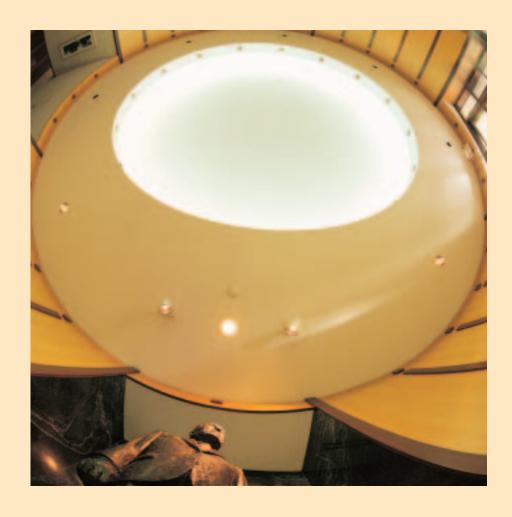


Beckman Institute
for Advanced
Science and
Technology

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# Director

#### **Message From the Director**

As I review the past year, I am tremendously impressed by the progress that has been made in fulfilling the Beckman Institute's mission to use a multidisciplinary research approach to address complex scientific questions. As this report shows, the three Main Research Themes have been very productive. The Beckman Institute, in cooperation with departments across the campus, has been able to attract new faculty of the highest caliber, and the research being pursued here continues to be funded successfully by external sources, such as the National Institutes of Health, the National Science Foundation, various agencies of the Department of Defense, and industry. You will find information on the following pages about all the various projects here at the Beckman Institute, but I would like to highlight a few.

Neuroimaging technologies, including functional MRI, near-infrared optical imaging, and event-related brain potential measurements, have emerged as central to the neuro-and cognitive scientists at the Beckman Institute. This field presents tremendous opportunities for cross-disciplinary research. Pushing the envelope of data acquisition, processing, and mining of multimodal data sets using new computational tools will be of great value to those who are studying learning, language acquisition and processing, and the aging memory. As of July 1, 2002, the Beckman Institute has been operating the Biomedical Imaging Center as a campus-wide facility. A new 3T full-head MRI machine is up and running, and the installation of a micro-MRI with high spatial resolution is progressing rapidly. We expect this facility to grow and be a great attraction for faculty and funding agencies.

Early in 2002, the Resource for Macromolecular Modeling and Bioinformatics, headed by Professor Klaus Schulten, was reviewed by the National Institutes of Health, and it was renewed through July 2007 with very high marks. The Theoretical and Computational Biophysics Group has established itself as a world-class research group known for its work on membrane proteins such as aquaporin, which is responsible for water transport in and out of cells, and for its virtual science laboratory, called Biological Collaborative Research Environment for Structural Biology, or BioCoRE.

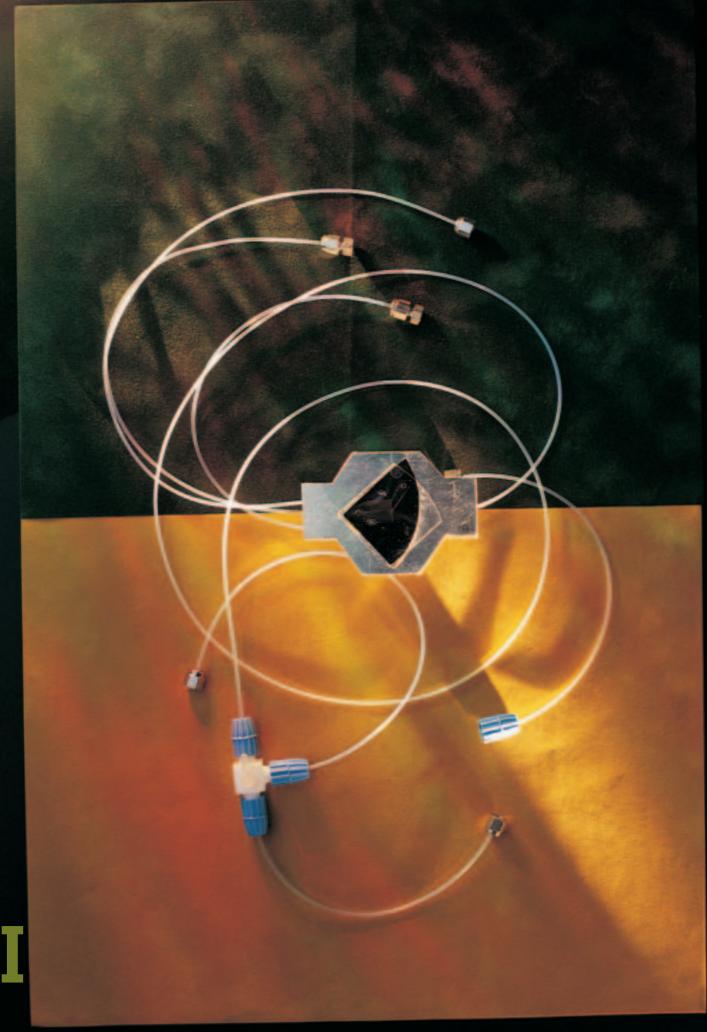
Human-factors research in driver safety and satisfaction has been enhanced by the installation of a car-driving simulator. The simulator has been operational since the spring of 2002 under a research program sponsored by General Motors.

The Chancellor and the Provost initiated, during the spring of 2002, a cross-campus discussion titled "Positioning the Campus for the Future." One of its components is arts in a technology-intensive world. A working group of faculty and staff from the Beckman Institute and the College of Fine and Applied Arts is exploring ways to help with the world's critical need to increase scientific literacy in the population, as well as yield some shorter-term, high-visibility results.

The Beckman Fellows program continues to be an important part of the Institute. It is supported by a generous grant from the Beckman Foundation and has grown over the years. We will hold the First Annual Beckman Foundation Fellows Symposium on May 1–3, 2003, here in Urbana. All prior fellows from the five Beckman Institutes will be invited; it should yield an interesting series of seminars and poster sessions.

In conclusion, I would like to thank and congratulate all the faculty, students, and staff who helped make 2002 a successful year.

-Pierre Wiltzius, Director



#### **Overview**

# The Biological Intelligence (BI) Main Research Theme seeks

to understand the links between the brain and intelligent behavior. Research in this area starts with the study of the individual molecules that comprise the cells of the brain, and builds toward an understanding of the anatomy and physiology of brain regions and sense organs. From there, researchers consider the functioning of the brain and how its parts work together to achieve basic abilities, such as perception, attention, learning, and memory. Ultimately, the **Biological Intelligence Main Research Theme** considers how adapted forms of these abilities can lead to the highest manifestations of intelligence, such as when a child acquires the ability to speak and understand language or learns mathematics in school. As the second decade of the Beckman Institute takes root, the **Biological Intelligence Main Research Theme** is poised to take advantage of the explosion in new knowledge and scientific tools that have come from breakthroughs in neuroscience, molecular biology, the physical sciences, and computation.



For example, the ability to create micro-electromechanical systems, which are capable of studying the smallest compartments of nerve cells, reflects dramatic advances in the field called nanotechnology. Similarly, at a larger scale but often using very similar chemical and physical principles, the creation of new brain imaging techniques, such as functional magnetic resonance imaging (fMRI), has revolutionized our ability to relate the activity of the brain to behavior and learning. By using fMRI in combination with related technologies, such as electroencephalograms (EEG), eye-movement monitoring, and near-infrared optical imaging of the brain, Beckman researchers are able to tell not only where something is happening in the brain, but also how many different parts of the brain are involved and what sequence of brain events underlies a seemingly smoothly executed intelligent behavior. Together, these techniques have extraordinary potential for revealing the nature of the computations that underlie intelligent behavior.

At the same time, interdisciplinary research in Biological Intelligence is leading to important applications in a variety of domains. For example, the intelligent hearing aid project brings together researchers from the neurosciences, signal processing, and the speech and hearing sciences. The real-time system that has been developed has great promise for hearing enhancement technology. Similarly, researchers interested in learning and education are making use of video technology to improve the teaching of mathematics and reading. In addition, research important to lifestyle choices is emphasizing the importance of physical exercise to brain function and cognition.

As the research highlights on the following pages illustrate, the efforts in Biological Intelligence are as diverse as intelligent behavior itself. If there is an underlying theme, it is that progress to date and progress in the future have depended and will depend on combinations of technologies and disciplines. The Beckman Institute provides a near-ideal environment for scientists with vastly different backgrounds to join in pursuing mutually important and interesting goals.

-William T. Greenough and Gary S. Dell, Co-chairs

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## Highlights



• The Department of Defense Advanced Research Projects Agency (DARPA) and the newly formed National Science Foundation Science and Technology Center have provided support to professors Paul Bohn, Mark Shannon, and Jonathan Sweedler, who lead a group at the Beckman Institute to extend microfluidic devices from two to three dimensions.

This will open new vistas for small-scale chemical analysis by making it possible to perform unit operations (separation, tagging, affinity recognition, etc.,) followed by movement of the sample to a vertically separated compartment for another chemical manipulation. The technology that makes this possible is the molecular gate, in which nanoporous membranes containing 15- to 200-nm diameter cylindrical pores are employed as interconnects to establish controllable fluidic communication between micrometer-scale channels operating in vertically separated planes. The potentials between any pair of layers can be independently controlled, so fluidic communication can be established among any number of vertically stacked planes. The nanoporous membranes act as an electrically controlled, non-moving valve between the layers. A major advance in the past year has been the realization of this approach for injection and collection of sample bands in preparative separations containing as little as 100 attograms (10-16g) of sample. A molecular gate membrane is placed between two channel layers at either end of a main separation channel. When the gate is off, the system acts as a standard electrophoresis device; when the gate is forwardbiased, the analyte may be transported to the vertically displaced receiving channel. For injection, the membrane is placed at the head of the electrophoresis channel, and for collection it is placed at the end. A current-generation, laser-induced fluorescence device in the main separation channel calculates the width

and electrophoretic velocity "on-the-fly" for each sample band. With this information, the computer can then selectively open the collection gate at the right time and for the right duration to completely capture the band of interest. It is expected that this new instrumentation will open new vistas for biological chemistry where the sample size is so small that even state-of-the-art laboratory-scale instrumentation is simply not able to address the sample.

 Language researchers at the Beckman Institute from the Cognitive Science, Artificial Intelligence, and Image Formation and Processing groups continue to work on their four-year project from the Knowledge and Distributed Intelligence Program of the National Science **Foundation (NSF).** The project, titled "The Role of Experience in Language Processing," brings together psychologists, linguists, and computer scientists with the goal of studying how people produce and understand language, and how this knowledge can be used to develop language technology. The group studies how people's speaking and comprehension skills change with experience by using a number of methods, including assessments of eye movements, electrical brain potentials, and functional magnetic resonance imaging. At the same time, the group is developing computational models of the language processing system, models that learn from experience and adapt to their current circumstances through these learning mechanisms. One important aspect of this year's work concerns how people learn the "rules" that characterize the pronunciation of their language. For example, all English speakers intuitively know the rule that "ng" cannot begin a word. Professors Cynthia Fisher, Jennifer Cole, and Gary Dell are examining the learning of artificial rules of this type by both adults and infants. Their experiments show

that experience with very few examples of a rule has a profound influence on how people of all ages perceive and produce speech. Other investigators on this project include professors J. Kathyrn Bock, Susan Garnsey, Adele Goldberg, Stephen Levinson, and Daniel Roth.

• In 2002 the Intelligent Hearing Aid team, which includes professors Albert Feng, Bruce Wheeler, Charissa Lansing, Douglas Jones, William O'Brien, and Robert Bilger, expanded **substantially.** With the expansion, the team was able to further develop several new technologies usable in hearing aids and telecommunication devices. The team filed two patent applications in 2002 covering methods for a wireless communication link, and for an advanced signal processing algorithm with possible implementation in a small package. Two other new technologies have been created that allow quantitative evaluations of complex auditory scenes. These inventions will be disclosed shortly in preparation for filing of patent applications. The team also made numerous human subject tests using real-time prototypes, resulting in significant benefits of the Beckman hearing aid system.

The team currently has three external funding sources that support different signal processing projects. The goal of the project funded by the National Institutes of Health (NIH) is validation of the concept of using binaural hearing aids to assist hearing-impaired listeners to extract speech amidst noisy backgrounds. A project funded by DARPA is aimed toward applying the Beckman signal processing schemes to build devices that may be used in battlefield applications. The goal of research sponsored by Phonak AG, which has exclusively licensed the Beckman technology for hearing aids, is to incorporate Beckman technologies into hearing aids to advance their performance.

• The NSF-supported Neuronal Pattern Analysis Project in neuroinformatics is continuing efforts to develop computational tools for neuroscience. This project brings state-of-theart computing technology to bear on the problem of storing, retrieving, analyzing, visualizing, and modeling time series neuronal data, particularly in relation to the very large data sets yielded by fast multichannel dataacquisition technologies. A collaboration between the laboratories of professors Michael Gabriel and Mark **Nelson** has led to the development of a novel database table schema, which allows multiple laboratories to implement customized graphical user interfaces that work with a shared relational database system. This collaboration also brought to maturity the Time Series Data Protocol (TSDP). Touted in a recent Nature article, TSDP is a standard for representation, transfer, and analysis of time-series data in a platform-independent manner; a suite of flexible/intuitive tools for data analysis and visualization; and a programming library for development of TSDP-compliant tools. Ultimately, this project intends to develop a complete neuroscience workbench that will be interoperable within the research community, and will serve as a means to facilitate collaboration and sharing of data.

