

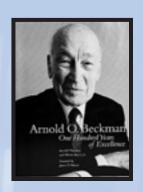


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Message From the Director

In April 2000, I had the opportunity to participate in the celebration of Dr. Arnold Beckman's 100th birthday. This joyous affair, which was held at Casa Pacifica in San Clemente, paid tribute to a man whose lifetime activities have had a profound, positive influence on industry and academia in the United States.



THIS CELEBRATION COINCIDED WITH THE RELEASE OF THE MONOGRAPH Arnold O. Beckman: One Hundred Years of Excellence, which gives a fascinating account of Dr. Beckman's life and his many accomplishments. All of us at the Beckman Institute at the University of Illinois have benefited and will continue to benefit from his vision and generosity.

When I consider a large multidisciplinary institute such as this one, there are many exciting research highlights I could discuss here, but unfortunately I will be able to mention only a select few in my introductory comments.

First, a joint workshop initiated by the Beckman Foundation Grants Advisory Council



took place on October 19-20, 2000, at the Beckman Institute for Advanced Science and Technology at the University of Illinois in an effort to strengthen the ties among the five Beckman institutes and centers supported by the Arnold and Mabel Beckman Foundation. The theme of the workshop was Imaging Science and Technology, as it was decided that this was a theme that was of general interest to researchers at all of the

DIRECTOR

institutes and centers. Representatives from all five of the Beckman institutes and centers, including those at the California Institute of Technology, the University of Illinois at Urbana-Champaign, Stanford University, City of Hope National Medical Center, and the University of California-Irvine Laser Institute, attended the workshop. The general goal of the workshop was to explore how the research institutes and centers could leverage their combined expertise to strengthen existing programs and to extend the range of scientific image acquisition and analysis.

One of the important goals of our research program at the Institute at Illinois is the development of unique research tools. In this regard, I would like to mention two major acquisitions the six-sided fully immersive virtual reality cave and the multi-photon confocal microscope. The virtual reality CUBE™ will allow researchers in our Human-Computer Intelligent Interaction main research theme to perform multimodal human perception experiments in a virtual environment unique in the world. The CUBE™ will be a virtual laboratory providing untethered data acquisition from subjects through commercial wireless body tracking. Most importantly, however, it will use eyetracking, gesture, and speech recognition technologies developed at the

Beckman Institute. The new confocal microscope will further enhance capabilities of the Beckman Institute's Imaging Technology Group.

As in earlier years, the Beckman faculty continued to be very successful in attracting federal and industrial funding. In particular, it is impressive to note that Beckman Institute faculty were successful in receiving funding for three proposals submitted to the National Science Foundation under the Information Technology Research (ITR) program. In view of the keen national competition for this ITR funding, it is clear that these funded projects are on the forefront of information technology research. The projects are discussed in more detail later in this Annual Report.

We were also
pleased to hear news
from the Beckman
Foundation that it
has established a
Beckman Fellows
Program. The aim of
the program is to



fund postdoctoral appointments in the five Beckman institutes and centers to carry out interdisciplinary research. Nearly all successful academic careers in science at present begin with a postdoctoral period of additional training and

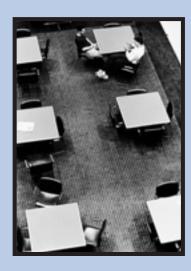
Message From the Director

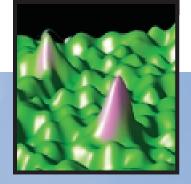
development prior to the first tenure-track faculty appointment. These fellowships will carry immense prestige and will attract the interest of the most highly qualified applicants. In addition, it is particularly gratifying for us at the Beckman Institute at the University of Illinois that the new Beckman Fellows Program initiated this year for all the institutes and centers was modeled after our own program, which has been running successfully for 10 years. The research of our current Beckman Fellows is highlighted later in the Annual Report.

No matter how satisfied we are with our recent accomplishments, we have to be aware of the fact that we cannot rest on our laurels and that there will always be new opportunities and challenges ahead. For example, we are in the process of re-competing for the large, multidisciplinary Army Federated Laboratory project, and we have also submitted two proposals to the National Science Foundation's Science and Technology Centers program.

In conclusion, I want to thank all faculty, students, and staff for their enthusiasm and the pride they take in making the Beckman Institute what it is today—a truly unique, world-class multidisciplinary institute.

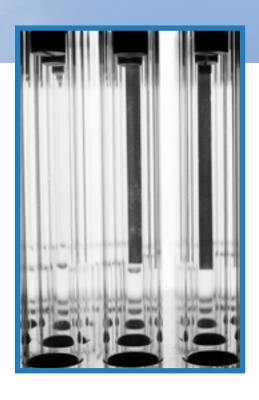
—Jiri Jonas, Director

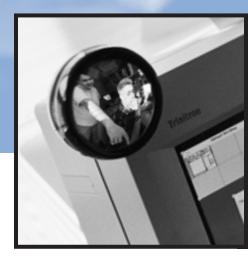




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Molecular & Electronic Nanostructures





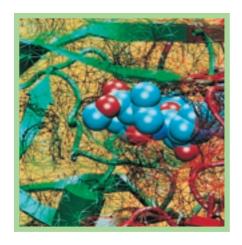
Molecular and Electronic Nanostructures

THE MOLECULAR AND ELECTRONIC NANOSTRUCTURES (M&ENS) MAIN RESEARCH THEME IS FOCUSED ON NEW MATERIALS, FABRICATION METHODS, AND THEORETICAL UNDERSTANDING TO ADVANCE COMPUTATION AND COMMUNICATION OF INFORMATION.

A MAJOR TREND IN THE PAST YEAR HAS BEEN THE MERGER OF BIOLOGY AND NANOSCALE ENGINEERING ON BOTH THEORETICAL AND EXPERIMENTAL FRONTS.

SIGNIFICANT STRIDES HAVE BEEN MADE IN THE DEVELOPMENT OF NEW TOOLS FOR FABRICATION AND IMAGING ON A RANGE OF SIZE SCALES.

Also during the last year, new methods have emerged for manipulating minute quantities of fluids. These advances set the stage for creating ultra-sensitive 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.

Interdisciplinary research interactions have gained considerable strength and have been extended in their range.

The scanning tunneling microscopy facility is a focal point of these interactions. Nanolithography, as developed by Professor Joseph Lyding, is used by many researchers of the

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physical and chemical sciences. It has been demonstrated that large molecules, including C_{60} and copper phthalocyanine, can be placed in predesigned arrange-

ments. Interesting functionality of these molecules has been proven. For example, the copper phthalocyanine molecules have been shown to rotate around a predetermined axis, electronic properties of C₆₀ on silicon surfaces have been studied, and conformational changes of amide groups appended to norbornadiene are being investigated. One can envision a combined use of mechanical (MEMS) and electronic properties, as well as optical properties, of molecules in predetermined patterns on silicon surfaces.

On the theoretical side, the past year has seen an introduction of simulation tools from computational electronics to the electrical properties of biological ionic channels. The current in such channels was calculated, successfully showing the use of the highly developed

computational electronics codes in biophysics. Atomistic views, in turn, have been shown to become of great importance for reliability considerations in electronics. The deuterium isotope effect in transistor degradation has given many clues to the science of degradation and promises considerable benefits for both transistor production and the scientific understanding of transistor reliability.

Interactive simulation using advanced visualization tools is still emphasized in the Theoreti-

cal Biophysics Group.

This work is not only
beneficial for the understanding of complex
bio-molecules and
mechanisms; it also
reaches out to important questions of



human-computer interactions, and thus to the main research theme of Human-Computer Intelligent Interaction.

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

HIGHLIGHTS IN 2000

Considerable progress has been made this year using deuterium as a scientific probe to elucidate the details of hot carrier degradation effects in silicon CMOS transistors. Recent experiments have now demonstrated that it is the channel hot carriers remaining in the silicon that dominate the transistor aging process. This contradicts the widely accepted view that degradation is dominated by only those carriers sufficiently energetic to be injected into the insulating gate oxide. This result is significant in that it points to the (now observed) fact that lower device operating voltages will not scale away the aging effect, as previously thought by industry. This, combined with the fact that the deuterium isotope effect increases dramatically at lower voltages, is now leading to 300-700X lifetime improvements for deuterium-processed state-of-the-art CMOS, such as Samsung's 0.1 micron, 1.2 V technology. Recent experiments by Professor Joseph Lyding's group have confirmed the theoretical prediction by Professor **Karl Hess'** group that there is a distribution of Si-H bond strengths at the silicon/oxide interface in CMOS transistors. The combined theory/



experiment effort has led to major predictions about the continued reliability of Si IC technology as the 0.1 micron node is crossed.

As a part of the Office of Naval Research Multidisciplinary University Research Initiative (MURI) program on nanoelectronics, Beckman

Institute researchers are developing methods for merging molecular nanotechnology with silicon chip technology. To this end, Professor Joseph Lyding's group has developed a new scanning tunneling microscopy



(STM)-based nanofabrication technique, termed feedback-controlled lithography (FCL), which enables the creation of atomically precise arrays of silicon dangling bonds on a hydrogen-passivated silicon surface. Together with Professor Jeffrey Moore's group, they have used these substrates as templates onto which organic molecules spontaneously self-assemble, creating precise molecular arrays. They have also demonstrated the ability to observe intramolecular electronic structure using STM spectroscopy. In another MURI-related project, Beckman researchers Karl Hess and Richard Martin have simulated extremely thin oxides (0.6 - 1.8 nm) and the effects of their structure on tunneling currents. They have found that the tunneling current of the currently used continuum models is about a factor of 100 too large, which in the past was compensated for by underestimating the oxide thickness by about 0.3 nm. For thick oxides, this is a negligible error; for the oxides of future generations, the error in thickness may amount to ~50%.

As the computational electronics simulation tools progress to encompass more detail on the atomistic level, they become more generally useful and transcend their original purpose. Beckman researchers Narayana Aluru, Karl Hess, Eric Jakobsson, Umberto Ravaioli, and Klaus Schulten have shown this by applying these tools successfully to calculate electronic currents in biological



ionic channels, such as gramicidin. This work is performed in collaboration with Richard Eisenberg from Rush Medical Center, Chicago. It appears that numerical solutions of the Boltzmann transport equation and the equation of Poisson, as known from electronics, can be successfully used to calculate macroscopic currents in biological ionic channels while at the same time still resolving the microscopic/atomistic level and addressing problems such as ion selectivity.

One the most important unsolved problems in the interdisciplinary arena of "nanobiotechnology" centers on the interface of wet biological macromolecules with the primarily inorganic semiconductor and optical materials. Researchers at the Beckman Institute are focusing on this area by developing general methodologies for controlling the assembly of proteins and nucleic acids onto substrates that can be patterned over the complete range of size scale from microns to individual atoms. The overall approach, funded by a grant from the National Science Foundation, involves creative synthesis of "linkers," which couple on one side to the "soft" biological component and on the other to the "hard" inorganic support. Toward this end, Professor Stephen Sligar's group has utilized the powerful tools of genetic engineering and combinatorial mutagenesis to provide unique attachment sites and functionalities to protein-based, electrooptically active modules. Professor Jeffrey Moore's group has synthesized organic linker molecules of defined size and polarity, which have chemically reactive ends that can specifically couple to engineered protein attachment sites and the semiconductor surface. Finally, Professor Joseph Lyding's group has refined the atomic level patterning of passivated silicon substrates using ultra-high vacuum scanning tunneling microscopy. Combining these advances with e-beam lithography and MOSFET design by Professor Gregory Timp promises to realize the integration of protein-based gated channels and sensors with semiconductor devices.

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The members of the Theoretical Biophysics Group (professors **Klaus Schulten**, **Laxmikant Kale**, **Todd Martínez**, and **Robert Skeel**) and the National Institutes of Health Resource for Macromolecular Modeling and Bioinformatics have continued their diverse efforts at the forefront of research and technology development. Mem-



bers have made significant contributions to the areas of interactive modeling, structure prediction of biomolecular assemblies, and molecular recognition and assembly. Recent highlights include the work on magnetoreception and the first release of BioCoRE, their online collaboratory for structural biology. For many years scientists have wondered how animals, from fish to migrating birds, use Earth's magnetic field to navigate. The group's studies have demonstrated that magnetic fields can influence biochemical reactions as they occur inside living cells. They have shown through physical theory and earlier chemical experiments that processes in animals' eyes could be affected by the weak geomagnetic field. Their research findings suggest how migrating birds can obtain visual feedback through magnetic field-dependent photoreactions and use this feedback to stay on path. For more information, go to http://www.ks.uiuc.edu/Research/magsense/ or to the Biophysical Journal web site at http://www.biophysj.org/cgi/reprint/78/2/707.pdf.

BioCoRE, their tool-oriented, web-based collaboratory for structural biology, offers four basic toolboxes: Workbench, Conferences, Notebook, and Documents. Without the tedious travel often required to meet in person, BioCoRE enables researchers to



join electronically in analyzing, viewing, and discussing data and to share resources such as computing equipment and electronic laboratory notebooks. BioCoRE empowers the formation of global, often cross-cutting research teams and is designed to support the entire cycle of research activities and needs. BioCoRE was first released to the public in March 2000 and is freely available. For more information on BioCoRE, go to http://www.ks.uiuc.edu/Research/biocore/.

