SYNERGY

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Sequencing DNA through a synthetic nanopore is the goal of a team of Beckman Institute researchers who were awarded $2.1 million for the project by the National Human Genome Research Institute. page 2

The career of former Beckman graduate student Yong Rui has taken off as Microsoft's top technical advisor in China. Page 5

Brad Sutton's time at Beckman's Biomedical Imaging Center prepared him well for his current position as an assistant professor in the U of I's Bioengineering Department. Page 11

The Center for Healthy Minds leads the way in research aimed at understanding cognitive aging and improving the quality of life. Page 7

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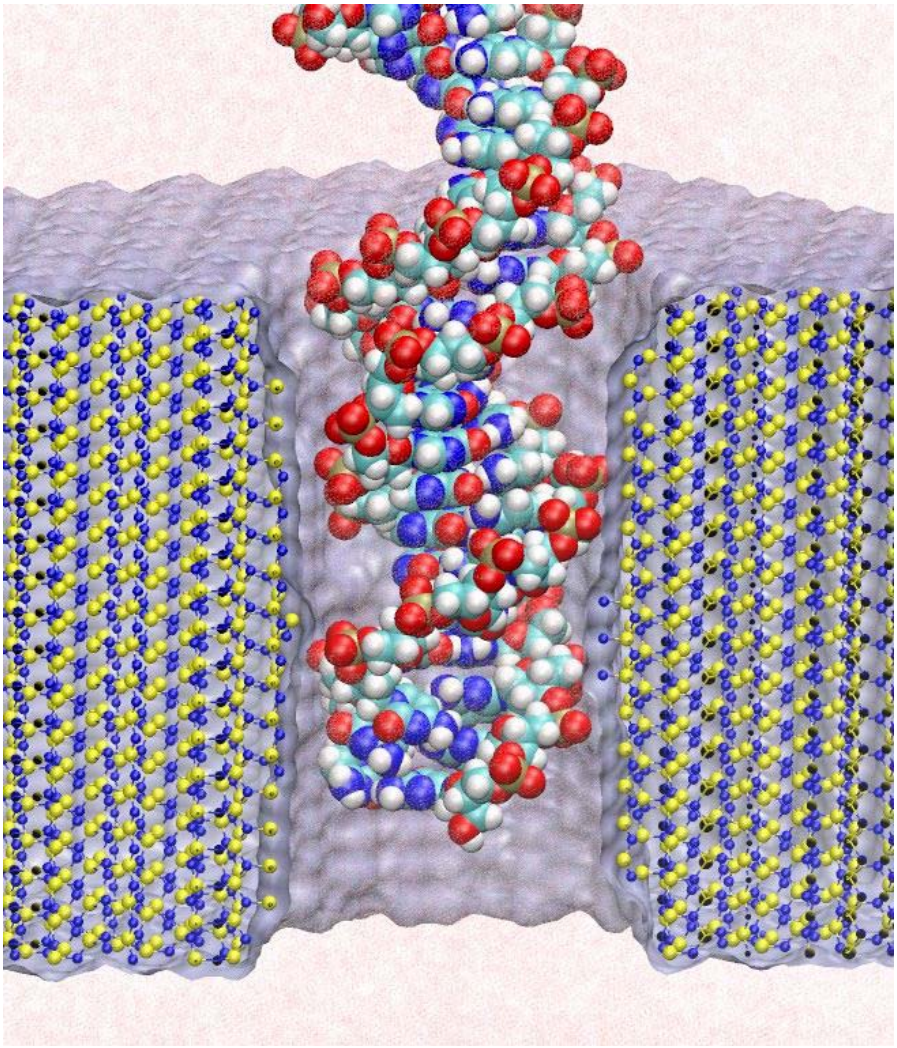


Courtesy of Aleksei Aksimentiev, Theoretical and Computational Biophysics Group

Aksimentiev finds his place with DNA Sequencing Challenge

The opportunity is great but so are the expectations. A lot is riding on the outcome of DNA sequencing research and technology development, including researchers hope, results that will some day allow the early diagnosis and treatment of diseases that have resisted medical efforts until now.

