMS/NEMS VLSI. This multi-university grant proposal included a team from Beckman led by principal investigator Andreas Cangellaris.

Beckman researchers have also led the efforts to secure two new multi-million-dollar Multidisciplinary University Research Initiative (MURI) grants. Art Kramer is the principal investigator on a $6.75 million project which is funded through the Office of Naval Research. The topic for this research is "Capitalizing on Research on Animal and Human Brain Plasticity" and includes researchers from the University of Illinois, MIT, the University of Minnesota, and Penn State.

Jeff Moore is the principal investigator on a $6.25 million MURI award titled, "Mechanochemically Active Polymer Composites." This project is funded through the Office of Army Research and includes the University of Illinois, University of Texas, and Duke University.

This past year Klaus Schulten and the Theoretical and Computational Biophysics group submitted a proposal and then hosted a site visit for their renewal as the National Institutes of Health (NIH) Resource for Macromolecular Modeling and Bioinformatics. This Resource, which has been funded since 1989, received extremely high scores for its work. The group has subsequently been notified that it will continue to receive significant NIH funding for the development of leading-edge and extensive computational tools and software used for experiments and visualization.

The National Science Foundation (NSF) also showed its support of new lines of research. For example, principal investigator Richard Sproat and his group received an award to explore the dynamics of second language fluency. This project is developing and testing psycholinguistic models of the relationship between first language fluency, second language competence and second language fluency.

Funding from the NIH, NSF, and other sources continues to be a significant segment of the research dollar pie. However, moving forward we must continue to develop private sector collaborations that provide non-governmental funding sources. We are also formalizing plans for a development and advancement model that will involve Beckman alumni and supporters for specific projects.

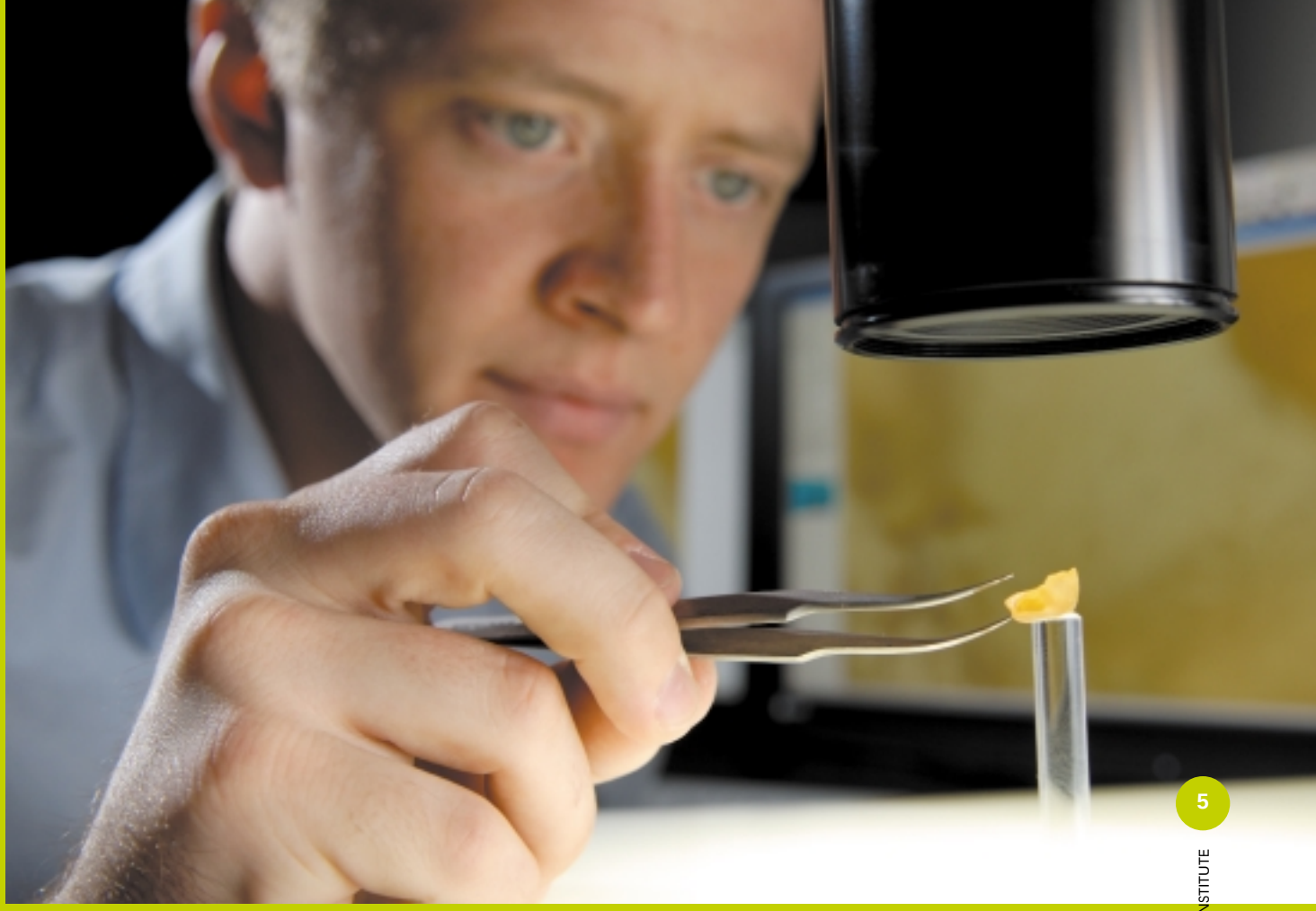
On par with our tradition of excellence, current faculty members continue to receive prestigious awards in their field of study. Last year Richard Powers won the National Book Award for Fiction; Art Kramer, Bill O'Brien, and Denise Park received NIH Merit Awards; Tom Huang received the Electronic Imaging Scientist of the Year Award from the International Society of Optical Engineering; Todd Martinez and Mark Nelson were named Fellows of the AAAS; Jeff Moore was named a Fellow of the Royal Society of Chemistry; and John Rogers and Greg Timp were named Fellows of the American Physical Society. Space doesn't permit me to mention every award, but you can find more details at the end of each research initiative section in the Annual Report and on our Web site at www.beckman.uiuc.edu.

At the Beckman Institute we are proud to host hundreds of researchers from more than 30 different departments. And as John Bardeen, Nobel Prize winner and Illinois faculty member for 40 years once said, "The combined results of several people working together is often much more effective than could be that of an individual scientist working alone." This is truly the case at the Beckman Institute and we look forward to a successful 2007-08.

Best Regards,

Pierre Wiltzius, Director

ABOUT THE BECKMAN INSTITUTE



The Beckman Institute for Advanced Science and Technology at the University of Illinois at Urbana-Champaign is an interdisciplinary research center devoted to leading-edge research in the physical sciences, computation, engineering, biology, behavior, cognition, and neuroscience.

Host to more than 600 researchers from more than 30 different departments, the Beckman Institute provides an environment that fosters interdisciplinary work of the highest quality, transcending many of the limitations inherent to traditional settings. The freedom to collaborate across disciplines allows researchers to imagine possibilities without boundaries, yielding novel research advances of global proportions.

Researchers at the Beckman Institute are broadly categorized into three research initiatives: Biological Intelligence (BI), Human-Computer Intelligent Interaction (HCII), and Molecular and Electronic Nanostructures (M&ENS). The mission of the BI initiative is to understand brain function and its role in behavior. HCII research spans a wide range of fields, but the overriding goal is to examine the complex relationships between humans and machines. The general goal of the M&ENS research initiative is to develop a fundamental understanding of chemical and physical processes involving structures on the nanometer scale. Each research initiative is constantly growing and evolving to lead the way in scientific discovery and advancement.

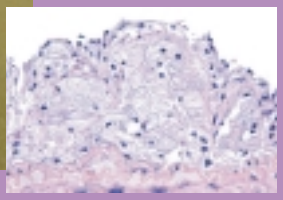
To assist research efforts, the Beckman Institute provides state-of-the-art resources, including the Biomedical Imaging Center (BIC), the Imaging Technology Group (ITG), and the Integrated Systems Laboratory (ISL). BIC offers a trio of powerful magnets that are a key resource for investigators using MRI and fMRI technology. ITG helps researchers bring their work to life with advanced imaging tools in the Visualization, Media, and Imaging Laboratory. ITG also hosts the Microscopy Suite, which provides a wide range of imaging modalities and equipment for the preparation, imaging, and analysis of microscopic specimens. ISL provides researchers with a place to conduct experiments in human multimodal perception and cognition, and connects art and technology in innovative ways.

BIOLOGICAL INTELLIGENCE

Work in the Biological Intelligence (BI) research initiative is grounded in the traditional methods of experiment and theory, but BI researchers also are taking advantage of advancements in technology that illuminate physiology and structure in new ways. By combining traditional methods with the latest technology and practical interdisciplinary collaborations, BI researchers are giving us a comprehensive perspective on biological intelligence while creating new technology for a number of applications.

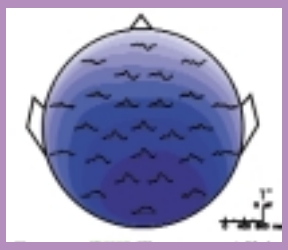
Research in the Biological Intelligence research initiative combines traditional methods with the latest technology.

The Bioacoustics Research Laboratory (BRL) has been conducting an eight-year NIH-funded study examining potentially damaging effects of diagnostic ultrasound equipment. Members of the BRL pictured at right include: (clockwise from the left) Rita Miller, Jim Blue, James Zachary, and Bill O'Brien.



The goal of this research initiative has always been to explore biological intelligence in the broadest terms, from investigating the molecular workings of the brain and expressions of intelligence like language and memory, to studying behavior and disease. Today, cutting-edge technology is an integral part of the mission in two ways: BI researchers are playing leading roles in crafting new technology for research and medical purposes, and advanced technology has become for many an essential component of doing basic research involving biological intelligence.

These technological advances are complementing and even improving the accuracy of traditional experiments involving cognition and intelligence through equipment like eye-tracking devices and magnetic resonance imaging (MRI) headscanners. From the beginning, research into human intelligence has relied on test subjects' impressions, or self-reported data, as a foundation for doing experiments. Researchers in BI are now using technology like eye-tracking equipment to precisely track attention during an experiment or functional MRI (fMRI) to follow blood flow to certain regions of the brain during task performance. They are tracing the physical movements required to speak a second language through a device called an articulograph **(C. Shih)**; are using advanced software developed by a Beckman researcher **(D. Roth)** to study how children learn to speak their native language **(C. Fisher)**; and are using optical brain imaging to investigate language processing in the brain with millisecond precision **(G. Gratton, M. Fabiani, S. Garnsey, G. Dell).**



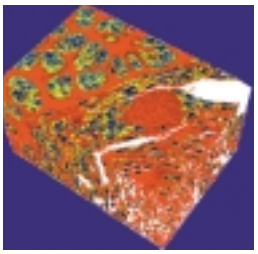
This image, from Kara Federmeier's research group, shows the cognitive electrophysical changes in response to a familiar acronym.

Imaging methods, particularly MRI, have long been a part of BI research but new equipment, newly developed techniques, and application of these imaging methods for the first time to lines of inquiry are expanding research possibilities involving intelligence and brain function. A new 3-T full-body MR scanner is set to go online next year at Beckman's Biomedical Imaging Center, while a new project is applying fMRI methods to a study of whether neural competition in the visual cortex can explain the limited processing capacity of the visual system **(D. Beck)**.

Advancing technology for medical and research purposes is also an important part of the work in Biological Intelligence. BI researchers are improving existing technologies such as ultrasound **(W. O'Brien, M. Oelze, and J. Zachary)** sonography **(M. Insana)**, optical microscopy **(S. Boppart, S. Carney, D. Marks, T. Ralston)** and MRI **(B. Sutton)** through advances in techniques and software. They are also modifying existing technology for studying event-related brain potentials (ERPs) in order to gain new insight into brain function and cognition **(K. Federmeier, G. Gratton, M. Fabiani)**.

Research into the most fundamental levels of brain activity is also strong in BI, as researchers are discovering how neurons communicate through signaling molecules and are developing techniques for characterizing their structure and activity **(J. Sweedler, W. Greenough, M. Gillette)**. Investigations into behaviors associated with alcoholism and drug addiction are being explored at the level of neural pathways, brain chemistry, and genetics **(J. Rhodes)**.

These varied approaches, combining traditional methods with leading edge technology, are based on chemistry and psychology, neuroscience and mathematics. Together they are producing results that keep the Beckman Institute at the forefront of biological intelligence research.



Michael Oelze (above) and his collaborators have made significant advances in improving ultrasound performance.

Ultrasound Findings for Medicine

By studying the interaction of ultrasound with biological materials and ultrasound imaging in biology and medicine, researchers from Beckman's Bioacoustics Research Laboratory (BRL) continue to advance the role of ultrasound technology in medicine. **William O'Brien, Michael Oelze,** and **James Zachary** of the BRL announced three findings that have important consequences for the medical use of ultrasound. They reported on an eight-year risk assessment study that found that the damage from a lung hemorrhage that can occur during a diagnostic ultrasound exam is not a medically significant problem. In the area of breast cancer screening, they found that quantitative ultrasound imaging techniques are able to distinguish between noncancerous and selected malignant tumors. In a major advance in improving ultrasound performance, Oelze developed a new coded excitation technique that doubles bandwidth and significantly improves axial resolution.

New Method for Screening Addiction Drugs

Justin Rhodes' research as part of the NeuroTech group is creating multi-generational mice models that can be bred for specific research projects, from studies involving genetics to those centering on his own interests of drug addiction and alcoholism. Rhodes, an Assistant Professor of Psychology, studies the causal mechanisms that underlie motivational behaviors such as beneficial ones like exercise and detrimental ones like alcoholism.

Rhodes has found that the motivation for exercise seems to involve the same neural circuits and the same chemicals that have been implicated in motivations for addictions. In one recent study, Rhodes used mice models to test the effectiveness of drug compounds used for treating alcoholism and found that, while effective, the compounds also dampened the pleasure rewards received from activities like eating and exercise.

The study demonstrated that Rhodes' mice model is an effective tool for screening new medications that specifically target the rewards associated with alcoholism.

Grant for Conceptual Approach to Physics Education

Cognitive Science group members **Brian Ross**, a Psychology Professor, and **Jose Mestre**, who holds appointments in both the Physics and Educational Psychology departments, are taking a new approach to physics education, one that could improve physics learning while offering students a deeper understanding of a science that seeks to explain the most fundamental laws of our universe. The project Ross and Mestre began in 2007 with a grant from the Department of Education is aimed at improving physics learning and long-term retention through a conceptual approach. They are developing and testing an intervention for inclusion in the regular curriculum of high school and college physics classes that would have students plan a strategy – for example putting a physics problem, its variables, different equations, and ways to solve it, into a story form – before doing the math. In addition to improving learning, the hope is to give physics students the same appreciation for physics that physicists have. "Physics professors would love for the students to come away with that deep understanding but the students, even the good students, don't appreciate it because they're trying to solve physics problems," Ross said.