Molecular architecture determines important properties of polymeric materials as well as their ability to be easily processed into useful

forms. Under support from an Army Research Office Multi-University Research Initiative, researchers in the groups of professors **Jeffrey Moore** and **Tony McHugh** are developing new types of polymer structures that are easily processed in comparison to conventional linear polymers. The large-scale synthesis of these materials, whose



molecular geometry can be varied systematically from nearly spherical to fully linear, has allowed the first full study relating molecular architec-

ture to mechanical properties and processing behavior. A narrow composition window was found in which processing and mechanical properties could be optimized. In particular, it was discovered that copolymers with 2.5-7.5% of a "hyperbranching" unit had relatively low viscosity, but nearly identical mechanical properties to that of the linear polymer. These results showed that small percentages of this special, structure-inducing monomer can increase processing efficiency without compromising the mechanical properties of the final polymeric material. Efforts are currently underway to investigate end-group modifications as additives to further reduce processing costs while enhancing performance.

Professor **Stephen Boppart's** group is establishing a biophotonics imaging laboratory at the Beckman Institute to develop novel optical techniques for imaging and diagnostics at the cellular level. Construction has begun on an integrated optical coherence tomography and multi-photon microscope. The integrated microscope will enable deep imaging in highly scattering tissue with site-specific labeling of tissue and cellular components. This microscope has a number of important applications, one of

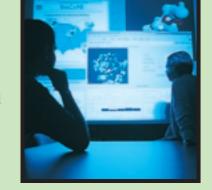
which includes identifying and tracking the behavior of malignant cells in living organisms. Professor Boppart is teaming up with professors David Brady, Lutgarde Raskin (Department of Civil and Environmental Engineering), and Beckman Institute Fellow Michal Balberg to investigate how optical coherence tomography and multi-photon microscopy can be used to assess and refine design parameters in microfluidic mixing and bioMEMS (microelectromechanical) systems. Three-dimensional structural and functional imaging will be performed as molecular beacons flow through microfluidic systems and serve as optical markers for identifying bacteria in environmental and biological fluids.

In 1996, the Photonic Systems Group (professors David Brady and David Munson, Ronald Stack, and Rick Morrison) launched a basic study of digital imaging under Beckman Institute seed support. The focus of the study was to explore the possibility that interferometric analysis could replace or augment the image formation role of lenses in digital systems, thus reducing the role of analog focus and allowing real-time 3D and multispectral imaging. The seed support yielded promising results, enabling the Photonic Systems Group to obtain support from the Defense Advanced Research Projects Agency (DARPA) in 1998 and the Air Force Office of Scientific Research in 1999 for continuing investigations. This program continued to accelerate in 2000 with new DARPA grants for wireless digital imaging arrays and for adaptive spatio-spectral imaging

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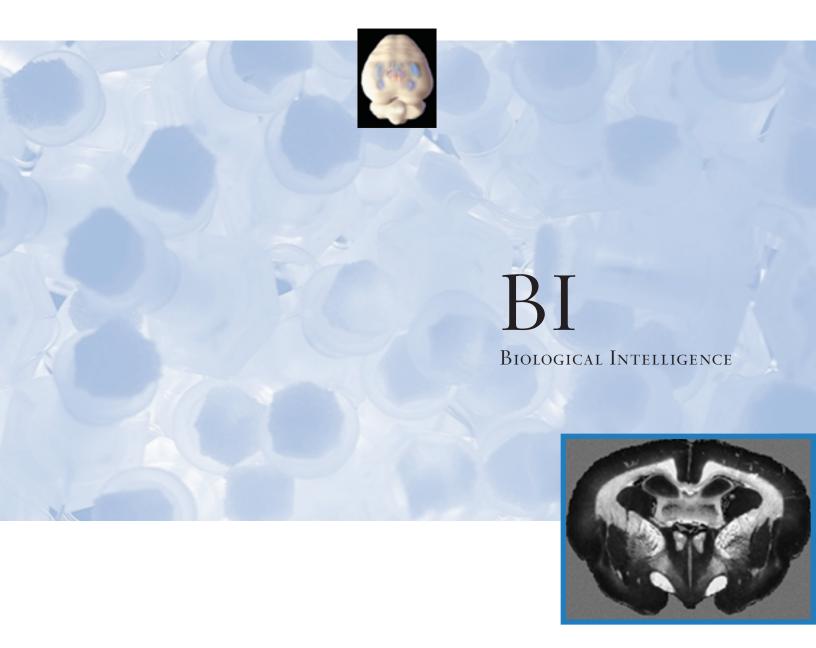
systems. Major achievements in 2000 included a demonstration of streaming 3D video from the Argus tomographic camera array at the University to the Pacifico Convention

Center in Yokohama (in collaboration with the Integrated Systems Laboratory) and development of a new class of afocal digital imager, the Astigmatic Coherence Sensor (ACS). **Daniel Marks**, a graduate student in the Photonic Systems Group, was a New Focus Student award winner at the 2000 Optical Society of America meeting for his work on the ACS. Marks had also won a New Focus award in 1999 and is the first two-time winner of the award.



A collaborative effort involving professors **Jeffrey Moore**, **Narayana Aluru**, and David Beebe (Department of Biomedical

Engineering at the University of Wisconsin, former member of the Biological Sensors Group) has led to the development of a new microfabrication platform called Microfluidic Tectonics (µFT). Funded by the Defense Advanced Research Projects Agency, the multidisciplinary project combines photopolymerization, lithography, and materials chemistry to achieve ultra-rapid prototyping of microfluidic systems. By in situ photopolymerization of liquid prepolymer mixtures through photomasks, components such as channels, actuators, valves, and sensors can be created simultaneously or sequentially, leading to complex systems able to regulate fluid flow without external intervention. A variety of materials can be used within the fabrication process, including both non-functional construction materials and stimuli-responsive hydrogels. Microfluidic Tectonics will be the foundation of their future efforts toward microfluidic-based systems for biological and chemical agent detection.



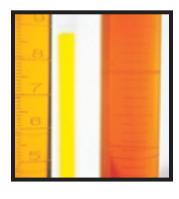


Biological Intelligence

THE BIOLOGICAL INTELLIGENCE MAIN RESEARCH THEME (MRT) SEEKS TO UNDERSTAND THE LINKS BETWEEN THE BRAIN AND INTELLIGENT BEHAVIOR. RESEARCH IN BIOLOGICAL INTELLIGENCE STARTS WITH THE STUDY OF THE INDIVIDUAL MOLECULES THAT COMPRISE NEURONS AND THEIR SYNAPSES, 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, how its parts work together to achieve basic abilities, such as perception, attention, learning, and memory. Ultimately, the Biological Intelligence MRT 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 begins, the Biological Intelligence MRT 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,

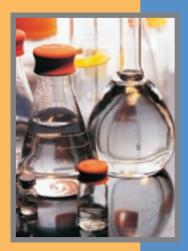
such as functional magnetic resonance imaging (fMRI), has revolutionized our ability to relate the activity of the brain to behavior and learning. By using fMRI in combination with related technologies, such as electroencephalograms (EEG), eyemovement monitoring, and optical imaging of the brain, Beckman 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. Altogether, 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.

As the following research highlights 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 nearideal environment for scientists with vastly different backgrounds to come together to pursue

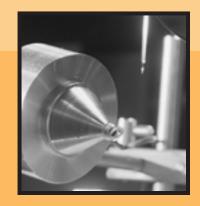


mutually important and interesting goals.

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

HIGHLIGHTS IN 2000

How do you isolate, characterize, and manipulate molecules in amounts so small that Mother Nature created special containers inside single cells just to transport them? In 2000, Beckman Institute faculty members **Paul Bohn**, **Mark Shannon**, and **Ionathan Sweedler** initiated a new collaborative pro-



ject funded through the Defense Advanced Research Projects Agency to design a new category of measurement device, the Biofluidic Intelligent Processor. This device will allow the active manipulation, detection, and characterization of biological fluids with volumes more than a million times smaller than a single drop of blood. At the heart of the Biofluidic Intelligent Processor are molecular gates with active areas not much larger than transistors in microprocessors. The molecular gates can intelligently separate specific components, passing the rest, concentrating them in attoliter volumes, then digitally tagging them for detection. As digitizing electronics has permitted complex operations to be processed, digitizing molecular fluid flow can potentially solve the daunting challenges posed by trace levels of extraordinarily lethal toxins. The active component, the molecular gate, is analogous to transistors, in that switching, gain, and digital manipulation of specific molecules, such as proteins, are now possible. A



number of interesting fundamental studies are under way. Because the flow occurs in a completely new size regime (10-100 nm), control of fluid transport accomplishes digital transfer of fluids, and the Achilles' heel of prior microfluidics devices, the device interconnects, are integral to the intelligent movement of biomolecules. This work builds upon the foundations from both the Biological Intelligence and the Molecular and Electronic Nanostructures main research themes.

Previous work using functional magnetic resonance imaging (fMRI) has investigated transient local changes in blood flow associated with mental activities. This year Beckman researchers **Erik Wiener**, **William Greenough**, **Paul Lauterbur**, and former postdoctoral fellow Rodney Swain have demonstrated (for the first time) a persisting effect of experience on brain blood flow, volume, and responsiveness in the motor cortex region of the brain of rats. The rats were permitted unlimited opportunity to exercise in a running wheel attached to their cage. Those that had exercised for 30 days had a higher basal level in blood volume in the region of the motor cortex that governs movement of the forelimb, compared to inactive controls. Moreover, the blood flow and volume to this region showed enhanced responsiveness to demand:

blood flow and volume in this region increased to a greater extent in the exercising animals when exposed to a gas mixture with a higher percentage of CO₂ mixed in with the air. This appears to be the first report of a lasting effect of exercise on brain blood flow and blood volume.

☐ The intelligent hearing aid project is aimed toward developing efficient signal processing systems that can extract a desired speech signal with high fidelity in the presence of multiple interfering sounds. For this, the interdisciplinary team working on this project (professors Robert Bilger, Albert Feng, Douglas Jones, Charissa Lansing, William O'Brien Jr., and Bruce Wheeler) has successfully created two novel computational algorithms and developed a real-time prototype of one of the two algorithms to validate the concept. The realtime system performs effectively in real-world environments, and preliminary tests on human listeners show significant gains in speech intelligibility. In 2000, the team filed two new patent applications, one on signal processing technology and the other on wireless communication technology. The latter is key for enabling practical use of the processing algorithm in commercial hearing aids. The team received two new grants this year, one from the National Institutes of Health and the other from the Defense Advanced Research Projects Agency. Moreover, the group is negotiating with a major hearing aid manufacturer for licensing these technologies and incorporating them into commercial hearing aids.

This year marked several milestones for the Beckman Institute/Carle Clinic Association functional brain mapping project. The most exciting accomplishment was obtaining a campus commitment to establish a new high-field magnetic resonance research facility. This will permit stateof-the art, non-invasive human brain imaging to be carried out on the Urbana-Champaign campus. This will be a campus-wide facility, with a strong presence from Beckman Institute faculty, particularly the Cognitive Neuroscience Group. The new facility will be a major enhancement to the resources of the functional brain mapping project, which now relies solely on magnetic resonance equipment located at Carle Clinic. Professor Wendy Heller received a National Institutes of Health grant to study cognitive and emotional function and dysfunction, specifically the relationship between regional

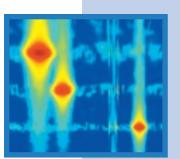
brain activity, and anxiety and depression. This project relies heavily on the resources of the functional brain mapping project to conduct functional magnetic resonance imaging (fMRI) studies of regional brain activity, as well as cam-



pus resources for electroencephalogram (EEG) recording. The project is conducted in collaboration with Beckman Institute faculty **Marie Banich**, **Neal Cohen**, **Gregory Miller**, and

Andrew Webb. Professor Arthur Kramer received funding from the campus' Critical Research Initiatives program to pursue research on the effects of exercise on cognitive aging and on brain mechanisms involved in the beneficial effects of aerobic exercise. Kramer's findings to date indicate that exercise minimizes typical declines in performance associated with aging. The project is done in collaboration with a number of Beckman Institute faculty, including professors Neal Cohen and Andrew Webb.

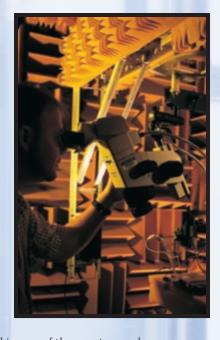
The brain derives its perception of the world from the input it receives through the senses. How does the brain combine input from multiple sensory systems? In a new project funded by the National Science Foundation, professors **Thomas Anastasio**, **Pierre Moulin**, and **Sylvian Ray** will combine their expertise in neuroscience, computer science, and engineering to develop computational models of multisensory interactions in the brain. The work will focus on a region



of the brain called the superior colliculus that fuses input from the visual, auditory, and somatosensory systems to determine the locations of targets of interest in the environment. The basic idea is that the colliculus uses sensory input to compute the

probability that a target has appeared at a particular location. Inputs from multiple sensory systems can provide multiple pieces of evidence concerning targets. The goal of the project is to develop theoretical and computational

models of multisensory interactions in the colliculus. The models developed will then be tested against experimental data from a leading laboratory off campus. These results will begin to help understand how the brain fuses multisensory input.