Last year the National Human Genome Research Institute (NHGRI) announced a $32 million grant program aimed at accelerating research for a breakthrough gene sequencing technology that is accessible, fast, and inexpensive. The name of the grant program — Revolutionary Genome Sequencing Technologies — portends both its purpose and its desired effect on medical research. The hope is to dramatically change everything from treatment to cost to the gathering of scientific knowledge through low-cost, efficient DNA sequencing. By revealing the information found in DNA (deoxyribonucleic acid), a chemical compound containing the genetic instructions all organisms need for development and direction of their activities, the genetic basis for pathologies such as cancer or heart disease could be found.

A team of researchers at the Beckman Institute for Advanced Science and Technology was one of the groups awarded grant money, receiving $2.1 million for sequencing a DNA molecule using a synthetic nanopore. The group includes top scientists from the fields of computational electronics (Jean-Pierre Leburton and Gregory Timp), theoretical biophysics (Klaus Schulten) and chemistry (Steven Sligar).

Aleksei Aksimentiev
(Photo by Thompson-McClellan)

There is one more member of the team who is not yet as well known, but who has already contributed one of the group's first big breakthroughs. Using software from Schulten's Theoretical and Computational Biophysics group,

researcher Aleksei Aksimentiev was able to do the first-ever simulation of DNA translocation through a synthetic nanopore.

It was an important first step in the team's goal of creating what has been referred to as a low-cost, reliable "gene chip" for sequencing DNA. The technology would use a type of silicon integrated circuit that incorporates a nanopore mechanism through which DNA molecules are forced. The narrow nanoscale opening changes the structure of single strand DNA, causing its base to tilt and the molecules to oscillate back and forth, thereby producing a unique electrical signal. These signals can then be read for the information contained in the individual DNA.

Each member of the team has a specific role in bringing a gene chip to reality. But for Aksimentiev, who knew little of biophysics three years ago, membership on the team is more than a role. It is the realization of an unexpected opportunity.

Aksimentiev grew up in the Ukraine with parents who are scientists — his mother is a chemistry professor and his father a physicist. He earned a cum laude Ph.D. in chemistry from the Institute of Physical Chemistry in Warsaw, Poland.

DNA research wasn't part of Aksimentiev's curriculum vitae when he came to Illinois in 2001. But he saw an opportunity with Schulten's group — known worldwide for molecular dynamics simulations — and was not afraid to follow his instincts. He wrote to Schulten while working for a private company in Japan because, he said, "I was in particle physics and polymer theory and I just wanted to do theoretical biophysics. And the theoretical biophysics group of Klaus' is probably the best."

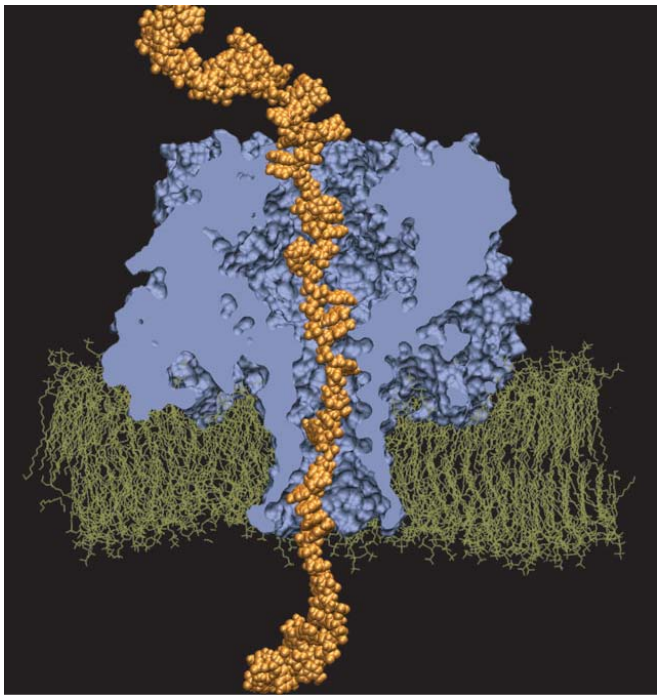
After joining TCBG, Aksimentiev worked on ATP synthase, a large multi-protein complex. It was during that time that he heard about the gene chip project.