Creating New Technology for Second Language Learning

Combining an innovative classroom teaching method she developed with computer technology, **Chilin Shih** of the Cognitive Science group is helping to create an effective new software program for improving second language learning and rating. Shih, a professor in both the Linguistics and East Asian Languages and Cultures departments at Illinois, has been using the public speaking techniques developed by the Toastmaster's program as a way of increasing fluency in her classes teaching Mandarin Chinese to English speakers. Her recordings of these presentations have formed a database used to research learners' strengths and weaknesses and to develop software that adapts to each individual's levels and to address their specific needs. Shih has found that the control of intonation and timing play an important role in learning to speak a second language effectively. The software their group has developed reacts to the variance between learners' speech and native speech by exaggerating the tonal differences when the learners' sounds are dissimilar from native speakers and decreasing them when the language learner is approximating native speakers' sounds. As opposed to traditional language training programs, this adaptive system becomes individualized for each learner. Shih is collaborating with Beckman colleagues **Richard Sproat, Kay Bock, Mark Hasegawa-Johnson,** and **Brian Ross** in multiple National Science Foundation-funded projects for studying second language fluency.

Projects in language acquisition studies explore how children use simple features of sentences to determine what a new verb means.

MURI Grant Involves BIC, 10 Beckman Researchers

A long history of research into brain plasticity at the Beckman Institute and its state-of-the-art neuroimaging facilities are playing key roles in a large new project headed by Biomedical Imaging Center (BIC) Director **Art Kramer**. Kramer is principal investigator on a Multidisciplinary University Research Initiative (MURI) grant from the Office of Naval Research for a project titled "Capitalizing on Research on Animal and Human Brain Plasticity to Enhance Warfighter Training and Performance." The goal of the project, which includes 10 Beckman researchers, is to increase our understanding of how complex skills are learned and create training strategies for transferring skills in a military environment. One of the key technical approaches of the project involves using BIC's advanced magnetic resonance imaging capabilities to measure and examine changes in brain function and structure accompanying the learning of skills, with a goal of identifying brain networks that support the learning of military-relevant skills. The project seeks to improve guidelines for the effective training, transfer, and retention of complex military-relevant skills. In addition to Kramer, the Beckman team includes faculty members **Monica Fabiani**, **Gabriele Gratton**, **Wai-Tat Fu**, **Brad Sutton**, and **Dan Simons**, as well as post-doctoral researchers **Walter Boot** and **Kirk Erickson**, and Beckman Fellows **Mark Neider** and **Chandramallika Basak**.

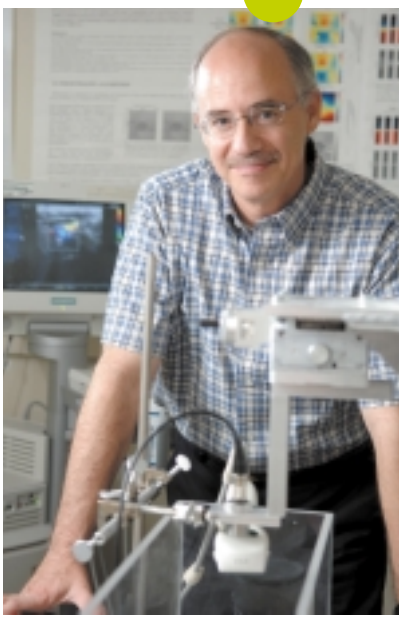
Language Acquisition Study Combines Experiments, Computation

A child learning a language and a computer program designed to label the semantic roles of words in sentences are both striving to find meaning in and assign roles to the words they are presented with. A project of Beckman faculty members **Cynthia Fisher** and **Dan Roth** and Beckman Fellow **Yael Gertner** combining experimental psychology with computational modeling is providing a new perspective into how language is acquired and used by young children. Fisher, a Psychology professor who has done groundbreaking work on the key role abstract mental representations play in language learning, brings an experimental background to the project, while Roth, a Professor of Computer Science who has developed a premier semantic role labeling model, contributes the computational methods, and Gertner has training in both areas. The project, through grants from the both the National Institutes of Health and the National Science Foundation, is conducting experiments aimed at testing the nature of children's mental representations of words in learning syntax and language comprehension while also examining the consequences of those representations in large samples of child-directed speech. The project seeks to advance knowledge about how children learn their native language and to create protocols for guiding the development of automatic natural language processing systems.

Cindy Fisher is conducting groundbreaking research on the key role abstract mental representations play in language learning.

Developing a New Approach to Optimize Breast Cancer Detection

Combining communications theory from electrical and computer engineering with radiological diagnosis, **Michael Insana** and his collaborators in a multi-university project are developing a novel approach to ultrasonic breast cancer imaging that holds great promise for significantly improving diagnosis of a disease that affects one in eight American women. Insana, leader of the Bioimaging Science and Technology group at Beckman, has a research focus on sonographic breast imaging, a technique that converts high-frequency sound waves into a picture on a video monitor. In a project funded by the National Institutes of Health, Insana and his colleagues are translating clinical diagnostic challenges into equations that generate new signal processing strategies ideal for imaging breast tissues. The goal is to dynamically optimize their diagnostic capabilities for different examination types and patient physiologies. The work began by translating five visual tasks associated with diagnosing breast cancer into mathematical equations. "The equations suggested data processing methods that seem to greatly improve human efficiency at visual tasks required of radiologists for breast cancer diagnosis," Insana said. "Systems need to adapt to the details of each patient they examine in order to deliver diagnostic information at their full potential. The adjustments tune the system to emphasize the most diagnostic features in a way that is easily detected by the human visual system."



Michael Insana (above) is the group leader for the Biomimaging Science and Technology group, which was formed in 2006.

Researcher Profile

Dedicated Researcher,

"I spend a lot of time with my students and I treat them as the intellectual colleagues that I expect them to become. … I think that's the most important part of my job."

2

Federmeier's work shows that the two halves of the brain use verbal information differently in the service of language comprehension.

5

Her recent paper, "Thinking Ahead: The Role and Roots of Prediction in Language Comprehension," describes her work over the past five years.

2006

The year Federmeier received the Society for Psychophysiological Research's Distinguished Scientific Award for Early Career Contributions to Psychophysiology.

Professor, Mentor

Kara Federmeier's graduate students won't let her forget about the comments she provided on a recent research paper coming out of their lab. It wasn't what she said that was striking, but the timing.

"My students tease me because the day after I gave birth, I got comments back to them on one of their papers," Federmeier said.

That kind of dedication has a lot to do with Federmeier's remarkable success as a young researcher in the area of psychophysiology, a field that links psychology and physiology. Federmeier was recognized in 2006 with the Society for Psychophysiological Research's Distinguished Scientific Award for Early Career Contributions to Psychophysiology. Her research group uses event-related brain potentials (ERPs) to study language, memory, and aging, and recently published a seminal paper offering a fresh perspective on the roles that the two hemispheres of the brain play in language comprehension.

Federmeier describes the Early Career Award as "a real honor" and is happy with the way the research lines she has been working on for the last several years have developed. But teaching is still a top priority.

"I'm a very involved mentor," she said. "I spend a lot of time with my students and I treat them as the intellectual colleagues that I expect them to become. So in a sense I have high expectations for them, but I also devote a lot of energy and time to them and meet with all of them every week. I think that's the most important part of my job."

Federmeier, a full-time faculty member in Beckman's Cognitive Neuroscience group, had good role models when it came to teaching and mentoring. While an undergraduate at the University of Illinois, her mentor was Biological Intelligence (BI) Co-chair Bill Greenough.

"He was a wonderful mentor of undergraduates in particular," Federmeier said. "A lot of times as an undergraduate you don't see much of the lab head, but he always met with his undergraduates and really helped me find out where to go to do what I wanted to do and what it was that I wanted to do."

Federmeier's academic path took her to the University of California at San Diego, where she earned a Ph.D. in Cognitive Science and was inspired by Professor Marta Kutas, a fellow Illinois graduate.

"She's part of the long tradition of electrophysiological research that comes out of Illinois," Federmeier said. "Marta is a mentor in every sense of the word. She experimentally is very rigorous and she just has a wonderful passion for the field."

Federmeier now serves as a role model for young women who are interested in cognitive electrophysiological research, a field that uses the brain's electrical signals to study cognitive processes.

"There are a lot of women in my lab and I think that, although there are subsets in psychology that have a lot women, like developmental and social psychology in some cases, the ones that are more technique heavy like electrophysiology tend to be more male dominated," she said. "So I hope I can be a role model to them."

Another major role for Federmeier is as a wife and mother. She has two children, one age 7 and one less than a year old, and is married to Aldo Manfroi, a lecturer in the Department of Mathematics at Illinois. Manfroi is from Italy and Federmeier is a home-grown Illinoisan, but they met in high school at a science summer camp in California. An alphabetical-order seating arrangement led to a meeting and eventually a long-term, long-distance romance ensued.

Combining an active research and academic career with parenting "works in part because I have a great husband who does a lot with the kids," Federmeier said. "It's challenging but in the end it's rewarding. You've got to find the time when you can. When the baby goes to sleep, then you can get a little bit of work done."

Federmeier is director of the Cognition and Brain Lab at Beckman and is a tenure-track professor in the Department of Psychology. Her recent paper, titled *Thinking Ahead: The Role and Roots of Prediction in Language Comprehension,* describes her work over the past five years showing that the two halves of the brain use verbal information differently in the service of language comprehension. Her research has shown that the brain's hemispheres work much more in tandem than what was previously thought.

"[The research] says that the brain is trying to have its cake and eat it too by solving the same cognitive problem in two different ways, which have complementary strengths and weaknesses," Federmeier said. "It's a new perspective for this domain."

In addition to researcher and professor, Federmeier may be adding author to her resume when she takes an upcoming sabbatical. She said a textbook on learning how to use electrophysiological techniques for studying cognition is needed in this rapidly growing field. She is considering writing that textbook to help students and colleagues new to the field gain the methodological and historical perspective she values from her own training.

"I was lucky to be part of that old school of being trained in a very hands-on fashion," she said. "And I was definitely well mentored. I hope to be able to pass that along, in whatever ways I can."

HUMAN-COMPUTER INTELLIGENT INTERACTION

As futuristic as the name Human-Computer Intelligent Interaction (HCII) sounds, the work coming out of this research initiative is as tangible as the cell phone in your hand or the newest addition to the lower Manhattan skyline.

Faculty members in HCII are doing innovative research in a wide variety of areas related to the relationship between humans and machines, particularly at the human-computer interface. Their efforts begin with the theoretical and experimental work that underlies the science behind HCII's mission of advancing human-machine interactions but they also include real-world results, like creating a cell phone avatar with human-like emotional responses, or contributing human factors elements to the final design for the first World Trade Center building rebuilt after 9-11.

The science of the HCII research initiative is bolstered by Beckman's state-of-the-art technical resources like the driving and flight simulators, and a diverse pool of human resources, including researchers from 14 different disciplines that range from expected fields such as computer science and electrical and computer engineering to areas that factor in the human component like psychology, linguistics, and kinesiology. In the cell phone avatar project, for example, there were contributions from researchers in Psychology **(J. Spencer-Smith)**, Speech and Hearing Science **(C. Lansing)**, and Electrical and Computer Engineering **(T. Huang, M. Hasegawa-Johnson)**.

Much of the research that goes on within HCII is geared toward making the everyday lives of people better in many different ways. A researcher in Human Factors **(A. Kirlik)** advocated for more people-friendly design elements in the new 7 World Trade Center building, while another Human Factors faculty member **(D. Morrow)** has developed ways for older adults to improve their adherence to taking medications. Research aimed at helping older adults is also a goal of a faculty member from Educational Psychology **(E. Stine-Morrow)**, who is developing an educational program that may help improve the cognitive abilities of these people.

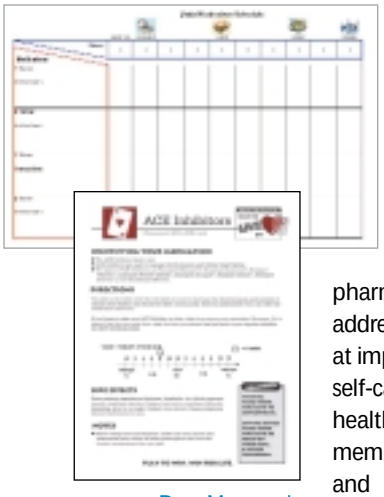
Technology plays a central role in HCII projects, both in terms of developing future applications and in fostering that development through the use of Beckman resources like the flight and driving simulators and immersive virtual reality environments like the Cube. The Beckman driving simulator continues to be an indispensable tool for psychology researchers investigating driver distraction **(D. Simons, A. Kramer, Y-C. Lee)**, while the Cube is home to research in spatial cognition **(R. Wang)**. HCII researchers are also helping to create technology such as next generation cameras **(N. Ahuja)**, tools for robotics **(S. Hutchinson, S. Levinson),** and software for applications like speech recognition **(Hasegawa-Johnson)**, emotion recognition **(Huang),** and word detection across languages **(R. Sproat)**.

The interdisciplinary collaborations that take place between HCII researchers from seemingly disparate fields create results that take the human-computer interaction from the algorithms that make new technology possible to end results that make computers and machines easier for people to use.

Alex Kirlik provided guidance for the 7 WTC project on building safety enhancements associated with human factors, which he describes as "the science and engineering of understanding and achieving a safe and effective coupling between people and their environments." (Image SPI, dBox)

Dan Morrow, a member of Beckman's Human Perception and Performance group, is involved in a project that focuses on adherence to heart medication and health literacy in patients with chronic heart failure.

Improving Medication Adherence for Older Adults with Diverse Cognitive and Literacy Abilities



Dan Morrow's group has found that medication instructions that include pictorials are one way to improve drug-taking adherence.

For many older adults with chronic illness, impairment in cognitive abilities and/or inadequate health literacy often undermine self-care behaviors such as taking medicine or monitoring symptoms, a problem that can lead to poor health outcomes. A National Institutes of Health-funded project involving pharmacists, physicians, and researchers addressed the problem with a study aimed at improving older adults' comprehension of self-care tasks through improved design of health care materials. **Dan Morrow,** a member of Beckman's Human Perception and Performance group, is one of the researchers involved in the project and lead author on a paper reporting the results of a study that focused on adherence to heart medication and health literacy in patients with chronic heart failure. The study's conclusion was that "medication instructions should be designed to reduce comprehension demands on general cognitive abilities as well as literacy skills." As part of the project, Morrow's group has developed a pharmacy-based patient education intervention that has been shown to improve medication adherence among older adults with diverse cognitive and literacy abilities. Morrow said the intervention was pharmacy based because of the important role that pharmacists play in medication management for older adults, and that the written instructions, which are complemented by pictorials, are designed to be consistent with how older adults think about taking medication. Their work has shown that older adults with varying amounts of health literacy understood and remembered these instructions better than typical instructions for the same medications available in a large chain pharmacy, primarily because they had better recall of the information when it was conveyed by pictures as well as text. Morrow said that the project shows that complex problems such as medication non-adherence are best addressed by collaborative teams that include researchers in behavioral and medical science.