# ■ The Beckman Institute/Carle Clinic Association Functional Brain Mapping Project experienced considerable expansion this year. Two new faculty members, professors Kara Federmeier and Denise Park, moved to campus and joined the project. Federmeier augments the group's expertise in fMRI/EEG integration with an emphasis on lingustic cognition. Park is a major figure in cognitive aging and in recent years has expanded her research program to include fMRI measures of brain function across adulthood. The group's integration of multiple techniques



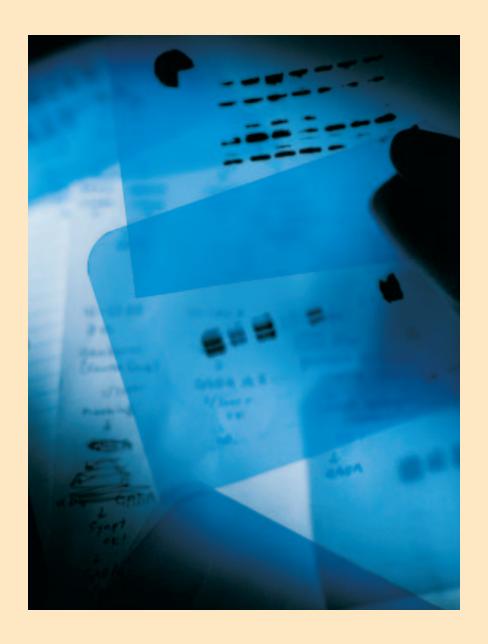
in studies of brain function includes optical imaging, electrophysiological imaging, and functional magnetic resonance imaging. The group is also pursuing another combined technology, the simultaneous collection of brain activity and eye movement data. Combining technologies in these ways allows investigators to validate and complement the data derived from one type of technique with another. Furthermore, because every individual method has limitations, the parallel deployment of multiple methods allows the group to draw on the strengths of each and to avoid the pitfalls of each.

Under the direction of professors **Gregory Miller** and **Andrew Webb**, and with the support of a number of departments on campus, including the Beckman Institute, the group significantly expanded its imaging enterprise in another way. A new high-field magnetic resonance imager was delivered in late spring. This research-dedicated 3-Tesla machine provides 24-hour access, providing investigators much better opportunities to develop and test new imaging protocols. The project's associated faculty had very considerable and expanded external funding this year. Professor Neal **Cohen**, in collaboration with Professor Andrew Webb and staff member Dr. Tracey Wszalek, received funding from the National Science Foundation. These studies combine behavioral, eye movement, and functional neuroimaging studies of normal subjects and amnesiac patients in order to explore the nature of relational (declarative) memory and its dependence on the hippocampal system. The Institute for the Study of Aging funded Professor **Arthur Kramer** and his colleagues, professors Neal Cohen, Andrew Webb, and **Edward McAuley**, to examine changes in cognition and functional brain activity in response to improvements in the aerobic fitness of healthy but sedentary older adults. Professor Gregory Miller, in collaboration with professors Wendy Heller, Marie Banich (University of Colorado), and Andrew Webb,

has a grant from the National Institute of Drug Abuse to investigate individual differences in a brain attentional/ emotional network, emphasizing the development of methods for classifying subjects and for measuring activity in the orbital frontal cortex via fMRI-scan parameter development. Professor Wendy Heller, in collaboration with professors Gregory Miller, Marie Banich (University of Colorado), and Andrew Webb, has funding from the National Institute of Mental Health for a related project. Professors Arthur Kramer, Gregory Miller, and **Zhi-Pei Liang** shared in the funding of a grant with the University of Illinois at Chicago campus to develop fMRI/EEG integration methods. Professors Monica Fabiani and Gabriele Gratton received funding from the National Institute of Mental Health and DARPA to integrate hemodynamic, optical, and EEG imaging. Professor Denise Park has received funding from the National Institute of Aging to study cognitive changes with age and associated alterations in brain function.

# • Since 1996 the Language Processing Training Program has been an ongoing NIHfunded effort centered at the Beckman Institute.

The program has two aims, both reflecting the interdisciplinary spirit of the Beckman Institute. The first is to give pre-doctoral students intensive, hands-on research experience in psycholinguistics, linguistics, and computational modeling, in addition to coursework in academic departments. The second is to provide post-doctoral scholars with cross-disciplinary experience. This means training behavioral psychologists in the research methods of cognitive neuroscience, linguistics, and computational modeling; and training linguists in the research methods of psycholinguistics. The program brings together Beckman researchers representing the disciplines of cognitive psychology, developmental psychology, and linguistics. They come



from both the Biological Intelligence and Human-Computer Intelligent Interaction Main Research Themes. The core faculty in the program (J. Kathryn Bock, Gary Dell, Kara Federmeier, Cynthia Fisher, Susan Garnsey, Adele Goldberg, Kevin Miller, George McConkie, Edward Shoben) and several of the affiliate faculty (Aaron Benjamin, William Brewer, Neal Cohen, Jennifer Cole, Brian Ross)

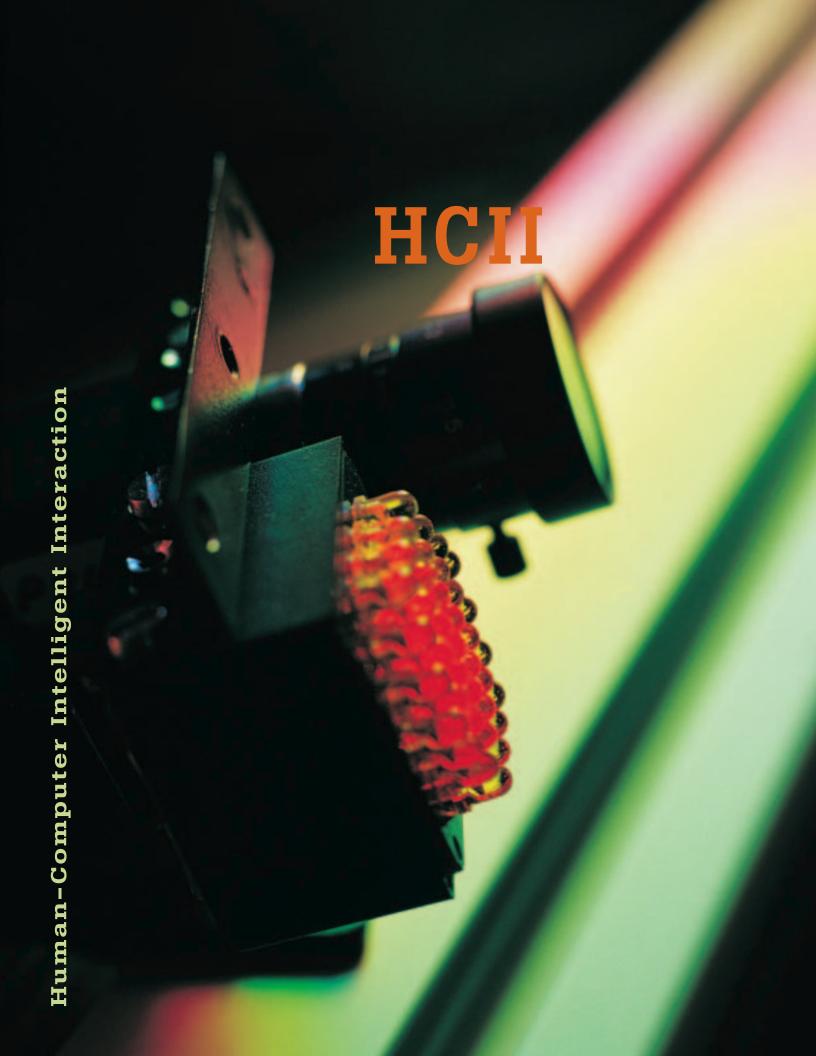
have appointments at the Beckman Institute, and all of their current pre-doctoral and post-doctoral trainees work in Beckman Institute laboratories. Their projects include basic research on how people speak, understand, and learn language using techniques that include optical imaging, eyetracking, functional magnetic resonance imaging, electroencephalography, computational modeling, and behavioral testing.

#### Overview

# The Human-Computer Intelligent Interaction (HCII)

Main Research Theme seeks to enhance human-machine interface design through the optimization of state-of-the-art technology development and engineering of mulitmodal interface design concepts. It also seeks to explicate the mechanisms of human perception, cognition, and action that are relevant to industrial, military, and consumer products. To this end, projects in the Human-Computer Intelligent Interaction Main Research Theme often involve the close collaboration of cognitive scientists, computer scientists, electrical engineers, human factors researchers, educational psychologists, kinesiologists, neuroscientists, and linguists in pursuit of knowledge relevant to the design of interfaces for human-computer systems. A major goal of the Main Research Theme is the integration of engineering and computer science expertise. HCII faculty, graduate students, and post-doctoral students in these fields join together to design and construct hardware and software interfaces, as well as develop formal models of human perception, cognition, and action.

The Integrated Systems Laboratory (ISL), under the direction of Henry Kaczmarski, figures prominently in this endeavor. The ISL includes a variety of state-of-the-art research facilities, including a completely immersive CUBE™, a number of large single-wall displays with integrated head- and eye-tracking, a motion-capture suite, and a high-fidelity driving simulator. The Human-Computer Intelligent Interaction Main Research Theme also makes constant use of facilities for high-fidelity simulation of commercial and military flight.



During the past year, a number of new projects have begun and other projects have continued to produce important new knowledge and products. For example, the General Motors Corporation has funded, through a series of grants and gifts, a new center for the study of driver safety and performance that has enabled a number of Beckman researchers to 'scale-up' their interests in areas such as scene perception, multimodal attention, individual differences, computational modeling of human performance, and adaptive human-machine interfaces to examine these issues in simulated high-fidelity environments, such as driving. As part of this effort, the Beckman Institute has established a driving simulation facility that has been interfaced with other such facilities at universities and in industry. The computer companion project, which is sponsored by the Yamaha Motor Corporation and involves a number of HCII faculty members and students, has made considerable progress in many areas, including image databases, graphical user interfaces for Web search, and intelligent agents.

Researchers at the Beckman Institute have also recently been awarded a five-year, \$3 million grant by the National Science Foundation's Information Technology Research program. The main theme of this project is to make computers and, more generally, information systems more proactive in their interaction with the users. The test-bed of basic research results will be an educational task—helping middle-school students to learn science and engineering concepts using Lego/Mindstorms construction and robotics materials.

When the HCII Main Research Theme was established in 1994, it was comprised of a diverse group of scientists and engineers who shared a common vision of integrated research teams pursuing basic and applied issues relevant to the design of better interfaces for human users of recreational, educational, industrial, and military systems. In the short time the theme has been in existence, HCII researchers have been able to turn their dream into a reality, as evidenced by their success in obtaining funding for a variety of both large and small research and engineering projects whose goal has been to develop better human-computer interfaces. We fully expect the next decade will see continued development of a truly multidisciplinary approach to the study and design of intelligent human-computer interfaces at the Beckman Institute.

-Thomas Huang and Arthur F. Kramer, Co-chairs



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## Highlights



 A group of Human-Computer Intelligent Interaction (HCII) Main Research Theme faculty members, including professors Arthur Kramer, George McConkie, and Christopher Wickens have received multi-year funding from General Motors to examine a number of important issues with regard to driver distraction. This funding, along with funding provided by the Beckman Institute, has enabled the establishment of a state-ofthe-art driving simulator facility, under the direction of Henry Kaczmarski, (Integrated Systems Laboratory). The research projects conducted in the present year have examined questions such as: How can eye-tracking measures be used to provide on-line measures of attention in complex dynamic environments? What can an examination of driving performance under varied driving environments tell us about how humans perceive and represent dynamic scenes? Can computational models of driver perception, cognition, and action be developed and used to aid in the design of new automotive vehicles that incorporate a multitude of telematic devices (e.g. navigation systems, information retrieval systems such as e-mail and cellular phones, active and passive safety systems, etc.)? Can multitask training methods developed in the laboratory be used to reduce driver distraction and enhance the performance of older adult drivers? How should collision warning devices be designed to ensure that drivers are rapidly alerted but not startled? Additional funding is being pursued to enable the expansion of the issues that will be addressed in the Beckman Institute driving simulator facility, as well as to increase the number of faculty members and graduate students who will participate in the research program.

• Supported by a National Science Foundation (NSF) Information Technology Research (ITR) grant, an interdisciplinary

team of Beckman Institute researchers is trying to change people's relationships with their computers. The team points out that when a computer knows more about the user, it can become more helpful. Thus, they are developing ways to give the computer more information about humans, including their emotional states (happy, frustrated, upset), motivational states (engaged, bored, tired), and cognitive states (comprehending, confused). Based on this information, the computer can be more 'proactive' in knowing when and in what ways to initiate interaction with the user rather than just waiting for the user to give it commands.

Children from the Don Moyers Boys and Girls Club, located in Champaign near the Beckman Institute, are an integral part of this project. They come to the laboratory to learn about science and engineering concepts through exploration with Lego materials under the watchful eyes of a half-dozen computers. Professor David Brown (Department of Curriculum and instruction) is videotaping and analyzing tutor-student sessions as the children learn about gears. Professor Daniel Roth is using computer learning methods to use this information to identify conditions under which a tutor takes different actions. Professor **Thomas Huang** is developing automated methods of analyzing facial expression and, with Beckman Fellow Jesse Spencer-Smith, is developing an emotionally expressive face that can show delight or concern as well as moving naturally as it talks. Professor **Stephen Levinson** is analyzing speech characteristics that indicate emotional state and speech content and is finding ways to produce speech with appropriate emotion. Professor **David Kriegman** (now at the University of California, San Diego) has developed methods to track the child's activities with the gears. Professor George McConkie is obtaining mental-state information from eye movement recording. The trick is to integrate all of this

real-time information into a system that then makes intelligent decisions in interacting with people. At present, research is being conducted with a 'Wizard of Oz' system in which the human tutor, located in another room, provides intelligence that the computer does not yet have. But as computer capability is developed, more and more responsibility is being taken from the tutor and given to the computer, making it increasingly 'proactive' in its interaction with the human.

• The NSF/ITR-funded project, "Development of Head-Mounted Projective Displays (HMPD) for Distance Collaborative Environments," is shared between the Beckman Institute (Beckman Fellow Hua Hong and Professor Narendra Ahuja) and the University of Central Florida. The objective is to investigate novel visualization solutions that enable collaborative visualization in distributed augmented environments. Based on the HMPD technology developed during the previous project year, researchers have now developed a preliminary test-bed of a collaborative infrastructure, referred to as SCAPE (Stereoscopic Collaboration in Augmented Projective Environments), which is equipped with multi-modality interface devices and customer-designed collaborative widgets. The SCAPE display environment consists of a 3'x5' workbench and a 12'x12'x9' four-walled, arched cage coated with retro-reflective film, and one head-tracked HMPD. The multi-modality interface devices include commercially available solutions, such as a dataglove for hand gesture recognition, a Hiball optical tracker for head pose detection, and a flock-of-birds magnetic tracker for hand pose detection. The interfaces also include customer-designed interface widgets, such as a visionbased tracker for object interaction and virtual image augmentation, and a magnifier widget to facilitate user interaction with virtual environments. The SCAPE

system provides a unique platform to bridge virtual environments and augmented environments through which a user can perform augmented tasks while being immersed in considerably larger virtual environments. It is anticipated that the SCAPE infrastructure will be used for a wide range of collaborative applications and visualization tasks.