☐ The ability to read is one of the most remarkable of human accomplishments, particularly when one looks at the wide variety of writing systems used around the world. Beckman Institute researchers Kevin Miller and George McConkie, and Beckman Graduate Fellow **Gary Feng** continued a project, supported by the National Science Foundation, using eyetracking methods to study the development of reading in Chinese and American children. In contrast to English, Chinese does not mark word boundaries with spaces or by any other means; Chinese characters correspond to syllables, and words are made up of one or more characters. Surprisingly, this turned out not to interfere with children's reading. Instead, readers of English were much more likely than readers of Chinese to have to "refixate" (look again at) longer words, suggesting that parsing long words, as English readers must do, is more difficult than putting together smaller units, as Chinese readers must do.

Language researchers at the Beckman Institute (from the Cognitive Science, Artificial Intelligence, and Image Formation and Processing groups) continue to work on their three-year project from the Knowledge and Distributed Intelligence Program of the National Science Foundation. The project, titled "The Role of Experience in Language Processing," brings together psychologists,

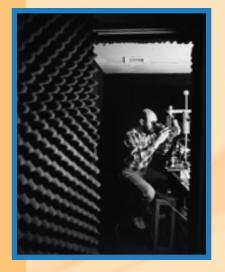


linguists, and computer scientists with the goal of studying how people produce and understand language, and how this knowledge can be used to develop language technology. The group studies how people's speaking and comprehension skills change with experience by using a number of methods, including assessments of eye movements, electrical brain potentials, and functional magnetic resonance imaging (fMRI). 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 comparisons among different languages. For example, Professor **Susan Garnsey** and colleagues have compared the electrical brain potentials that occur when people understand Japanese to those that occur with English. Other research has investigated the processing of Dutch and Mandarin Chinese. The investigators are professors **Gary Dell** (PI), **J. Kathryn Bock**, **Jennifer Cole**, **Cynthia Fisher**, **Susan Garnsey**, **Adele Goldberg**, **Stephen Levinson**, and **Daniel Roth**.

Beckman Institute researchers **Kevin Miller**, **Michelle Perry**, and **David Brady** recently received funding from the National Science Foundation as part of the Interagency Educational Research Initiative to use advanced video technology to improve the training of mathematics teachers. The project will use multi-viewpoint video methods to produce representations of classroom instruction that can in turn be used both in training teachers and in studying instruction. Learning to teach is largely a matter of trial and error; developing methods to make classroom instruction more accessible for scientific study is a critical step toward understanding what constitutes effective mathematics education.

Research is also continuing on a National Science Foundation–funded, cross-disciplinary initiative on Learning and Intelligent Systems. The goal of this project is to construct an integrated theory of concept learning in humans and machines. The theory will be integrated in that it will investigate and account for a wide variety of concept learning results that are often studied separately, and it will pool the research

strengths of psychology, artificial intelligence, and computational learning theory (CLT). These goals will lead to a comprehensive theory that is psychologically and computationally plausible, while at the same time is sufficiently rigorous to be analyzed with the mathematical tools of CLT. The interdisciplinary focus in 2000 has led the Beckman Institute researchers Jerry DeJong, Gregory Murphy, Leonard Pitt, Karl Rosengren, and Brian Ross to address two issues with computational and expe-



rimental techniques. First, a major goal has been the examination of how prior knowledge interacts with learning from experience. There are models of learning the statistical regularities of concepts, and theories of how knowledge may influence concept judgments. However, there is no model that integrates the statistical regularities and knowledge during learning, which is necessary for intelligent functioning (and which people do easily). In the last year, the researchers have completed a large number of empirical studies of this interaction and have started the development of a set of computational models to better understand and capture this interaction. Second, the researchers have concentrated on how explanations can be used to help people and machines

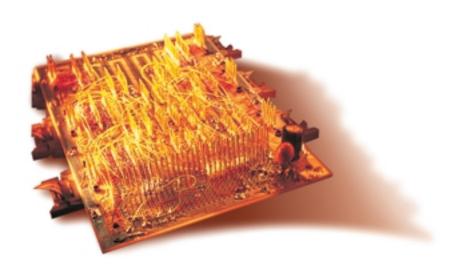
learn concepts in complex learning situations more efficiently and usefully. This recent work builds upon the researchers' earlier work on developing formalisms for explanations that do not require soundness (i.e., logical consistency), since people's explanations often are not logically consistent with all their other knowledge.



HCII

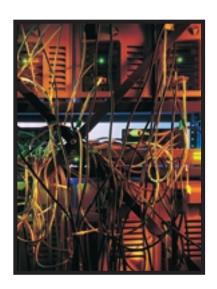
Human-Computer Intelligent Interaction





Human-Computer Intelligent Interaction

THE HUMAN COMPUTER INTELLIGENT INTERACTION (HCII) MAIN RESEARCH THEME (MRT) IS TRULY INTERDISCIPLINARY IN NATURE, INVOLVING THE CLOSE COLLABORATION OF COGNITIVE SCIENTISTS, COMPUTER SCIENTISTS, ELECTRICAL ENGINEERS, HUMAN FACTORS RESEARCHERS, EDUCATIONAL PSYCHOLOGISTS, KINESIOLOGISTS, AND LINGUISTS IN PURSUIT OF KNOWLEDGE RELEVANT TO THE DESIGN OF INTERFACES FOR COMPLEX SYSTEMS. A MAJOR GOAL OF THE MRT IS THE INTEGRATION OF THE ENGINEERING AND COMPUTER SCIENCE EXPERTISE OF THE HCII FACULTY AND STUDENTS IN THE DESIGN AND CONSTRUCTION OF HARDWARE AND SOFTWARE INTERFACES WITH THE DEVELOPMENT OF FORMAL MODELS OF HUMAN PERCEPTION, COGNITION, AND ACTION.



To this end, HCII members have been working together, often in collaboration with members of the Biological Intelligence and Molecular and Electronic Nanostructures MRTs, as well as with colleagues in government and industrial laboratories. Together, they are working on a number of large-scale efforts in the development of knowledge and concepts relevant to next-generation human-computer interfaces.

For example, the Army Research Laboratory's Federated Laboratory for Advanced Displays and Interactive Displays, which is a six-year, Armyfunded project with university, industry, and military research partners, has produced a number of important products in the past year. They

include the transition of a number of collaborative decision-planning and management tools to industry and military facilities; the development of algorithms supported by psychophysical research that can be used to create prototype multimodal avatars to enhance human speech comprehension in noise; the development of eyetracking, gesture and speech recognition algorithms as a means to enhance communication between humans and computers; and the continued development of a knowledge base relevant to the design of navigational and wayfinding aids for ground- and airbased navigational tasks and human situational awareness. 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. Yamaha is exploring some of these technologies for use in their future products. 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 testbed of basic research results will be an educational task—helping middle-grade students to learn science and engineering concepts using Lego/ Mindstorms construction and robotics materials.



When the HCII MRT was first 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

HIGHLIGHTS IN 2000

Beckman Institute researchers have recently completed the fifth of six years of the multi-disciplinary Army Research Laboratory project on advanced displays. A number of the software



and engineering research projects developed during the course of the Federated Laboratory for Advanced Displays and Interactive Displays are currently in the process of being transferred to gov-

ernment and corporate facilities. For example, Fox and Co-Raven, two decision-planning and management software tools developed by Beckman researchers (professors Caroline Hayes, currently at the University of Minnesota, and Patricia Jones) have been transferred to a number of government facilities for both experimental and operational implementation. Several research projects on human perception, cognition, and action in complex multimodal displays and decision architectures have also been conducted and completed within the past year. For example, a project on the enhancement of speech in noisy environments (Professor Art Kramer) has found that the addition of visual information can dramatically improve the comprehension of auditory speech, with benefits increasing with the amount of noise. In another project,

Beckman researchers (Professor Chris Wickens) have explored the impact of display parameters and system reliability on operator's trust in automation. Finally, a multiresolutional display has been developed that permits the reduction of the bandwidth of visual information outside of a user's attentional field (Professor George McConkie). Notable progress has also been made on the technology front. This includes the iMAP system (Rajeev Sharma, Pennsylvania State University), which employs an integrated speech recognition and gesture analysis interface to a map information system. In a second project (Professor Thomas Huang), tools have been developed for constructing synthetic talking faces (avatars) that use text or speech to drive the animation of the avatars.

☐ The collaboration between the Beckman

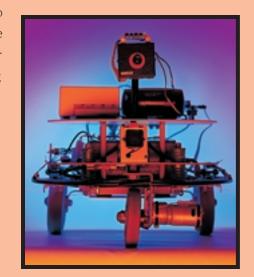
Institute and Yamaha Motor Corporation on various research issues related to making information systems more human-centered is now in its fourth year. Considerable progress has been made during this year in the following interrelated areas: image and video databases, visualization of



web searching, intelligent and affective agents and dialog systems, visual tracking of humans,

sonification, machine learning, and human behavioral studies. Yamaha is looking at each research component and exploring its applicability for potential future Yamaha products. The Affective Speech Group (Professor **Stephen Levinson**) has made progress

on its ambitious effort to use agent modeling to mediate between speech analysis and synthesis. The Vision Group (Professor **Thomas Huang**) has further developed its impressive system for face tracking and emotion recognition, and is moving on to gestural recognition. The Human Factors Group (**Michelle Perry**) continues to explore ways that people interact with computer systems, developing models that have proven valuable for the other groups. The Audio Group (**Rachael Brady**) has expanded on the sonification of a location system, simplifying its operation while increasing its utility, so that it can now be used when walking as well as



when driving. The Linguistics Group (Jerry Morgan, Professor Georgia Green) has developed and is testing an expanded version of the Restaurant Finder, using it as a testbed for investigating the use of linguistic particles for "humanizing" computer text and speech output. The Machine Learning Group (Professor Gerald DeJong) has made progress in using detailed process data as the basis for learning about user preferences, for example, the complexity of a screen display. The Image Group (Professor **Thomas Huang**) has developed state-of-the-art algorithms for determining similarity between video segments based on multiple factors. The Community of Computer Companions Group (James Levin) has developed a substantially improved graphical interface to Internet-based information, and has added powerful knowledge-building tools that will create powerful collaborative environments. Overall, significant progress has been made by the research team in 2000, and it looks forward to continuing to work with Yamaha Motor Corporation to collaboratively extend these exciting research and development advances into usable products. In the meantime, the results of the basic research during the last four years have formed a solid foundation to build a new, exciting research project on Proactive Computers funded by the National Science Foundation.

HCII

Researchers at the Beckman Institute have been awarded a five-year, \$3 million grant by the National Science Foundation's Information Technology Research program. This project is being led by professors **Thomas Huang** and **George McConkie**, David Brown (Curriculum and Instruction), **David Kriegman**, **Dan Roth**, and **Stephen Levinson** as co-principal investigators. The project is titled "Multimodal Human Computer Interaction: Toward a Proactive Computer." The goal of the project is to



investigate ways of providing a computer with more information about its human user, including emotional state, cognitive state, and task state, so the computer can then become more proactive in its interactions with its user. Work is being conducted using visual analysis of a user's facial expression, posture, gestures, and constructions (using Lego materials), analysis of signal characteristics of speech, and analysis of the user's eye movements to provide the computer with user information and speech input. Advanced speech and video presentation methods are being investigated for communicating with the user. Learning algorithms and video analysis of human communications are being used to develop ways of identifying the appropriate times for the computer to initiate communication with the user. This system will be applied to an educational task—helping middle-grade children to learn science and engineering concepts using Lego/Mindstorms construction and robotics materials. A large corpus of videotapes is being developed that show

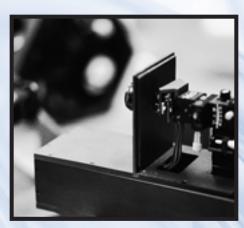


tutor-student interactions that can be used to train computer learning systems in appropriate human instructional interactions. A local boys and girls club is a participant in this research, and many of the children participating in the research are coming from that organization. Thus, the project will give a number of minority children the opportunity to participate in science tasks and to interact with advanced computer technology. This will also ensure that the algorithms developed for facial expression analysis, speech analysis, and human interaction, etc., are appropriate for these children.

Professor **Narendra Ahuja** and Beckman Fellow Hong Hua were recently awarded an Information Technology Research grant from the National Science Foundation for the development of a multi-user interactive workbench system based on a novel head-mounted projective display technology. The grant, titled "Development of Head-Mounted Projective Displays for Distance Collaborative Environments," is shared with the University of Central Florida. The objective of the research is to develop a novel visualization device and a head-mounted projective display (HMPD), build a multi-user interactive workbench by integrating the developed HMPD technology with a unique real-time image acquisition system, and evaluate and quantify the system as an effective tool for remote collaboration. The HMPD will be comprised of projection optics mounted on the head and strategically placed retro-reflective material. A lightweight and compact head-mounted prototype will be designed and implemented, and the retroreflective material employed for imaging will be evaluated and optimized. An interactive workbench for multi-user applications will be developed using the HMPD concept and a panoramic image acquisition system, where the retro-reflective material will be used to make a tabletop display. The workbench will be equipped with several HMPDs, two of which will be used for the prototype development. Basic interaction devices and an omnifocus panoramic image acquisition system will be integrated. Evaluation will be done

through collaboration among several remotely located researchers, sharing and interacting

in the same workbench space through a high-speed Internet link. Such a visualization environment can be used for a wide range of applications



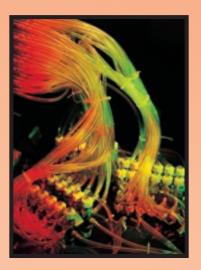
requiring tele-presence and tele-manipulation.