Emotive Audio-Visual Avatar for Text Messaging

Studies have shown the importance of emotional cues like those carried in the tone of voice or visual ones such as are expressed in facial movements to effective communication. Text-based messages or even visual aids such as avatars aren't yet capable of relaying those emotional signals, but a new project of **Tom Huang's** group is factoring in emotion and voice tone in order to create a computer-generated avatar capable of accurately and realistically communicating information. Huang's group, in conjunction with Motorola Labs, has developed an avatar with a synthesized voice for use in text messaging. The avatar uses text encoded with emotion markers to deliver a message through the avatar that carries the appropriate facial expressions and tone of voice of the sender. A major application of this technology in the future is expected to be in cell phones, but other uses could include smart kiosks, virtual worlds, and in gaming. Huang said the biggest challenge for the group now is to make the avatar's facial expressions, lip movements, and expressive synthetic voice as realistic as possible. Among Huang's collaborators are Beckman colleagues **Charissa Lansing** from Speech and Hearing Science, **Mark Hasegawa-Johnson** from Electrical and Computer Engineering, and **Jesse Spencer-Smith** from Psychology. Improving the avatar's voice to include inflections that represent emotions is a key goal of the project. "The voice is synthesized and the current commercial speech synthesizer systems give you neutral speech," Huang said. "We want to make it expressive."

Audio-visual Automatic Speech Recognition Based on Articulatory Phonology

According to researchers in the field, automatic speech recognition technology has a 30 percent error rate when it comes to natural conversational speech. **Mark Hasegawa-Johnson** has been a leader in developing algorithms for use in speech recognition applications, and now his group has developed a model that works to improve the error rates found with current techniques. Hasegawa-Johnson, a member of Beckman's Artificial Intelligence group, and his students have demonstrated a model of audio-visual automatic speech recognition (AVASR) that can provide a useful complement to standard methods in AVASR. The model is based on articulatory phonology (AP) – a theory that combines the physical (movements of the tongue, lips, etc) and cognitive aspects of speech production – in order to better identify the spoken word when there are challenging circumstances as happens, for example, when speech is spontaneous, or in noisy environments. While automatic speech recognition methods have been based on the view that a word can be represented as a single sequence of phonetic states, the AP model utilizes multiple streams of articulatory features, both physical and cognitive, to recognize words. Hasegawa-Johnson's work accommodates available functional Magnetic Resonance Imaging (fMRI) and psychophysical data regarding planned muscle actions into its AVASR model. They have found that the combination of the AP model with standard algorithms results in a lower word error rate for speech recognition than either algorithm alone.

Tom Huang's group has developed an avatar with a synthesized voice for use in text messaging.

Named Entity Detection and Transliteration

Richard Sproat is one of the principal investigators on a project that has developed a novel technique for estimating the likelihood of named entities in the categories of person, organization, or location in one language being a transliteration of a word in another language. The Named Entity Recognition and Transliteration for 50 Languages project uses computational methods to create a phonetic scoring method based on phonetic features and pseudo-features for detection of the same words or phrases in streams of texts from other languages, including ones with completely different scripts such as Chinese and English. Named Entity Recognition (NER) is an area that has traditionally focused on widely used languages but Sproat, Beckman colleague **Dan Roth**, their graduate students, and collaborators are developing a suite of software tools that will permit the rapid creation of named entity detectors for 50 different languages, almost all of which have millions of speakers. The method uses phonetic features and pseudo features based on pronunciation error data of second-language learners of English and a phonetic feature linear classifier algorithm for detection and transliteration in multiple languages. The method's use of language-independent phonetic features makes it effective for languages other than the target pairs and even when there is limited training data as, for example, is sometimes the case with a rarely spoken language.

Human Factors Considered in World Trade Center Building Design

Alex Kirlik of Beckman's Human Perception and Performance group contributed his expertise to the design of the first World Trade Center address rebuilt after 9/11. 7 World Trade Center, completed in 2006, includes state-of-the-art safety and security elements, as well as human factors elements that Kirlik helped bring to the project as part of a University of Illinois team that advised the building's architectural firm. Kirlik, head of the Human Factors Division at the University of Illinois, focuses primarily on cognitive issues such as understanding and supporting judgment and decision-making in his research. On the 7 WTC project, Kirlik provided guidance on building safety enhancements associated with human factors, which he describes as "the science and engineering of understanding and achieving a safe and effective coupling between people and their environments." He said the study of human factors can include topics ranging from "carpal tunnel syndrome to eye strain, to effective use of colors and fonts, all the way up to cognitive, social, and even cultural issues." Based on his reading of a FEMA report on building performance issues during 9/11, Kirlik became primarily concerned with improving emergency egress, or how people exit a building via hallways, stairs, and elevators during an emergency situation. As the lone human factors consultant on the project, Kirlik used research from his discipline to advocate for expansion of stairwell width above and beyond code. He also recommended using photoluminescent paint and additional lighting in stairwell areas. Despite some opposition to the proposals and numerous code requirements that Kirlik said sometimes made the group's efforts "an exercise of creativity in a straightjacket," the finished building contained many of the design elements Kirlik recommended.

Human Factors Considered in World Trade Center Building Design

This digital image of a future lower Manhattan skyline includes the 7 World Trade Center building that was designed with input from Beckman researcher Alex Kirlik. (Image SPI, dBox)

Inadequate Compensation for Driver Distraction

Human Perception and Performance group member **Dan Simons** took a fresh look at driver distraction with an experiment in the Beckman Institute driving simulator that featured more naturalistic, or real-world, driving conditions than previous, similar studies. The results of the approach, reported in a 2007 paper Simons co-authored with former graduate student William Horrey, provide new insight into the timely topic of driver distraction, particularly as it relates to multi-tasking in real-world driving situations. The study built on extensive past research showing, first, that dual-task driving (such as talking on a cell phone while attempting to pass another car) is risky and, secondly, that drivers in steady-state driving conditions (following another car going at a constant speed) compensate for dual-task driving by adaptively increasing safety margins such as the distance between their vehicle and the one they are following. Simons' study replicated those results but also included, for the first time, naturalistic experiments which examined whether drivers compensate for dual-task driving situations in tactical-control conditions (variable speed traffic situations that require multiple decisions such as whether to pass or reduce speed and remain in a lane). The answer they found is that drivers in dual-task, tactical-control conditions don't, in fact, compensate for the extra mental workload by increasing their safety margins. "The question was do you do something when you're driving to reduce the effects, to ameliorate the effects of those distractions. The finding was no, people don't do that." Simons said. "They don't realize that they will need more time to react."

Researcher Profile

Sproat's Interests

"One of the things that was so appealing about Beckman is you do have people with all kinds of backgrounds and we really do work together. So it was really the interdisciplinary nature that was the pull here."

6

Number of living languages he is proficient in.

50

Number of languages included in the named entity recognition and transliteration software Sproat is developing.

24

Number of hours Sproat spent taking a taxi across India in order to catch a flight.

Take Him Around the World

Richard Sproat is one of those lucky people whose travels have taken him around the world and led to some memorable experiences. His globe-trotting adventures have run from the frightening (witnessing burning armored vehicles during the Tiananmen Square uprising), to the draining (a 24-hour fog-enshrouded taxi ride across 400 miles of hazardous Indian highway), to the fascinating (communing with the famous stone statues of Easter Island).

Sproat's journeys have been part business, part cultural and historical tourism, and part of his longtime interest and research into languages and the written word. Travel for him is often a mixture of work, as in side trips coinciding with a conference, and his own personal interest in the history and culture of societies like those found in China and India.

"I love traveling and I tend to like to go to exotic places," Sproat said. "I much prefer going to developing countries than to, say, Western Europe. Things are less homogenized in developing countries. You can still find places where things have not changed so much in the last couple of hundred years. It's getting harder and harder to find places like that."

Sproat is head of the Computational Linguistics Laboratory, a member of the Artificial Intelligence group at the Beckman Institute, and a professor in the departments of Linguistics and Electrical and Computer Engineering at Illinois. He says the overall theme of his research deals with the relationship between written and spoken language, and how that relationship is computed by humans and machines. He has research interests in a number of areas, including writing systems, cross-linguistic named entity recognition, and applying speech and language processing to second language pedagogy.

Sproat has been involved in many projects, but currently much of his time is spent as principal investigator on a National Science Foundation grant that studies second language fluency, with a long-term goal of creating a second-language fluency assessment center at Illinois. He is also one of the principal investigators on a project called Named Entity Recognition and Transliteration for 50 Languages that is developing software for detection and transliteration of named entities (in this case persons, organizations, and locations) across multiple languages.

Sproat, who grew up mostly in California but also lived for a time in England, said he has been interested in languages since he was in high school. He is or has been able in the past to speak or write, with varying degrees of proficiency, a half-dozen languages, and is familiar with many more, including "dead" ones such as Old Icelandic and Classical Chinese and a "resurrected" one called Manx Gaelic.

Sproat came to the University of Illinois and the Beckman Institute in 2003 after working in industry for Bell Laboratories and AT&T. He said he was drawn to Beckman because the interdisciplinary approach to research at the Institute replicated what he was used to at Bell Labs.

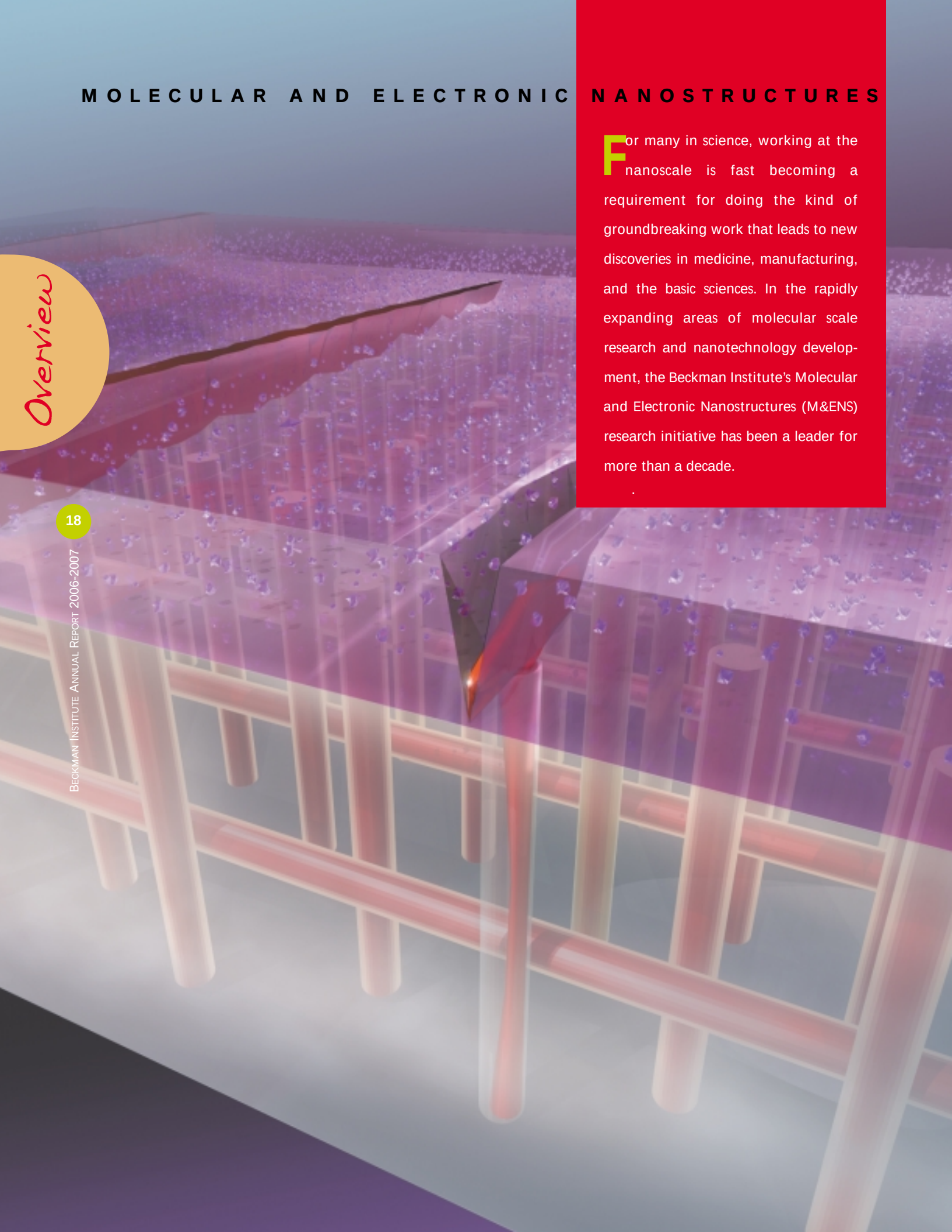
"One of the things that was always very nice about Bell Labs – which was quite different from what I knew the case to be in academia – was that I could walk down the hall and talk to an engineer, or a computer scientist or psychologist, all on the same hallway," Sproat said. "You would never get that in a typical academic environment. One of the things that was so appealing about Beckman is you do have people with all kinds of backgrounds and we really do work together. So it was really the interdisciplinary nature that was the pull here."

Sproat's worldwide travels have fit in well with his work and research interests. The visit to China during the Tiananmen Square uprising in 1989 and the long-distance taxi ride in India were two of his more memorable adventures. While the sight of burning armored vehicles and having machine guns pointed at his taxi in China was nerve-racking, it was the lack of knowledge during the upheaval that was most worrisome.

"There were all these kinds of rumors going around and it was really, really hard to know what was going on," Sproat said. "That was the frightening part; it wasn't anything specific, it was just that we had no idea what was going on."

A few years later, after attending a conference in India, Sproat needed to travel more than 400 miles to catch a flight out of Delhi. Forgoing a train trip for fear of not making their flight, Sproat and three fellow conference attendees opted for a "12-hour" cab ride. The roads proved "abysmal," a thick fog shadowed their journey, and numerous stops and wrong turns turned it into a 24-hour trek. While he did catch a late flight, Sproat got perhaps more of an up-close look at a developing country than he bargained for.

"It wasn't frightening, it was more tiring than anything else," Sproat said. "It wasn't the worst experience I've had but it seemed like the longest at the time. My colleagues and everybody in the cab were all Indian and they were saying I was going to see the real India. Looking back it was an interesting experience, not necessarily one I would want to repeat."



MOLECULAR AND ELECTRONIC NANOSTRUCTURES

For many in science, working at the nanoscale is fast becoming a requirement for doing the kind of groundbreaking work that leads to new discoveries in medicine, manufacturing, and the basic sciences. In the rapidly expanding areas of molecular scale research and nanotechnology development, the Beckman Institute's Molecular and Electronic Nanostructures (M&ENS) research initiative has been a leader for more than a decade.

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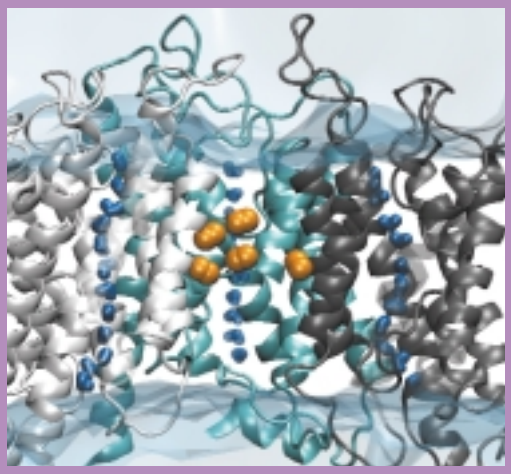
Overview



Researchers in the Theoretical and Computational Biophysics group used NAMD (Nanoscale Molecular Dynamics), a parallel dynamics code designed for high-performance simulation of large biomolecular systems, to investigate the gas permeability of AQP1.