• Professor Zhi-Pei Liang's group is continuing to develop model-based methods for high-speed imaging of time-varying biological events (e.g., cardiac motion and brain activities) using magnetic resonance signals. Building on earlier success in developing a generalized series method for fast imaging, the group has achieved a more than factor-of-four improvement in imaging speed over the classical Fourier series imaging method. Professors Liang and Norbert Pelc (Stanford University) have a pending patent application on the technique. The group is also working with Professor **Erik Wiener**'s group to further develop and evaluate the technology for early detection of breast tumors, and with Professor Arthur Kramer's group for functional brain mapping. In collaboration with Professors Yoram Bresler (Department of Electrical and Computer Engineering), Fernando Boada (University of Pittsburgh) and Chien Ho (Carnegie Mellon University), Professor Liang's group is developing a new class of minimum-redundancy imaging methods (integrating fast k-space scanning, optimal image representation, and parallel data acquisition), which promise to provide the highest imaging speed possible for real-time imaging. Professor Liang's group has also been collaborating with professors **Thomas Huang** and **Stephen Levinson** on developing effective methods for information fusion and intelligent image analysis, which will lay the foundation for build-

ing an intelligent imaging system using multiple sensors.



● The research grant from the Yamaha Motor Corporation has entered its fifth year. Although the research emphasis may vary from year to year, the main theme has always been multimodal human-computer interaction. During 2002, professors Thomas Huang, James Levin, and others have studied issues related to biometrics and passenger-vehicle interaction. A real-time access control system has been constructed that integrates visual face recognition and audio speaker identification to recognize persons in a database. A person sits in front of a computer terminal and her face is detected and recognized. She is then asked to read a string of words displayed on the monitor; this

audio input is used for speaker identification. Finally, the results of visual face recognition and audio speaker identification are combined using a naive Bayesian network to make a final decision. For a small database (30 persons), the recognition accuracy is 100 percent. The system allows on-line addition of new persons to the database. This access control system has been successfully transferred to and implemented at the Yamaha Motor Corporation, Japan. Other results during 2002 include a real-time emotion recognition system using a tree-augmented, naive Bayesian network and theoretical studies on the use of unlabeled data in training pattern classification algorithms.

Molecular and Electronic Nanostructures

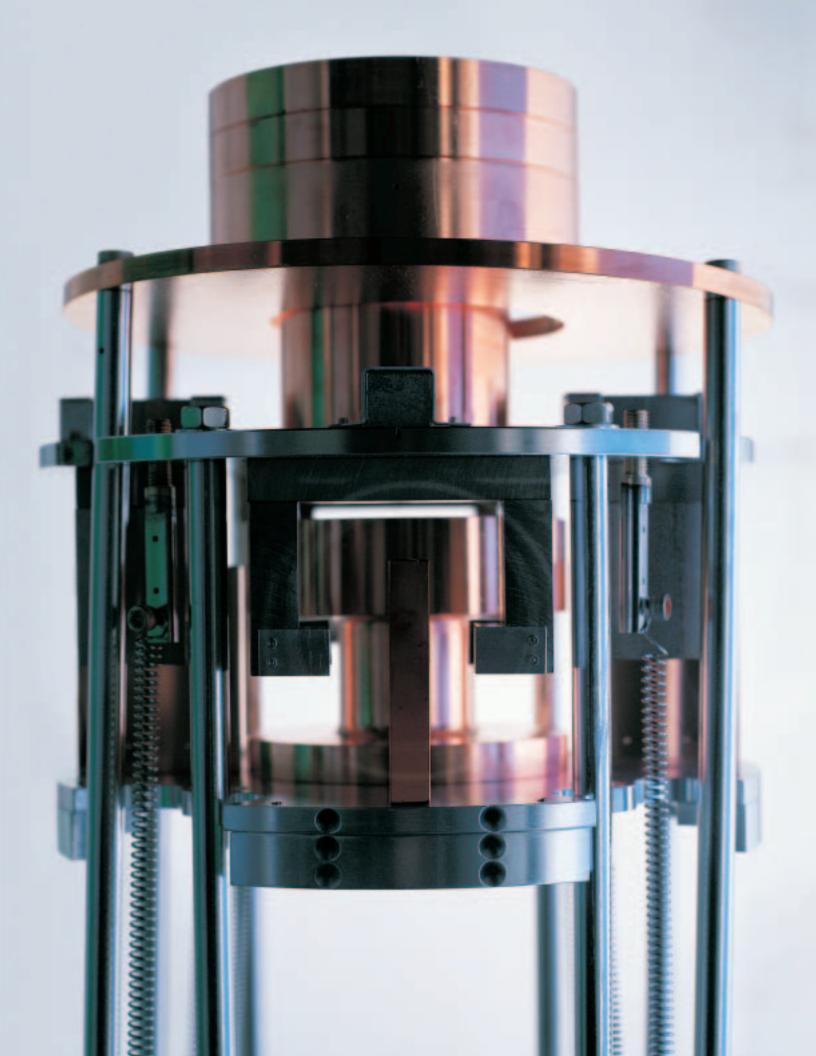
# M&ENS

#### Overview

### The Molecular and Electronic Nanostructures (M&ENS)

Main Research Theme focuses on the development of new materials and methods to advance the collection, computation, and communication of information. A major trend in the past year has continued to be the merger of biology and nanoscale engineering on both the theoretical and experimental fronts. Significant advances have been made in the development of new tools for fabrication and imaging on a range of size scales. These findings set the stage for creating ultrasensitive detectors, nanoelectronic integrated circuits, and a new type of hybrid architecture involving both biological and semiconductor components. This Bio-CMOS interface will process both chemical and electrical signals to fuse the speed of electronics with the complexity of biomimetic logic. Several major developments of the past year in the Molecular and Electronic Nanostructures Main Research Theme have set the stage for future research at the Beckman Institute.

Theory and simulation have received new as well as continuation research grants. The National Institutes of Health Resource Award, the major funding of the Theoretical and Computational Biophysics Group (Professor Klaus Schulten and co-workers), has been renewed for five more years. The National Science Foundation (NSF) has created a Network for Computational Nanotechnology (NCN) and has awarded a multi-million-dollar grant for its implementation. This network will be administered by Purdue University (lead), the University of Illinois, and Northwestern University.



The Beckman Institute's Computational Electronics Group will direct major NCN efforts in nano-bioelectronics (Professors Karl Hess, Jean-Pierre Leburton, and Umberto Ravaioli) and nano-electro-mechanics (Professor Narayana Aluru), including educational aspects (Professor Ravaioli). The Theoretical and Computational Biophysics Group has already been extremely successful in releasing software for use by researchers nationwide and worldwide. Over 23,000 researchers are registered users of the group's software. The newly created NCN is chartered to become another major resource for software use in nano-bioelectro-mechanics. Another major research grant, NSF Nanoscale Interdisciplinary Research Teams (NIRT), has been awarded by the NSF to a Beckman group led by Professor Gregory Timp. The group's work will be dedicated to questions such as whether nanometer-scale electronics can be integrated with biology.

Research in the M&ENS area has taken several new directions, with nanometer pores, carbon nanotubes, and biological ion channels continuing to play a major role. Collaborations between various Beckman groups on these topics have been developed. On the experimental side, nanopores are "drilled" by Professor Timp and co-workers into silicon dioxide. The electrical characteristics of molecules transiting the membrane through the pore are measured under physiological conditions. Professor Joseph Lyding has shown that single-wall carbon nanotubes can be deposited, modified, and manipulated on hydrogen-passivated silicon surfaces, setting the stage to test Professor Aluru's simulation results for controlling ion transport through carbon nanotubes. Generally, this research concentrates on connections between the "wet" (bio) and "dry" (electronics, electro-mechanics) worlds.

Research in biophotonics (Professor Stephen Boppart) is also along these lines, although with a different goal. The majority of this research involves the development and application of optical coherence tomography with resolutions approaching those of histology. Another area of major development this past year is the establishment of the Autonomic Materials Laboratory by Professor Scott White and co-workers. This laboratory aims to design and study materials that automatically respond to changes in their state or their surrounding environment.

-Karl Hess and Jeffrey S. Moore, Co-chairs

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### Highlights



- The Biophotonics Imaging Laboratory, headed by Professor Stephen Boppart, is pursuing research on the use of light and optics for detecting and diagnosing disease. The majority of the research involves the development and application of optical coherence tomography (OCT). OCT is an emerging high-resolution biomedical imaging technique that can perform "optical biopsies" of cells and tissues, generating images with resolutions approaching those of histology. In 2002, Professor Boppart's group collaborated with Professor Kenneth Suslick (Department of Chemistry) on the development of novel optical contrast agents for OCT. By altering the local scattering properties, these contrast agents have the potential to target and enhance the diagnostic capabilities of OCT, particularly in the area of cancer detection. A new technology, named nonlinear interferometric vibrational imaging, is also being developed to perform molecular mapping in cells and tissues to look for early molecular precursors to disease. Utilizing concepts from OCT and coherent anti-Stokes Raman scattering (CARS) microscopy, this technique will push imaging diagnostics to the molecular level. This work is in collaboration with Professors **Martin Gruebele**, Dana Dlott (Department of Chemistry), and Barbara Kitchell (College of Veterinary Medicine). Finally, Professor Boppart's laboratory has recently developed an integrated microscope that combines OCT and multiphoton microscopy. This instrument has been used to image microfluidic devices, in collaboration with Professor Lutgarde Raskin (Department of Civil and Environmental Engineering) and most recently, engineered tissues.
- Members of the Theoretical and Computational Biophysics Group (professors Klaus Schulten, Laxmikant Kale, Zan Luthey-Schulten, Todd Martínez, and Robert Skeel;

and Drs. Gila Budescu and Emad Tajkhorshid) and the NIH Resource for Macromolecular Modeling and Bioinformatics have continued their diverse efforts at the forefront of research and technology development (www.ks.uiuc.edu/). In the past year, the NIH Resource award, the major funding for the group, has been renewed for five more years, beginning on August 1, 2002. Group members have made significant contributions in the areas of structure prediction of biomolecular assemblies, molecular recognition and assembly, molecular modeling, and visualization. Recent highlights include the culmination of the study of the ubiquitous membrane channel aquaporin; a major release of NAMD, the parallel molecular dynamics code designed for high-performance simulation of large biomolecular systems; a growing functionality and use of BioCoRE, the collaborative environment software; and a major release of VMD, the popular graphics software for the visualization and analysis of biomolecular systems. Over 23,000 researchers in the United States and around the globe are registered users of Theoretical and Computational Biophysics Group software. The group's website is a highly respected and dynamic resource. It disseminates publications and expertise, and distributes software, receiving about 733,000

• Beckman investigators have made progress on several fronts of the NSF Nanoscale Interdisciplinary Research Teams (NIRT) on "protein logic." Professor Gregory Timp has used an electron beam to drill nanometer-size holes through thin dielectric membranes that can be used to isolate CMOS transistors from the biological environment. Professor Stephen Sligar has optimized the synthesis of 10nm diameter nanodiscs, which consist of scaffold proteins that self-assemble around a

hits each month.

phospholipids bilayer to form cassettes that will be evaluated for regulating ion flow through Timp's nanopores. Carbon nanotubes are also being considered for ion transport conduits. Professor **Joseph Lyding** has shown that single-wall carbon nanotubes can be deposited, modified, and manipulated on hydrogen-passivated silicon surfaces. This sets the stage to test the simulation results of Professor **Narayana Aluru** for controlling ion transport through carbon nanotubes. Professor **Paul Braun** has initiated studies of the diffusion channels that will be used to route molecular flow in protein logic structures, and Professor **Stephen Boppart** has developed the optical characterization tools that will be used to characterize the diffusion flow fields.

 As research in nanotechnology extends the tools for integrated circuit fabrication to nanometer dimensions (the scale of the secondary structure in a protein or a DNA molecule), it uncovers new vistas in biology. As a result, new challenges emerge, such as: Can nanometer-scale electronics be integrated with biology to directly extract information about physiology? Following a multidisciplinary approach, professors Klaus Schulten, Alexey Bezryadin, Jean-Pierre Leburton, and Gregory Timp are attempting to answer this question using a new type of integrated circuit that incorporates a nanometer diameter pore with a silicon transistor amplifier. As part of an NSF NIRT grant, pores 1.5-10nm in diameter are being produced in SiO<sub>2</sub>, Si, and Si<sub>3</sub>N<sub>4</sub> membranes ranging in thickness from 2-30nm, that comprise the gate electrode of a transistor amplifier. The electrical characteristics of molecules transiting the membrane through the pore are being measured under physiological conditions. From simulations of these measurements, researchers plan to infer information about the structure of the molecule.

- With the establishment of the Autonomic Materials Laboratory, members of the Advanced Chemicals Systems Group are actively engaged in developing materials with autonomic func**tions.** Such materials are inspired by biological systems, including self-healing materials with the ability to automatically repair internal damage whenever and wherever it occurs. Professor Scott White leads a team of researchers on this Air Force Office of Scientific Research (AFOSR)-sponsored project, which includes professors Jeffrey Moore, Nancy Sottos, and Paul **Braun** together with Professors Philippe Geubelle (Department of Aeronautical and Astronautical Engineering) and Jennifer Lewis (Department of Materials Science and Engineering). Self-healing action is accomplished by incorporating a microencapsulated healing agent and an embedded chemical catalyst within a polymer matrix. A living ring opening metathesis polymerization (ROMP) is triggered by contact with an embedded catalyst so that internal fracture surfaces are rebonded. Work is ongoing in an effort to optimize the material system and assess the efficiency of healing under a variety of environmental conditions. Self-healing polymers and composites are being developed for applications ranging from microelectronics to cryogenic fuel tanks to automotive tires. Interest in industry for this work is quite high, and the group is actively cultivating potential application areas in collaboration with the University's Office of Technology Management.
- The Network for Computational nanotechnology (NCN), recently funded by the National Science Foundation, is a multi-million dollar, five-year enterprise, subject to renewal for another five years. The core of the work will be performed by researchers at Purdue University (lead institution), the University of Illinois, and Northwestern University.