Professor Jean Ponce's research focuses on computer vision and robotics. His vision work addresses two basic problems: the construction of geometric object models from multiple images, and the recognition of complex shapes from photographs. The latter is conducted in collaboration with Professor David Kriegman. Ponce's robotics research is funded by the National Science Foundation and is concerned with geometric planning algorithms for automating the manipulation of mechanical parts by various robotic devices. This work has involved two former Beckman Fellows and resulted in the design and construction of several new mechanisms. It includes a new part-feeder (in collaboration with **Srinivas Akella** — a patent is pending for this device) and several novel gripper prototypes (in collaboration with Narayan Srinivasa, and a professional designer, Thomas Howell). Ponce's research also involves path planning

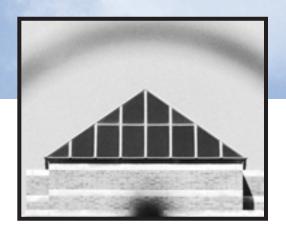


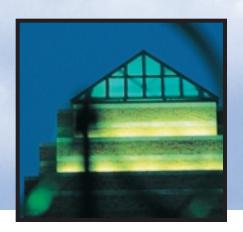
for mobile robots. This work is conducted in the Beckman Institute Computer Vision and Robotics Laboratory and involves collaborations with Beckman researchers **David Kriegman** and **Seth Hutchinson**. Together with professors Hutchinson and

Kriegman, Ponce is also actively involved in the campuswide collaboration with two French national research organizations, CNRS and INRIA, including collaborations with INRIA laboratories in Grenoble and Sophia-Antipolis, and the CNRS LAAS laboratory in Toulouse.



2000 Maintaining the Edge







Maintaining the Edge

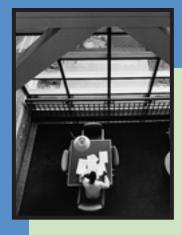
FOR THE BECKMAN INSTITUTE TO REMAIN ONE OF THE PREMIER MULTIDISCIPLINARY RESEARCH INSTITUTES IN THE WORLD, ITS FACILITIES AND INFRASTRUCTURE MUST KEEP PACE WITH THE RAPIDLY CHANGING TECHNOLOGICAL LANDSCAPE. THE FACILITIES AND INFRASTRUCTURE PLAY A MAJOR ROLE IN THE INSTITUTE'S ABILITY TO ATTRACT AND RETAIN ITS WORLD-CLASS FACULTY AND RESEARCH STAFF.

In 2000, the Institute invested heavily in several key areas. First, a vast majority of the building's network upgrade has been completed. Currently, over 85 percent of the network upgrade is complete, and we hope to finish in the spring of 2001. The entire network infrastructure is being converted from a 10Base2 to a 10/100/1000BaseT cable plant. The building's network connectivity to the campus was upgraded to Gigabit (1000Mbps.)



cabling and the backbone network was upgraded to 100Mb backbone. At the conclusion of the network upgrade, each computer system in the Institute will have the possibility of having a dedicated connection to the backbone network at either 10, 100, or 1000 Mbps. speeds. The upgrade will increase network throughput speeds, reduce errors and operational costs, allow enhanced network security, as well as better allow the support staff to detect, isolate, and correct all types of network problems.

FACILITIES



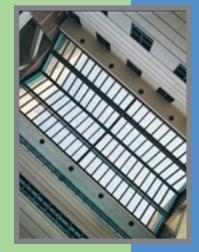
Several major pieces of new equipment were purchased this year. The first, a six-sided fully-immer-

sive virtual reality CUBE™ will arrive in early 2001, and should be operational by the spring of 2001. This facility will allow researchers to perform multimodal human perception experiments in a virtual environment unique in the world. A Major Research Instrumentation grant from the National Science Foundation is providing a significant portion of the funding for this facility. In addition, funds received by the Institute from the Arnold and Mabel Beckman Foundation are being used to buy supporting equipment for the CUBETM, as well as to cover remodeling costs associated with building the new facility. The CUBE™ will be operated by the Integrated Systems Lab (ISL) and will be available to both Institute and campus researchers.

The Institute has also purchased a multiphoton confocal light microscope that is expected to be operational in early 2001. This new instrument will provide the only general access to multiphoton imaging on the Urbana-Champaign campus. Funds for the purchase of this new instrument were provided by the Arnold and Mabel Beckman Foundation, as well as by individual faculty and departmental contributions and the campus Research Board. The new microscope will be operated by the Imaging Technology Group (ITG), and will become another addition to the world-class microscopy suite ITG operates for the benefit of the Institute and the campus as a whole.

The Institute continued to invest significant funds this year in the partnership with Carle Clinic Association, providing Beckman researchers access to Carle's 1.5 Tesla magnetic resonance

imaging (MRI) machine. This partnership has recently been extended for an additional three years, guaranteeing Beckman researchers continued access to functional magnetic resonance capabilities. In addition, the campus has now committed to purchasing a 3 Tesla MRI,



which will be located on the south campus. Though the new MRI facility could not be located at the Institute due to space constraints, the Institute is providing financial support and is expected to play a role in its operation.

FACILITIES

Finally, the Beckman Institute has undertaken a systematic plan of replacing commonly shared infrastructure resources, such as floor and wall coverings. A long-term,

integrated approach will allow us to continue to maintain the outstanding appearance of the Institute and to preserve and foster the image Dr. Beckman originally envisioned for this premier, world-class interdisciplinary research facility.

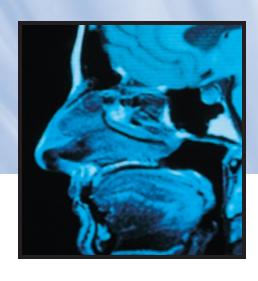
- —Jennifer Quirk, Associate Director for External Affairs and Research
- —Michael D. Smith, Associate Director for Operations and Systems Services





2000

BECKMAN FELLOWS





BECKMAN INSTITUTE FELLOWS PROGRAM

The Beckman Institute Fellows Program was initiated in Fall 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 two or three 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 corpo-



rate and governmental laboratories throughout the nation.

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

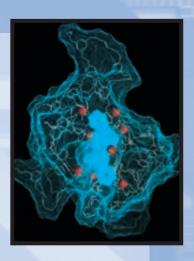
FELLOWS IN RESIDENCE

JOHN PAUL MINDA, 2000 FELLOW

Ph.D. 2000, University at Buffalo, State University of New York

John Paul Minda's research focuses on how humans learn categories and concepts, and on how this knowledge is applied to classification decisions. This research relies on empirical studies, formal modeling, and computer simulations. In particular, Minda's research also considers how categories are represented and whether those representations are prototypes or exemplars. Prototype theory assumes that categories are represented by a central tendency that is abstracted from a person's experience with a category's members. Exemplar theory assumes that categories are represented by specific stored exemplars instead of abstracted prototypes. As a graduate student, Minda worked with I. David Smith at the University at Buffalo. They discovered that people often pass through an extended stage of category learning (lasting hundreds of trials) that is consistent with pure prototype use, but that later people seem to rely mostly on exemplar traces. Minda subsequently discovered that prototype use occurs most strongly with larger, more complex categories and that exemplar use occurs most strongly with smaller, simpler categories. Minda's dissertation investigated the effects of response deadlines and concurrent tasks on category learning. He found that deadlines impeded the exemplar-learning process, but not the prototype-learning process. At Beckman, Minda has

been working with professors **Brian Ross** and **Gregory Murphy** to investigate other ways in which learning environments and conditions affect how people represent categories.



SLAVA ROTKIN, 2000 FELLOW

Ph.D. 1996, Ioffe Physico-Technical Institute, St. Petersburg

As a Beckman Fellow, Slava Rotkin is investigating the theory of the formation of carbon nanotubes (CNT) using a semi-empirical simulation based on a model he originally developed for the energetics of CNT nucleation. The problem is of particular interest due to growing needs of applied CNT research. This semiclassical approach has been successfully used for the calculation of the energy level shift in nanoscale zero-dimensional systems. For the first time, it is now possible to qualitatively take into account the electrodynamic correction in quantum dot theory. The new physical models will be applied in the simulation of next generation Si devices. At extreme nanoscale conditions, the quantum mechanical computation of the transport properties is important, especially in the case of material microscopic disorder and high carrier density.

Fellows

ILYA ZHAROV, 2000 FELLOW

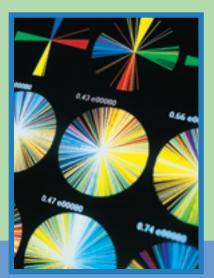
Ph.D. 2000, University of Colorado

The main focus of Ilya Zharov's doctoral work was on the preparation of R3M+ (M = Si, Ge, Sn, Pb) cations in non-polar media, on weakly nucleophilic carboranyl anions, on novel photoresist materials, and on lithium conducting polymers. As a Beckman Fellow, Zharov collaborates with the members of the Advanced Chemical Systems Group. He works on the use of dendrimers and hyperbranched polymers for molecular recognition. The general approach in this work is to covalently attach a molecule of interest to dendrons or to hyperbranched polymeric chains carrying cross-linkable substituents. Cross-linking and removal of the core molecule 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 macromolecules, such as aromatic polyether dendrimers and carbon nanotubes. He is also starting an effort towards using cryo-transmission electron microscopy in organic media for visualization of dendrimers and their hydrogen-bonded assemblies.

DALE BARR, 1999 FELLOW

Ph.D. 1999, University of Chicago

Dale Barr's work investigates how speakers and listeners coordinate reference in conversation. Currently, his work focuses on how language users exploit conversational experience when they produce and understand referring expressions. To explore these issues, Barr uses eyetracking techniques and computer simulations. His research



proceeds along two major lines of inquiry. The first line seeks to identify the kinds of acoustic information, beyond the phonological form of words, that speakers and listeners can use to establish reference. One set of recent studies found that speakers' hesitations and other non-verbal indices of uncertainty can be referentially meaningful, and that listeners take advantage of this information to identify referents. In a related, collaborative project with professors **Cynthia Fisher**,



Susan Garnsey, and others, he is investigating whether the reduced acoustic form of a repeated expres-

sion can help listeners locate referential antecedents. In his second line of research, Barr investigates how language users establish and use referring conventions to minimize uncertainty and enhance coordination. He has been collaborating with professor J. Kathryn Bock on a project that investigates how speakers develop syntactic conventions that encode relations among objects. In addition, he recently completed a set of eyetracking studies that examined how listeners use lexical precedents to guide lexical access and referential search. Finally, in a set of computer simulations, he showed that the same low-level mechanisms by which speakers and listeners coordinate reference in conversation can lead to the emergence of conventions at the level of the language community.

Hong Hua, 1999 Fellow

Ph.D. 1999, Beijing Institute of Technology

Hong Hua's research at the Beckman Institute focuses on the research and development of novel head-mounted displays (HMDs) and human-computer interaction devices. One of her major research themes (in collaboration with Beckman's Human Perception and Performance Group) is to investigate a pupil/corneal reflection eyetracking scheme and develop an HMD system with fully integrated eyetracking

capability. Her long-term motivation is to exploit this integrated display system for visual interaction within virtual environments, as well as to develop a multi-resolution display scheme in HMDs. Collaborating with professor Narendra Ahuja in the Artificial Intelligence Group, Hua has initiated research on the development of a multi-user interactive workbench system based on a novel head-mounted projective display technology. A grant for this research has been awarded by the National Science Foundation. Her objective is to develop a novel visualization device referred to as head-mounted projective display (HMPD), build a multi-user interactive workbench by integrating the developed

HMPD technology with a unique real-time image acquisition system, and evaluate and quantify the system as an effective tool for remote collaboration. Some of the properties of the HMPD concept, such

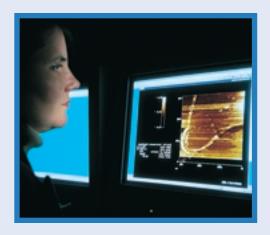


as correct occlusion depiction, optical seethrough capability, independent viewpoint, and no crosstalk in multi-user environments, make it extremely suitable for multiple-user collaborative applications. Hua hopes the proposed research will spur new interest and exploration in the development of novel visualization devices, and in new applications of HMPD technology in multi-user environments.

LOLITA ROTKINA, 1999 FELLOW

Ph.D. 1996, loffe Physico-Technical Institute, St. Petersburg

Lolita Rotkina's main research interest centers around the development of practical nanotechnology approaches for implementing new functions and capabilities in electronic, optoelectronic, and biologically based systems. Recent experiments have focused on the growth of the carbon nanotubes (CNT) in collaboration with Professor Joseph Lyding's group. Samples of CNTs have been obtained where the nanotubes are highly oriented along the crystallographic directions (high symmetry planes) of a Si wafer and connected with the islands of silicide metal. These samples have been carefully characterized with atomic force microscopy, scanning electron microscopy, auger spectroscopy, x-ray analysis, and transmission electron microscopy. Rotkina plans to use this growth technique to prepare CNT scanning tunneling microscope (STM) tips and other nanodevices.