Research within Molecular and Electronic Nanostructures involves manipulation and study at the molecular scale for both basic science research purposes and for designing and engineering nanoscale applications. Properties such as tighter molecular bonding found at the nanoscale are creating a huge potential for nanotechnology development in areas ranging from medical applications to electronics to large-scale manufacturing. M&ENS has been a national leader in fostering nanoscale research since it was formed, and that role continues today with scientific breakthroughs, innovative technology development, and the addition of new centers at the Beckman Institute.

For the second year in a row, a new national center for nanotechnology was headquartered at the Beckman Institute. The IMPACT Center for the Advancement of MEMS/NEMS VLSI is now at Beckman, following a successful funding proposal from a team of M&ENS researchers **(A. Cangellaris, N. Aluru, P. Geubelle, I. Chasiotis**, and **U. Ravaioli).** Just last year, the National Center for the Design of Biomimetic Nanoconductors, one of four National Institutes of Health centers for advancing nanoscale research and medical technology, was housed at the Institute and is led by a M&ENS researcher **(E. Jakobsson)**. The Network for Computational Nanotechnology (NCN) at Illinois, also led by M&ENS researchers **(N. Aluru, E. Jakobsson, U. Ravaioli),** is part of a National Science Foundation multi-university effort to share nanotechnology research and resources.

The ability of M&ENS researchers to work at scales of a billionth of a meter using leading-edge technology and techniques like scanning tunneling microscopy **(J. Lyding)** and molecular dynamics simulations **(K. Schulten)** facilitates basic research in biology and the physical sciences.

While M&ENS research is always evolving, previously successful research lines such as self-healing materials continue to generate breakthroughs and garner large funding grants. In the past year, researchers who were responsible for discovering self-healing plastics **(J. Moore, S. White, N. Sottos)** reported on a new way to do chemistry for potential self-healing applications, and are part of a new program funded by a large Multidisciplinary University Research Initiative grant for developing polymer composites.

The promise of nanotechnology is being realized in M&ENS through research into biological and medical applications like sensors and tests for use in drug detection, targeted drug delivery, and DNA sequencing (**Y. Lu, J-P. Leburton, K. Schulten**, **others**). Nanoscale research for microchip and electronics applications within M&ENS is among the most innovative in the field with fascinating discoveries in silicon technology (**J. Rogers, J. Lyding, others**) and newly-developed fabrication techniques **(N. Fang)**.

With a steady stream of peer-reviewed papers in the top scientific journals and attention from national journals like *Science* and *Nature*, the results coming from M&ENS continue to shine a light on the nanoscale world. The applications from this work are already helping to bring the vast potential of nanotechnology into the real world.

The image at left was created by the Imaging Technology Group for the Microvascular Autonomic Composites group. It illustrates how cracks in a brittle coating are healed autonomously via a 3-D microvascular network embedded in the underlying substrate. The network contains a healing agent (red), which polymerizes after contacting the catalyst (purple) in the damaged regions.

Jean-Pierre Leburton

Developing Semiconductor Membranes for Bio-molecule Control in Nanopores

A national effort called the Revolutionary Genome Sequencing Technologies program is funding a team of researchers at the Beckman Institute who are working to develop a synthetic nanopore for sequencing DNA in a low cost and reliable way. A key player in that effort, **Jean-Pierre Leburton** of the Computational Electronics group, has shown a novel way to increase the versatility and control capabilities of an artificial nanopore by taking advantage of the latest advances in semiconductor technology.

Leburton and his collaborators reported that by using thin, multilayer semiconductor materials as artificial membranes, they were able to control the electrolyte charge in a nanopore and regulate ion flow. This method offers greater electric control of the double layer at the membrane surface, thus enhancing the ion selectivity capabilities that are crucial to creating an artificial nanopore for single molecule detection and DNA sequencing.

The nanopores in a p-n semiconductor membrane offer tunability without the need for buffer solution replacement or membrane treatment, and unlike artificial nanopores in dielectric membranes, have the added benefit of being able to filter positive *and* negatively charged ions.

Leburton said that advances in semiconductor technology have enabled the fabrication of nanometer scale layers with arbitrary *n*- or *p*- doping levels and that by taking advantage of this technology, his research is advancing efforts to separate bio-molecules for single molecule detection and sequencing purposes.

"We really haven't used all the potential of semiconductor technology, so the fact that you can control the charge and have tunability that means you can separate the bio-molecules according to their charge," Leburton said.

That capability means the semiconductor membrane could provide better performance and more flexibilty than a biological membrane.

New Approach to Chemistry Advances Self-Healing Materials Research

A "fundamentally new way of doing chemistry" is how M&ENS researcher **Jeffrey Moore** describes the method he and collaborators **Nancy Sottos** and **Scott White** developed that uses mechanical force to drive and control chemical reactions.

The three researchers, all members of the Autonomous Materials Systems group, have received national attention in the past few years for their discoveries in the area of self-healing materials. This new method may lead to materials that can sense damage or alter their mechanical properties during use. The researchers demonstrated that a mechanically active molecule called a mechanophore could be used to produce a desired chemical reaction upon application of external force.

"We created a situation where a chemical reaction could go down one of two pathways," Moore said. "By applying force to the mechanophore, we could bias which of those pathways the reaction chose to follow."

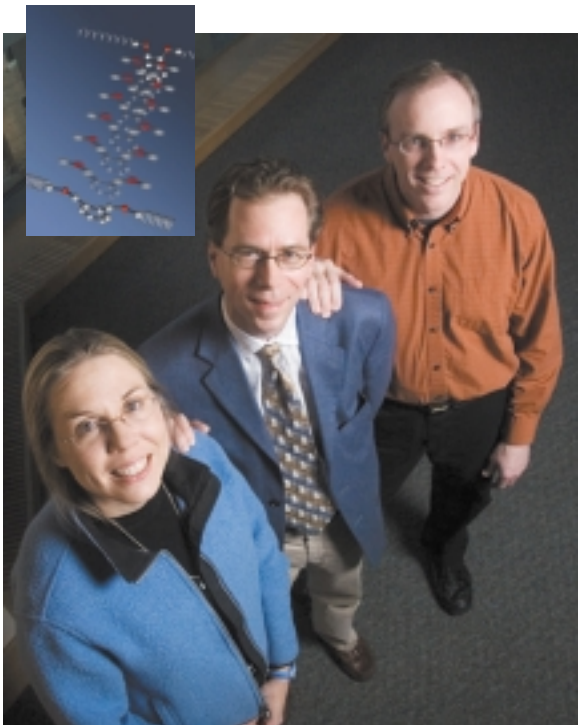
Starting chemical reactions has depended on energy sources such as heat and light; using mechanical force adds not only another path to initiate reactions, but also offers results that aren't possible with other methods.

"We have demonstrated that it is now possible to use mechanical force to steer chemical reactions along pathways that are unattainable by conventional means," Moore said.

Large Grants Fuel New Center, Polymer Composite Research

The Molecular and Electronic Nanostructures research initiative continues to be a magnet for leading research, as evidenced by two large grants awarded to M&ENS researchers this past year.

A new multi-university center for advancing the development of micro- and nano-electromechanical systems (MEMS and NEMS) for integration with larger systems will be headquartered at the Beckman Institute thanks to a team of M&ENS researchers and a $4.5M grant from the Defense Advanced Research Projects Agency (DARPA) and a group of high-tech corporations. The IMPACT Center for the Advancement of MEMS/NEMS VLSI was created following a proposal from a team led by principal investigator **Andreas Cangellaris** (who serves as



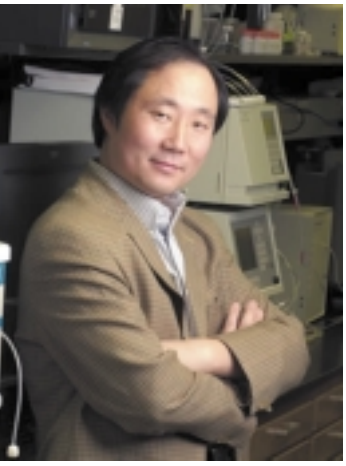
Nancy Sottos, Scott White, and Jeff Moore of the Autonomous Materials Systems group have discovered a new approach to chemistry that is advancing research in self-healing materials. Their work was featured the March 22, 2007, issue of *Nature*.

Research by Narayana Aluru is investigating stimuli-responsive hydrogels.

a co-director), and fellow M&ENS researchers **Narayana Aluru**, **Philippe Geubelle**, **Ioannis Chasiotis**, and **Umberto Ravaioli**. The center is one of 11 created by DARPA for the mission of conducting "fundamental research needed for comprehending the impact of material properties, surfaces, material interfaces, and operating conditions on MEMS/NEMS functionality and device failure."

Jeffrey Moore of the Autonomous Materials Systems group is the principal investigator on a winning proposal in the Multidisciplinary University Research Initiative (MURI) grant competition announced by the Department of Defense. The multi-university grant is for a program to develop mechanochemically-active polymer composites for self-sensing and self-healing applications.

Moore and Beckman Institute colleagues **Nancy Sottos**, **Paul Braun**, **Todd Martinez**, and **Scott White** are working to develop new types of self-sensing and self-healing polymer composites based on molecular-level mechanochemical transduction.



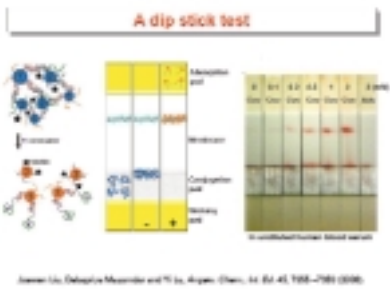
Yi Lu

Developing A Simple "Dipstick" Sensor for Drug Detection

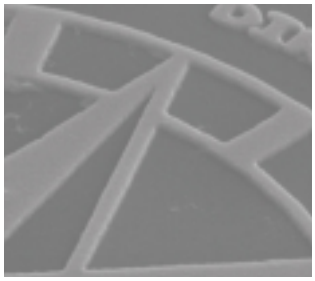
Yi Lu, a member of the 3-D Micro and Nanosystems group in M&ENS, designs and engineers nanoscale biomaterials for applications in sensing and imaging. In 2006, Lu and his collaborators Juewen Liu and Debapriya Mazumdar developed a simple, easy-to-use test for detecting cocaine and other drugs and chemical agents in saliva, blood serum, and urine.

The method is similar to home pregnancy tests in that it uses a "dipstick" or colorimetric sensor that reacts to a molecular target such as cocaine. Lu and his group developed the sensor using gold nanoparticles, aptamers, and lateral flow technology.

Aptamers are single-stranded nucleic acids that can perform the same kind of functions antibodies do in humans due to their proficiency at binding to specific molecules. An aptamer corresponding to the molecular target of the test is chosen from a DNA library for the test; the nanoparticles are linked into aggregates by the aptamers and then upon dipping into a solution containing targets, separated for detection purposes using lateral flow devices.



Unlike other drug tests, Lu's method doesn't require a laboratory setting, greatly reducing its cost and response time. Lu said the method's quick response time would make it especially useful for first responders or for doctors in an emergency room. The method has been verified through successful tests, including a test for cocaine in human blood serum.



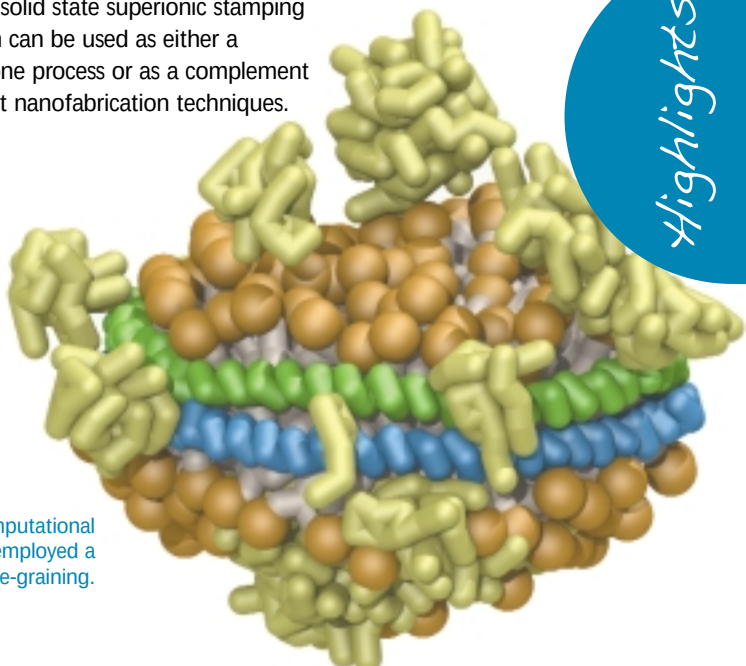
Nicholas Fang and his collaborators developed a novel electrochemical stamping process that creates a new method for nanopatterning.

Direct Patterning of Nanostructures Developed

A research effort led by **Nicholas Fang** of the 3-D Micro and Nanosystems group discovered a simple, one-step nanoscale fabrication technique that could reduce costs and increase production of devices like microchips and sensors. Fang and his collaborators developed a solid-state, superionic stamping process for the direct patterning of nanostructures such as metallic interconnects that are a vital component of microchip fabrication.

The stamp used in the nanoimprinting method is a superionic (a solid with extremely high conductivity) material like silver sulfide into which the desired pattern is etched using focused ion beam milling. The process consists of placing the stamp on a substrate and applying a voltage; the resulting electrochemical reaction causes metal ions to move into the stamp and progress into the substrate, creating a complementary pattern on the metallic film substrate. The patterning resolution is on the scale of 50 nanometers, a number the group hopes to improve in the future with better tools.

The solid state superionic stamping approach can be used as either a stand-alone process or as a complement to current nanofabrication techniques.



The image at right was created by the Theoretical and Computational Biophysics group. The simulations used to created the image employed a new method called residue-based course-graining.

Aluru: A Passion for

"I'm excited about nano because there is so much there that we don't understand. It's a rare opportunity for us to discover new things, to understand how the classical understanding of physics breaks down and to develop new theories."

1

A nanometer is one-billionth of a meter—25,000 times smaller than the width of a human hair.

1999

Received the National Science Foundation CAREER Award.

3

Aluru has affiliations with three different departments at Illinois:

- Professor, Department of Mechanical Science and Engineering
- Affiliate, Department of Electrical and Computer Engineering
- Affiliate, Department of Bioengineering

Researcher Profile

the Nanoscale

Looking out from his office window on the third floor of the Beckman Institute, Narayana Aluru sometimes becomes wistful – at least when he stops to watch the occasional cricket match taking place on the grass below.

"I see them and I'm tempted to go play, but no time," Aluru said.

Aluru grew up playing cricket in his native India and continued the sport as a graduate student in the United States, competing for a team at Stanford while earning a Ph.D. and in Boston while doing post-doctoral work at MIT.

"It's a fascinating game but for someone on the outside looking at it, it may look like a boring game," Aluru said. "There are subtle aspects of the game which if you play, you can really appreciate in terms of how you score runs versus how you bowl, how you pitch the ball. It's a skill and to really excel at that you need to have those fine skills."

There is no time for cricket these days because Aluru is too busy excelling as a leading micro- and nanoscale researcher, full-time professor in the Department of Mechanical Science and Engineering at the University of Illinois, and as a key member of the Beckman Institute faculty.