During the course of its 10-year mission, the NCN will conduct three projects in each of its three theme areas. These projects will contribute to a growing body of understanding, approaches, algorithms, and software that will benefit subsequent projects as well as the broader community. Broad collaborations between the three main contributing universities and other institutions (e.g. NASA Ames) are planned. The Beckman Institute participants at Illinois will work in several areas. The nanoelectronics theme begins with a project on nanowire transistors (Professor Jean-Pierre **Leburton**) that will develop computational tools and multi-scale methods. The nanoelectromechanical systems (NEMS) theme (Professor Narayana Aluru) will focus on understanding material properties at the nanoscale and on capturing atomic scale information in continuum scale models that can be used

for efficient design. The initial focus will also be on carbon nanotube structures (Beckman Fellow Slava Rotkin), where the experimental knowledge base is rapidly expanding (Professor Joseph Lyding). The software resulting from this approach will impact a variety of other structural and material nanoscale problems. The nanobioelectronics theme (professors Narayana Aluru, Karl Hess, Umberto Ravaioli, Klaus **Schulten**) is motivated by natural systems based on proteins that are embedded in a wet (water-related) environment, while present chip technology is based on silicon and dry environments. For certain applications that are already within reach (e.g., related to sensing), the interface between wet and dry systems becomes of extraordinary importance. The wet-dry interface will ultimately be applicable to a broad range of bio-nano engineered structures.

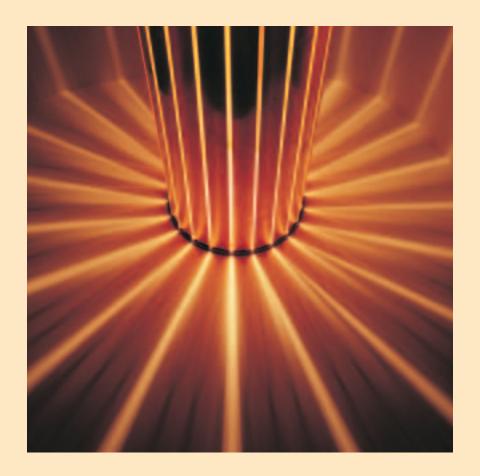
# Resources and Facilities

The Beckman Institute is committed to providing the most advanced facilities and resources for research programs centered in the building. These include the Imaging Technology Group which consists of the Microscopy Suite and the Visualization, Media, and Imaging Laboratory; the Integrated Systems Laboratory; and the Biomedical Imaging Center. These various facilities are used by research groups to conduct experiments in human multimodal perception and cognition, and in the automated and intelligent aquisition of images from a transition electron microscope. Other projects focus on combining novel engineering research with psychological studies in an effort to determine the efficacy of the engineered solutions to human-machine communication.



# BIC

#### BIOMEDICAL IMAGING CENTER



The Beckman Institute's Biomedical Imaging Center (BIC) is home to a wide variety of research programs, providing facilities, equipment, and training for research on nuclear magnetic resonance imaging and spectroscopy. A recent initiative of the Center is the integration of magnetic resonance methods with simultaneous optical imaging. It became a unit of the Beckman Institute in the summer of 2002, fostering access to a wide variety of resources. Researchers in civil, mechanical, and electrical engineering; neuroscience; speech and hearing science; psychology; biology; chemistry; medicine; and other fields pursue their research at the Center. The facility is supported by funds from campus resources, user fees, the National Science Foundation, and the National Institutes of Health.

- A Varian/spectroscopy Imaging Systems
  Corporation (SISCO) 4.7T/33cm-bore imaging
  Spectrometer continues to be a workhorse for
  the Center. It is equipped with shielded gradients and
  a Doty Scientific microprobe, as well as locally constructed probes for microscopy. Gradient and radiofrequency coils for special purposes have also been
  designed and constructed.
- A new 3T Siemens Magnetom Allegra scanner, installed in 2002, is a state-of-the-art system designed for human neurological and cognitive fMRI studies. Although it is a research-dedicated system, it is available for veterinary and human clinical imaging as well as for public service to the state of Illinois. The development environment for protocols and pulse sequences is fully integrated, allowing simulating, testing, and debugging of protocols and pulse sequences. In addition, the system supports real-time processing of BOLD studies during measurement, with real-time motion detection, correction, and statistical evaluation and immediate display of results. It also facilitates simultaneous optical and MR, or eye-tracking and MR recording.
- A 600 MHz, 9cm-bore Varian MR system will become functional in 2003. This machine is used for micro-imaging studies of single-cell and neuron systems as well as small animals, such as mice. The four-receiver-channel system will enable phased array capability to be developed at very high fields.
- The Center's complement of four quite distinct magnetic resonance systems will be complete with the move from the Beckman Institute main building in 2003 of a 1.5T, 33cm system. The Center will now become the primary site for all Beckman magnetic resonance research and applications.

• The Center provides high-speed, fiber-optic network connections to a variety of campus computing and imaging resources, such as the National Center for Supercomputing Applications and the Beckman Institute. This is in addition to desktop computers and workstations at the Center, as well as MR-dedicated computers elsewhere on campus. The Center's network link will be upgraded shortly.

Professional and support staff are expanding, and the physical plant is being upgraded, thanks to new resources available to the Center from the campus and particularly via the Beckman Institute.

In joining the Beckman Institute, the Center brings substantial additional space and MR research resources to the Beckman portfolio. In turn, the Center benefits from the exceptional support infrastructure that its growing capabilities need in order to live up to their potential for state-of-the-art research.

-Gregory A. Miller, Director-Tracey Wszalek, Assistant Director

# ISL

#### INTEGRATED SYSTEMS LABORATORY



The Integrated Systems Laboratory (ISL) is a Beckman Institute facility for advancing scientific understanding of human-computer interactions. As an Institute-wide facility, the ISL uses its expertise in the integration of advanced visualization, sonification, and interface technologies to enable researchers to conduct experiments in human multi-modal perception and cognition, cognitive and motor development, and multi-dimensional dataset visualization. ISL staff collaborate with researchers in the three Main Research Themes at the Institute to prepare virtual reality environments, and to develop and assist in programming individual experiments within those environments.

- The Beckman CUBE™, a six-surface, threemeter virtual reality chamber, has begun fulfilling its role as a precise, repeatable test environment in the basement of the Beckman **Institute building.** With a grant from the Major Research Instrumentation program in the Computer and Information Science and Engineering Directorate of the National Science Foundation, and major support from the Beckman Foundation, it is now possible for researchers to perform multi-modal human perception experiments in a virtual environment that is unique in the world. The CUBE™ is a virtual laboratory providing untethered data acquisition from subjects through commercial wireless body-tracking technologies, but most importantly by using eye-tracking, gesture, and speech recognition technologies developed within the research groups of the Beckman Institute.
- Reliance on expensive, easily outmoded visualization supercomputers is a thing of the past, thanks to ISL-developed visualization-cluster PC technology. Researchers using the Syzygy toolkit software, written by staff member Benjamin Schaeffer, are now able to develop applications for cognitive science studies in the six-projector CUBE™ that can then seamlessly scale to a single projection surface and even to an individual researcher's desktop computer. Untethered multi-modal human perception studies are now possible in the CUBE™, thanks to spatialized sonification and 6DOF navigation tools developed by staff member Camille Goudeseune.
- The addition of a 10-camera motion analysis motion-capture system gives researchers in kinesiology and electrical and computer engineering a human motion analysis tool unequaled at the University of Illinois. The ability to capture and analyze human motion in real time, coupled with

discreet kinesiologic and animation modeling software, allows research such as modern and anthropological gait comparisons to be performed concurrently with low-bandwidth-enhanced avatar creation. Using the mocap system, kinesiologists Les Carlton and Tania Straczek are researching shoulder and torso kinematics in individuals with thoracic spinal cord injuries, while **Karl Rosengren** and graduate student Jenelle Dorner are studying the effects of static and dynamic visual cues on gait initiation in Parkinson's disease.

• The human-factors research in driver safety and satisfaction has been greatly enhanced by the addition of the recently installed globalsim automotive driving simulator. Professors Arthur Kramer, Christopher Wickens, and George McConkie are the principal investigators on initial simulator studies designed to analyze training interventions to reduce driver distraction, monitor and predict driver workload, and develop a quantitative model of driver performance to predict driver responses to new technology interventions. Integration of this six-projected surface simulator with ISL-developed haptic, eye-tracking, and sonification interfaces provides another unique research environment at the Beckman Institute.

-Henry J. Kaczmarski, Director

## ITG

#### IMAGING TECHNOLOGY GROUP



Serving over 400 researchers from the Beckman Institute and nearly every department on campus, the **Imaging Technology Group** (ITG) provides state-of-the-art service facilities in the Microscopy Suite and the Visualization, Media, and Imaging Laboratory. A secondary focus of the group is to develop advanced imaging technologies, with an emphasis on projects in remote scientific instrumentation.

#### Facilities

Over the last year the Microscopy Suite has matured instrumentally with the addition of three new microscopes to the existing collection of scanning probe, electron, and light **microscopes.** A bioscope combining an atomic force microscope with an inverted optical microscope provides an easy means of imaging biological samples as well as liquid-solid interfaces with an AFM and optical microscope simultaneously. A reflected-light microscope providing imaging and point spectral analysis from 400nm to 1700nm was constructed with **Paul Braun**. PerkinElmer donated a Spectrum Spotlight for six months, providing spectral imaging in the mid infrared region. This instrument is our first step into surface molecular mapping. The additional instrumentation has proven popular with the Beckman research community.

This year, the Visualization, Media, and Imaging Laboratory (VMIL) concentrated its updates in the areas of high-end video editing **and infrastructure.** In video editing, a new system that supports uncompressed video editing and DVD production rounds out the laboratory's multimedia resources. In addition to increased performance and storage, this system provides researchers with the ability to generate videos from computer-generated images without the obscuring effects of compression artifacts. We are also pleased to announce that two publication covers were produced in the VMIL during 2002. First, the cover of the Journal of Polymer Science (4/15/2002) highlights the work of Joshua Orlicki, Jeffrey Moore, and others from the Advanced Chemical Systems group. The second was a book cover for the Handbook of Nanoscience, Engineering, and Technology, which highlighted work by **Karl Hess**, Beckman Fellow Slava Rotkin, and other researchers from Molecular and Electronic Nanostructures MRT.

#### Technology and Outreach

ITG has obtained a grant from the National Aeronautics and Space Administration as part of their Hierarchical Learning Network initiative to develop a research-grade remote environmental scanning electron microscope (ESEM) application.

This grant will enable us to take the next step towards a facility that supports remote access, collaboration, and research.

ITG continues to provide educational outreach to the national K-12 community through its Bugscope project, which provides real-time access to our ESEM for schools investigating insects as part of their science curriculum. Along with the Discovery Science Center in California, we have been awarded a grant from the Toshiba America Foundation to provide Bugscope access and teacher training to a select set of schools.

ITG's ongoing lecture series, the ITG Forum, included 26 presentations on a variety of topics of interest to the Beckman community. Additionally, the group published a paper, gave presentations at conferences, and published technical reports in order to document and disseminate information about the techniques and applications they developed throughout the year.

Additional information about the group can be found at www.itg.uiuc.edu/.

-Benjamin Grosser and Glenn Fried, Co-directors

## 2002

#### FELLOWS PROGRAM

The Beckman Institute Fellows Program was initiated in the fall of 1991, using funding provided by the Arnold and Mabel Beckman Foundation. It is intended for recent Ph.D.s or students in their final year of doctoral study in any of the research areas encompassed by the Institute. A competition for the fellowships is held once a year, with four Fellows being selected to spend a period of up to three years at the Beckman Institute.

Selection of Beckman Fellows is based upon evidence of professional promise, capacity for independent work, interdisciplinary interests, and outstanding achievement during their graduate careers. Because Fellows have no specific administrative or teaching responsibilities during their tenure, they are able to take maximum advantage of the opportunity to launch strong research careers. Past Fellows have competed effectively for research positions in major universities, and corporate and governmental laboratories throughout the nation, such as Motorola, The State University of New York at Stonybrook and at Buffalo, Hughes Research Labs, Oxford University, and the University of North Carolina.

The Beckman Graduate Fellows Program, also supported by funding from the Arnold and Mabel Beckman Foundation, is intended for graduate students who are already working at the Beckman Institute. The purpose is to encourage inter-disciplinary research at the graduate student level. Research projects must involve at least one Beckman faculty member in addition to a second faculty member, and preference is given to those proposals involving the active participation of two faculty members from two different Beckman Institute groups.



### **Fellows**

### • Tyler Bruns, 2002 Fellow Ph.D. 2001

#### University of Illinois at Urbana-Champaign

Tyler Bruns is interested in developing computer-aided analysis and synthesis tools for the conceptual design of innovative structures, flexible multibody and compliant mechanisms, and microelectromechanical (MEM) devices. Today, the design of MEM systems (MEMS) is primarily based on an expensive and time-consuming trial-and-error process. The intent of this research is to develop a systematic and automated computer-aided design tool to rapidly prototype the design of MEM devices. The result of the initial phase will be an automated process in which the MEM device is taken from art to part. After proof of concept, the second focus will be to further develop and incorporate computational methods that can handle these large-scale, multiphysics design problems.

### • Stanley Colcombe, 2002 Fellow Ph.D. 2000

#### University of Illinois at Urbana-Champaign

Stanley Colcombe's research focuses on neurocognitive decline in the aging brain and how these changes might be slowed or reversed through cognitive or physiological interventions. Recent findings from structural and functional magnetic resonance imaging (fMRI) studies have shown that older adults with greater levels of cardiovascular fitness tend to show better neurocognitive function and also tend to experience less agerelated brain atrophy. Currently, in collaboration with Professor **Arthur Kramer**, Colcombe is investigating the neural plasticity of the prefrontal and parietal cortices of older adults through training in dual-task and attentional control-task paradigms. By approaching the issue of neurocognitive decline from multiple methodological routes, this research promises to provide

not only a better understanding of the nature of agerelated changes in the brain, but also a better understanding of the factors that might prevent or repair age-related declines.