JASON S. McCarley, 1999 Fellow Ph.D. 1997,

University of Louisville



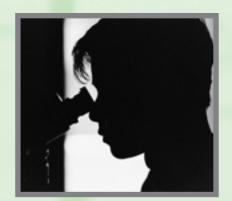
Jason McCarley was awarded a Ph.D. in 1997 from the University of Louisville, where he studied experimental psychology with a concentration on visual perception and cognition. He spent a year at the Naval Postgraduate School in Monterey, California, as a postdoctoral associate for the Office of Naval Research, collaborating with psychologists, engineers, and physicists to explore techniques for improving military imaging sensors. At the Beckman Institute, he works with professors, postdoctoral associates, and students in the Human Perception and Performance group to study various basic and applied aspects of vision, attention, and eye movements. Over the past year, McCarley has employed behavioral measures, psychophysical techniques, and eyetracking to explore the control of attention in visual search of complex displays; the effects of non-visual dual-task interference on visual scanning of and memory for naturalistic scenes; the role of perceptual object representations in the control of eye movements and covert attentional spread; and the effects of aging on attentional control.

MICHAL BALBERG, 1998 FELLOW

Ph.D. 1998, Hebrew University of Jerusalem

As a Beckman fellow, Michal Balberg is interested in microdevices for biological and environmental applications of bio-microelectromechanical systems (bioMEMS). These devices are integrated with optical elements to provide efficient detection of fluorescent molecules inside microfluidic channels. Additionally, Balberg is working on functional imaging of microfluidic and MEMS devices. The techniques she is developing are based on three-dimensional imaging of microscopic structures (such as confocal microscopy). Her research is conducted in collaboration with professors **Lutgarde Raskin** (Department of Civil and Environmental Engineering), **David Brady**, and

Stephen Boppart. Balberg's Ph.D. thesis focused on the implementation of electrooptic devices in a hardware system for artificial neural networks. The devices were based on electrically controlled volume holograms in novel KLTN crystals, and performed parallel analog and binary computations.



BECKMAN GRADUATE FELLOWSHIPS AWARDED IN 2000

GIULIA BENCINI: "Investigating the Relationship Between Language Structure and Meaning: An Eye Tracking Study of Structural Priming in Language Production"

Bencini's project offers a new approach to questions about the relationship between language structure and meaning by introducing eyetracking methodology to investigate the phenomenon of structural priming in language production. Advisors are professors **J. Kathryn Bock** (Psychology), **Adele Goldberg** (Liguistics), and **Gary Dell** (Psychology), all members of the Cognitive Science Group.



EDGAR LARIOS: "Experimental-Computational Study of Fast Protein Folding"

Larios is carrying out basic research using both computational and experimental approaches to identify the pathway along which the physical process of protein folding occurs. Advisors are professors **Martin Gruebele** (Chemistry) in the Photonic Systems Group and **Klaus Schulten** (Physics) from the Theoretical Biophysics Group.

SONG WANG: "Kernel-Based Learning: Theory and Applications"

Wang's project is motivated by the recent exciting developments of kernel-based learning, which will allow problems in human-computer intelligent interaction to be addressed from a new perspective. Advisors are professors **Zhi-Pei Liang** (Electrical and Computer Engineering) from the Image Formation and Processing Group, **Stephen Levinson** (Electrical and Computer Engineering), and **Thomas Huang** (Electrical and Computer Engineering), both in the Artificial Intelligence Group.

QING YU: "Toward the Development of a Botulinum-Responsive 'Bio-Fuse' Using Microfluidic Tectonics"

The goal of Yu's research is to develop a Botulinum-responsive one-shot biosensor. Advisors are professors **Jeffrey Moore** (Chemistry) from the Advanced Chemical Systems Group and David Beebe (University of Wisconsin), a former member of the Biological Sensors Group.



ITG

IMAGING TECHNOLOGY GROUP



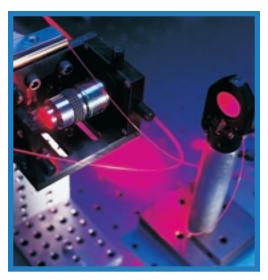




THE PRIMARY MISSION OF THE IMAGING TECHNOLOGY GROUP (ITG) IS TO PROVIDE BECKMAN RESEARCHERS WITH STATE-OF-THE-ART SERVICE FACILITIES IN THE MICROSCOPY SUITE AND THE VISUALIZATION, MEDIA, AND IMAGING LABORATORY. THERE ARE CURRENTLY OVER 300 USERS OF THESE FACILITIES DRAWN FROM ALMOST EVERY DEPARTMENT ON CAMPUS. A SECONDARY FOCUS OF THE GROUP IS TO DEVELOP ADVANCED IMAGING TECHNOLOGIES, PRIMARILY IN THE AREA OF MICROSCOPE CONTROL AND AUTOMATION. ADDITIONAL INFORMATION ON THE GROUP CAN BE FOUND AT HTTP://www.itg.uiuc.edu.

HIGHLIGHTS IN 2000

Microscopy Suite: This year a multi-photon confocal light microscope (Leica TCS MP two photon imaging system) was added to the instruments in the facility. The new instrument will provide the only general access to multi-photon imaging on this



campus. The choice of the Leica instrument was based on the need to combine a number of critical components: the ability to use the multi-photon capability in an innovative way for the design of biosensors; a need for diffraction-limited spectroscopic imaging tools; and an excellent, hardy instrument suitable for use in a multi-user facility. The instrument provides the unique capability for examining specimens spectroscopically while also providing multi-photon imaging. Funding for the instrument



was provided by the Beckman Institute, individual faculty and departmental contributions, and the University Research Board. Other major additions to the

microscopy facility in 2000 included a new 2K x 2K x 12 bit digital camera to be attached to the Philips CM200 Transmission Electron Microscope. The new camera will effectively quadruple the specimen area that can be acquired digitally from this instrument.

Visualization, Media, and Imaging Laboratory (VMIL): This year a major investment has been made to support digital video technology in the VMIL. The laboratory now provides capabilities for DVD authoring, mastering, and replication. The new DVD suite includes authoring software, MPEG-2 real-time encoding hardware, a DVD-R burner, and digital video cameras. Additional new capabilities in the VMIL added this year include a 3D printer that can produce solid models made from a high-strength polyester compound and a 3D object scanner.

Bugscope: This is an educational outreach program for K-12 classrooms. The program provides a resource to classrooms so that they can remotely operate a scanning electron microscope to image arthropods at high magnification. The microscope is remotely controlled from a classroom computer in real-time over

the Internet using a web browser. Bugscope provides a state-of-the-art microscope resource for teachers that can be readily integrated into classroom activities. To date the project has provided access to the scanning electron microscope to over 50 classrooms around the nation. The project has been supported for several years by grants from the Illinois Consolidated Telephone Company. This year, the ITG was awarded a grant from the National Science Foundation to develop an infrastructure and tools that can be used by other groups to support projects similar to Bugscope. For additional information see http://bugscope.beckman.uiuc.edu.

Technology Development: The ITG is involved in several technology development projects based around automated and remote control of instrumentation. This year, the ITG received a new grant from the National Institutes of

Health to support a project to develop an integrated system for molecular microscopy. The goal of the project is to automatically generate an electron density map of a macromolecule within a few hours



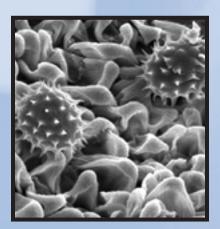
of inserting a specimen into a transmission electron microscope. Co-investigators on the project are **Bridget Carragher**, **Clint Potter**, professors **David Kriegman**, and **Zhi-Pei Liang** from the Beckman Institute, and Ron



Milligan from The Scripps Research Institute. For additional information, please visit http://www.itg.uiuc.edu/technology.

Outreach: The ITG Forum series provides an opportunity to learn about the tools, techniques, and technologies available within the group. Forty-four forums were presented during 2000 and included presentations from members of the ITG, users of the ITG facilities, members of the Beckman Institute, the university campus, and

local and national communities. Additionally, a total of 13 technical reports were published to document the techniques and applications developed within the Imaging Technology Group. Additional information can be obtained at: http://www.itg.uiuc.edu/publications.



ISL INTEGRATED SYSTEMS LABORATORY





INTEGRATED SYSTEMS LABORATORY

THE INTEGRATED SYSTEMS LABORATORY (ISL) IS A BECKMAN INSTITUTE FACILITY FOR ADVANCING SCIENTIFIC UNDERSTANDING OF HUMAN-COMPUTER INTERACTIONS. THE PRIMARY MISSION OF THE ISL IS TO SUPPORT THE INTEGRATION OF ADVANCED TECHNOLOGIES SO THAT INSTITUTE RESEARCHERS CAN CONDUCT EXPERIMENTS IN HUMAN MULTIMODAL PERCEPTION AND COGNITION. TO FACILITATE THIS MISSION, THE ISL MAINTAINS DISCRETE LABORATORIES ALLOWING THE INCORPORATION OF INDIVIDUALIZED MULTIMODAL CONTROL AND MONITORING TECHNOLOGIES INTO EXTANT VIRTUAL REALITY DISPLAY ENVIRONMENTS.

HIGHLIGHTS IN 2000

The Integrated Systems Laboratory (ISL) continues in its role of providing laboratory facilities and integration expertise for conducting cognitive studies in the fourth year of the Federated Laboratory for Advanced Displays and Interactive Displays project funded by the Army Research Laboratory. Previously developed advanced multimodal



display control technologies from the Beckman Institute and from industry researchers have been integrated into the final year of usability studies in complex virtual environments. This is yielding significant research data in cognitive studies as well as opportunities for the transition of research projects into products for the military. One example of this transition is the successful delivery to the Army of the Acoustical Spatial Interface System (ASIS). ASIS provides sonification assistance in cluttered visual display environments for Army command center personnel. Laser pointer and human speech control of complex display environments has also

proved to be a fertile field for product delivery to various military units.

ALICE, the Adaptive Laboratory for Immersive Cognitive Experiments, is being constructed in the basement of the Beckman facility. A grant from the Major Research Instrumentation program in the Computer and Information Science and Engineering Directorate of the National Science Foundation to Rachael Brady, Professor Thomas Huang and Professor Arthur Kramer and major support from the Beckman Foundation will allow researchers to perform multimodal human perception experiments in a virtual environment unique in the world. The broad appeal of this project is demonstrated by the campus units that have provided matching funds: the Institute of Aviation, and the departments of Kinesiology, Psychology, Computer Science, and Electrical and Computer Engineering. TAN Projektionstechnologie has been awarded a contract to construct and install this 3 meter. fully immersive solid-walled virtual reality CUBE ™, which will become operational early in 2001. The CUBE ™ will be a virtual laboratory providing untethered data acquisition from subjects through commercial wireless bodytracking technologies. Most importantly, however, it will use eyetracking, gesture, and speechrecognition technologies, developing within the research groups of the Beckman Institute. Driven by both a supercomputer on loan from the National Center for Supercomputing Applications and a Myrinet-connected PC cluster with distributed graphics and control implemented by **Benjamin Schaeffer**, the CUBE [™] has a long list of campus-wide research projects being prepared by ISL programmers.

Sonification controlled by Global Positioning Satellite (GPS) is the ISL's contribution to the Yamaha Motor Corporation's computer companions project in 2000. **Camille Goudeseune** has

implemented a completely portable 1.5 meter-accuracy GPS and flux-gate compass-controlled stereo sound system capable of providing location-specific information for a wide variety of computer-assisted applications.

IVE doesn't just grow on walls, it lives in the ISL. The Intelligent Virtual



Ensemble is a project funded by the campus' Critical Research Initiative. Karen Ruhleder from the School of Library and Information Science, professors Guy Garnett and Fred Stoltzfus from the School of Music, and Professor Klara Nahrstedt from the Department of Computer Science join the ISL's Rachael Brady and Henry J. Kaczmarski in creating a multidisciplinary, collaborative research enterprise using the teaching of choral and orchestral conducting in a virtual environment as a testbed for creating a more general virtual environment for distributed and collocated work and learning. The first year of this project has seen research into quality-of-service issues and implementation of wireless detection of the subtlest human gestures, resulting in algorithms for control of a virtual ensemble.

—Henry J. Kaczmarski, Director

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University of Illinois at Urbana-Champaign

Chancellor:

Michael T. Aiken

Provost and Vice-Chancellor for Academic Affairs:

Richard Herman

Vice-Chancellor for Research:

Tony G. Waldrop

2000 FACTS AND FIGURES

BECKMAN INSTITUTE FUNDING

Funding Awarded to Beckman Institute Faculty Administered by the Beckman Institutute²

	FY96	FY97	FY98	FY99	FY00
DEPARTMENT OF DEFENSE	2,942,604	3,018,926	4,244,105	8,596,145	3,567,490
NATIONAL INSTITUTES OF HEALTH	1,841,717	1,907,009	2,024,355	3,096,564	3,433,321
NATIONAL SCIENCE FOUNDATION	1,782,607	3,447,156	1,823,786	3,714,184	1,555,040
OTHER	1,016,751	1,645,026	817,864	1,161,601	890,974
Total	7,583,679	10,018,117	8,910,110	16,568,494	9,446,825
Funding Awarded	to Beckman I	NSTITUTE FACU	lty Administer	RED BY OTHER D	DEPARTMENTS ³
DEPARTMENT OF DEFENSE	4,435,872	4,524,577	6,475,573	7,480,679	8,736,643
NATIONAL INSTITUTES OF HEALTH	4,982,368	4,752,157	5,614,090	5,316,533	5,623,463
NATIONAL SCIENCE FOUNDATION	1,754,112	3,176,276	1,837,054	1,937,805	7,580,850
OTHER	2,240,345	2,218,587	2,452,133	632,688	2,737,686
Total	13,412,697	14,671,597	16,378,850	15,367,705	24,678,642

¹In addition to the sources itemized in the chart, funding for the Institute is received from the following:

- 1. The state of Illinois to the University of Illinois and allocated through individual departments: Faculty Salaries
- 2. The state of Illinois to the Beckman Institute:

Daily Operating Expenses

3. The Arnold and Mabel Beckman Foundation:

Beckman Institute Fellows Program

Beckman Institute Graduate Fellows Program

Beckman Institute Equipment Competition

 $^{^2}$ All interdisciplinary grants with faculty investigators from multiple departments are administered by the Beckman Institute.