Aluru is co-chair of one of Beckman's three main research initiatives, Molecular and Electronic Nanostructures, a principal investigator on large research projects involving micro- and nano-electromechanical systems (MEMS and NEMS), and is a leading advocate for nanotechnology research.

Aluru's research focus is on applying computational methods to a number of microscale and nanoscale issues in the areas of MEMS, NEMS, microfluidics, and nanofluidics. His group was one of the first to do modeling and simulation of micro-electromechanical systems, while solving some of the most complicated problems and showing novel physics in the area of MEMS. On the nanometer scale, Aluru said his group was among the first to propose a physical theory for NEMS.

"More recently we have dealt with the very, very difficult problem of finite temperature in multi-scale modeling," Aluru said. "Also, I think our best accomplishments are in the area of nanofluidics because we have shown some very unique phenomena and developed some theories to explain these unique phenomena."

Aluru said advances in understanding nanofluidics could lead to breakthroughs in disease detection, drug therapies, and water purification. The field of nanoscale research is one that is important to Aluru. As evidence, he has been a leader of the Network for Computational Nanotechnology at Illinois, part of a National Science Foundation effort to share knowledge and resources about nanotechnology with others in academia, government, and industry.

"I'm excited about nano because there is so much there that we don't understand," Aluru said. "It's a rare opportunity for us to discover new things, to understand how the classical understanding of physics breaks down and to develop new theories. It does have applications and the applications are enormous. If you look at future advances in energy, in human health, in the environment, and in computing, they will all probably come from advances in nanotechnology."

Aluru's academic background includes stops at some of the premier research universities and laboratories in his field, but he puts the Beckman Institute at the top because of the collaborations he has had here and because of its facilities.

"I think that Beckman is the best research institute that I've ever been at and I did research at places like Stanford, MIT, and I've seen the labs there," he said. "I think this is perhaps the best place to do interdisciplinary research. Having people like Karl Hess and Umberto Ravaioli just makes it even more fun.

"If you look at the kind of applications that I was working on before I joined Beckman and you look at the applications that I'm working on since I joined Beckman, you will see that they are quite different. That's because I was exposed to all these different collaborations here."

Aluru has also been exposed to American sports since coming here from India.

"I religiously watch the World Series every year," he said. "I watch football more and I like the Bears now."

Even though he may no longer have time to play cricket, a sport which features matches that can last for five days, Aluru said he derives some of the same satisfaction from doing research work.

"In science you need to have a lot of patience," he said. "In science you dig deeper and deeper into the problem, you learn more and more and you appreciate the significance of things that you didn't know before."

BIOMEDICAL IMAGING CENTER

How does exercise affect the brain? What can we do to improve our cognitive abilities as we age? How can we develop better, non-invasive methods for detecting cancer? These wide-ranging questions are just a few that are being explored using the Beckman Institute's Biomedical Imaging Center (BIC).

BIC is a tremendous facility for conducting research and developing MRI and fMRI technologies that range from imaging single cells to the complex systems of cognitive function. BIC is committed to developing novel, leading-edge techniques that combine magnetic resonance imaging with other imaging techniques such as optical imaging, eye-tracking, EEG, and transcranial magnetic stimulation.

The wide array of projects being conducted using BIC include researchers from more than 20 different departments including psychology, electrical and computing engineering, kinesiology and community health, mechanical science and engineering, speech and hearing science, chemistry, veterinary clinical medicine, and pathology. A snapshot of the work they are conducting at BIC includes cognitive studies on the effects of aging and exercise, cortical plasticity and adult development, emotional and cognitive processing, multimodal imaging of cognition, and cancer imaging and treatment models.

Hardware and software development is also an integral part of the work at BIC. Projects that are under way include RF coils development, creating custom-built MRI accessories, pulse programming, developing k-t Spatiotemporal MRI, measuring flow velocities in micro-flow-cells using the Diffusion Enhancement of Signal and Resolution (DESIRE) effect, using multiple micro-coil probes to reduce data acquisition time in multi-dimensional NMR spectroscopy, and using parallel imaging for NMR microscopy at 14.1T.

Art Kramer on the new 3T whole-body MRI system. "It will accommodate the next generation of multimodal imaging and it will allow for expansion into other areas of demand including cardiac imaging, animal imaging, and neural activity related to language processing."

Expanding Capabilities with a new 3T Whole-Body MRI System

This past year the Biomedical Imaging Center and the Beckman Institute worked to secure a state-of-the-art three Tesla (3T) whole-body magnetic resonance imaging (MRI) system.

Art Kramer, director for BIC, was instrumental in putting the proposal together and is very excited about the new possibilities it will bring to the Biomedical Imaging Center and the University of Illinois.

"Our current head-only 3T MRI system has been highly successful," Kramer said. "But, in order to sustain the cutting-edge research programs that have developed, we need to move forward with a 3T whole-body MRI system. It will accommodate the next generation of multimodal imaging and it will allow for expansion into other areas of demand including cardiac imaging, animal imaging, and neural activity related to language processing."

The new 3T whole-body MRI system is expected to be up and running in the Fall of 2008.

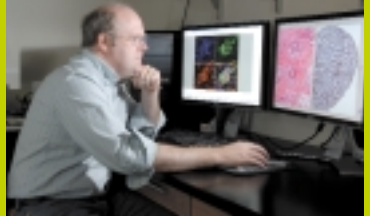
Biomedical Imaging Center Equipment and Facilities

- 3T Siemens Magnetom Allegra MR Headscanner
- Varian/Spectroscopy Imaging Systems Corporation (SISCO) Imaging Spectrometer
- 600 MHz Varian MR System
- 512 Channel Bi-Wavelength Near-Infrared Imager
- 3T Allegra Mock Magnet
- Advanced AC magnetic field applicator for small animal hyperthermia treatment
- Low-magnetic field (5 ÷ 50 G) polarizer for gas and liquid DNP-enhanced MRI
- Reference library
- Computer laboratory
- Electronic shop
- Mechanical shop
- Wet lab
- Human subject preparation area

Denise Park of the Cognitive Neuroscience group collaborates with neurologist Michael Chee of Singapore Hospital on cross-cultural research studies.

The Biomedical Imaging Center is used by researchers from more than 20 different departments. The 3T Magnetom Allegra MR Headscanner will soon be complemented with a new 3T Whole-Body MRI system.

IMAGING TECHNOLOGY GROUP



The Imaging Technology Group provides state-of-the-art resources via the Microscopy Suite and the Visualization, Media, and Imaging Lab. Through these two interrelated facilities, researchers from all disciplines are given the tools and help they need to document, enhance, and showcase their work. These facilities are open to the entire Illinois campus, as well as workers from government, other universities, and industry.

Microscopy Suite

The Microscopy Suite supports a wide variety of instrumentation. Most researchers who are interested in collecting high-resolution images of their samples are likely to find what they need within the suite, without having to go elsewhere.

Microscopy in the suite is divided generally into:

Light Microscopy — including multiphoton confocal, with two-photon capability and a range of wavelengths from UV to IR; fluorescence, with structured illumination and excellent 2- and 3-D tiling capabilities, reflected light, with laser tweezers, UV and visible light spectrometers, and a high-sensitivity IR camera; stereo-zoom dissecting for low magnification imaging; and stereology/nerve tracing, primarily for neuroscience work;

Electron microscopy — including a 200-kV transmission electron microscope (TEM) with standard and custom-built holders, and a field-emission environmental scanning electron microscope (ESEM) with every useful option as well as excellent hi-vacuum (normal SEM) imaging capability;

Scanned Probe Microscopy — including a multimode atomic force microscope (AFM) and versatile nearfield scanning optical microscopes (NSOM). Along with the necessary preparation equipment, such as the ultramicrotome and critical point dryer, the suite maintains and supports light-scattering particle size analyzers as well as a range of sputtering, resistive evaporative, and plasma coating equipment.

Besides its array of state-of-the-art microscopes, the Microscopy Suite has an enthusiastic, full-time staff with the expertise and experience to assist researchers with their work. This friendly, knowledgeable staff is one of the most distinguishing factors of the Beckman Microscopy Suite and sets it apart from other facilities.

Visualization, Media, and Imaging Laboratory

The Visualization, Media, and Imaging Laboratory (VMIL) at the Beckman Institute provides researchers with an incredible cutting-edge facility that supports a wide range of projects. From providing computer animations that illustrate scientific concepts to helping with volumetric data analysis, the VMIL allows its users to stay on the leading edge of research.

The VMIL provides resources, equipment, and services for:

- Image analysis
- Scientific visualization
- Animation and high-definition video production
- Color 3-D printing
- X-ray micro-CT scanning
- High-resolution macro photography
- 3-D object scanning
- Research presentation

What sets the VMIL apart from its peers is its dedication to providing an expert and diverse staff that intimately understands the software and hardware resources of the facility. VMIL staff members use this knowledge to provide custom training to Beckman researchers that helps them not only meet the goals of their projects, but exceed them.

Technology Development

ITG's secondary mission is to develop advanced imaging technologies, with an emphasis on remote and virtual instrumentation. These projects allow ITG to provide new methodologies for imaging and data viewing, while also enabling novel and substantive educational outreach opportunities for Beckman faculty.

The Bugscope project allows children worldwide to remotely control ITG's high resolution scanning electron microscope (ESEM). These students collect insect specimens from their own backyard, mail them to ITG, and then log in from their classroom to operate the ESEM using a Web browser. The students collect high magnification images of the bugs while they "chat" with Beckman's "bugteam" during their session.

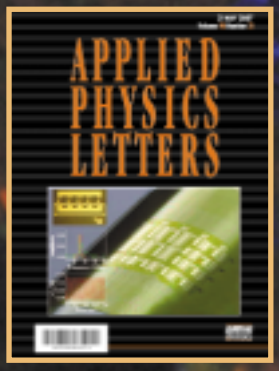
The Virtual Microscope project provides software to explore pre-captured high-resolution, multi-dimensional image data sets from light, electron, and scanning probe microscopes. Supporting features such as focus, excitation wavelength, and x-ray spectroscopy allow both students and researchers to use the Virtual Microscope just as they would the real instruments.

Both projects have been very successful. Bugscope has provided hundreds of sessions throughout the United States for K-12 teachers and students, while the Virtual Microscope enjoys thousands of downloads each month.

Jon Ekman, microscopist in the Imaging Technology Group.

This stunning image illustrates a cut view through a 3-D volumetric stack of XY images using our Zeiss Apotome on the Zeiss Axiovert 200M Fluorescence Microscope and the Roper Cascade 512B camera.

The Imaging Technology Group provides researchers with assistance on a wide range of projects including illustrations and images that can be used on high-profile journal covers.



The Integrated Systems Laboratory (ISL) provides research opportunities that stretch the limits of imagination in a diverse range of fields. From psychology to urban planning and earthquake visualization to art and technology, the tools found in ISL advance the understanding of human-computer interactions. ISL provides researchers with an advanced visualization environment — both immersive and ultra-high resolution — that is ideal for studies in human multimodal perception and cognition.

Key components of ISL include the Beckman Driving Simulator, the Cube, the CAVE and CANVAS.

The Driving Simulator

The Beckman Institute Driving Simulator is an integral part of the ISL and it is used extensively by perceptual psychologists who are examining the way drivers interact with both their environment and the increasingly complex nature of their automobiles. Results from research conducted using the Driving Simulator have been a "hot topic" with both the media and the general public and as a result, this work has been featured in numerous high-profile media outlets around the world.

Using a General Motors Saturn automobile, the driving simulator surrounds the "driver" with eight projected moving images. These images, and a fully integrated eye-tracking system, allow researchers to gather data on how humans interact with the automobile.

A "driver" navigates the streets using the Beckman Institute Driving Simulator.

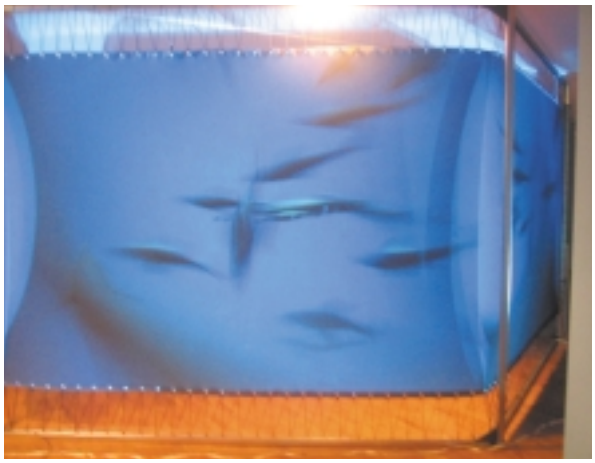
The CAVE

The CAVE™ is a four-sided immersive reality environment operated by ISL. First constructed in 1995, it recently moved to a newly renovated space adjacent to the Cube that includes a new control and machine room. Several Immersadesks are in the same environment, connected to Onyx supercomputers and PC clusters, enabling users to quickly develop, test and remotely demonstrate new applications.

The Cube

The Cube is a world-renowned, six-sided virtual reality chamber that provides a completely immersive environment. Used extensively by researchers in psychology, the Cube is driven by a cluster of personal computers using an ISL-developed application called Syzygy. Current research projects in the Cube include human spatial navigation, object memory, visualization of urban planning data, virtual painting, and motion capture in virtual environments, just to name a few.

The Cube is also involved in several outreach projects using the latest addition to Syzygy, Myriad, a collaborative infrastructure that allows researchers anywhere with a network connection to interact with the images seen by researchers inside the Cube.