### Diego Díaz, 2002 Fellow Ph.D. 2001 Cornell University

Diego Díaz's research focuses on the field of porous semiconductors, mostly porous GaN. Porous GaN is of great interest for its ability to enhance light-emission properties and blue-shifting of the light emission, as well as for its mechanical, chemical, and thermal stability. However, little is known about the mechanisms of etching and how to reliably prepare porous GaN in a way that is compatible with the restrictions of device preparation. Díaz's research deals with the development of an electroless etching technique that yields the porous GaN, and on understanding the etching of the GaN material that leads to the porous GaN. Moreover, he is interested in the correlation between the etching parameters and the resulting morphology as well as its light emission properties. Such knowledge is required in order to be able to prepare a new generation of UV light emitters and LEDs.

### Sarah Grison, 2002 Fellow Ph.D. 2002 University of Wales Bangor

University of Wales, Bangor (United Kingdom)

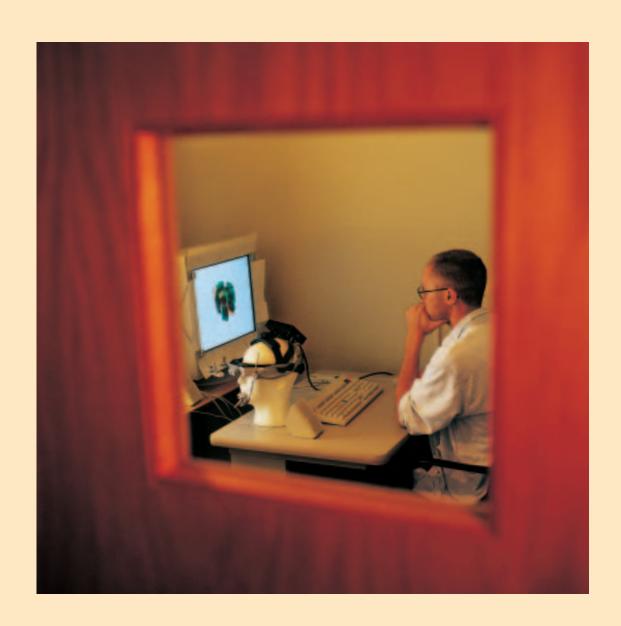
Sarah Grison explores the cognitive and neural mechanisms that mediate behavior in our complex visual world. In particular, it is known that while attention to relevant information facilitates correct response, processing of irrelevant information also aids behavior. For example, short-term tasks (e.g., using a corkscrew to open a bottle of wine) are completed via inhibition



of irrelevant items for up to a few seconds. By contrast, long-term tasks (e.g., finding a corkscrew long after the search was begun) are completed by encoding and retrieving irrelevant, inhibited items from memory. As a Beckman Fellow, Grison will use converging techniques, such as event-related brain potentials, event-related optical signals, and measures of eyemovements to develop a neurally plausible connectionist model of how inhibition works with memory to mediate behavior across short- and long-term tasks.

#### Cristina Iani, 2002 Fellow Ph.D. 2001 University of Bologna (Italy)

Cristina Iani's work focuses on basic and applied aspects of visual attention. At any given moment a human observer is confronted with a multitude of environmental inputs, many of which are irrelevant to current behavior. In order to behave efficiently, the observer needs to select the relevant information



while excluding the irrelevant one in order for further processing to occur. Iani's research investigates the attentional strategies that determine this selection. Another topic of interest includes the relationship between mental effort and autonomic responses. In collaboration with researchers at the Technion (Israel Institute of Technology), she is developing a method for on-line assessment of mental effort in complex tasks (e.g., flight and driving).

#### • Donald M. Cannon, Jr.,

2001 Fellow Ph.D. 2001

#### The Pennsylvania State University

As a Beckman Fellow, Donald Cannon's research is aimed at interrogating neuronal chemical dynamics through the application of a novel biofluidic intelligent processor that was recently proposed by researchers at the Beckman Institute. These fluidic analyzers, incorporating nanometer-scale structures, are designed for analyses of multiple molecular species from extremely low (attoliter) volumes, a revolutionary step towards a yet unknown size regime for fluid control and molecular manipulation. A current focus by this research team involves the detection of biochemical warfare agents, such as botulinum neurotoxins. Long-term research goals include the implementation of novel bioanalytical strategies that investigate the spatial and temporal chemical dynamics in and around single cells.

#### Christina Grozinger,

2001 Fellow Ph.D. 2001 Harvard University

Christina Grozinger's research focuses on elucidating the molecular basis of social behavior and behavioral plasticity, using the honey bee as a model system.

Bees display several distinct behaviors, which are modulated in response to the colony's requirements. As in many vertebrate and invertebrate species, these behavioral states are regulated by pheromones, some of which produce stable, extensive changes in behavior and physiology. These pheromones are being used to determine the gene expression changes underlying this regulation of behavior, using the bee brain microarrays developed in the laboratory of Professor Gene Robinson in the University of Illinois' Department of Entomology. The brain transcriptional response to pheromones provides a novel link between the physiological state of the individual and the social state of the colony. Pursuit of this novel link promises to shed light on the molecular basis of social behavior.

#### • Jesse Spencer-Smith,

2001 Fellow Ph.D. 2002 Indiana University

Jesse Spencer-Smith's research focuses on how humans perceive emotional facial expressions. He is also developing a large database of three-dimensional scans of racially diverse faces for use in expression and face identification studies. He has developed an interactive program for displaying faces and facial expressions using a synthesized three-dimensional head, and is exploring the role dynamics play in understanding expressions. Spencer-Smith is working with Beckman Institute faculty in the Human-Computer Intelligent Interaction Main Research Theme to incorporate this work into a real-time system for human-computer interaction. He has also developed new mathematical modeling tools to investigate the psychological representations that underlie expression perception. In particular, he has developed new tests for curvature in psychological spaces.

#### • John Paul Minda, 2000 Fellow

Ph.D. 2000

University at Buffalo, State University of New York

Paul Minda's research deals with how people learn categories and how they use category representations when making decisions. Since coming to Beckman in 2000, Minda has been working on several projects. One project looks at how people's knowledge is represented for general aspects of a category and knowledge for specific category members. Another project, with Professor **Brian Ross**, investigates how people learn about categories of objects by predicting things about them, which may approximate how some real-world categories are learned. Minda has also been developing a new computational model of category learning that abstracts general things about categories but also gradually builds up knowledge about specific category members. This model can account for some data that many

### • Slava Rotkin, 2000 Fellow

current models are unable to account for.

Ph.D. 1996

Ioffe Physico-Technical Institute, St. Petersburg (Russia)

In 2002, Slava Rotkin's research demonstrated that there is a principal physical limit for fabricating nanoelectromechanical systems (NEMS), using theory that is based on a developed compact model for nanotube (NT) devices. The compact model allowed for the simulation of a light-controlled electronic NT switch and the operation of NT nanotweezers. Rotkin also calculated a many-body correction to van der Waals energy; analytical expression for pull-in voltage for NT-NEMS, including quantum corrections and van der Waals interactions; analytical expression for quantum corrections to electrostatics of metallic NTs with arbitrary lateral

deformations; and, scattering probability for a potential of charged impurity near the NT channel and its ballistic conductance. These results have formed the basis of a new course for graduate students, scheduled for Spring 2003 (ECE 497).

## • Ilya Zharov, 2000 Fellow Ph.D. 2000

#### **University of Colorado**

As a Beckman Fellow, Zharov collaborates with the members of the Advanced Chemical Systems Group to work on the use of dendrimers and hyperbranched polymers for molecular recognition. The general approach in this work is to covalently attach dendrons or hyperbranched polymeric chains carrying cross-linkable substituents to a template molecule. Cross-linking and removal of the template creates an imprint, which can be used for recognition or for catalysis. In addition to synthetic work, Zharov is using molecular mechanics, molecular dynamics, and quantum-chemical calculations to model dendrimers and carbon nanotubes.

## • Hong Hua, 1999 Fellow Ph.D. 1999

#### Beijing Institute of Technology (China)

Hong Hua has been leading the NSF-ITR project, titled "Development of Head-mounted Projective Displays for Distance Collaborative Environments," to investigate novel visualization solutions that enable collaborative visualization in distributed augmented environments. In 2002, she has been focusing on the development of a unique collaborative infrastructure, referred to as SCAPE (Stereoscopic Collaboration in Augmented Projective Environments), and a tool kit that provides a cross-platform and extensible framework for augmented collaborative applications. The

SCAPE is equipped with multi-modality interface devices and customer-designed collaborative widgets. It provides a unique platform to bridge virtual and augmented environments through which a user can perform augmented tasks while being immersed in considerably large virtual environments. In addition, she has been investigating various calibration methods of the SCAPE system and studying computational models to create accurate registration in augmented environments. In collaboration with Professor **Narendra Ahuja**, she has also been developing high-resolution panoramic imaging methods. She anticipates these technologies will stimulate a wide range of applications in collaborative visualization tasks.

### Jason McCarley, 1999 Fellow Ph.D. 1997 University of Louisville

Jason McCarley collaborates with members of the Human Perception and Performance Group at the Beckman Institute. His research explores basic and applied aspects of visual perception and cognition. Current topics of interest include the interplay of attention and perceptual representation, the relationship between perceptual representation and oculomotor control, and the acquisition and nature of visual/attentional skills in naturalistic tasks, such as airport security inspection and driving.

#### Lolita Rotkina, 1999 Fellow Ph.D. 1996

Infe Physico-Technical Institute, St. Petersburg (Russia)

Over the past year, Lolita Rotkina's research has focused on building a low-pressure chemical vapor deposition workstation. The system is based on a Lindberg Blue-M three-zone tube furnace that has

three temperature zones, can be heated up to 1200°C, and has computerized control of both temperature and gas flow. It has been designed for multipurpose use and can be used to perform CVD and LPCVD synthesis, physical vapor crystal growth, annealing, and sintering of compounds under vacuum and in a gas atmosphere. Rotkina has also been involved in a second project that has used an ion beam (FIB) technique to deposit Pt nano-interconnects. She has then studied the electrical properties of the Pt nano-interconnects formed on SiO2 substrates. Future work will focus on fabricating various types of nanoscale junctions and prototypes of the nano-devices by connecting nanotubes, nanopipes, nanoribbons, and nanocrystals.

### **Graduate Fellows**

#### Timothy Bigelow:

"Temperature Estimates During Diagnostic Ultrasound Exposures"

The goal of Bigelow's research is to develop a quantitative assessment of tissue temperature increase under in vivo and in utero exposure to ultrasound, thereby providing the medical professional with the ability to assess the risk of the diagnostic exposure. Advisors are professors **William D. O'Brien, Jr.** (Electrical and Computer Engineering), **Narendra Ahuja** (Electrical and Computer Engineering), and James Zachary (Veterinary Pathobiology).

#### • Kirk Erickson:

"An Examination of Age Differences in Neural Activity Using Structural Equation Modeling and Event-related fMRI"

Erickson's research proposes a series of studies that will incorporate psychological, physiological, statistical, and functional MRI techniques to investigate cognitive decline in the aging brain. Advisors are professors **Arthur Kramer** (Psychology), **Andrew Webb** (Electrical and Computer Engineering), and **Gregory Miller** (Psychology).

#### • Tin Man Lee:

"Optical Contrast Agents for Optical Coherence Tomography (OCT)"

Lee's research proposes to prepare and characterize optical contrast agents for use in optical coherence tomography (OCT). Advisors are professors **P. Scott Carney** (Electrical and Computer Engineering), **Stephen Boppart** (Electrical and Computer Engineering), and Kenneth Suslick (Chemistry).

#### Jilin Tu:

"Developing Lip-readable Synthetic Talking Face"

The goal of Tu's research is to develop a speech-driven synthetic talking face as a substitute for video, and to evaluate the improved intelligibility of speech with the addition of this face. Advisors are professors **Thomas Huang** (Electrical and Computer Engineering), **Stephen Levinson** (Electrical and Computer Engineering), and **Charissa Lansing** (Speech and Hearing Science).

#### • Fangqiang Zhu

"Molecular Dynamics Simulations of Water Conduction Through Nanotubes"

Zhu proposes to perform molecular dynamics simulations to study water transport through carbon nanotubes. Advisors are professors **Klaus Schulten** (Physics), **Karl Hess** (Electrical and Computer Engineering), **Umberto Ravaioli** (Electrical and Computer Engineering), and **Narayana Aluru** (General Engineering).



# '02 Facts and Figures

# '98-'02 Funding

#### Beckman Institute Funding 1

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riinding Aw	ARDED TO BECKM	AN INSTITUTE FACILIA	Y ADMINISTERED BY TH	E BECKMAN INSTITUTES

	FY98	FY99	FY00	FY01	FY02
DEPARTMENT OF DEFENSE	4,244,105	8,596,145	3,567,490	7,220,570	4,591,675
NATIONAL INSTITUTES OF HEALTH	2,024,355	3,096,564	3,433,321	3,845,206	3,250,386
NATIONAL SCIENCE FOUNDATION	1,823,786	3,714,184	1,555,040	4,939,857	4,446,613
OTHER	817,864	1,161,601	890,974	1,882,971	2,227,403
TOTAL	\$ 8,910,110	\$16,568,494	\$9,446,825	\$17,888,604	\$14,516,077

#### Funding Awarded to Beckman Institute Faculty Administered by Other Departments<sup>3</sup>

Total	\$16,378,850	\$15,367,705	\$24,678,642	\$14,708,914	\$15,767,936
OTHER	2,452,133	632,688	2,737,686	2,681,499	2,953,591
NATIONAL SCIENCE FOUNDATION	1,837,054	1,937,805	7,580,850	3,371,477	6,118,599
NATIONAL INSTITUTES OF HEALTH	5,614,090	5,316,533	5,623,463	4,355,386	3,090,999
DEPARTMENT OF DEFENSE	6,475,573	7,480,679	8,736,643	4,300,552	3,604,747

<sup>&</sup>lt;sup>1</sup>In addition to the sources itemized in the chart, funding for the Institute is received from the following:

Daily Operating Expenses

3. The Arnold and Mabel Beckman Foundation:

Beckman Institute Fellows Program

Beckman Institute Graduate Fellows Program

Beckman Institute Equipment Competition

<sup>1.</sup> The state of Illinois to the University of Illinois and allocated through individual departments: Faculty Salaries

<sup>2.</sup> The state of Illinois to the Beckman Institute:

<sup>&</sup>lt;sup>2</sup>All interdisciplinary grants with faculty investigators from multiple departments are administered by the Beckman Institute.