³All single investigator grants are administered by the investigator's home department.

Molecular and Electronic Nanostructures

FACULTY BY BECKMAN INSTITUTE GROUP

ADVANCED CHEMICAL SYSTEMS GROUP Paul W. Bohn: Chemistry Paul V. Braun: Materials Science and Engineering ■ Theodore L. Brown: Emeritus, Chemistry ■ Jiri Jonas (Institute Director): Chemistry | Jeffrey S. Moore: Chemistry | Stephen G. Sligar: Biochemistry Scott R. White: Theoretical and Applied Mechanics 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: Emeritus, Statistics and Mathematics ■ Umberto Ravaioli: Electrical and Computer Engineering ■ **PHOTONIC SYSTEMS** GROUP ■ Stephen A. Boppart: Electrical and Computer Engineering ■ David J. Brady: Electrical and Computer Engineering ■ Martin H.W. Gruebele: Chemistry ■ Nancy Makri: Chemistry ■ Margery D. Osborne: Curriculum and Instruction ■ Eric Michielssen: Electrical and Computer Engineering **Scanning Tunneling Microscopy Group** ■ Ilesanmi Adesida: Electrical and Computer Engineering ■ Joseph W. Lyding: Electrical and Computer Engineering ■ Gregory Timp: Electrical and Computer Engineering ■ THEORETICAL BIOPHYSICS GROUP Laxmikant V. Kale: Computer Science Todd J. Martínez: Chemistry
Klaus J. Schulten: Physics Robert D. Skeel: Computer Science ■ No Group ■ Sung-Mo (Steve) Kang: Electrical and Computer Engineering



AWARDS, PATENTS, GRANTS

MAJOR AWARDS

Martin H.W. Gruebele

Coblentz Award, Coblentz Society

Sung-Mo (Steve) Kang

Fellow, Association of Computing Machinery
IEEE Third Millennium Medal

Joseph W. Lyding

Fellow, American Vacuum Society

Nancy Makri

Annual Academic Prize in Physical Sciences, Bodossakis Foundation

Todd J. Martínez

Dreyfus Teacher-Scholar Award, Camille and Henry Dreyfus Foundation

Margery D. Osborne

Scholar, College of Education, University of Illinois at Urbana-Champaign

Stephen G. Sligar

Merit Award, National Institutes of Health

PATENTS AND PATENT APPLICATIONS

(Beckman Institute faculty in bold)

David Beebe, Hyuk-Jeen Suh, **Jeffrey S. Moore**, and Pamidighantam Bharathi: "Dendritic Material Sacrificial Layer Micro-scale Gap Formation Method," File date (year only): 2000.

David Beebe and **Jeffrey S. Moore**: "Microfabricated Devices and Method of Manufacturing the Same," File date (year only): 2000.

Stephen G. Sligar and Timothy Bayburt: "Membrane Scaffold Proteins," File date (year only): 2000.

GRANTS AWARDED

(Principal Investigator in bold)

Ilesanmi Adesida, Paul W. Bohn, and Xiuling Li: Department of Defense/Office of Naval Research, "Porous GaN: Production, Characterization, and Application," 01-Jan-00 to 30-Dec-02.

Ilesanmi Adesida: Triquint Semiconductor, "AlGaN/GaN HFET Fabrication and Characterization." 15-Feb-00 to 14-Feb-01.

Ilesanmi Adesida: Department of Defense/Air Force, "Ultra-High Power GaN Power Amplifier at X-Band," 16-Jun-00 to 17-Aug-01.

Ilesanmi Adesida: Department of Defense/ Defense Advanced Research Projects Agency, "Resonant-enhanced Modulators (Sarnoff Corporation)," 21-Jun-00 to 14-Jun-03.

Paul W. Bohn, Mark A. Shannon, and Jonathan V. Sweedler: Department of Defense/Defense Advanced Research Projects Agency, "Biofluidic Intelligent Processors for Preparative Manipulations of Biological Warfare Agents at the Attomole Level," 10-Jul-00 to 09-Jul-03.

Paul W. Bohn: Dreyfus Foundation, "An Undergraduate Three-dimensional Visualization Facility for the New Curriculum in Chemical Biology," 01-Ian-00 to 31-Dec-00.

Paul W. Bohn and Christopher Bardeen: National Science Foundation, "Purchase of A Picosecond Fluorescence Spectrometer," 15-Jan-00 to 31-Dec-02.

Paul W. Bohn: National Science Foundation, "Actively Controlled Transport with Molecular Assemblies," 15-Jan-00 to 31-Dec-02.

Stephen A. Boppart, Michal Balberg, David J. Brady, and Lutegarde Raskin: National Science Foundation, "Integrated Optical Coherence Tomography and Multi-photon Microscopy for Microfluidic System Analysis and Molecular Beacon Monitoring," 15-Sep-00 to 31-Aug-03.

David J. Brady, Rachael Brady, Andrew Singer, and Rick Morrison: Department of Defense/Army Research Office, "Tomographic Imaging on Distributed Unattended Ground Sensor Arrays," 05-Jul-00 to 04-Jul-01.

David J. Brady, James Coleman, and Jean-Pierre Leburton: Department of Defense/Defense Advanced Research Projects Agency, "Adaptive Multiplex Wavelength and Special Signal Processing," 15-May-00 to 14-May-04.

David J. Brady: Department of Defense/Army Research Office, "Integrated Sensing and Processing Workshop," 08-Aug-00 to 07-Feb-01.

Paul V. Braun: Caterpillar Inc., "Exploratory Studies of Rubber to Metal Interfaces," 01-Jan-00 to 31-Dec-01.

Martin H.W. Gruebele: National Science Foundation, "Modeling and Laser Control of Molecular Vibrational Energy Flow," 01-May-00 to 30-Apr-03.

Sung-Mo (Steve) Kang: Intel Corporation, "Noise-driven Dynamic Logic Synthesis and Maximum Power Estimation," 01-Jan-00 to 31-Dec-00.

Joseph W. Lyding: Department of Defense/Office of Naval Research, "Nanoscale Interface Characterization by UHV STM Spectroscopy," 01-Jan-00 to 31-Dec-02.

Richard M. Martin: National Science Foundation, "Materials Computation Center," 01-Jan-00 to 31-Dec-02.

Todd J. Martínez: Camille and Henry Dreyfus Foundation, Inc., "Camille Dreyfus Teacher Scholar Awards Program," 01-Apr-00 to 31-Mar-05.

Eric Michielssen, Weng Chew, and Andreas Cangellaris: Department of Defense/Army Research Office, "Fast Multipole/Wavelet IML Hybrids for Electromagnetic Analysis," 01-Aug-00 to 30-Apr-01.

Jeffrey S. Moore, Narayana Aluru, and Matthew Wheeler: Department of Defense/Defense Advanced Research Projects Agency, "An Advanced Platform for Biomolecular Detection and Analysis Systems: Microfluidic Tectonics and Pocket BC Detector Systems," 29-Jun-00 to 28-Jun-03.

Margery D. Osborne: National Science Foundation, "Parents in Poverty and Science Education Reform: A Relational Systems Approach," 01-Jan-00 to 31-Dec-00.

Margery D. Osborne: Spencer Foundation, "A Relational Analysis of Early Childhood Science Education in At-risk Settings," 01-Jan-00 to 31-Dec-00.

Klaus J. Schulten: National Science Foundation, "Simulation of the Functional Dynamics of Bacteriphodopsin in the Integral Purple Membrane," 15-Mar-00 to 28-Feb-03.

Klaus J. Schulten: National Institutes of Health, "Steered Molecular Dynamics Investigations of Protein Function," 01-Apr-00 to 31-Mar-03.

Klaus J. Schulten: Human Frontier Science Program Organization, "Investigation of the Molecular Mechanism of the Light Energy Storage in Retinal Proteins," 01-Jul-00 to 30-Jun-03.

M&ENS

GRANTS, PUBLICATIONS

Stephen G. Sligar, Joseph W. Lyding and Jeffrey S. Moore: National Science Foundation, "Exploratory Research on Biosystems at the Nanoscale: Nanobioelectronics," 15-Feb-00 to 31-Jan-02.

SELECTED PUBLICATIONS

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Biological Intelligence

FACULTY BY BECKMAN INSTITUTE GROUP

BIOACOUSTICS RESEARCH LABORATORY • Floyd Dunn: Emeritus, Electrical and Computer Engineering 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 Jonathan V. Sweedler: Chemistry ■ Andrew G. Webb: Electrical and Computer Engineering ■ Bruce C. Wheeler: Electrical and Computer Engineering • Cognitive Neuroscience Group ■ Marie T. Banich: Psychology ■ Neal J. Cohen: Psychology ■ Michael G. Coles: Psychology ■ Emanuel E. Donchin: Psychology ■ Susan M. Garnsey: Psychology ■ Wendy Heller: Psychology • Gregory A. Miller: Psychology • COGNITIVE SCIENCE GROUP • 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 ■ Gregory L. Murphy: Psychology ■ Brian H. Ross: Psychology ■ Edward J. Shoben: Psychology ■ Daniel D. Silverman: Linguistics Robert A. Wilson: 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

AWARDS, PATENTS, GRANTS

Major Awards

Ronald J. Adrian

Fellow, American Academy of Mechanics

Michael G.H. Coles

Visiting Research Fellow, Max-Planck Institute, Nijmegen, Germany

Adele E. Goldberg

Associate, Center for Advanced Study, University of Illinois at Urbana-Champaign

Paul C. Lauterbur

Honorary Doctor of Science, Case Western Reserve University, Cleveland, Ohio IEEE Millennium Medal of Honor Distinguished Alumni Award, Department of Chemistry, University of Pittsburgh

Yuqing Li

Fellow, Center for Advanced Study,
University of Illinois at Urbana-Champaign

Chang Lui

Career Award, National Science Foundation

William D. O'Brien, Jr.

IEEE Millennium Medal of Honor

Jonathan V. Sweedler

Fellow, American Association for the Advancement of Science Gill Prize in Instrumentation and Measurement Science

Andrew G. Webb

Guest Professorship, University of Wurzburg, Germany

PATENTS AND PATENT APPLICATIONS

(Beckman Institute faculty in bold)

Mark A. Shannon, David Beebe, Michael Philpott, and Clark Bullard: "Active Compressor Vapor Compression Cycle Integrated Heat Transfer Device," Issue date: November 27, 2000, Patent No. 6,148,635.

Mark A. Shannon and Richard Masel: "Microcombuster Having Submillimeter Critical Dimension," File Date (year only): 2000.

Douglas Jones, Michael Lockwood, Robert Bilger, **Albert S. Feng**, and Charissa Lansing: "Interference Suppression Techniques," File date (year only): 2000.

GRANTS AWARDED

(Principal Investigator in bold)

Thomas J. Anastasio, Pierre Moulin, and Sylvian Ray: National Science Foundation, "Modeling Multisensory Integration in the Superior Colliculus," 01-Sep-00 to 31-Aug-03.

Thomas J. Anastasio, Pierre Moulin, and Sylvian Ray: Department of Defense/Office of Naval Research, "Developing an Adaptive Self-aiming Camera Based on the Neurobiology of the Superior Colliculus," 15-Dec-00 to 30-Nov-03.

Emanuel E. Donchin and Laura Bischoff: International Foundation for Music Research, "The Processing of Pitch and Scale: An ERP Study," 01-May-00 to 30-Apr-01.

William T. Greenough: Fraxa Research Foundation, "Studies of Synaptic Regulation of Protein Synthesis and of Possible Therapeutic Approaches to Fragile X Syndrome," 01-Mar-00 to 28-Feb-01.

William T. Greenough: Fraxa Research Foundation, "Studies of FMR-1 Gene Delivery Using Herpes Simplex Viral Vectors," 01-Mar-00 to 28-Feb-01.

William T. Greenough and Valerie Bertaina-Anglade: Fraxa Research Foundation, "Studies of the Fragile X Knockout Mouse: Characterization of the Behavioral Profile and Mnesic Abilities of the FVB and C57BL/6 FMRP - Deficient Knockout Mice," 11-May-00 to 10-May-01.

William T. Greenough: Fraxa Research Foundation, "Electron Microscopic Analysis of Synaptic Morphology and Number in Development and Early Adulthood in the FMR-1 Knockout Mouse," 01-June-00 to 31-May-01.

William T. Greenough: Retirement Research Foundation, "Physical Exercise Effects Upon the Structure and Function of the Primate Brain," 15-Dec-00 to 15-Dec-01.

Wendy Heller, Marie T. Banich, Gregory A. Miller, Neal J. Cohen, John Gergen, and Andrew G. Webb: National Institutes of Health, "Mechanisms of Attentional Bias in Psychopathology," 03-July-00 to 31-Mar-03.

Douglas Jones, Chang Liu, Albert S. Feng, Bruce C. Wheeler, William D. O'Brien, Jr., and Naresh Shanbhag: Department of Defense/Defense Advanced Research Projects Agency, "Development of a Biomemetic Acoustic Microsensor," 29-Sep-00 to 28-Sep-03.