A virtual school of fish on display in the CANVAS project located in the Digital Gallery of the University of Illinois Krannert Art Museum. (Rose Marshack)

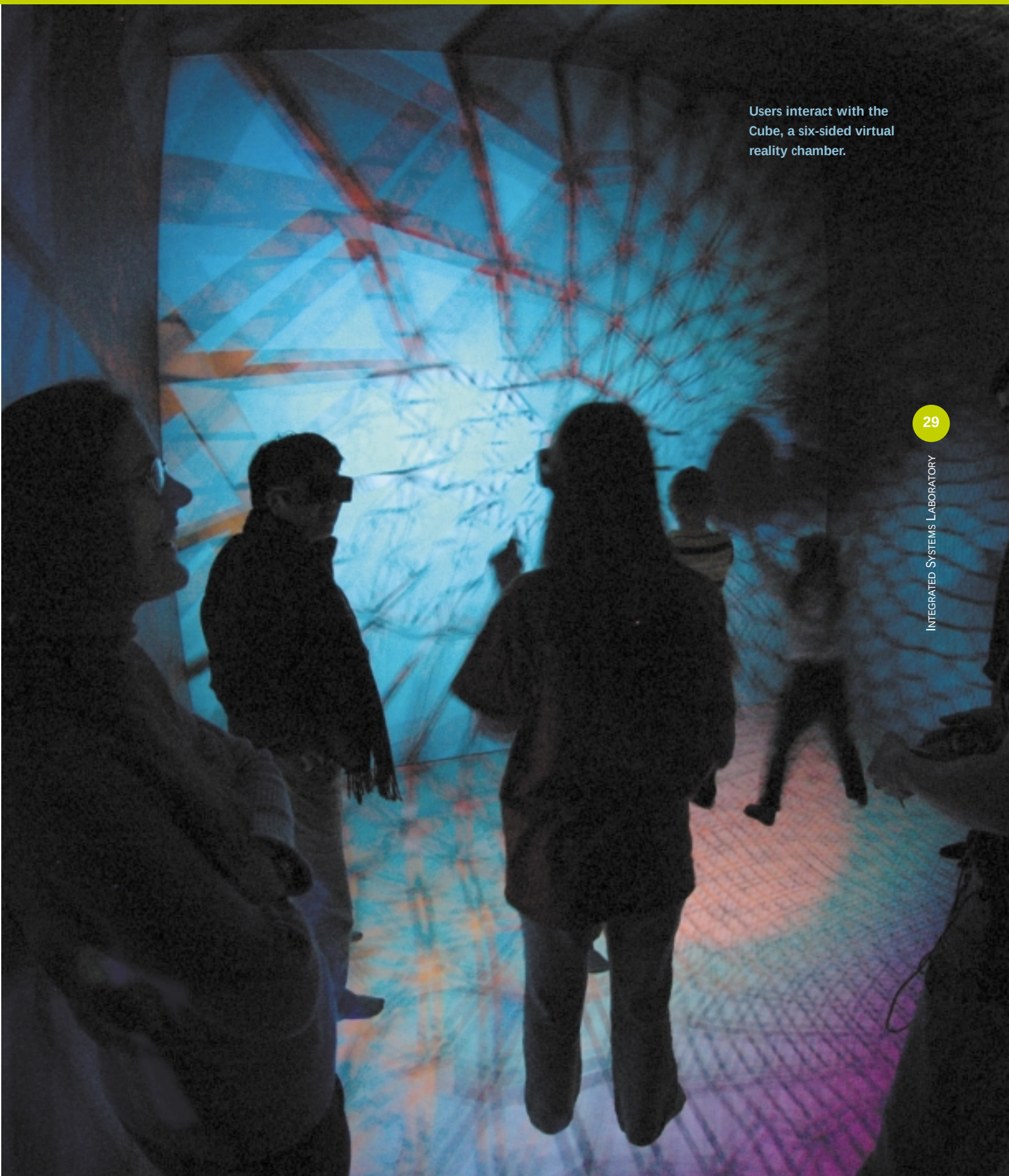
CANVAS

(Collaborative Advanced Navigation Virtual Art Studio)

ISL is instrumental in bringing art and technology together via CANVAS, a collaborative project at the Krannert Art Museum. CANVAS runs on the Syzygy grid-operating system which is open source. It runs under Windows, Linux, and macOSX.

A new project has also just emerged called The Traveling CANVAS. This movable display will travel to many different places to allow an even greater number of people to experience immersive 3-D. The Traveling CANVAS will be unveiled in January 2008 at the Dennos Museum Center at Northwestern Michigan College.

“Blue Julia” is an image currently on display in the CalculArt Traveling CANVAS exhibit. It is a three-dimensional slice of a four-dimensional quaternion Julia set. (Nicholas Duchnowski)



Users interact with the Cube, a six-sided virtual reality chamber.

BECKMAN INSTITUTE FELLOWS PROGRAM

The Beckman Institute Fellows program provides an excellent opportunity for young scholars to initiate a post-Ph.D. career of independent research in a stimulating and supportive interdisciplinary environment.

The Beckman Institute Fellows are selected based on evidence of professional promise, capacity for independent work, outstanding achievement, and interdisciplinary research interests that correspond to one or more of the Beckman Institute's research initiatives.

Pierre Wiltzius, director of the Beckman Institute, says the Fellows program is invaluable. "The Fellows program brings talented, young scholars from around the world to the Beckman Institute. Their varied backgrounds and leading-edge research topics complement the global work that is being done at Beckman," says Wiltzius.

Current Beckman Institute Fellows

Joe Geddes, 2006 Fellow
Joe joins Beckman from Penn State where he received his doctorate in Engineering Science. His thesis work focused on the time-domain optical response of inhomogenous, anisotropic, and nonlinear materials like chiral sculptured thin films to excitation by ultrashort optical pulses. At Beckman he is extending that work into new areas, particularly the design of novel photonic materials.

Yael Gertner, 2006 Fellow
Yael was a Postdoc Fellow in the Psychology Department at the University of Illinois. Her research deals with how children acquire words and rules of their native languages and how these processes can be modeled using computational tools. Gertner is pursuing further research in this area using experimental psycholinguistics and techniques from computational learning theory. She plans to use the knowledge derived from the experiments to design better learning algorithms that use the same features children use and obtain the same feedback that children obtain.

Ming Hsu, 2006 Fellow
Ming comes to the Beckman Institute from the California Institute of Technology where he received his Ph.D. in Social Sciences in June of 2006. His thesis work focused on decision theory, microeconomic theory, behavioral economics, and neuroeconomics. At the Beckman Institute Ming is continuing his work in neuroeconomics. His research uses brain imaging to examine which brain processes are engaged in the Ellsberg Paradox and the role of home bias phenomenon in investment decisions.

Mark Neider, 2006 Fellow
Mark comes to Beckman from the SUNY Stony Brook Department of Psychology. His thesis work examined the effects of target-background similarity on visual search. Neider's research goals are to reconcile the basic search literature with behavior observed under lifelike conditions, while concurrently providing environmentally valid data from which to inform current models of visual attention and visual search.

Stephanie Rinne, 2006 Fellow
Stephanie received her Ph.D. in Materials Science and Engineering at the University of Illinois. Her research interests include optical coherence tomography (OCT), which affords cellular resolution and *in vivo* imaging capability. Stephanie is exploring contrast in this imaging modality and strives to improve the current contrast mechanisms to help provide earlier diagnosis techniques for cancer.

Dirk Walther, 2006 Fellow
Dirk earned his Ph.D. in Computational and Neural Systems at the California Institute of Technology in Pasadena, California. His research topic was "Modeling interactions of visual attention and object recognition in human and machine vision." As a Beckman Fellow, he is investigating the effects of task on human visual processing and their applications.

Sarah Brown-Schmidt, 2006 Fellow
Sarah earned her Ph.D. from the University of Rochester in Brain and Cognitive Sciences. Her research focuses on the mechanisms by which people produce and understand utterances during the most basic form of language use: interactive conversation. She also has strong interests in language production, in particular how messages are planned during conversation.

Chandramallika Basak, 2005 Fellow
Chandramallika received a Ph.D. in Experimental Psychology from Syracuse University. Her research interests include aging and the effect of video-game training on brain and cognition; and individual differences in working memory span and retrieval dynamics of items in working memory – both from behavioral and biological perspectives. Chandramallika collaborates with faculty in the Cognitive Neuroscience and Human Perception and Performance research groups.

Silvio Savarese, 2005 Fellow
Silvio earned his Ph.D. in Electrical Engineering at the California Institute of Technology completing his dissertation on "Perception and 3-D reconstruction of specular surfaces." His current research in computer vision is focused on the recognition of scene and object categories and the perception and recognition of reflective surfaces. Silvio is pursuing those interests as a member of the Human-Computer Intelligent Interaction (HCII) Research Initiative.

Zhihong Zeng, 2005 Fellow
Zhihong earned his Ph.D. from the Institute of Automation, Chinese Academy of Sciences, with his dissertation "Real-time Shape Tracking under Various Circumstances." He has been working with the Image Formation and Processing group at the Beckman Institute since 2002. Zhihong's research interests in multimodal emotion assessment for human-computer interaction includes the psychological analysis of human emotion perception, computer vision, speech processing, and machine learning. Zhihong does research in the HCII research initiative, focusing on multimodal emotional state assessment for human-computer interactions in naturally occurring settings.

Maxim Raginsky, 2004 Fellow
Maxim completed his Ph.D. from Northwestern University in June 2002. His research interests are in the area of statistical physics, information theory, probability theory and discrete mathematics. As a Beckman Fellow, Maxim applies the paradigm of collective phenomena in complex multi-component systems to the following two problems: (1) development of unified information–theoretical methods for statistical learning and (2) mathematical modeling of information storage in the brain. Maxim works with the Image Formation and Processing, NeuroTech, and Artificial Intelligence research groups.

Richard Godijn, 2003 Fellow
Richard received his Ph.D. in Cognitive Psychology from Vrije Universiteit in Amsterdam in 2003. His research interests include the areas of visual selection and the brain mechanisms related to visual attention and eye movements. As a Beckman Fellow, he is working with members of the Cognitive Neuroscience and Human Perception and Performance research groups.

The Beckman Graduate Fellows Program, supported by funding from the Arnold and Mabel Beckman Foundation, offers University of Illinois graduate students at the M.A., M.S., or Ph.D. level the opportunity to pursue interdisciplinary research at the Institute.

Research projects must involve at least one Beckman faculty member in addition to a second U of I faculty member, and preference is given to those proposals that are interdisciplinary and involve the active participation of two Beckman faculty members from two different groups.

2006-2007 Beckman Institute Graduate Fellows

Eamon Caddigan
Eamon is pursuing his Ph.D. in Visual Cognition and Human Performance in the Department of Psychology. As a Beckman Graduate Fellow he plans to continue his research on human perception of natural scenes. He hopes his ability to collaborate with Beckman Institute faculty members will result in improved understanding and knowledge of how humans interact with the visual world.

Yun Fu
Yun is pursuing his Ph.D. in Electrical and Computer Engineering. His work focuses on applying multimodal manifold-embedded subspace learning to different biomedical imaging modalities and then using them to view important biomolecular signaling events in cancer. Specifically, he will be working with breast cancer diagnosis and will be aiming to find ways to conduct accurate breast cancer diagnosis by the fusion of ultrasound and FTIR imaging. This could lead to innovative clinical diagnosis and biological study tools, as well as computer-aided surgical technologies.

Matthew George
Matthew is working on his Ph.D. in Materials Science and Engineering. His ultimate research goal is to build and test a functional, chalcogenide glass-based, nonlinear 3-D photonic crystal device. His research will require collaboration with Beckman Institute researchers as well as international collaborations. The results of this work are expected to enable numerous applications in photonics and telecommunications.

James Rinne
James is pursuing his Ph.D. in Materials Science and Engineering. His research has emerged as a promising route to the low-cost fabrication of 3-D periodic structures for applications in photonic crystals, microfluidics, and drug delivery. To more effectively employ this technique, James has developed a computational strategy for the design of 3-D periodic structures based on genetic algorithms. His research goal will be to illustrate this design strategy and explore potential applications.

Su-Youn Yoon
Su-Youn is working on a Ph.D. in Linguistics. Her research is developing a computer-aided pronunciation training system for second language learners. The system she is working on assesses the user's pronunciation accuracy and provides feedback to correct errors. This system would allow language learners to work independently and would provide a more economic solution than traditional methods.

Behzad Sharif
(accepted with deferred start date of Summer 2008)
Behzad is working toward a Ph.D. in Electrical Engineering. His research goal is to pursue significant fMRI improvements that yield higher spatial and temporal resolution, and reduced magnetic susceptibility artifacts that currently plague fMRI investigations. His work bridges the gap between engineering development and cognitive neuroscience research.

NEW FACULTY

The Beckman Institute welcomed a dozen new faculty members with a wide variety of research interests this past year, ensuring that our work continues to evolve and remain vibrant. Joining the Institute were one full-time faculty member, seven part-time faculty and four affiliate faculty.

FULL-TIME FACULTY

Biological Intelligence

Marni Boppart has joined the Bioimaging Science and Technology group. She is an Assistant Professor in the Department of Kinesiology and Community Health at the University of Illinois. Her research interests include areas such as cellular biomechanics and cell signaling, including experiments that look at counteracting the loss of skeletal muscle through molecular-based or exercise therapy interventions.

PART-TIME FACULTY

Biological Intelligence

William Olivero is a member of the Bioimaging Science and Technology group and a Professor in the College of Medicine, Department of Surgery, and part of the Neuroscience Program at Illinois. His main research areas involve brain tumors, hydrocephalus, and brain cooling, using fMRI to study patients with low back pain from herniated lumbar discs, and a project attempting to measure the consistency of brain tumors using MRI technology.

Human-Computer Intelligent Interaction

Timothy Bretl is an Assistant Professor of Aerospace Engineering who joined the Artificial Intelligence group. His research involves aerospace information technology, systems, and control, with a focus on robotics and autonomous vehicles.

Todd Coleman is an Assistant Pofessor in the Department of Electrical and Computer Engineer and has affiliations with the Coordinated Science Laboratory and the Neuroscience Program. His research interests include information theory, communications, operations research, security and information forensics, statistical signal processing, and computational neuroscience.

Wai-Tat Fu is a member of the Human Perception and Performance group and an Assistant Professor in the Human Factors Division at the Institute of Aviation at Illinois. His research interests include human performance modeling, training and skill acquisition, adaptive behavior, human-technology interaction, judgment and decision making, and computational cognitive modeling.

Yi-Ching Lee is a member of the Human Perception and Performance group and an Assistant Professor in the Human Factors Division at the Institute of Aviation at Illinois. Her research looks at human factors in ground transportation, guidance of attention in naturalistic settings, driver distraction, and modeling of driver performance.

Molecular and Electronic Nanostructures

Iwona Jasiuk is a professor in the Department of Mechanical Science and Engineering and a member of the 3-D Micro and Nanosystems group at Beckman. Her research interests involve solid mechanics, biomechanics, composites, biological nanomaterials, bone mechanics, micromechanics, composite interface, and elasticity.

Erik Luijten is a member of the Computational Multiscale Nanosytems group and an Assistant Professor of Materials Science and Engineering. He focuses on the thermodynamic properties and phase behavior of materials, with a strong emphasis on complex fluids, such as polymeric systems and electrolytes. His current research projects concern the properties of electrolyte solutions near their critical point and the phase behavior of ternary polymer solutions as a function of the degree of polymerization.

AFFILIATE FACULTY

Biological Intelligence

Stephanie Ceman of the Neurotech group is an Assistant Professor of Cell and Developmental Biology at Illinois. Her research focuses on the molecular basis of disease, post-translational modifications, regulation of RNA expression, and RNA-protein interactions with a goal of gaining insight into the molecular basis of learning and memory by using the fragile X mental retardation protein, FMRP, as a model system.

Christopher Grindrod is an Assistant Professor in the Department of Speech and Hearing Science and a member of the Cognitive Neuroscience group. His research interests are in the areas of the neural basis of language, the role of left and right cerebral hemispheres in integrating word meanings into higher-level sentence and discourse contexts, and the cognitive bases of neurological communication disorders.

Human-Computer Intelligent Interaction

Jacob Sosnoff is a member of the Human Perception and Performance group and Assistant Professor in the Department of Kinesiology and Community Health. His research work involves the issues of motor behavior and control, aging, and perceptual-motor variability. He studies the underlying neurophysiological and behavioral factors responsible for fluctuations (i.e. variability) in performance across the lifespan.

Molecular and Electronic Nanostructures

Xuiling Li is an Assistant Professor in the Department of Electrical and Computer Engineering and a member of the Nanoelectronics group at Beckman. Her research interests are in the area of semiconductor materials and devices, including III-V semiconductors from growth by metal organic chemical vapor deposition (MOCVD) to fabrication of nanostructures and applications in optoelectronics.

EDUCATIONAL OUTREACH

Beckman Institute Open House visitors wear 3-D glasses to explore complex biological images.