 $<sup>^3</sup>$ All single investigator grants are administered by the investigator's home department.

# **BI** Biological Intelligence

#### **Faculty by Beckman Institute Group**

**Bioacoustics Research Laboratory** • Leon A. Frizzell: Electrical and Computer Engineering • William D. O'Brien, Jr.: Electrical and Computer Engineering • Biological Sensors Group • Ronald J. Adrian: Theoretical and Applied Mechanics • Sahraoui Chaieb: Theoretical and Applied Mechanics • Deborah E. Leckband: Chemical Engineering • Chang Liu: Electrical and Computer Engineering • Mark A. Shannon: Mechanical and Industrial Engineering • Andrew G. Webb: Electrical and Computer Engineering • **Cognitive Neuroscience Group** • Neal J. Cohen: Psychology • Monica Fabiani: Psychology • Kara D. Federmeier: Psychology • Susan M. Garnsey: Psychology • Gabriele Gratton: Psychology • Wendy Heller: Psychology • Gregory A. Miller: Psychology • Denise Park: Psychology • Cognitive Science **Group** • Aaron Benjamin: Psychology • J. Kathryn Bock: Psychology • William F. Brewer: Psychology • Jennifer S. Cole: Linguistics • Gary S. Dell: Psychology • Cynthia L. Fisher: Psychology • Adele E. Goldberg: Linguistics • Georgia M. Green: Linguistics • Kevin Miller: Psychology • Brian H. Ross: Psychology • Edward J. Shoben: Psychology • Daniel D. Silverman: Linguistics • Jonathan Waskan: Philosophy • Magnetic Resonance Imaging and Spectroscopy Group • Paul C. Lauterbur: Medical Information Sciences • Erik Wiener: Nuclear Engineering • Neuronal Pattern Analysis Group • Thomas J. Anastasio: Molecular and Integrative Physiology • David F. Clayton: Cell and Structural Biology • Albert S. Feng: Molecular and Integrative Physiology • Michael Gabriel: Psychology • William T. Greenough: Psychology • Yuqing Li: Molecular and Integrative Physiology • Mark E. Nelson: Molecular and Integrative Physiology • Jonathan V. Sweedler: Chemistry • Bruce C. Wheeler: Electrical and Computer Engineering • **No Group** • Eric G. Jakobsson: Molecular and Integrative Physiology

#### **Major Awards**

#### Ronald J. Adrian

Fellow, American Society of Mechanical Engineers AIAA Prize in Measurement Technology, American Institute of Aeronautics and Astronautics Fellow, World Innovation Foundation Asanuma Award, Flow Visualization Society

#### Aaron S. Benjamin

Board of Editors, Journal of Experimental Psychology: Learning, Memory and Cognition

#### Adele E. Goldberg

Humanities Released Time Award, University of Illinois at Urbana-Champaign

#### **Deborah Leckband**

University Scholar, University of Illinois at Urbana-Champaign

#### **Denise Park**

Distinguished Contribution Award to Psychology of Aging, Division 20, Adult Development and Aging, American Psychological Association Board of Directors, American Psychological Society

#### Jonathan V. Sweedler

Heinrich-Emanuel Merck Prize, Merck Company Instrumentation Award, Analytical Division, American Chemical Society Special Creativity Extension, National Science Foundation

#### Andrew G. Webb

Xerox Award for Faculty Research, Xerox Foundation Willett Faculty Scholar Award, College of Engineering, University of Illinois at Urbana-Champaign

#### **Patents and Patent Applications**

(Beckman Institute faculty in bold)

**Andrew Webb** and **Jonathan Sweedler**: "Method and Apparatus for Simultaneous Acquisition of High Resolution NMR Spectra From Multiple Samples," Issue date: September 24, 2002, Patent No. 6,456,072.

**Thomas Anastasio**, Sylvian Ray, and **Thomas Huang**: "Method for Determination of Spatial Target
Probability Using a Model of Multisensory Processing
by the Brain," File date (year only): 2002.

**Paul Bohn**, **Jonathan Sweedler**, **Mark Shannon**, and Tzu-chi Kuo: "Hybrid Microfluidic and Nanofluidic System," File date (year only): 2002.

#### **Grants Awarded**

(Principal Investigator in bold)

**Ronald J. Adrian**: Civilian Research and Development Fund, "Modeling of the Dynamics of Hairpin Vortex Packets in Wall Turbulence," 01-Jul-02 to 30-Jun-03.

- **J. Kathryn Bock**: National Science Foundation, "Making Syntax of Sense," 01-Sep-02 to 31-Aug-03.
- **J. Kathryn Bock**: National Institutes of Health, "Tracking Time from Visual Perception to Articulation," 05-Sep-02 to 31-Jul-05.
- **J. Kathryn Bock**: National Institutes of Health, "Language Processing: A Training Program," 01-Jul-02 to 30-Jul-07.

**Neal Cohen**, Andrew Webb, and Tracy Wszalek: National Institutes of Health, "The Hippocampal System and Relational (Declarative) Memory Processes," 01-Jul-02 to 30-Jun-05. **Gary Dell** and Scott Watter: National Institutes of Health, "Functional Mechanisms of Executive Control of Attention," 02-Jul-02 to 01-Jul-03.

**Monica Fabiani**, Gabriele Gratton, Enrico Gratton, and Arthur Kramer: National Institutes of Health, "Studying Neurovascular Coupling in Aging With Optical Methods," 15-Nov-02 to 30-Jun-07.

**Leon Frizzell**: National Institutes of Health, "High Intensity Ultrasound for Prostrate Treatment," 02-Feb-02 to 31-Jan-04.

Im Joo Rhyu and **William T. Greenough**: FRAXA Research Foundation, "Axonal Elimination and Synaptic Maturation in Development and Early Adulthood on the FMR-1 Knockout Mouse," 01-Mar-02 to 28-Feb-03.

**William T. Greenough**: National Institutes of Health, "Structural Substrates of Synapse Plasticity," 26-Feb-02 to 30-Nov-05.

**William T. Greenough**: National Institutes of Health, "Developmental Psychobiology and Neurobiology Training Grant," 16-May-02 to 30-Apr-07.

**William T. Greenough** and Anna Klintsova: National Institutes of Health, "Therapeutic Motor Training and Fetal Alcohol Effects," 01-Jul-02 to 31-Mar-07.

**Yuqing Li** and Charles L. Cox: National Institutes of Health, "Animal Model Of Juvenile Epileptogenesis NMDA Receptors," 01-Mar-02 to 28-Feb-05.

**Chang Liu**: Department of Defense—Air Force, "A Proposal to Acquire a Micro Thermal Imaging Microscope," 01-May-02 to 30-Apr-03.

**Chang Liu**: National Science Foundation, "Biomimetic Sensors for Autonomous Underwater Vehicles," 01-Oct-02 to 30-Sep-04.

**Change Liu**: NanoInk, "Development of Standard DPN-Substrates (NanoInk)," 01-Mar-02 to 01-May-02.

**Denise Park** and Gregory A. Miller: National Institutes of Health, "Imagery, Visual Memory, and Aging: A Neuroimaging Approach," 30-Sep-02 to 31-Jan-06.

**Denise Park**: National Institutes of Health, "Memory, Aging, and Culture," 01-Nov-02 to 31-Aug-03.

**Denise Park**: National Institutes of Health, "Center on Aging and Cognition: Health Education and Training," 01-Dec-02 to 30-Jun-03.

**Jonathan V. Sweedler**: National Institutes of Health, "Subcellular Characterization of Neurotransmitters," 01-May-02 to 30-Apr-06.

**Andrew G. Webb**: National Institutes of Health, "High Field Magnetic Resonance Research and Technology," 01-May-02 to 30-Apr-03.

**Bruce C. Wheeler**: National Science Foundation, "Information Processing in Designed Neuronal Circuits," 01-Feb-02 to 31-Jan-05.

**Erik Wiener**: National Institutes of Health, "Folate Dendrimes as Tumor Specific Contrast Agents," 26-Apr-02 to 31-Mar-05.

#### **Selected Publications**

(Beckman Institute faculty in bold)

- Patton, P.E., Belkacem-Boussaid, K., and **Anastasio, T.J.** (2002), "Multimodality in the Superior Colliculus: An Information Theoretic Analysis," *Cognitive Brain Research*, **14**, pp. 10-19.
- Castel, A.D., **Benjamin, A.S.**, Watkins, M.J., and Craik, F.I.M. (2002), "The Effects of Aging on Selectivity and Control in Short-term Recall," *Memory and Cognition*, **30**, pp. 1078-1085.

- Bencini, G., **Bock, J.K.**, and **Goldberg, A.** (2002), "How Abstract is Grammar? Evidence from Structural Priming in Language Production," poster presented at the 15th Annual CUNY Conference on Human Sentence Processing, New York, NY.
- Nayfeh, M.H., Rao, S., Barry, N., Therrien, J., Belomoin, G., Smith, A., **Chaieb, S.** (2002), "Observation of Laser Oscillation in Aggregates of Ultrasmall Silicon Nanoparticles," *Applied Physics Letters*, **80/1**, pp. 121-123.
- Belomoin, G., Therrien, J., Smith, A., Rao, S., Twesten, R., **Chaieb, S.**, Nayfeh, M.H., Wagner, L., Mitas, L., (2002), "Observation of a Magic Discrete Family of Ultrabright Si Nanoparticles," *Applied Physics Letters*, **80/5**, pp. 841-843.
- Park, K., and **Clayton, D.F.** (2002), "Influence of Restraint and Acute Isolation on the Selectivity of the Adult Zebra Finch Zenk Gene Response to Acoustic Stimuli," *Behavioural Brain Research*, **136/1**, pp. 185–191.
- Gupta, P. and **Cohen, N.J.** (2002), "Skill Learning, Repetition Priming, and Procedural Memory: Theoretical and Computational Analysis," *Psychological Review*, **109/2**, pp. 401-448.
- Milham, M.P., Erickson, K.I., Banich, M.T., **Kramer, A.F.**, **Webb, A.**, Wszalek, T., and **Cohen, N.J.** (2002), "Attentional Control in the Aging Brain: Insights from an fMRI Study of the Stroop Task," *Brain and Cognition*, **49/3**, pp. 277-296.
- **Cole, J.** (2002), "Learning Sindhi Online: Teaching to a Distributed Student Population," presented at the 2nd Heritage Languages Conference, Washington D.C.
- **Cole, J.** (2002), "Evidence for a Production Bias in Vowel Harmony," 8th Conference on Laboratory Phonology, Yale University, New Haven, Connecticut.

- Chen, J.-Y., Chen, T.-M., and **Dell, G.S.** (2002), "Wordform Encoding in Mandarin Chinese as Assessed by the Implicit Priming Task," *Journal of Memory and Language*, **46**, pp. 751-781.
- Gordon, J.K. and **Dell, G.S.** (2002), "Learning to Divide the Labor Between Syntax and Semantics: A Connectionist Account of Deficits in Verb Production," *Brain and Cognition*, **48**, pp. 376-381.
- **Gratton, G.** and **Fabiani, M.** (2002), "Fast Optical Signals: Principles, Methods, and Experimental Results," R. Frostig, ed., *In Vivo Optical Imaging of the Central Nervous System*, (Boca Raton: CRC Press), pp. 223-247.
- **Federmeier, K.D.** and Kutas, M. (2002), "Picture the Difference: Electrophysiological Investigations of Picture Processing in the Cerebral Hemispheres," *Neuropsychologia*, **40**, pp. 730-747.
- **Federmeier, K.D.**, McLennan, D.B., De Ochoa, E., and Kutas, M. (2002), "The Impact of Semantic Memory Organization and Sentence Context Information on Spoken Language Processing by Younger and Older Adults: An ERP study," *Psychophysiology*, **39**, pp. 133-146.
- **Feng, A.S.**, Narins, P.M., and Xu, C.H. (2002), "Vocal Acrobatics in a Chinese Frog, *Amolops tormotus*," *Naturwissenschäften*, **89**, pp. 352-356.
- Galazyuk, A.V., White, K.R., and Feng, A.S. (2002),
   "Temporal Dynamics of Central Auditory Processing,"
   J. Thomas, C. Moss, and M. Vater, eds., Echolocation in
   Bats and Dolphins (Chicago: University of Chicago Press).
- **Fisher, C.** (2002), "The Role of Abstract Syntactic Knowledge in Language Acquisition: A Reply to Tomasello (2000)," *Cognition*, **82**, pp. 259-278.
- Onishi, K.H., Chambers, K.E., and **Fisher, C.** (2002), "Learning Phonotactic Constraints from Brief Auditory Experience," *Cognition*, **83**, pp. B13-B23.

- **Gabriel, M.**, Burhans, L., Talk, A., and Scalf, P. (2002), "Cingulate Cortex," V.S. Ramachandran, ed., *Encyclopedia of the Human Brain*, (San Diego: Academic Press), pp. 775-791.
- **Gabriel, M.**, Burhans L., and Kashef, A. (2002), "Consideration of a Unified Model of Amygdalar Associative Functions," L. Cahill, P. Shinnick-Gallagher, A. Shekar, and A. Pitkanen, eds., *The Amygdala in Brain Function: Basic and Clinical Approaches* (New York: New York Academy of Sciences).
- Bencini, G., **Bock, J.K.**, and **Goldberg, A.** (2002), "How Abstract is Grammar? Evidence from Structural Priming in Language Production," poster presented at the 15th Annual CUNY Conference on Human Sentence Processing, New York, NY.
- **Goldberg, A.** (2002), "Surface Generalizations: An Alternative to Alternations," *Cognitive Linguistics*, **13/3**, pp. 327-356.
- **Gratton, G.** and **Fabiani, M.** (2002), "Fast Optical Signals: Principles, Methods, and Experimental Results," R. Frostig, ed., *In Vivo Optical Imaging of the Central Nervous System* (Boca Raton: CRC Press), pp. 223-247.
- Angenstein, F., Evans, A.M., Settlage, R.E., Moran, S.T., Ling, S-C., Klintsova, A.Y., Shabanowitz, J., Hunt, D.F. and **Greenough, W.T.** (2002), "A Receptor or Activated C Kinase (RACK1) is Part of mRNP-Complexes Associated with PolyA-mRNAs in Neurons," *Journal of Neuroscience*, **22**, pp. 8827-8837.
- Federmeier, K.D., Kleim, J.A., and Greenough, W.T. (2002), "Multiple Synapse Formation in the Cerebellar Cortex After Complex Motor Learning," *Neuroscience Letters*, **332**, pp. 180-184.
- Chiu, S.-W., **Jakobsson, E.**, Mashl, R.J., and Scott, H.L. (2002), "Cholesterol-induced Modifications in Lipid Bilayers: A Simulation Study," *Biophysical Journal*, **83**, pp. 1842-1853.