"To me it looked like a fantastic thing," said Aksimentiev, an Assistant Professor of Physics at the University of Illinois. "It was a project that didn't have enough people computation-wise. It looked very, very attractive to me."

Aksimentiev joined the project enthusiastically.

"I thought it was a fantastic idea of bringing silicon and biomolecules into one thing, and nanopores is just one example of that," he said. "Plus it's very important, because if it succeeds it will be something that is very useful."

How useful may not be known for 10 or 20 years, but the potential applications of gene research are revolutionary. The NHGRI is the government agency behind the Human Genome Project, which sequenced and mapped the human genome (the aggregate of the genes of Homo sapiens) in 2003, allowing scientists to read the complete genetic blueprint for a human being.



Courtesy of Aleksei Aksimentiev, Theoretical and Computational Biophysics Group

Researchers at NHGRI and the National Institutes of Health, writing about completion of the Human Genome Project, said that "genome sequences, the bounded sets of information that guide biological development and function, lie at the heart" of a revolution in understanding organisms at the molecular level. "In short," they wrote in *Nature* in 2004, "genomics has become a central and cohesive discipline of biomedical research."

"When you put DNA in a very narrow place it behaves differently than when it's in a solution," Aksimentiev said. "What we discovered was that when we confine a single DNA strand to a very narrow pore, the DNA bases tilt."

Genomics have also been an expensive undertaking. The NHGRI estimates that DNA sequencing costs have fallen by more than 50 fold in the last 10 years, but that it still costs around $10 million to "sequence 3 billion base pairs — the amount of DNA found in the genomes of humans and other mammals.

The oft-repeated goal is to do sequencing for less than a thousand dollars. That's where the gene chip could prove especially useful. Aksimentiev said the process proposed by his group involves forcing single DNA strands through an opening one nanometer wide in an artificial metal-oxide-semiconductor membrane.

"When you put DNA in a very narrow place it behaves differently than when it's in a solution," Aksimentiev said. "What we discovered was that when we confine a single DNA strand to a very narrow pore, the DNA bases tilt. If you move the strand back and forth in the pore, the tilt of the bases will change its direction and that is what we think will be the signal for us to detect."

Aksimentiev compared the process to retrieving the signals from a recording.

"The way you would use a magnetic head in a tape recorder, you thread a tape through and you're trying to read a signature," he said. "In the case of a tape recorder it's a magnetic signal but in the case of DNA we're basically reading different electrical potentials that are written along the strand."

In a 2005 paper in Bell Labs Technical Journal titled "Beyond the Gene Chip," Aksimentiev, Schulten, Timp, and others wrote that "molecular dynamics provides us with a means to design (the gene chip) and analyze the experimental outcomes."

Modeling the operation of the gene chip with molecular dynamics is Aksimentiev's role in the project. He is developing a numerical model of the nanopore sensor to test its design and detection capabilities. These simulations will give the team an understanding of the dynamics of the translocation process that is essential to successful development of a gene chip.

"What we saw was we could take a look at DNA, how it goes through (the nanopore)," Aksimentiev said of the simulations. "We noticed that it is a very, very complex process. DNA is not a rigid rod as people very often picture it. It has all kinds of conformational dynamics that are interesting.

"So what we discovered basically was the time scale for the translocation, how fast it could go, and we saw that indeed it goes very, very fast. We couldn't really measure that before because the resolution of the measurement was not good enough. With simulation you can see that it actually goes very fast."

Aksimentiev said simulations tell researchers about the electrical signals resulting from the DNA-nanopore interaction and will tell them how to read the signal. The fact the nanopore is solid-state makes the system robust and able to perform in ways other detectors can't.

The grant received by the Beckman group and other researchers will aid biomedicine in ways other than reducing cost, according to NHGRI Director Francis S. Collins.

"Not only will these technologies substantially reduce the cost of sequencing a genome, but they will provide a quantum leap in the scope and scale of research aimed at uncovering the genomic contributions to common diseases, such as cancer, heart disease and diabetes," Collins said.