Educational outreach is an important part of the Beckman Institute's mission of fostering interdisciplinary research. Through Web-based resources, presentations from faculty, students, and staff, a biennial Open House, and a wide variety of other projects and programs, educational outreach efforts demonstrate the Beckman Institute's commitment to making research relevant to people.

A colony of trap jaw ants entertained and educated visitors to the Open House.

In March of 2007 the Beckman Institute Open House was held in conjunction with Engineering Open House at the University of Illinois. Exhibits displaying everything from the latest technology developments like stretchable silicon to research featuring ants that use their jaws to fly through air helped introduce the general public to the work that takes place here. For two days thousands of visitors listened to presentations about our work, took part in interactive displays, and got up close looks at Beckman Institute projects and the technological resources that help make the research happen.

Educational outreach at Beckman also involves programs geared to schoolchildren. The Imaging Technology Group continues to operate the popular Bugscope educational outreach project, which has allowed thousands of K-12 students to remotely control ITG's environmental scanning electron microscope (ESEM) and view their specimens at the kind of high magnification usually reserved for academic researchers. Students are also given a glimpse into research at Beckman through various school-based programs. In the summer of 2007, students from the Urbana (Ill.) Middle School Achievement Program got a first-hand view of research at the Institute during a visit.

In addition, many of the research groups and laboratories at Beckman have their own educational outreach programs that tell the stories of their work to both peer audiences and the general public. One example that drew a large audience was the campus talk given by Dr. Michael Roizen, a doctor and best-selling author who spoke as part of a presentation sponsored by the Center for Healthy Minds at Beckman.

Sharing knowledge and resources with others is also part of the research mission for many groups at Beckman. One example of a Web-based resource that Beckman researchers contribute to through the Network for Computational Nanotechnology (NCN) at Illinois is nanoHUB.org. NCN at Illinois is led by Beckman researchers, who contribute software, online tutorials, and other resources to nanoHUB.org, described as "a web-based resource for research, education, and collaboration in nanotechnology."

This rapidly growing program is already a success story as one of the early outposts on the new frontier of online education and research resources. Appropriately, the Beckman Institute is a part of this growing trend as it continues and expands its goal of educating people about the value of interdisciplinary research efforts.

The Amnesia Lab explains its research to Beckman Institute Open House visitors.

For a complete list visit www.beckman.uiuc.edu.

BIOLOGICAL INTELLIGENCE FACULTY

(name followed by home department)

Bioacoustics Research Laboratory
Leon A Frizzell, *Electrical and Computer Engineering*
William D O'Brien, *Electrical and Computer Engineering*
Michael L Oelze, *Bioengineering*
James F Zachary, *Veterinary Pathobiology*

Bioimaging Science and Technology
Rohit Bhargava, *Bioengineering*
Marni D Boppart, *Kinesiology and Community Health*
Stephen Allen Boppart, *Electrical and Computer Engineering*
Paul Scott Carney, *Electrical and Computer Engineering*
Michael Insana, *Bioengineering*
Jianming Jin, *Electrical and Computer Engineering*
John A Katzenellenbogen, *Chemistry*
Zhi-Pei Liang, *Electrical and Computer Engineering*
William C Olivero, *Surgery*
Gabriel Popescu, *Electrical and Computer Engineering*
Kenneth S Suslick, *Chemistry*
Bradley P Sutton, *Bioengineering*
Ning Wang, *Mechanical Science and Engineering*
Yingxiao Wang, *Bioengineering*
Yongmei Michelle Wang, *Statistics*
Kenneth L Watkin, *Speech and Hearing Science*

Cognitive Neuroscience
Diane M Beck, *Psychology*
Neal J Cohen, *Psychology*
Monica Fabiani, *Psychology*
Kara Federmeier, *Psychology*
Susan M Garnsey, *Psychology*
Brian D Gonsalves, *Psychology*
Gabriele Gratton, *Psychology*
Christopher M Grindrod, *Speech and Hearing Science*
Wendy Heller, *Psychology*
Gregory A Miller, *Psychology*
Hernando C Ombao, *Statistics*
Denise Park, *Psychology*
Richard S Powers, *English*

Cognitive Science
Aaron Benjamin, *Psychology*
J Kathryn Bock, *Psychology*
William F Brewer, *Psychology*
Kiel Christianson, *Educational Psychology*
Jennifer S Cole, *Linguistics*
Gary S Dell, *Psychology*
Cynthia L Fisher, *Psychology*
Susanne Gahl, *Linguistics*
Jose Mestre, *Educational Psychology*
Michelle Perry, *Educational Psychology*
Brian H Ross, *Psychology*
Chilin Shih, *East Asian Languages and Cultures*
Duane G Watson, *Psychology*

NeuroTech
Thomas J Anastasio, *Molecular and Integrative Physiology*
Stephanie S Ceman, *Cell and Developmental Biology*
David F Clayton, *Cell and Developmental Biology*
Charles (Lee) Cox, *Molecular and Integrative Physiology*
Albert S Feng, *Molecular and Integrative Physiology*
Martha U Gillette, *Cell and Developmental Biology*
Rhanor Gillette, *Molecular and Integrative Physiology*
William T Greenough, *Psychology*
Yuqing Li, *Molecular and Integrative Physiology*
Douglas L Jones, *Electrical and Computer Engineering*
Janice M Juraska, *Psychology*
Richard J Kollmar, *Molecular and Integrative Physiology*
Joseph G Malpeli, *Psychology*
Mark E Nelson, *Molecular and Integrative Physiology*
Justin S Rhodes, *Psychology*
Gene E Robinson, *Entomology*
Edward J Roy, *Psychology*
Jonathan V Sweedler, *Chemistry*
Bruce C Wheeler, *Electrical and Computer Engineering*

SELECTED HONORS AND AWARDS

Jennifer S Cole
Executive Committee, Linguistics Society of America, 2007

Monica Fabiani
Fellow of the Association for Psychological Science (APS), 2007
President of the Society for Psychophysiological Research (SPR), 2007

Gabriele Gratton
Fellow of the Association for Psychological Science (APS), 2007

Michael Insana
Fellow, American Institute for Medical and Biological Engineering (AIMBE), 2006

Mark E Nelson
Fellow, American Association for the Advancement of Science, 2006.

Denise Park
MERIT Award, The National Institute on Aging, 2007

Richard S Powers
Winner, National Book Award, National Book Foundation, 2006

Kenneth Suslick
Sir George Stokes Medal, Analytical Division, Royal Society of Chemistry, 2007

Jonathan V Sweedler
ERDC Award for Outstanding Team Effort, 2007

Bruce C Wheeler
Editor in Chief, IEEE Transactions on Biomedical Engineering, 2007-2010

SELECTED PATENTS AND PATENT APPLICATIONS

(Beckman faculty members in bold)

Stephen Boppart, Daniel Marks, **Kenneth Suslick**, and Farah Jean-Jacques Toublan: "Optical Contrast Agents for Optically Modifying Incident Radiation," Patent issued: April 3, 2007, Patent Number 7,198,777.

Albert Feng, Michael Lockwood, **Douglas Jones**, Robert Bilger (Carolyn Bilger, Legal Representative), **Charissa Lansing**, **William O'Brien**, and **Bruce Wheeler**: "Systems and Methods for Interference-Suppression with Directional Sensing Patterns," Patent application: July 11, 2006, Application Number 11/484,838.

Albert Feng, Michael Lockwood, **Douglas Jones**, **Charissa Lansing**, **William O'Brien**, **Bruce Wheeler,** and Robert Bilger (Carolyn Bilger, Legal Representative): "Systems and Methods for Interference-Suppression with Directional Sensing Patterns," Patent issued: July 11, 2006, Patent Number 7,076,072.

Albert Feng, **Douglas Jones**, **Bruce Wheeler**, Robert Bilger, **Charissa Lansing**, and **William O'Brien**: "Intrabody Communication for a Hearing Aid," Patent issued: April 17, 2007, Patent Number 7,206,423.

Douglas Jones, Michael Lockwood, Robert Bilger (Carolyn Bilger, Legal Representative), **Albert Feng**, **Charissa Lansing**, **William O'Brien**, **Bruce Wheeler**, Mark Elledge, and Chen Liu: "Interference Suppression Techniques," Patent application: October 10, 2006, Application Number 11/545,256.

Yuqing Li, Mai Dang, and Fumiaki Yokoi: "Methods and Compositions for the Treatment of Dystonia," Patent application: October 5, 2006, Application Number 11/544,070.

Daniel Marks and **Stephen Boppart**: "Volumetric Endoscopic Coherence Microscopy using a Coherent Fiber Bundle," Patent application: January 23, 2007, Application Number 11/656,892.

Tyler Ralston, Daniel Marks, **Paul Scott Carney**, and **Stephen Boppart**: "Interferometric Synthetic Aperture Microscopy," Patent application: July 10, 2006, Application Number 60/819,593.

Kenneth Suslick, Farah Jean-Jacques Toublan, **Stephen Boppart**, and Daniel Marks: "Surface Modified Protein Microparticles," Patent application: April 10, 2007, Application Number 11/733,614.

Kenneth Suslick, Farah Jean-Jacques Toublan, **Stephen Boppart,** and Daniel Marks: "Surface Modified Protein Microparticles," Patent issued: May 15, 2007, Patent Number 7,217,410.

Yingxiao Wang and Mingxing Ouyang**:** "FRET-based Assay," Patent application: October 12, 2006, Application Number 60/829,191.

Adam Zysk, Steven Adie, Matthew Leigh, Julian Armstrong, David Sampson, and **Stephen Boppart**: "Method and Apparatus for Measurement of Optical Properties in Tissue," Patent application: January 31, 2007, Application Number 11/669,561.

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(Beckman faculty members in bold)

Thomas Anastasio, **Pierre Moulin**, and **Sylvian Ray**: DOD, "Developing an Adaptive, Self-aiming Camera based on the Neurobiology of the Superior Colliculus," 12/1/06 – 9/30/07.

Thomas Anastasio: Sandia National Labs, "A Cerebellar Model of Visual Tracking," 5/30/07 – 9/28/07.

Stephen Boppart and **Bill Greenough**: NSF, "Development of a Multimodality Microscope," 8/1/06 – 7/31/08.

Stephen Boppart, Keith Singletary, Amy Oldenburg, **Kenneth Suslick**, and **Kenneth Watkins**: NIH, "Optical Coherence Tomography Image-Guided Surgical Resection of Solid Tumors," 9/1/06-6/30/10.

Jennifer Cole and **Mark Hasegawa-Johnson**: NSF, "Landmark-based Robust Speech Recognition Using Prosody-guided Models of Speech," 6/1/07 – 5/31/09.

Gabriele Gratton, **Monica Fabiani**, **Joseph Malpeli**, and **Edward Maclin**: NIH, "Functional Brain Imaging Based on Fast Optical Signals," 8/15/06.

Bill Greenough :NIH, "Exercise Effects on the Primate Nigrostriatal Pathway," 9/1/06 -8/31/08.

Bill Greenough: Fraxa Research Foundation, "Provision of fMRI Knockout Mice to Select Investigators," 1/1/07 – 12/31/07.

Bill Greenough and Julie Markham: Fraxa Research Foundation, "Glucocorticoid Regulation and the Phenotype of the Fragile X Knockout Mouse," 8/16/06 – 8/15/07.

Yuqing Li and Jianyong Li: Dystonia: "siRNA and Pharmacological Intervention Strategies for DYT1 Dystonia," 7/17/06 – 7/16/07.

Denise Park, **Brian Gonsalves**, **Brad Sutton**, and **Yongmei Michelle Wang**: NIH, "Neuroimaging of Dedifferentiation and Memory Across the Lifespan," 9/1/06 – 6/30/11.

Jonathan Sweedler, **Bill Greenough**, Stanislav Rubakhin, and Anna Klintsova: NIH, "Neuropeptides in the CNS with Imaging Mass Spectrometry," 8/1/06 - 4/30/11.

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HUMAN-COMPUTER INTELLIGENT INTERACTION FACULTY

(name followed by home department)

Artificial Intelligence
Narendra Ahuja, *Electrical and Computer Engineering*
Jont B Allen, *Electrical and Computer Engineering*
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Mark A Hasegawa-Johnson, *Electrical and Computer Engineering*
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Dan Roth, *Computer Science*
Richard W Sproat, *Linguistics*

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Edward McAuley, *Kinesiology and Community Health*
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Jacob J Sosnoff, *Kinesiology and Community Health*
Jesse Spencer-Smith, *Psychology*
Elizabeth Al Stine-Morrow, *Educational Psychology*
Sharon Tettegah, *Curriculum and Instruction*
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Minh N Do, *Electrical and Computer Engineering*
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George K Francis, *Mathematics*
Jiawei Han, *Computer Science*
Thomas S Huang, *Electrical and Computer Engineering*
Yi Ma, *Electrical and Computer Engineering*
Pierre Moulin, *Electrical and Computer Engineering*
Klara Nahrstedt, *Computer Science*

SELECTED HONORS AND AWARDS

Narendra Ahuja
Best Paper Award, IEEE Transactions on Multimedia, 2006

Thomas S Huang
IBM Faculty Award, IBM, 2006

Seth Hutchinson
Fellow, IEEE, 2006

Art Kramer
NIH Merit Award

Denise Park
NIH Merit Award

Elizabeth Stine-Morrow
President, Division 20 (Adult Development and Aging) of the American Psychological Association

SELECTED PATENTS AND PATENT APPLICATIONS

(Beckman faculty members in bold)

Jont Allen and Marion Regnier: "Speech Decoding Methods and Devices," Patent application: September 19, 2006, Application Number 60/845,741.

Jont Allen and Marion Regnier: "Apparatus and Method Using Across-Frequency Timing Coincidences," Patent application: February 8, 2007, Application Number 60/888,919.

Jont Allen: "Apparatus and Method for Feature-Based Speech," Patent application: March 5, 2007, Application Number 60/905,289.

Robert Morrison, **Minh Do**, and David Munson: "Synthetic Aperture Focusing Techniques," Patent application: April 6, 2007, Application Number 60/922,106.

SELECTED GRANTS AWARDED

(Beckman faculty members in bold)

Art Kramer and Michelle Webb: NCAA, "Sport Expertise and Perceptual and Cognitive Performance," 9/16/06 – 9/15/07.

Charissa Lansing, **Art Kramer**, **Jont Allen**, **Mark Hasegawa-Johnson**, and **Jason McCarley**: Qualcomm Inc., "Annoying Cell Phone Research Evidence," 1/1/07 – 12/31/07.

Douglas Wiegmann and **Hank Kaczmarski**: FAA, "Redesigning Weather-related Training and Testing of General Aviation Pilots," 7/25/06 – 12/31/09.

Richard Sproat, **Mark Hasegawa-Johnson**, **Chilin Shih**, **Kathryn Bock**, and **Brian Ross**: NSF, "An Interdisciplinary Study of the Dynamics of Second Language Fluency," 2/1/07 – 1/31/10.

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For a complete list visit www.beckman.uiuc.edu.