- Van der Straaten, T., Varma, S., Chiu, S.-W., Tang, J., **Aluru, N.**, Eisenberg, R., **Ravaioli, U.**, and **Jakobsson, E.**, (2002), "Combining Computational Chemistry and Computational Electronics to Understand Protein Ion Channels," *Proceedings of the International Conference on Computational Nanoscience and Nanotechnology*, pp. 60-63.
- Zhu, B., Davies, E.A., van der Merwe, A., **Leckband, D.** (2002), "Direct Measurements of Heterotypic Adhesion Between the Cell Adhesion Proteins CD2 and CD48," *Biochemistry*, **41**, pp. 12163-12170.
- Cao, B.-J. and **Li, Y.** (2002), "Reduced Anxiety- and Depressive-like Behaviors in Emx1 Homozygous Mutant Mice," *Brain Research*, **937**, pp. 32-40.
- Zhang, M., Bullen, D., Chung, S.-W., Hong, S., Ryu, K.S., Fan, Z., Mirkin, C.A., and **Liu, C.** (2002), "A MEMS Nanoplotter with High-density Parallel Dip Pen Nanolithography (DPN) Probe Arrays," *Journal of Nanotechnology*, **13**, pp. 212-217.
- Heller, W., Isom, J., Nitschke, J.B., Koven, N., Mohanty, A., Fisher, J.E., Herrington, J.D., and Miller, G.A. (2002), "States, Traits, and Symptoms: Investigating the Neural Correlates of Emotion, Personality, and Psychopathology," D. Cervone and W. Mischel, eds., *Advances in Personality Science* (New York: Guilford Press), pp.106-126.
- Lewine, J.D., Thoma, R.J., Provencal, S.L., Edgar, C., **Miller, G.A.**, and Canive, J.M. (2002), "Abnormal Stimulus-response Intensity Functions in Posttraumatic Stress Disorder: An Electrophysiological Investigation," *American Journal of Psychiatry*, **159**, pp. 1689-1695.
- Miller, K.F. (2002), "Children's Early Understanding of Writing and Language: The Impact of Characters and Alphabetic Orthographies," W. Li, J.S. Gaffney, and J.L. Packard, eds., Children's Reading Acquisition: Theoretical and Pedagogical Issues (Boston: Kluwer Academic Publishers), pp. 17-29.

- **Nelson, M.E.**, MacIver, M.A., and Coombs, S. (2002), "Modeling Electrosensory and Mechanosensory Images During the Predatory Behavior of Weakly Electric Fish," *Brain Behavior and Evolution*, **59**, pp. 199-210.
- Brandman, R. and **Nelson, M.E.** (2002), "A Simple Model of Long-term Spike Train Regularization," *Neural Computation*, **14**, pp. 1575-1597.
- O'Brien, W.D., Jr., Kramer, J.M., Waldrop, T.G., Frizzell, L.A., and Zachary, J.F. (2002), "Ultrasound-induced Lung Hemorrhage: Role of Acoustic Boundary Conditions at the Pleural Surface," *Journal of the Acoustical Society of America*, 111, pp. 1102-1109.
- Oelze, M.L., Zachary J.F., and **O'Brien, W.D., Jr.**, (2002), "Parametric Imaging of Rat Mammary Tumors In Vivo for the Purposes of Tissue Characterization," *Journal of Ultrasound in Medicine*, **21**, pp. 2101-2110.
- Park, D.C., Lautenschlager, G., Hedden, T., Davidson, N., Smith, A.D., and Smith, P. (2002), "Models of Visuospatial and Verbal Memory Across the Adult Life Span," *Psychology and Aging*, **17/2**, pp. 299-320.
- Hedden, T., **Park, D.C.**, Nisbett, R., and Lijun, J. (2002), "Cultural Variation in Verbal Versus Spatial Neuropsychological Function Across the Lifespan," *Neuropsychology*, **16**, pp. 65-73.
- **Ross, B.H.**, ed. (2002), *The Psychology of Learning and Motivation*, **41**, (San Diego: Academic Press).
- **Ross, B.H.** and Warren, J.L. (2002), "Learning Abstract Relations from Using Categories," *Memory and Cognition*, **30**, pp. 657-665.
- Selby, J.C., **Shannon, M.A.**, and **Boppart, S.A.** (2002), "Design of a Microfabricated Cell Straining Device for Investigating Cellular Response to Finite Mechanical Strains," *Second Annual International IEEE-EMBS on Microtechnologies in Medicine and Biology*, Madison WI, May, pp. 174-179.

- Gagne, C.L. and **Shoben, E.J.** (2002), "Priming Relations in Ambiguous Noun-noun Combinations," *Memory and Cognition*, **30**, pp. 637-646.
- **Sweedler, J.V.**, Li, L., Rubakhin, S.S., Dembrow, N.C., Dawling, O., Jing, J., Weiss, K.R., and Vilim, F.S. (2002), "Identification and Characterization of the Feeding Circuit Activating Peptides (FCAPs), A Novel Neuropeptide Family in Aplysia," *Journal of Neuroscience*, **22**, pp. 7797-7808.
- Wolters, A.M., Jaywickrama, D.A., Larive, C.K., and **Sweedler**, **J.V.** (2002), "Insights into the cITP Process Using Online NMR Spectroscopy," *Analytical Chemistry*, **74**, pp. 4191-7.
- Behnia, B., Suthar, M., and **Webb, A.G.** (2002), "Closed-loop Feedback Control of Phased-array Microwave Heating Using Thermal Measurements from Magnetic Resonance Imaging," *Magnetic Resonance Engineering*, **15**, pp.101-110.
- Lacey, M.E., **Webb, A.G.**, and **Sweedler, J.V.** (2002), "Online Temperature Monitoring in a CEC Frit Using Microcoil NMR," *Analytical Chemistry*, **74**, pp. 4583-4587.
- Cornish, T., Branch, D.W., **Wheeler, B.C.**, and Campanelli, J.T. (2002), "Microcontact Printing: A Versatile Technique for the Study of Synaptogenic Molecules," *Molecular Cellular Neuroscience*, **20/1**, pp. 140-53.

# HCII Human-Computer Intelligent Interaction

#### **Faculty by Beckman Institute Group**

**Artificial Intelligence Group** • Narendra Ahuja: Electrical and Computer Engineering • Gerald F. DeJong: Computer Science • Mark A. Hasegawa-Johnson: Electrical and Computer Engineering • Seth Hutchinson: Electrical and Computer Engineering • David J. Kriegman: Computer Science • Steven LaValle: Computer Science • Stephen E. Levinson: Electrical and Computer Engineering • Jean A. Ponce: Computer Science • Dan Roth: Computer Science • Michael J. Shaw: Business Administration • Yoshihisa Shinagawa: Electrical and Computer Engineering • David C. Wilkins: Institute of Aviation • **Human Perception and Performance Group** • David E. Irwin: Psychology • Alex C. Kirlik: Institute of Aviation • Arthur F. Kramer: Psychology • Charissa Lansing: Speech and Hearing Science • Edward McAuley: Kinesiology • George W. McConkie: Educational Psychology • Karl S. Rosengren: Psychology and Kinesiology • Daniel Simons: Psychology • Janet A. Sniezek: Psychology • Ranxiao (Frances) Wang: Psychology • Christopher D. Wickens: Institute of Aviation • Douglas A. Wiegmann: Aviation Research Laboratory • Image Formation and Processing Group • Minh Do: Electrical and Computer Engineering • Robert M. Fossum: Mathematics • Thomas S. Huang: Electrical and Computer Engineering • Zhi-Pei Liang: Electrical and Computer Engineering • Yi Ma: Electrical and Computer Engineering • Pierre Moulin: Electrical and Computer Engineering • David C. Munson, Jr.: Electrical and Computer Engineering

#### **Major Awards**

#### Thomas S. Huang

Foreign Member, Chinese Academy of Sciences Information Science Award, Association for Intelligent Machinery

King-Sun Fu Prize, International Association of Pattern Recognition

Outstanding Research Award, Pan Wen-Yuan Foundation

IBM Faculty Partnership Award, IBM Honorary Professorship,

National Chiao Tong University, Taiwan, ROC Honorary Professorship,

Hong Kong Polytechnical University Advisory Professorship,

Shanghai JiangTung University, PRC

Best Paper Award (paper by M. Nakazato and T. S. Huang), International Symposium of Visual Systems

#### Arthur F. Kramer

Herbert A. deVries Distinguished Research Award, Council on Aging and Adult Development

#### Zhi-Pei Liang

Distinguished Lecturer, IEEE Engineering in Medicine and Biology Society

#### Pierre Moulin

Fellow, IEEE

#### Jean Ponce

Fellow, IEEE

Editor, International Journal of Computer Vision

#### **Daniel Roth**

Willett Faculty Scholar Award,
College of Engineering,
University of Illinois at Urbana-Champaign
Fellow, Center for Advanced Studies,
University of Illinois at Urbana-Champaign

#### Douglas A. Wiegmann

Williams E. Collins Award for the Outstanding Publication in the Field of Human Factors, The Aerospace Human Factors Association Luis de Florez Award for Significant Contributions to Aviation Safety, Flight Safety Foundation

#### **Patents and Patent Applications**

(Beckman Institute faculty in bold)

**Thomas Anastasio**, Sylvian Ray and **Thomas Huang**: "Method for Determination of Spatial Target Probability using a Model of Multisensory Processing by the Brain," File date (year only): 2002.

#### **Grants Awarded**

(Principal Investigator in bold)

**Narendra Ahuja**: Department of Defense–Navy, "Modeling Estimation and Retrieval of Hierarchical Spatiotemporal Visual Structure," 10-Jul-02 to 30-Sep-05.

**Narendra Ahuja** and Yoshihisa Shinagawa: National Science Foundation, "Acquisition, Compression, and Interpolation of Panoramic Stereo Images of a Scene for Remote Walkthroughs," 15-Aug-02 to 31-Jul-03.

**Mark A. Hasegawa-Johnson**: National Science Foundation, "Career: Landmark-based Speech Recognition in Music and Speech Backgrounds," 01-Jul-02 to 30-Jun-03.

**Thomas S. Huang**: National Science Foundation, "Constraint-based Visual Hand Gesture Analysis," 01-Aug-02 to 31-Jul-05.

**Thomas S. Huang**: Yamaha Motor Corporation, "Multi-modal Human-computer Interface in the Context of Passenger Vehicle Interaction," 01-Apr-02 to 20-Jun-03.

**Seth Hutchinson** and David J. Kriegman: National Science Foundation, "NSF-Conacyt Collaborative Research on Sensor-based Robotics," 15-Mar-02 to 28-Feb-05.

**David E. Irwin**: National Science Foundation, "Cognitive Processing During Saccadic Eye Movements," 01-Jun-02 to 30-Apr-05.

**Arthur F. Kramer**, Neal J. Cohen, Edward Mcauley, Andrew Webb, and Naftali Raz: National Institutes of Health, "Aging, Fitness and Neurocognitive Function," 01-Mar-02 to 31-Jan-05.

**Steven M. LaValle**: Department of Defense—Navy, "Multi-robot Sensor-based Pursuit Strategies," 01-Jan-02 to 30-Apr-05.

**Steven M. LaValle**: National Science Foundation, "Career: Motion Strategy Algorithms For Geometry-Intensive Applications," 15-Aug-02 to 30-Sep-03.

**Steven M. LaValle**, Jeff Erickson, and John C. Hart: National Science Foundation, "ITR: Making 3D Visibility Practical," 01-Sep-02 to 31-Aug-05.

**Edward McAuley**: National Institutes of Health, "Exercise, Aging, and Psychological Function," 01-Feb-02 to 31-Jan-04.

**Edward McAuley**: National Institutes of Health, "Activity, Gait, and Efficacy (Age) in Older Women," 15-Aug-02 to 31-Jul-06.

**Edward McAuley** and Jerome Gerald: American College of Sports Medicine Foundation, "Effectiveness of an Internet Delivered Walking Program ," 01-Mar-02 to 30-Nov-02.

**Daniel G. Morrow**: National Institutes of Health, "Improving Medication Use in Patients with Heart Failure," 30-Sep-02 to 31-Aug-03.

**Daniel G. Morrow**: National Institutes of Health, "Improving Medication Use in Patients with Hypertension," 01-Sep-02 to 31-Aug-03.

**Pierre Moulin**: National Science Foundation, "Statistical Theory and Algorithms for Signal Authentication," 15-Jul-02 to 30-Jun-05.

**Pierre Moulin**: National Science Foundation, "Perspectives in Signal Authentication," 15-Jun-02 to 31-Oct-02.

**Pierre Moulin**: North Atlantic Treaty Organization, "A Study on Passive Radar Tracking and Automatic Target Recognition," 01-Jan-02 to 31-Aug-02.

**Christopher D. Wickens:** National Aeronautics and Space Administration, "Attention and Aviation Display Layout," 01-Mar-02 to 28-Feb-05.

**Christopher D. Wickens**: National Aeronautics and Space Administration, "The Primary Flight Display and its Pathway Guidance: Workload, Performance, and Situation Awareness," 12-Mar-02 to 06-Jan-03.

**Douglas A. Wiegmann** and Esa M. Rantanen: National Aeronautics and Space Administration, "Defining the Relationship Between Human Error Classes and Technology Intervention Strategies," 01-Jan-02 to 30-Jun-03.

**Douglas A. Wiegmann**: Department of Transportation, "Human Error and General Aviation Accidents: A Comprehensive, Finegrained Analysis Using HFACS," 22-Feb-02 to 21-Feb-03.

#### **Selected Publications**

(Beckman Institute faculty in bold)

• Yang, M.-H., **Kriegman, D.,** and **Ahuja, N.** (2002), "Detecting Faces in Images: A Survey," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, pp. 34-58.