Yuqing Li: Dystonia Medical Research Foundation, "Pathophysiology of DYT1 Dystonia: Conditional Torla Mutant Mice," 01-Sep-00 to 31-Oct-02.

Chang Liu and Jeffrey S. Moore: Department of Defense/Office of Naval Research, "Science and Technology Foundations for Hybrid Myosin-based Actuators," 01-May-00 to 30-Apr-01.

Chang Liu: National Science Foundation, "Career: Biologically Inspired Integrated Sensors for Robotics Applications," 01-May-00 to 30-Apr-04.

Chang Liu, Douglas Jones, and Naresh Shanbhag. National Science Foundation, "Integrated Sensitive Skin with Advanced Data Architecture," 01-Oct-00 to 30-Sep-03.

Kevin F. Miller and Tanya Sharon: National Institutes of Health, "Intentionality and Inhibition in Early Symbolic Skill," 12-Jan-00 to 11-Jan-01.

Kevin F. Miller and George W. McConkie: National Science Foundation, "Language, Symbol Systems, and Cognitive Development," 01-Aug-00 to 31-Jul-03.

Kevin F. Miller, Michelle Perry, and David J. Brady: National Science Foundation, "Representing and Learning from Classroom Processes," 01-Oct-00 to 30-Sep-04.

Mark E. Nelson: National Science Foundation, "Statistical Signal Processing Models of Electrosensory Acquisition," 15-Aug-00 to 31-Jul-03.

William D. O'Brien, Jr.: Industrial Management Systems, "Near Surface Acoustic Imaging in Soils," 01-Aug-00 to 31-Jul-01.

William D. O'Brien, Jr.: U.S. Civilian Research and Development Foundation for the Independent States of the Former Soviet Union, "A New Approach to High-Resolution 3D Ultrasound Imaging Based on Linear Phased Arrays," 01-Aug-00 to 31-Jan-02.

GRANTS, PUBLICATIONS

Jonathan V. Sweedler and Andrew G. Webb: National Institutes of Health, "Nanoliter Volume Nuclear Magnetic Resonance," 01-May-00 to 30-Apr-04.

Bruce C. Wheeler, Robert Bilger, Albert S. Feng, Douglas Jones, Charissa Lansing, and William D. O'Brien, Jr.: National Institutes of Health, "Real-time Noise Cancellation for Improved Speech Understanding with Hearing Aids," 01-Jul-00 to 30-Jun-02.

Bruce C. Wheeler and John Chang: National Institutes of Health, "Studies of Living, Sparse, Patterned Neural Network," 21-Aug-00 to 20-Aug-01.

SELECTED PUBLICATIONS

(Beckman Institute faculty in bold)

- Liu, R.H., Stremler, M. A., Sharp, K.V., Olsen, M. G., Santiago, J.G., **Adrian, R.J.**, Aref, H., and Beebe, D.J. (2000), "Passive Mixing in a Three-dimensional Serpentine Microchannel," *Journal of Microelectromechanical Systems*, **9**, pp.190-197.
- Spengler, J., Jekel, M., Christensen, K.T., **Adrian, R.J.**, Hawkes, J.J., and Coakley, W.T. (2000), Seventh Meeting of the European Society of Sonochemistry, Biarritz-Guethary, France, May.
- Anastasio, T.J., Patton, P.E., and Belkacem-Boussaid, K. (2000), "Using Bayes' Rule to Model Multisensory Enhancement in the Superior Colliculus," Neural Computation, 12, pp. 997-1019.
- **Bock**, **J.K.**, and Griffin, Z.M. (2000), "The Persistence of Structural Priming: Transient Activation or Implicit Learning?" *Journal of Experimental Psychology: General*, **129**, pp.177-192.
- Griffin, Z.M. and **Bock, J.K.** (2000), "What the Eyes Say About Speaking," Psychological Science, **11**, pp. 274-279.

- Brewer, W.F. (2000), "Bartlett's Concept of the Schema and Its Impact on Theories of Knowledge Representation in Contemporary Cognitive Psychology," in A. Saito, ed., Bartlett, Culture and Cognition (Philadelphia: Psychology Press), pp. 69-89.
- Brewer, W.F., Chinn, C.A., and Samarapungavan, A. (2000), "Explanation in Scientists and Children," in F. C. Keil and R. A. Wilson, eds., Explanation and Cognition (Cambridge, MA: MIT Press), pp. 279-298.
- da Silviera, R., **Chaieb, S.**, and Mahadevan, L.(2000), "Rippling Instability of a Collapsing Bubble," *Science*, **287**, pp.1468-1471.
- **Chaieb, S.**, Sato-Matsuo, E., and Tanaka, T. (2000), "Shrinking-induced Instability in Gels," Department of Theoretical and Applied Mechanics Report, **952**, pp.1-7.
- Kruse, A.A., Stripling, R., and **Clayton, D.F.** (2000), "Minimal Experience Required for Immediate-early Gene Induction in Zebra Finch Neostriatum," Neurobiology of Learning and Memory, **74**, pp. 179-184.
- Perrin, R.J., Woods, W.S., **Clayton, D.F.**, and George, J.M. (2000), "Interaction of Human Alphasynuclein and Parkinsonian Variants with Phospholipids: Structural Analysis Using Site-directed Mutagenesis," *Journal of Biological Chemistry*, **275**, pp. 34393-34398.
- Banich, M., Milham, M., Atchley, R., Cohen, N., Webb, A., Wszalek, T., Kramer, A., Liang, Z., Barad, V., Gullett, D., Shah, C., and Brown, C.(2000), "Prefrontal Regions Play a Predominant Role in Imposing an Attentional 'Set': Evidence from fMRI," Cognitive Brain Research, 10, pp.1-9.
- Ryan, J.D. and **Cohen, N.J.** (2000), "Amnesia Is a Deficit in Relational Memory," Psychological Science, **11**, pp. 454-461.

- **Cole, J.** (2000), "Sindhi," in J. McGarry, ed., Facts about the World's Languages, (New York and Dublin: HW Wilson Publishers).
- Guest, D., **Dell, G.**, and **Cole, J.** (2000), "Violable Constraints in Language Production: Testing the Transitivity Assumption in Optimality Theory," *Journal of Memory and Language*, **42**, pp. 272-299.
- Scheffers, M.K. and **Coles, M.G.H.** (2000), "Performance Monitoring in a Confusing World: Error-related Brain Activity, Judgments of Response Accuracy, and Types of Errors," *Journal of Experimental Psychology*: Human Perception and Performance, **26**, pp. 141-151.
- Fournier, L.R., Scheffers, M.K., **Coles, M.G.H.**, Adamson, A., and Vila, E. (2000), "When Complexity Helps: An Electrophysiological Analysis of Multiple Feature Benefit in Object Perception," *Acta Psychologica*, **104**, pp.119-152.
- Foygel, D. and **Dell, G.** (2000), "Models of Impaired Lexical Access in Speech Production," *Journal of Memory and Language*, **43**, pp. 182-216.
- **Dell, G.S.**, Reed, K.D., Adams, D.R., and Meyer, A.S. (2000), "Speech Errors, Phonotactic Constraints, and Implicit Learning: A Study of the Role of Experience in Language Production," *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **26/6**, pp. 1355-1367.
- Otten, L., and **Donchin, E.** (2000), "The Relationship Between P300 Amplitude and Subsequent Recall for Distinctive Events: Dependence on Type of Distinctiveness Attribute," Psychophysiology, **37**, pp. 644 661.

- **Donchin, E.**, Spencer, K.M., and Wijesinghe, R. (2000), "The Mental Prosthesis: Assessing the Speed of a P300-based Brain-computer Interface," IEEE *Transactions on Rehabilitation Engineering*, **8**, pp.174-179.
- Feng, A.S. and Ratnam, R. (2000), "Neural Basis of Hearing in Real World Situations," Annual Review of Psychology, 51, pp. 699-725.
- Galazyuk, A.V., Llano, D.A., and **Feng, A.S.** (2000), "Temporal Dynamics of Acoustic Stimuli Enhance Amplitude Tuning of Inferior Colliculus Neurons," *Journal of Neurophysiology*, **83**, pp. 128-138.
- Fisher, C. (2000), "From Form to Meaning: A Role for Structural Analogy in the Acquisition of Language," in H.W. Reese, ed., Advances in Child Development and Behavior, 27, (New York: Academic Press), pp.1-53.
- O'Brien, Jr., W.D., Frizzell, L.A., Weigel, R.M., and Zachary, J.F., "Ultrasound-induced Lung Hemorrhage is not Caused by Inertial Cavitation," *Journal of the Acoustical Society of America*, **108**, pp. 1290-1297.
- Bencini, G.M.L. and **Goldberg, A.E.** (2000), "The Contribution of Argument Structure Constructions to Sentence Meaning," *Journal of Memory and Language*, **43**, pp. 640-651.
- **Goldberg, A.E.** (2000), "Patient Arguments of Causative Verbs Can Be Omitted: The Role of Information Structure in Argument Distribution," Language Sciences, pp.1-22.
- **Green, G.** (2000), "The Nature of Pragmatic Information," in Ronnie Cann, Claire Grover, and Philip Miller, eds., *Grammatical Interfaces in HPSG*, (Stanford, CA: CSLI Publications), pp.113-138.



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- Irwin, S.A., Swain, R.A., Christmon, C.A., Chakravarti, A., Weiler, I.J., and **Greenough, W.T.** (2000), "Evidence for Altered Fragile-X Mental Retardation Protein Expression in Response to Behavioral Stimulation Neurobiology of Learning and Memory," Neurobiology of Learning and Memory, **73/1**, pp. 87-93 (Erratum, 74/1, pp. 80-87).
- Irwin, S.A., Galvez, R., and **Greenough, W.T.** (2000), "Dendritic Spine Structural Anomalies in Fragile-X Mental Retardation Syndrome," *Cerebral Cortex*, **10**, pp.1038-1044.
- Nitschke, J.B., **Heller, W**., and **Miller, G.A.** (2000), "Anxiety, Stress, and Cortical Brain Function," in J.C. Borod, ed., *The Neuropsychology of Emotion* (New York: Oxford University Press), pp. 298-319.
- Keller, J., Nitschke, J.B., Bhargava, T., Deldin, P.J., Gergen, J.A., **Miller, G.A.**, and **Heller, W.** (2000), "Neuropsychological Differentiation of Depression and Anxiety," *Journal of Abnormal Psychology*, **109**, pp.3-10.
- **Jakobsson, E.** (2000), "Portals to Knowledge: Information Technology, Research, and Training," Graduate Education in the Chemical Sciences Issues for the 21st Century, (Washington, DC: National Academy Press), pp. 56-72.
- Chiu, S.W., Clark, M., Subramaniam, S., and **Jakobsson, E.** (2000), "Collective Motion Artifacts Arising in Long-duration Molecular Dynamics Simulations," *Journal of Computational Chemistry*, **21**, pp. 121-131.
- Gulani, V., Iwamoto, G.A., Gorkov, P., Subramabian, R., **Webb, A.G.**, and **Lauterbur, P.C.** (2000), "Magnetization Transfer Contrast in Electrically Stimulated Neural Tissue," *Proceedings of the Eighth Meeting of the International Society for Magnetic Resonance in Medicine*, Denver, CO, **3**, p. 2075.

- Tsao, J. and **Lauterbur**, **P.C.** (2000), "Visual GSLIM: Software for an Integrative Approach to Spectroscopic Image Reconstruction Using Prior Information," Proceedings of the Eighth Meeting of the International Society for Magnetic Resonance in Medicine, Denver, CO, **3**, p. 1838.
- Sheth, S.R., Efremova, N., and **Leckband**, **D.** (2000), "Interactions of Polyethylene Oxide Brushes with Chemically Selective Surfaces," *Journal of Physical Chemistry* B, **104**, pp.7652-7662.
- Efremova, N., Bondurant, B., O'Brien, D., and **Leckband, D.** (2000), "Interaction Forces and Protein Resistance of Neutral Membranes with Endgrafted Poly(ethylene glycol)," *Biochemistry*, **39**, pp. 3441-3451.
- Jin, X.L., Guo, H., Mao, C., Atkins, N., Wang, H., Avasthi, P.P., Tu, Y.-T. and **Li, Y.** (2000), "Emx1-specific Expression of Foreign Genes Using "Knock-in" Approach," Biochemical and Biophysical Research Communications, **270/3**, pp. 978-982.
- Guo, H., Christoff, J.M., Campos, V.E., and **Li, Y.** (2000), "Normal Corpus Callosum in Emx1 Mutant Mice with C57BL/6 Background," Biochemical and Biophysical Research Communications, **276/2**, pp. 649-653.
- Armani, D. and **Liu, C.** (2000), "Microfabrication Technology for Polycaprolactone, A Biodegradable Polymer," *Journal of Micromechanics and Microengineering*, **10**, pp.80-84.
- Zhu, Z. and **Liu, C.** (2000), "Micromachining Process Simulation Using a Continuous Cellular Automata Method," *Journal of Microelectromechanical Systems*, **9/2**, pp. 252-61.