MOLECULAR AND ELECTRONIC NANOSTRUCTURES FACULTY

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Gerard Chee Lai Wong, *Materials Science and Engineering*
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Philippe Geubelle, *Aerospace Engineering*
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Andreas Cangellaris, *Electrical and Computer Engineering*
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Yonggang Young Huang, *Mechanical Science and Engineering*
Eric Jakobsson, *Molecular and Integrative Physiology*
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Nancy Makri, *Chemistry*
Eric Michielssen, *Electrical and Computer Engineering*
Margery Osborne, *Curriculum and Instruction*
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Min-Feng Yu, *Mechanical Science and Engineering*

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Aleksei Aksimentiev, *Physics*
Laxmikant V Kale, *Computer Science*
Zaida (Zan) Luthey-Schulten, *Chemistry*
Todd J Martinez, *Chemistry*
Klaus Schulten, *Physics*

SELECTED HONORS AND AWARDS

Narayana Aluru
ASME Gustus L. Larson Memorial Award, 2006

Yi Lu
Early Career Award, Society of Biological Inorganic Chemistry, 2007

Todd J Martinez
AAAS Fellow, American Association for the Advancement of Science, 2006

Jeffrey S Moore
Fellow, Royal Society of Chemistry, 2006

John A Rogers
Baekeland Award, American Chemical Society, 2007
Fellow, American Physical Society, 2007
Xerox Distinguished Lecturer, Xerox, 2006
Selected as one of the top 15 Innovators in Nanotechnology, Nanotech Briefs, NASA Technology Briefs, 2006

Nancy R Sottos
Fellow, Society of Engineering Science, 2007
Distinguished Career Alumni Award, University of Delaware, 2007

Gregory Timp
Fellow, American Physical Society, 2006
Fellow, American Academy of Nanomedicine

Scott R White
Centennial Fellow, Dept of Eng Sci & Mech at Penn State, 2006

SELECTED PATENTS AND PATENT APPLICATIONS

(Beckman faculty members in bold)

Robert Barry, **Jennifer Lewis,** Robert Shepherd, and **Pierre Wiltzius:** "Viscosity-Tunable Elastomeric Hydrogel Ink," Patent application: April 9, 2007, Application Number 11/733,144.

David Beebe, **Jeffrey Moore**, and Jaisree Moorthy: "Method of Fabricating a Flow Constriction within a Channel of a Microfluidic Device," Patent issued: September 26, 2006, Patent Number 7,111,635.

Paul Bohn, **Jonathan Sweedler**, **Mark Shannon**, and Tzu-chi Kuo: "Hybrid Microfluidic and Nanofluidic System," Patent issued: May 22, 2007, Patent Number 7,220,345.

Paul Braun, Soo Hyoun Cho, and **Scott White:** "Self-Healing Coating System," Patent application: January 5, 2007, Application Number 11/620,276.

Paul Braun and Xindi Yu: "Variably Porous Structures," Patent application: April 9, 2007, Application Number 11/733,151.

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Jennifer Lewis, **Jeffrey Moore**, **Nancy Sottos**, Kathleen Toohey, and **Scott White**: "Self-Healing Materials with Microfluidic Networks," Patent application: June 8, 2007, Application Number 11/760,517.

Chang Liu, Nannan Chen, Jonathan Engel, Jack Chen, Zhifang Fan: "Conformal Mesh for Thermal Imaging," Patent application: October 31, 2006, Application Number 60/863,702.

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Yi Lu, **Gerard Wong**, Mehmet Veysel Yigit, and Abhijit Mishra: "Amphiphilic Substances and Functionalized Lipid Vesicles Including the Same," Patent application: January 19, 2007, Application Number 60/885,744.
Yi Lu and Juewen Liu**:** "Aptamer- and Nucleic Acid Enzyme-Based Systems for Simultaneous Detection of Multiple Analytes," Patent application: April 24, 2007, Application Number 60/913,757.

Joseph Lyding and Scott Schmucker: "Nanometer-Scale Sharpening of Conductor Tips," Patent application: April 26, 2007, Application Number 11/740,678.

Larry Markoski, Piotr Waszczuk, **Paul Kenis**, and Eric Choban: "Emulsions for Fuel Cells," Patent issued: April 17, 2007, Patent Number 7,205,064.

Richard Masel, Zheng Ni, and **Mark Shannon**: "High Gain Selective Metal Organic Framework Preconcentrators," Patent application: October 6, 2006, Application Number 11/539,405.

Debapriya Mazumdar, and Juewen Liu, **Yi Lu**: "Lateral Flow Devices," Patent applications: August 1, 2006 and March 15, 2007, Application Numbers 60/821,043 and 11/686,601.

Ralph Nuzzo, **John Rogers**, Nathan Mack, Matthew Stewart, and Viktor Malyarchuk: "Multispectral Plasmonic Crystal Sensors," Patent application: July 25, 2006, Application Number 60/820,254.

Ralph Nuzzo, **John Rogers,** Etienne Menard, Keon Jae Lee, Dahl-Young Khang, Yugang Sun, Matthew Meitl, Zhengtao Zhu, and Heung-Cho Ko: "Controlled Buckling Structures in Semiconductor Nanoribbons with Application Examples in Stretchable Electronics," Patent application: September 6, 2006, Application Number 60/824,683.

Walter Pelton and **Paul Kenis**: "Distributed Electrochemical Cells Integrated within Microelectronic Structures," Patent application: July 19, 2006, Application Number 11/490,510.

John Rogers, Seong Kang, Coskun Kocabas, Jang-Ung Park, and Moonsub Shim: "Methods of Making Spatially Aligned Nanotubes and Nanotube Arrays," Patent application: August 17, 2006, Application Number 11/465,317.

John Rogers and Etienne Menard: "Devices and Methods for Pattern Generation by Ink Lithography," Patent application: October 27, 2006, Application Number 60/863,248.

John Rogers, Matthew Meitl, Ralph Nuzzo, Chang-Jae Yu, Osman Ataman, Jong-Hyun Ahn, Etienne Menard, Jimin Yao, Xiaoying Guo, Kent Choquette, Antonios Giannopoulos, Ansas Kasten, Alfred Baca, Michael Motala, and Sang Il Park: "Printable, Flexible, and Stretchable Inorganic Light Emitting Diode Displays," Patent application: January 17, 2007, Application Number 60/885,306.

John Rogers and Etienne Menard: "Devices and Methods for Pattern Generation by Ink Lithography," Patent application: February 16, 2007, Application Number 11/675,659.

John Rogers and Etienne Menard**:** "Composite Patterning Devices for Soft Lithography," Patent issued: March 27, 2007, Patent Number 7,195,733.

John Rogers, Ralph Nuzzo, Matthew Meitl, Etienne Menard, Alfred Baca, Michael Motala, Jong-Hyun Ahn, Sang Il Park, Chang-Jae Yu, Heung-Cho Ko, Mark Stoykovich, and Jongseung Yoon: "Optical Systems Fabricated by Printing-Based Assembly," Patent application: June 18, 2007, Application Number 60/944,611.

John Rogers, Matthew Meitl, Yugang Sun, Heung-Cho Ko, Andrew Carlson, Won Mook Choi, Mark Stoykovich, Hanqing Jiang, and Young Huang: "Controlled Buckling Structures in Semiconductor Interconnects and Nanomembranes for Stretchable Electronics," Patent application: June 18, 2007, Application Number 60/944,626.

John Rogers, Ralph Nuzzo, Matthew Meitl, Heung-Cho Ko, Xiaoyu Zhao, Sakulsuk Unarunota, Jongseung Yoon, Coskun Kocabas, Seong Kang, Christoph Nottbohm, and Etienne Menard: "Release Strategies for Making Printable Semiconductor Structures, Devices and Device Components," Patent application: June 18, 2007, Application Number 60/944,653.

Mark Shannon, Byunghoon Bae, and Richard Masel: "Bi-Direction Rapid Action Electrostatically Actuated Microvalve," Patent applications: July 26, 2006 and May 1, 2007, Application Numbers 11/493,376 and 11/797,197.

Mark Shannon, Shaurya Prakash, **Jeffrey Moore**, and Timothy Long: "System for Chemical Modification of Polymer Surfaces," Patent application: October 5, 2006, Application Number 60/828,266.

Scott White, **Nancy Sottos**, and Benjamin Blaiszik: "Capsules, Methods for Making Capsules, and Self-Healing Composites Including the Same," Patent application: May 31, 2007, Application Number 11/756,280.

SELECTED GRANTS AWARDED

(Beckman faculty members in bold)

Paul Braun: Sandia National Labs, "NNEDC-National Inst for Nanoengineering," 5/17/07 – 5/16/08.

Andreas Cangellaris, **Narayana Aluru**, **Umberto Ravaioli**, **Philippe Geubelle**, **Ionnis Chasiotis**, and Linda Katehi: DARPA/DOD, "IMPACT — Center for Advancement of MEMS/NEMS VLSI," 9/19/06 – 9/18/09.

Ioannis Chasiotis and **Nancy Sottos**: DOD, "A Novel MEMS Platform for Mechanical Testing of Polymeric Nanofibers," 8/1/06 – 4/30/07.

Jeffrey Moore, **Todd Martinez**, **Paul Braun**, and **Nancy Sottos**: DOD, "Mechanochemically-active Polymer Composites," 6/15/07 – 6/15/12.

Klaus Schulten and **Emad Tajkhorshid**: NIH, "Molecular Mechanisms of Cellular Mechanics," 6/14/07 – 6/30/11.

Stephen Sligar and **Chang Liu**: NSF, "Nanoscale Science and Engineering Center for Integrated Nanopatterning and Detection Technologies," 9/1/06 – 8/31/11.

Nancy Sottos, **Jeff Moore**, and **Scott White**: Bayer Material Science, "Preparation and Evaluation of Isocyanate-filled Microcapsules," 12/15/06 – 8/15/07.

SELECTED PUBLICATIONS

(Beckman faculty members in bold)

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Carmichael, E. S.; Ballard, J. B.; **Lyding, J. W.; Gruebele, M.**, Frequency-modulated, single-molecule absorption detected by scanning tunneling microscopy. *Journal of Physical Chemistry C* **2007,** 111, (8), 3314-3321.

Hickenboth, C. R.; **Moore, J. S.; White, S. R.**; **Sottos, N. R.;** Baudry, J.; Wilson, S. R., Biasing reaction pathways with mechanical force. *Nature* **2007,** 446, (7134), 423-427.

Kang, S. J.; Kocabas, C.; Ozel, T.; Shim, M.; Pimparkar, N.; Alam, M. A.; Rotkin, S. V.; **Rogers, J. A.,** High-performance electronics using dense, perfectly aligned arrays of single-walled carbon nanotubes. *Nature Nanotechnology* **2007,** 2, (4), 230-236.

Kim, H.; Liu, J.; Li, J.; Nagraj, N.; Li, M.; **Lu, Y.,** Metal-dependent global folding and activity of the 8-17 DNAzyme studied by fluorescence resonance energy transfer. *Journal of the American Chemical Society* **2007**, 129, 6896-6902.

Mashl, R. J.; **Jakobsson, E.,** Protonation states in potassium channels. *Biophysical Journal* **2007**, 267A-267A.

Mauldin, T. C.; Rule, J. D.; **Sottos, N. R.; White, S. R.; Moore, J. S.**, Self-healing kinetics and the stereoisomers of dicyclopentadiene. *Journal of the Royal Society Interface* **2007,** 4, (13), 389-393.

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Sotomayor, M.; **Schulten, K.,** Single-molecule experiments in vitro and in silico. *Science* **2007,** 316, (5828), 1144-1148.

Sotomayor, M.; van der Straaten, T. A.; **Ravaioli, U.; Schulten, K.,** Electrostatic properties of the mechanosensitive channel of small conductance MscS. *Biophysical Journal* **2006,** 90, (10), 3496-3510.

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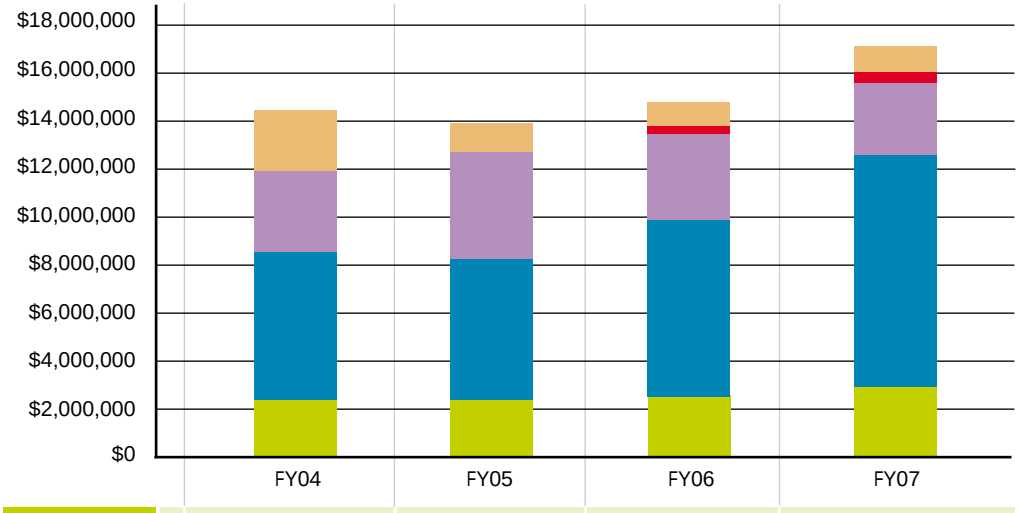
Beckman Institute Grant Expenditures by Funding Source[1]



	FY04	FY05	FY06	FY07
DOD	$ 2,344,546	$ 2,322,793	$ 2,603,956	$ 3,172,803
NIH	$ 6,153,758	$ 5,940,245	$ 7,144,039	$ 9,889,110
NSF	$ 3,322,946	$ 4,412,354	$ 3,760,526	$ 3,004,266
IBHE	$ -	$ 93	$ 156,333	$ 512,229
Other	$ 2,559,179	$ 1,284,260	$ 1,087,590	$ 1,008,914
Total	**$ 14,380,430**	**$ 13,959,746**	**$ 14,752,443**	**$ 17,587,322**

DOD = Department of Defense; NIH = National Institutes of Health; NSF = National Science Foundation
IBHE = Illinois Board of Higher Education (grant match funds)

Awarded Funding by Source[2]

	FY04	FY05	FY06	FY07
DOD	$ 5,968,347	$ 6,379,539	$ 191,000	$ 11,012,039
NIH	$ 5,418,065	$ 3,211,450	$ 20,527,604	$ 7,450,733
NSF	$ 949,942	$ 2,757,986	$1,818,340	$ 2,349,181
Other	$ 555,183	$ 709,338	$ 685,903	$ 5,262,943
Total	**$ 12,891,537**	**$ 13,058,313**	**$ 23,222,847**	**$ 26,074,896**

DOD = Department of Defense; NIH = National Institutes of Health; NSF = National Science Foundation

[1] In addition to the sources itemized in the chart, funding for the Beckman Institute is received from the following:
a. The state of Illinois to the University of Illinois and allocated through individual departments:
Faculty Salaries
b. The state of Illinois to the Beckman Institute:
Administration, Operating Expenses
c. The Arnold and Mabel Beckman Foundation
Beckman Institute Fellows Program
Beckman Institute Graduate Fellows Program
Beckman Institute Equipment Competition

[2] All interdisciplinary grants with faculty investigators from multiple departments are administered by the Beckman Institute. Total funding for multi-year grants is reported in the fiscal year of the award.

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