- Xu, N. and **Ahuja**, **N.** (2002), "Object Contour Tracking Using Graph Cuts Based Active Contours," *IEEE International Conference on Image Processing*, **3**, Rochester, NY, September, pp. 277-280.
- Laud, A. and **DeJong, G.** (2002), "Reinforcement Learning and Shaping: Encouraging Intended Behaviors," C. Sammut and A. Hoffmann, eds., *International Conference on Machine Learning*, Sydney, Australia, July, pp. 355-362.
- **Do, M.N.** and Vetterli, M. (2002), "Wavelet-based Texture Retrieval Using Generalized Gaussian Density and Kullback-Leibler Distance," *IEEE Transactions on Image Processing*, **11**, pp. 146-158.
- **Do, M.N.** and Vetterli, M. (2002) "Contourlets: A Directional Multiresolution Image Representation," *IEEE International Conference on Image Processing*, Rochester, New York, September.
- **Feng, A.S.**, Narins, P.M., and Xu, C.H. (2002), "Vocal Acrobatics in a Chinese frog, *Amolops tormotus*," *Naturwissenschäften*, **89**, pp. 352-356.
- Galazyuk, A.V., White, K.R., and **Feng, A.S.** (2002), "Temporal Dynamics of Central Auditory Processing," J. Thomas, C. Moss, and M. Vater, eds., *Echolocation in Bats and Dolphins* (Chicago: University of Chicago Press).
- Huang, K., **Fossum, R.**, and **Ma,Y.** (2002), "Generalized Rank Conditions in Multiple View Geometry with Applications to Dynamical Scenes," *Springer Lecture Notes in Computer Science (LNCS)*, **2351**, pp. 201.
- **Hasegawa-Johnson, M.** and Alwan, A. (2002), "Speech Coding: Fundamentals and Applications," J. Proakis, ed., *Encyclopedia of Telecommunications* (New York: Wiley and Sons).

- Tao, H. and **Huang, T.S.** (2002), "Visual Estimation and Compression of Facial Motion Parameters Elements of a 3D Model-based Video Coding System," *International Journal of Computer Vision*, **50/2**, pp. 111-126.
- Naphade, M.R. and **Huang, T.S.** (2002), "Extracting Semantics From Audiovisual Content: The Final Frontier in Multimedia Retrieval," *IEEE Transactions on Neural Networks*, **13/4**, pp. 793-810.
- Akella, S. and **Hutchinson**, **S.** (2002), Coordinating the Motions of Multiple Robots with Specified Trajectories," *Proceedings of the IEEE International Conference on Robotics and Automation*, pp. 624-631.
- Nickels, K. and Hutchinson, S. (2002), "Estimating Uncertainty in SSD-Based Feature Tracking," *Image and Vision Computing*, 20/ER1, pp. 47-58.
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## Molecular and Electronic Nanostructures

#### **Faculty by Beckman Institute Group**

Advanced Chemical Systems Group • Paul W. Bohn: Chemistry • Paul V. Braun: Materials Science and Engineering • Paul J.A. Kenis: Chemical Engineering • Jeffrey S. Moore: Chemistry • Stephen G. Sligar: Biochemistry • Nancy R. Sottos: Theoretical and Applied Mechanics • Scott R. White: Aeronautical and Astronautical Engineering • Computational Electronics • Narayana R. Aluru: General Engineering • Karl Hess: Electrical and Computer Engineering • Jean-Pierre Leburton: Electrical and Computer Engineering • Richard M. Martin: Physics • Walter Philipp: Statistics and Mathematics • Umberto Ravaioli: Electrical and Computer Engineering • Nanoelectronics and Biophotonics Group • Stephen A. Boppart: Electrical and Computer Engineering • P. Scott Carney: Electrical and Computer Engineering • Martin H.W. Gruebele: Chemistry • Joseph W. Lyding: Electrical and Computer Engineering • Gregory Timp: Electrical and Computer Engineering • Pierre Wiltzius: Materials Science and Engineering; Physics • Theoretical and Computational Biophysics Group • Laxmikant V. Kale: Computer Science • Zaida Luthey-Schulten: Chemistry • Todd J. Martínez: Chemistry • Klaus J. Schulten: Physics • Robert D. Skeel: Computer Science

#### **Major Awards**

#### Narayana R. Aluru

Xerox Award for Faculty Research, Xerox Foundation Willett Faculty Scholar Award,

College of Engineering,

University of Illinois at Urbana-Champaign

#### Stephen A. Boppart

100 Top Young Innovators Award,Technology Review MagazineXerox Award for Faculty Research, Xerox Foundation

#### Paul V. Braun

Willett Faculty Scholar Award,
College of Engineering,
University of Illinois at Urbana-Champaign
2002 Robert Lansing Hardy Award,
The Minerals, Metals, and Materials Society

#### Martin H.W. Gruebele

Creativity Extension Award,
National Science Foundation
Fellow, American Physical Society
Alumni Scholar Professor,
University of Illinois at Urbana-Champaign

#### Paul J.A. Kenis

3M Young Faculty Award, 3M

#### Todd J. Martinez

Helen Corley Petit Professor, College of Liberal Arts and Sciences, University of Illinois at Urbana-Champaign

#### Jeffrey S. Moore

Vista Chemical Company Regents Endowed Memorial Lectureship in Organic Chemistry, University of Texas at Austin; "Conformational Order in Nonbiological Oligomers and Polymers" Howard Memorial Lecturer,

University of New South Wales and Sydney University; "Autonomous Materials Systems: Chemistry on the Submillimeter Scale" and "Synthetic Oligomers that Fold"

#### Umberto Ravaioli

Fellow, IEEE

#### Stephen G. Sligar

Fellow, World Innovation Foundation

#### Nancy R. Sottos

University Scholar,
University of Illinois at Urbana-Champaign
Presidential Citation for Outstanding Achievement,
University of Delaware

Best Paper Award (with co-authors S. White and J. Moore), American Society for Composites

Editorial Board Member, Composites Science and Technology

#### Patents and Patent Applications

(Beckman Institute faculty in bold)

David Beebe and **Jeffrey Moore**: "Microfabricated Devices and Method for Manufacturing the Same," Issue date: December 3, 2002, Patent No. 6,488,872.

**Joseph Lyding** and **Karl Hess**: "Semiconductor Devices, and Methods for Same," Issue date: September 9, 2002, Patent No. 6,444,533.

#### Paul Bohn, Jonathan Sweedler, Mark Shannon,

and Tzu-chi Kuo: "Hybrid Microfluidic and Nanofluidic System," File date (year only): 2002.

Larry Markoski, **Joseph Lyding**, and **Jeffrey Moore**: "Electrochemical Cells Comprising Laminar Flow Induced Dynamic Conducting Interfaces, Electronic Devices Comprising Such Cells, and Methods Employing Same," File date (year only): 2002.

**Klaus Schulten**, Hui Lu, Viola Vogel, Andrew Krammer, and Barry Isralewitz: "Force-regulated Molecular Recognition Switches," File date (year only): 2002.

#### **Grants Awarded**

(Principal Investigator in bold)

**Narayana R. Aluru**: National Science Foundation, "Mixed-domain Simulations, Reduced-order Models, and Circuits for Bio-Mems," 01-Aug-02 to 31-Jul-04.

**Narayana R. Aluru**: National Science Foundation, "ITR: Computational Prototyping of Micro-Electro-Fluidic Mechanical Systems," 01-Sep-02 to 31-Aug-05.

**Paul W. Bohn**: Department of Defense—Air Force, "Multidimensional Surface-enhanced Sensing and Spectroscopy," 01-Jul-02 to 31-Jan-03.

**Paul W. Bohn**, Yi Lu, and Jonathan V. Sweedler: Department of Defense—Army, "Metal Ion Sensor with Catalytic DNA in a Nanofluidic Intelligent Processor," 31-May-02 to 31-Mar-03.

**Paul W. Bohn**: National Institutes of Health, "Cell Migration Consortium—Facility I Biomaterials," 01-Aug-02 to 31-Jul-03.

**Stephen A. Boppart**, Tejal A. Desai, and Deborah Leckband: National Institutes of Health, "Optimal Imaging of 3D Engineered Tissues," 05-May-02 to 30-Apr-05.

**Paul Scott Carney**: National Aeronautics and Space Administration, "Three-Dimensional, Reflection-Mode Near-Field Microscopy for Microfluidic Phenomena," 13-Mar-02 to 12-Mar-06.

**Paul Scott Carney** and Vyacheslav Rotkin: National Science Foundation, "NER: Investigation of the Optics of Carbon Nanotubes," 15-Aug-02 to 31-Jul-03.

**Martin H.W. Gruebele**: American Chemical Society, "Pressure Jump Kinetics and Multidimensional Folding Phase Diagrams for Fast Proteins (Petroleum Research Fund)," 01-Jan-02 to 31-Aug-04.

**Karl Hess**, Jean-Pierre Leburton, Umberto Ravaioli, and Narayana Aluru: National Science Foundation, "Network for Computational Nanotechnology," 15-Sep-02 to 31-Aug-03.

**Laxmikant V. Kale**: National Aeronautics and Space Administration, "N-Chilada: A Framework for Parallel Data Analysis and Visualization," 01-Jun-02 to 31-Aug-03.

**Laxmikant V. Kale** and Marianne S. Winslett: National Science Foundation, "ITR: Collaborative Research: Advanced Parallel Computing Techniques with Applications to Computational Cosmology," 01-Sep-02 to 31-Aug-07.

**Jean-Pierre Leburton** and Narayana R. Aluru: Department of Defense—Navy, "Entanglement and Decoherence in Quantum Dots for Quantum Information Technology," 10-Dec-02 to 09-Dec-03.

**Joseph W. Lyding**, Jeffrey S. Moore, and Gregory Timp: Department of Defense—Navy, "System for Multiscale Fabrication and Characterization," 01-May-02 to 31-Mar-03.

**Joseph W. Lyding**, Judith E. Baker, and Jinju Lee: National Science Foundation, "Acquisition of a Time of Flight Secondary Ion Mass Spectometer," 01-Aug-02 to 31-Jul-03.

**Todd J. Martínez**: National Science Foundation, "AB-Initio Multiple Spawning Dynamics," 01-Jul-02 to 31-Jul-03.

**Klaus J. Schulten**, Laxmikant Kale, Robert Skeel, and Gila Budescu: National Institutes of Health, "Macromolecular Modeling and Bioinformatics," 01-Aug-02 to 31-Jul-07.

**Robert D. Skeel**: National Science Foundation, "Numerical Methods for Molecular Dynamics," 01-Jul-02 to 30-Jun-05.

**Stephen G. Sligar**: National Institutes of Health, "Cell Migration Consortium—Initiative E, Signaling," 01-Aug-02 to 31-Jul-03.

**Stephen G. Sligar**: National Institutes of Health, "Metalloenzyme Mechanisms," 06-Dec-02 to 30-Nov-06.

**Nancy R. Sottos** and Scott R. White: National Science Foundation, "Self-healing Polymers for Improved Fatigue Performance," 01-Aug-02 to 31-Jul-05.

**Gregory Timp**: Department of Defense–Navy, "Micrometer-scale MOS Integrated Circuits Operating at Frequencies Beyond 10GHz," 01-Apr-02 to 31-Mar-03.

**Gregory Timp**: Department of Defense–Navy, "Nanoelectronics for Biotelemetry and Remote Sensing," 10-Dec-02 to 14-Nov-05.

**Gregory Timp**, Alexey Bezreyadin, Jean-Pierre Leburton, and Klaus J. Schulten: National Science Foundation, "NIRT: A Nanometer-scale Gene Chip," 15-Jul-02 to 30-Jun-06.

**Scott R. White**, Philippe H. Geubelle, and Nancy R. Sottos: Department of Defense—Air Force, "Multiscale Modeling and Experiments for Design of Self-healing Structural Composite Materials," 01-Jan-02 to 31-Dec-04.

**Scott R. White**, Nancy R. Sottos, Harry Hilton, and Timothy Wentling: National Aeronautics and Space Administration, "Hierarchical Learning Network at the University of Illinois," 15-Jul-02 to 14-Jul-03.

#### **Selected Publications**

(Beckman Institute faculty in bold)

- Aktas,O. and **Aluru, N.R.** (2002), "A Combined Continuum/DSMC Technique for Multiscale Analysis of Microfluidic Filters," *Journal of Computational Physics*, **178/2**, pp. 342-372.
- Li,G. and **Aluru**, **N.R.** (2002), "A Lagrangian Approach for Electrostatic Analysis of Deformable Conductors," *Journal of Microelectromechanical Systems*, **11/3**, pp. 245-254.
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- Brown, E., **Sottos, N.R.**, and **White, S.R.** (2002), "Fracture Testing of a Self-healing Polymer Composite," *Experimental Mechanics*, **42/4**, pp. 372-379.
- Kessler, M.R. and **White, S.R.** (2002), "Cure Kinetics of the Ring-opening Metathesis Polymerization of Dicyclopentadiene," *Journal of Polymer Science*, **40/14**, pp. 2373-2383.

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## Fellows 2002

#### Beckman Institute Fellows in Residence

Tyler Bruns (2002)
Donald M. Cannon, Jr. (2001)
Stanley J. Colcombe (2000)
Diego Díaz (2001)
Sarah Grison (2002)
Christina Grozinger (2001)
Hong Hua (1999)
Christina Iani (2002)
Jason S. McCarley (1999)
John Paul Minda (2000)
Slava Rotkin (2000)
Lolita G. Rotkina (1999)
Jesse Spencer-Smith (2001)
Ilya Zharov (2000)

- Roddy, T.P., **Cannon, D.M.**, Jr., Ostrowski, S.G., Winograd N., and Ewing, A.G. (2002), "Identification of Cellular Sections with Imaging Mass Spectrometry Following Freeze Fracture," *Analytical Chemistry*, **74**, pp. 4020-4026.
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- **Minda, J.P.** and Smith, J.D. (2002), "Comparing Prototype-based and Exemplar-based Accounts of Category Learning and Attentional Allocation," *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **28**, pp. 275-292.
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- Zimmerman, S.C., Wendland, M.S., Rakow, N.A., **Zharov, I.**, Suslik, K.S. (2002), "Synthetic Hosts by Monomolecular Imprinting Inside Dendrimers," *Nature*, **418**, pp. 399-403.
- Rotkin, S.V. and Zharov, I.(2002), "Nanotube Light-controlled Electronic Switch" (2002), *International Journal of Nanoscience*, 1, pp. 347–356.

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