That's a tall order, but Aksimentiev says the unique combination of interdisciplinary collaborations and facilities found at Beckman provide the support needed for success.

"One person who really pushed me doing this was Greg Timp," he said. "He was a fantastic collaborator. I started this project and very quickly I got some results and since then, he wants more and it's great. We are on the same floor and we meet maybe every other day, so it's a continuous flow of information back and forth.

"The other thing that is very important is the TCB group has actually developed software I can use."

Aksimentiev was referring to the NAMD coding software the TCB group uses to do atomic-scale simulations of biomolecular systems. Aksimentiev used NAMD to complete the first simulation of DNA translocation through a synthetic nanopore.

"I don't think this would be possible anywhere else," Aksimentiev said of working with the TCB group on the simulation. "I could just stop by next door. That's just something you can't replace or find anywhere else.

"The fact that I was in that group when I started is also very important because I had the expertise of all of them, so I could make a jump to the next level and simulate silicon."

Aksimentiev said he has also benefited from working with Leburton, an expert in computational electronics.

"One person who really pushed me doing this was Greg Timp," he said. "He was a fantastic collaborator. I started this project and very quickly I got some results and since then, he wants more and it's great."

"He is over the entire device simulation, a higher scale than what we do," Aksimentiev said. "It has also been a great collaboration with him."

With Sligar contributing the expertise in chemistry and Schulten in biophysics, it's a team that looks ready to fulfill its goal. And that is just a starting point, Aksimentiev said.

"The other thing is detecting cell signals," he said. "With nanopores, if we can sequence DNA, we can probably sequence everything the cell produces — rapidly, on a chip."

So has this native of the Ukraine who has been all around the world found a niche with his research at Beckman?

"Absolutely. I feel this is the best place to be," he said. "I will definitely be working in the area of bringing together silicon and bio-materials in terms of sensors, but also in terms of a means of communicating between those two — wet and dry. That is something that is just starting."

SYNERGY is a quarterly publication of the External Relations office of the Beckman Institute for Advanced Science and Technology at the University of Illinois at Urbana-Champaign. Each issue will spotlight the people and science that make the Institute one of the premier facilities for interdisciplinary research in the world.

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Beckman Institute Part of AIRSTREAM

Roadside Conversations Exhibit

The Roadside Conversations Airstream uses technology from the Integrated Systems Laboratory to give visitors a 3-D virtual reality experience. (Photo by L. Brian Stauffer)

You may have seen it parked at the Krannert Art Museum this spring, or cruising along I-80 in June, or visited it at the Illinois State Fair in August. If you were one of those who stepped inside the Roadside Conversations Airstream trailer during one of its stops, then you saw how technology and people from the Beckman Institute are helping tell the story of the United States Eisenhower Interstate Highway System.

The Airstream trailer contains a studio for recording people's stories of traveling on the nation's highway system and two flat panel monitors with an interactive joystick for viewing those stories. It also contains 3-D immersive reality technology from Beckman's Integrated Systems Laboratory that lets visitors seated at one display "drive" through a virtual Interstate system marked only by the iconic blue block I highway signs and those at another negotiate a virtual representation of St. Louis.

The design of the Airstream exhibit came from a contest done as part of a celebration of the 50th anniversary of the Eisenhower system. The winning design was a combination of two proposals: one submitted by Art and Design instructor Steve Kostell and another by Beckman Web Specialist Rick Valentin and U of I Art and Technology Integration Specialist Rose Marshack. ISL Director Hank Kaczmarski and Marshack have helped staff the Airstream during some of its travels, which have included a journey to Washington D.C. as part of a cross-country convoy celebrating the anniversary. The Airstream trailer returned to the University of Illinois campus in late August, but future road trips are planned for the exhibit.

Beckman Alum Playing Important Role in Chinese Technology Development

Yong Rui knows how many mobile phone users there are in China (nearly twice the U.S. population) and when the Chinese will overtake Americans as the most frequent users of the Internet (next year).