- Deldin, P.J., Keller, J., Gergen, J.A., and **Miller, G.A.** (2000), "Right-posterior Face-processing Anomaly in Depression," *Journal of Abnormal* Psychology, **109**, pp.116-121.
- Keller, J., Nitschke, J.B., Bhargava, T., Deldin, P.J., Gergen, J.A., **Miller, G.A.**, and **Heller, W.** (2000), "Neuropsychological Differentiation of Depression and Anxiety," *Journal of Abnormal Psychology*, **109**, pp.3-10.
- Miller, K.F., Major, S.M., and Shu, H. (2000), "Ordinal Knowledge: Number Names and Number Concepts in Chinese and English," Canadian Journal of Experimental Psychology, **54/2**, pp.129-139.
- Miller, K.F. (2000), "Representational Tools and Conceptual Change," *Journal of Applied Developmental Psychology*, **21**, pp.21-25.
- Kaplan, A.S. and **Murphy, G.L.** (2000), "Category Learning with Minimal Prior Knowledge," *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **26**, pp. 829-846.
- Zelinsky, G.J. and **Murphy, G.L.** (2000), "Synchronizing Visual and Language Processing: An Effect of Object Name Length on Oculomotor Behavior," Psychological Science, **11**, pp.125-131.
- MacIver, M.A. and **Nelson, M.E.** (2000), "Body Modeling and Model-based Tracking for Neuroethology," *Journal of Neuroscience Methods*, **95**, pp. 133-143.
- Ratnam, R. and **Nelson, M.E.** (2000), "Non-renewal Statistics of Electrosensory Afferent Spike Trains: Implications for the Detection of Weak Sensory Signals," *Journal of Neuroscience*, **20**, pp. 6672-6683.

- O'Brien, Jr., W.D., Frizzell, L.A., Weigel, R.M., and Zachary, J.F. (2000), "Ultrasound-induced Lung Hemorrhage is not Caused by Inertial Cavitation," *Journal of the Acoustical Society of America*, **108**, pp.1290-1297.
- Frazier, C.H., Tian, Q., Ozguler, A., Morris, S.A., and **O'Brien, Jr., W.D.** (2000), "High Contrast Ultrasound Images of Defects in Food Package Seals," IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control," **47**, pp. 530-539.
- **Ross, B.H.** (2000), "The Effects of Category Use on Learned Categories," Memory and Cognition, **28**, pp. 51-63.
- Spalding, T.L., and **Ross, B.H.** (2000), "Concept Learning and Feature Interpretation," *Memory and Cognition*, **28**, pp.439-451.
- Xu, K., Economy, J., and **Shannon, M.A.** (2000), "A General Purpose Adhesive for Microelectronic Devices," *International Journal of Microcircuits and Electronic Packaging*, **23/1**.
- Moser, K.W., Raguin, L.G., Harris, A., Morris, H.D., Georgiadis, J.G., **Shannon, M.A.**, and Philpott, M.L. (2000), "Visualization of Taylor-Couette and Spiral Poiseuille Flows Using a Snapshot FLASH Spatial Tagging Sequence," Magnetic Resonance Imaging, **18/2**, pp.199-207.
- Sailor, K.M. and **Shoben, E.J.** (2000), "The Role of Part-whole Information in Reasoning about Relative Size," *Memory and Cognition*, **28**, pp. 585-96.
- Rubakhin, S.S., Garden, R.W., Fuller, R.R., and **Sweedler, J.V.** (2000), "Measuring the Peptides in Individual Vesicles with MALDI Mass Spectrometry," Nature Biotechnology, **18**, pp.172-175.

PUBLICATIONS

- Li, L., Garden, R.W., and **Sweedler, J.V.** (2000), "Single- cell MALDI: A New Tool for Direct Peptide Profiling," *Trends in Biotechnology*, **18**, pp. 151-160.
- Grant, S.C., Aiken, N., Mareci, T., Plant, D., Webb, A.G., and Blackband, S. (2000), "Single Cell Neural Analysis Using Localized NMR Spectroscopy," Magnetic Resonance in Medicine, 44, pp.19-22.
- Lacey, M.E., **Webb, A.G.**, and **Sweedler, J.V.** (2000), "Monitoring Temperature Changes in Capillary Electrophoresis with Nanoliter-volume NMR Thermometry," *Analytical Chemistry*, **72**, pp.4991-4998.
- Branch, D.W., **Wheeler, B.C.**, Brewer, G.J., and **Leckband, D.** (2000), "Long-term Maintenance of Patterns of Hippocampal Pyramidal Cells on Substrates of Polyethylene Glycol and Microstamped Polylysine," IEEE *Transactions on Biomedical Engineering*, **47**, pp. 290-300.
- Chang, J.C., **Wheeler, B.C.**, Brewer, G.J., and Chang, J.C. (2000), "Microelectrode Array Recordings of Patterned Hippocampal Neural Networks for Four Weeks," *Biomedical Microdevices*, **2/4**, pp. 245-253.
- F.C. Keil and **R.A. Wilson**, eds. (2000), Explanation and Cognition (Cambridge, MA: MIT Press).
- Wilson, R.A. (2000), "The Mind Beyond Itself," in D. Sperber, ed., Metarepresentation: A Multidisciplinary Perspective, Vancouver Studies in Cognitive Science, 10, (New York: Oxford University Press), pp.31-52.



Human-Computer Intelligent Interaction

FACULTY BY BECKMAN INSTITUTE GROUP

ARTIFICIAL INTELLIGENCE GROUP • Narendra Ahuja: Electrical and Computer Engineering Nigel Boston: Mathematics Gerald F. DeJong: Computer Science Mehdi T. Harandi: Computer Science ■ Mark A. Hasegawa-Johnson: Electrical and Computer Engineering
Thomas S. Huang: Electrical and Computer Engineering Seth Hutchinson: Electrical and Computer Engineering • Patricia M. Jones: Mechanical and Industrial Engineering David J. Kriegman: Computer Science Stephen E. Levinson: Electrical and Computer Engineering I Jean A. Ponce: Computer Science I Larry A. Rendell: Computer Science Dan Roth: Computer Science Michael J. Shaw: Business Administration David C. Wilkins: Institute of Aviation HUMAN **PERCEPTION AND PERFORMANCE GROUP** ■ David E. Irwin: Psychology ■ Arthur F. Kramer: Psychology

Edward McAuley: Kinesiology

George W. McConkie: Educational Psychology ■ Tamara A. Rahhal: Psychology ■ Karl S. Rosengren: Psychology ■ Janet A. Sniezek: Psychology Ranxiao (Frances) Wang: Psychology Stanley Wasserman: Psychology Christopher D. Wickens: Institute of Aviation Douglas A. Wiegmann: Aviation Research Laboratory and Psychology • IMAGE FORMATION AND PROCESSING **GROUP** • Weng C. Chew: Electrical and Computer Engineering • Thomas S. Huang: Electrical and Computer Engineering

Zhi-Pei Liang: Electrical and Computer Engineering Pierre Moulin: Electrical and Computer Engineering David C. Munson, Jr.: Electrical and Computer Engineering ■ Benjamin W. Wah: Electrical and Computer Engineering



AWARDS, PATENTS, GRANTS

Major Awards

Thomas S. Huang

IEEE Third Millennium Medal Honda Lifetime Achievement Award for contributions to Motion Analysis

Arthur F. Kramer

Appointed to the Scientific Advisory Board of the Institute for the Study of Aging

David C. Munson, Jr.

IEEE Third Millennium Medal Distinguished Lecturer, IEEE Signal Processing Society

Jean A. Ponce

General Co-chair, 2000 International Conference on Computer Vision and Pattern Recognition Editorial Board, International Journal of Computer Vision

Dan Roth

Career Award, National Science Foundation

Michael J. Shaw

Leonard C. Hoeft Distinguished Professor in Information Technology and Management

Benjamin W. Wah

IEEE Third Millennium Medal

Christopher D. Wickens

Henry Taylor Founders Award, Aerospace Medical Association

Douglas A. Wiegmann

Service Award, presented by the National Transportation Safety Board for contributions made to the investigation of the TWA flight 800 accident

PATENTS AND PATENT APPLICATIONS

(Beckman Institute faculty in bold)

Narendra Ahuja and Rakesh Dugad: "Transformation of Image Parts in Different Domains to Obtain Resultant Image Size Different from Initial Image Size," File Date (year only): 2000.

Srinivas Akella, **Jean A. Ponce**, Sebastian Blind, and Chris McCullough: "Automated Reconfigurable Object Manipulation Device with an Array of Pins," File date (year only): 2000.

GRANTS AWARDED

(Principal Investigator in bold)

Nigel Boston, Richard Blahut, and Shang Teng: National Science Foundation, "A Cryptography Center For Research and Education," 15-Sep-00 to 31-Aug-03.

Thomas S. Huang, Rachael Brady, and Arthur F. Kramer: National Science Foundation, "Live: Laboratory for Immersive Virtual Experiments," 15-Aug-00 to 31-Jul-03.

Thomas S. Huang, Stephen E. Levinson, David J. Kriegman, Dan Roth, George W. McConkie, and David Brown: National Science Foundation, "Multimodal Human Computer Interaction Toward a Proactive Computer," 01-Sep-00 to 31-Aug-05.

Seth A. Hutchinson: National Science Foundation, "Real-time Path Planning in Changing Environments," 15-Sep-00 to 31-Aug-03.

David J. Kriegman: National Science Foundation, "New Shape and Reflectance Models for Vision and Image-based Rendering," 01-Oct-00 to 30-Sep-02.

Pierre Moulin and Ralf Koetter: National Science Foundation, "ITR/IM Theory and Design of Information-hiding Codes," 01-Sep-00 to 31-Aug-01.

Dan Roth: National Science Foundation, "Career: Learning Coherent Concepts: Theory and Applications to Natural Language," 01-Mar-00 to 28-Feb-04.

Douglas A. Wiegmann: Federal Aviation Administration, "Continued VFR Flight into IMC: An Empirical Investigation of the Possible Causes," 14-Mar-00 to 13-Mar-03.

David C. Wilkins and Janet A. Sniezek: Department of Defense/Office of Naval Research, "Dialogue Understanding for Intelligent Tutoring Systems," 01-May-00 to 29-Nov-00.

SELECTED PUBLICATIONS

(Beckman Institute faculty in bold)

- Yang, M.H. and **Ahuja**, **N.**, (2000), "A Geometric Approach to Train Support Vector Machines," IEEE International Conference on Computer Vision and Pattern Recognition, I, Hilton Head, SC, June, pp.430-437.
- Ma, J. and **Ahuja**, **N.** (2000), "Region Correspondence by Global Configuration Matching and Progressive Delauney Triangulation," IEEE International Conference on Computer Vision and Pattern Recognition, **II**, Hilton Head, SC, pp. 637-64.
- **Boston, N.** (2000), "The Educational Use of Computer Algebra Systems at the University of Illinois," in Grabmeir, Kaltofen, and Weispfennig, eds., New Reference Book on Computer Algebra, (New York: Springer).
- **Boston, N.** (2000), "P-adic Galois Representations and Pro-P Groups," Proceedings of the Durham 1997 Pro-p Groups Meeting, in M. du Sautoy, A. Shalev, and D. Segal, eds., New Horizons in Pro-P Groups, (Boston: Birkhauser).
- **DeJong, G.** (2000), "Hidden Strengths and Limitations: An Empirical Investigation of Reinforcement Learning," in P. Langley ed., International Conference on Machine Learning, (Stanford: Morgan Kaufmann), pp. 215-222.

- Hasegawa-Johnson, M. (2000), "Time-frequency Distribution of Partial Phonetic Information Measured Using Mutual Information," Proceedings on International Conference on Spoken Language Processing, IV, Beijing, China, October, pp.133-136.
- Hasegawa-Johnson, M. (2000), "Line Spectral Frequencies Are the Poles and Zeros of a Discrete Matched-impedance Vocal Tract Model," Journal of the Acoustical Society of America, 108/1, pp. 457-460.
- Jojic, N., Petrovic, N., Frey, B. and **Huang, T.S.**(2000), "Transformed Hidden Markov Models: Estimating Mixture Models of Images and Inferring Spatial Transformations in Video Sequences," *Proceedings*, IEEE Conference on Computer Vision and Pattern Recognition, II, Hilton Head, SC, June, p.26.
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FELLOWS

BECKMAN INSTITUTE FELLOWS IN RESIDENCE

Dale J. Barr (1999) Michal Balberg (1998) Hong Hua (1999) Jason S. McCarley (1999) John Paul Minda (2000) Slava Rotkin (2000) Lolita G. Rotkina (1999) Ilya Zharov (2000)

GRANTS AWARDED

(Principal Investigator in bold)

Hong Hua and **Narendra Ahuja**: National Science Foundation, "Collaborative Research: ITR/HCI: Development of Head-mounted Projective Display for Distance Collaborative Environments," 01-Sep-00 to 31-Aug-03.

SELECTED PUBLICATIONS

(Beckman Institute fellows and faculty in bold)

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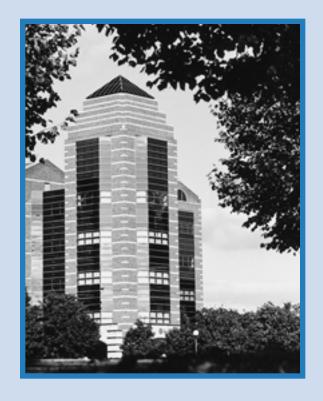
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GRANTS AWARDED

(Principal Investigator listed in bold)

Bridget Carragher, Clinton Potter, David J. Kriegman, and Zhi-Pei Liang: National Institutes of Health, "An Integrated System for Molecular Microscopy," 01-Jun-00 to 31-May-04.

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