As technical assistant to Microsoft's top boss in the company's China R&D Group, Rui knows where China has been and where it is in terms of technology development. Since January of this year, Rui now has a say in where some of that development is headed.

Rui grew up in China, graduated from its top engineering college, and studied computer vision at the Beckman Institute from one of the field's pioneers, Human-Computer Intelligent Interaction Co-chair Thomas Huang. After graduating from the University of Illinois with a Ph.D. in electrical and computer engineering in 1998, Rui joined Microsoft Research and subsequently became head of the Multimedia Collaboration team at the company's headquarters in Redmond, Washington.

During those same years, Microsoft was building its presence in China. After starting a sales office and a research and development center there in the 1990s, the software giant launched Microsoft Research China, later renamed Microsoft Research Asia, in 1998. Other research and technology development centers followed until the company decided to establish an umbrella organization in 2006 called the Microsoft China Research and Development Group. Microsoft chose Corporate Vice-President Ya-Qin Zhang to be president of this new group, with Rui serving as Zhang's top technical adviser.

Yong Rui, Microsoft's Top Technical Assistant in the China R&D Group
Image courtesy Yong Rui.

The group's purpose, says Rui, is to guide Microsoft's research and development directions in China. The group will explore new research lines for Microsoft applications while also developing products geared toward China's burgeoning consumer base.

China's stunningly rapid emergence as a major player on the world's economic stage is having a huge impact on everything from manufacturing to technology, and Microsoft plans on being a part of it. Rui's responsibility, he said, is "to help the president define and drive the overall R&D strategy in China."

That's a big task, but one for which Rui is uniquely qualified. The knowledge Rui gained at Beckman and UIUC in computer vision, signal processing, and machine learning, he applied to developing communication and multimedia systems at Microsoft. Over the years he has published research papers and book chapters with Huang and many others, remaining in the forefront of image and signal processing and multimedia issues.

Rui's focus for his Ph.D was on image retrieval, and it turned out to be the first of several smart choices. Rui found himself in a perfect position while working toward his doctorate when UIUC was selected as one of five universities to take part in a seminal government-sponsored digital library project.

"I was very lucky," he said. "I was Tom's first student who was doing research in this particular area, because it was very, very new. A new field can be both good and bad — good in the sense that if you discover something, then wow, you can really make a big impact. The not so good part is you don't have much to learn from because it is so new. I was lucky in the sense that I actually discovered something in the field."

Rui's contribution was relevant feedback, which uses algorithms for image retrieval that work like a text search on Internet search engines. It dovetailed nicely with the digital library project.

"I was lucky in that I entered this field at the right time and I introduced this technology," Rui said. "Now it's pretty much everywhere. This by itself is already a research direction in the multimedia research community. So I'm very happy and proud that I did something in that field."

Rui's talent undoubtedly played a bigger role than luck, but he does seem to be in the right place at the right time. While the move to China may seem like an unbridled opportunity to affect important research and development over the next few years, it was also a big change for Rui. He left his research group behind, and moved his wife and four-year-old to Beijing in March.

"Sometimes you just have to take risks," Rui said. "For example, my move to China in some sense is risky because I'm doing pretty well here in our headquarters. Why would I want to take a risk and go to China and spend a few years there? Sometimes you need to leave your previous success behind and move on to the next big challenge with a peaceful mindset."

Rui believes Microsoft China R&D will have a big impact because of the research and development areas it is focusing on and because China is so ripe with opportunity.

"There are three key areas that Microsoft China R&D Group will be focusing on: mobile and embedded systems, digital entertainment, and Internet technologies and services. I think these areas are very carefully chosen so that it makes sense to be in China," Rui said. "China is already the No. 1 market in mobile telephones. Today it has over 430 million users. It's also No. 1 in consumer electronics as a manufacturer and as consumers. That's why digital entertainment is very big there."

Rui said online gaming is also a booming market in China and other Asian countries, and the number of Internet users there is growing exponentially.

"Today, China is No. 2, but next year it will likely pass the U.S in the number of Internet users, people who have Internet access," he said. "All three areas are very exciting. You're looking at a huge market. You want to do innovations, bring in new research technology and transfer that into products and bring it to the market. So that by itself is very, very exciting."

Rui's focus in his new position will be different from the research he did with his old team. As part of Microsoft's Communication and Collaboration systems group, the team he managed worked on creating innovative multimedia collaboration systems for meetings and seminars. They developed a system called Automated Lecture Rooms, or iCam, that features localized sound detection microphones and real-time person-tracking cameras to record meetings and lectures automatically in the same manner as a live camera crew. Rui and his colleagues also developed a RingCam recording system featuring an array of cameras at the center of a table, and Worklounge for integrating videoconferencing tools.

The iCam has been used for six years at Microsoft Research's headquarters, recording more than 600 lectures seen by more than 20,000 visitors. Rui has developed two technologies that have shipped commercially as part of Microsoft products. Microsoft's Moviemaker 1.0. for digitalizing home video includes a frame index developed by Rui. It uses a shot boundary locator based on when the camera is turned on and off to find the frames users are looking for, using a key frame to represent a shot sequence. Another is a bandwidth estimator for collaborators communicating via the Internet. It tells end point users how much bandwidth they have available for sharing files.

> "Many times what helps you to be successful in your field after college is not only solid knowledge, the hard skills, but also the soft skills."

Although his work at Microsoft has differed somewhat from his research at Beckman, Rui said he was prepared well at UIUC for his future endeavors. He credits Huang for providing both freedom and opportunity for his students.

"He gave some high-level directions and suggestions," Rui said. "I would try something and tell Tom 'oh this works, this doesn't work. Do I try A or B or C?' Tom has a lot of experience and would say 'oh C won't work because I tried that many years ago.' Also Tom has this very open approach. He gave me a lot of freedom so I could try many different things."

That freedom led to his discovery of relevant feedback in image retrieval, Rui said.

"Relevant feedback was not in this image processing or computer vision field," he said. "I actually read many unrelated things. I borrowed this idea from text-based retrieval. It had nothing to do with my image video analysis. Because of Tom's openness I was able to explore many other fields and discovered this was a good algorithm to be used in image and video analysis."

The interdisciplinary aspect of working at Beckman was also helpful.

"When I talked to other people who are doing bioengineering or something involving people from very different fields, the discussions sometimes led me to look at problems from different perspectives," Rui said.

Recently, Rui and Microsoft China R&D Group President Zhang toured 10 of the top universities in China. Rui offered the students advice based on the acronym SCORE. Rui said it starts with 'S for having a solid foundation in whatever field a student is studying.

"You have to understand your particular field in a very solid way — in double E you have to know signal processing very well, in computer science you better know how to write a compiler or how an operating system is working," he said.

But technical knowledge only will take a student so far, Rui said. Communication is just as important.

"Many times what helps you to be successful in your field after college is not only solid knowledge, the hard skills, but also the soft skills." Rui said. "How do you communicate, how do you make people understand you and you listen to them. So the C skill is very important."

Rui also advises keeping an open mind (O) and taking risks (R), which he has done by moving to China. Lastly, he counsels students to be enterprising (E).

"We encourage people to think not only on the technical side but they should also think about it from an end-user's point of view," Rui said. "There are different models. Sometimes you start with a product and look for a scenario. Other times you start with a scenario and you find the right technology. For technology to be successful you should have good knowledge but also have an entrepreneurial mindset. Hopefully if a student follows this they will score well."

Rui followed his own advice and now is in a position to have a real effect on the future of technology in his native country and the world.

Understanding the Aging Mind: Center for Healthy Minds a Key Resource

Denise Park

Art Kramer

The "Our Research" page on the Center for Healthy Minds Web site features a vibrant silver-haired woman astride a motorcycle, wearing a leather jacket and a beaming smile. Below her are links to four of the Center's major study areas where visitors can click and learn about the research into cognition and aging that makes this facility distributed throughout the Beckman Institute a world leader in the field.

On the Web site's home page the phrase "aging brilliantly" is headlined, with a link below leading to practical tips for maintaining or even increasing cognitive health in older adulthood. The message of the Web pages is clear: research at the Center is serious and academic, but also geared toward the goal of helping older adults live a mentally healthy life. Center researchers want older adults to know what they've learned — that research points to positive mental health benefits from certain lifestyle strategies.

The Web site is one way to publicize the message. The Center has also played host to motivational speaker and author Mitch Albom, while its co-directors, Denise Park and Art Kramer, have been quoted on the aging mind in publications from *The New York Times* to *USA Today*. Park testified before the United States Senate's Special Committee on Aging in 2005 on why older adults may be more susceptible to fraud. While its researchers are already considered a go-to resource for expertise in the field, the Center for Healthy Minds is poised to make even more news over the next few years.

As the baby boomer generational bulge pushes age demographics upwards, the boomers are also pushing the boundaries of what it means to be an older person in the early part of the 21st

Century. Medical care, exercise, diet, lifestyle choices, and other factors have people in the United States living longer and in better physical shape than preceding generations. But, as Park points out, the mind may not be keeping pace with the body.

"Our bodies are starting to outlive our minds, so we need to play catch-up," Park said. "All of this work (at the Center), it's still in the discovery phase."

That discovery phase is why the Center for Healthy Minds can play an important role in contributing to the science of the aging mind. Begun at the University of Georgia in 1993 under Park's direction with funding from the Roybal Center, the Center for Healthy Minds moved with her to the University of Michigan in 1998. Park came to the University of Illinois at Urbana-Champaign in 2002, where she is a member of the Cognitive Neuroscience group at Beckman.

Kramer said most of the funding for specific projects comes from separate grants, primarily from the National Institute on Aging. The Center's goal, Kramer said, is "to promote research in successful aging and the distribution of research results to the scientific community, as well as the general community of citizens."

Park said the Center is there to spur new research and empower researchers who are relatively new to the field of cognitive aging.

"The Center is about innovating and about developing new ideas and test beds for some of these ideas and funding them, so if they are good ideas they can develop significant research programs," Park added.

The Center serves as a focal point for projects involving cognitive aging and possible mediating factors such as fitness, skill acquisition, social engagement, and other interventions that seem to point the way to improved mental health for older adults.

Park said the University of Illinois at Urbana-Champaign is one of the premier aging research institutions in the world, and the Center for Healthy Minds is a key part of that standing. The research done there is on the leading edge of cognitive aging studies, and the Beckman Institute offers an unparalleled array of technology support for its investigations. Researchers use magnetic resonance imaging machines from Beckman's Biomedical Imaging Center, as well as other imaging techniques developed by Beckman researchers. Park said imaging work on the brain and cognitive aging is in its infancy.

"There are only a few people who do this work," she said. "Right now we're sort of mapping what processes are associated with what neural circuits, how can we change neural circuitry based on interventions, and things of that sort. The real issue is what can we do to slow down the process of cognitive aging so people die cognitively intact. It's better for everybody, it's better for the families, better for the person."

That is why promoting intervention strategies are a prominent feature of the Center's mission. The Center's Web site lists seven recommendations for a healthy mind, with all seven linked to research papers that bolster the advice. Recommendations include advice traditionally given for general health, such as exercising and eating food rich in antioxidants. The list also includes recent research evidence that suggests older adults should maintain an active social life and do work that is challenging and complex toward maintaining cognitive health.

Kramer said there are plenty of studies indicating that intervention strategies like those recommended by the Center work to maintain or even improve cognition in the aging mind.

With respect to exercise training interventions, Kramer said that studies don't always find positive results. However, he said, in quantitative meta-analysis that summarize results across studies over the past several decades, exercise training has been found to both enhance cognition and to delay the onset of age-related disorders such as Alzheimer's dementia.

"The fitness literature is pretty clear that you get fairly broad effects on different aspects of cognition from fitness training, with fairly modest amounts of improvement in fitness," Kramer said. "Nobody in the fitness training studies is running marathons, nobody is winning races. These are people who are walking further and longer, and maybe a little faster.

"So for a pretty modest investment, virtually no investment in money except for a pair of sneakers or shoes, you can actually find some pretty substantial benefits in cognition and brain health."

Kramer, along with his frequent collaborator Professor Edward McAuley, leads the Active Aging Program at the Center, which studies possible cognitive benefits from fitness training such as aerobic exercise. They have completed two exercise trials and are now involved in a third thanks to a five-year

NIA Awards Park Big Grant for Long-term Study

The project will take a decade to complete but once done, Denise Park's study of cognitive and neural function across a lifespan could be a landmark in the field of cognitive aging.

Park, Co-director of the Center for Healthy Minds at the Beckman Institute, was recently awarded a 10-year, $5 million MERIT award from the National Institute on Aging for a study that will include subjects ranging in age from 20 to 90. The project will focus on what are called neural signatures in middle-aged adults.

Park said the study is unique for a couple of reasons. One is its focus on cognition in middle-aged adults, an area that she says few studies have focused on. The second reason is the project's methodological approach.

"Most research for cognitive function takes high performers and low performers and uses that to predict the brain," Park said. "But that's not how our mind works. The brain controls behavior, behavior doesn't control the brain.

"So we're really interested in trying to sort people into categories of brain activations and say based on these patterns, can we predict their cognitive function and what's going to happen to them as they get older."

Park said there are different patterns of neural activation between older brains and younger brains when it comes to learning new material, while middle-aged brains have been shown to have both activation patterns. These activation patterns — where both hemispheres are used to learn in older brains and only one in younger brains — are called neural signatures.

The project will use functional magnetic resonance imaging to record activation patterns in the brain.

"We want to take those neural functions and see how they relate to their cognitive behavior," Park said. "Are the people that have old looking brains having worse cognition than the people who have young looking brains? If we follow them over time, does it predict decline?"

The study is slated to begin in August or September.

grant from the National Institute on Aging. The third trial adds to information gained from MRI measures and neuropsychological measures by collecting blood samples from subjects.

"We are examining the influence of fitness training on substances like inflammatory cytocines, which are implicated in aging and obesity and poor fitness, and tend to be negatively related to thinking and cognition," Kramer said. "This study is going to allow us to understand more fully from looking at different systems and different measures, the nature of (brain) plasticity as a function of exercise interventions in older adults."

Park said more research is required to investigate intervention strategies such as doing mentally challenging tasks.

"It's really now clear what improves cognitive function," Park said. "The exercise work seems pretty solid, so that's one thing that clearly makes a difference. I think it's probably a good thing to use your mind but I think some definitive studies need to be done, which we're trying to do."

Park has studied many aspects of cognitive aging, with a focus on the applications of basic laboratory research. Promoting interventions like skill acquisition and social engagement as possible ways to mediate cognitive decline are a natural part of her work. The Viva project at the Center had older adults learn new skills like digital photography to gather data on that concept. Park said that while research doesn't yet show that training on one skill translates to better mental health, MRI data does show changes in the brain from skill acquisition.

"There's evidence, for example, that if you spend a couple of hours a day juggling you'll literally show changes in visual and motor areas and those changes persist," Park said. "So the general idea is that different kinds of experiences create different kinds of wiring in the brain and if you give people enough experience in the lab, you can literally trace how their neural circuits react.

"We don't have enough resolution to see processes that small, like learning a fact, how that changes the brain," she said. "But we can watch the processes in the brain while people are learning. If you give people a lot of practice on something you can watch how that changes the brain."

Collaborators at the Center for Healthy Minds include kinesiologists and psychologists with a variety of interests. Elizabeth Stine-Morrow is an educational psychologist who created the Senior Odyssey of the Mind project, in which team problem-solving is studied as a possible path to cognitive health. More than 60 older adults make up the teams, which work together creatively to solve both short-term and long-term problems. The exercises test subjects' abilities like inductive reasoning, working memory, and collaborative problem-solving.

Dan Morrow is a professor at the U of I's Institute of Aviation who studies aging and communication, specifically focusing on older adults' performance of complex daily tasks. Morrow has looked at communication in the area of health care for older adults and at expertise in aging pilots, with an eye toward designing task environments that promote successful performance. His research has shown that older pilots who use domain-relevant external aids like a notepad for taking air traffic control instructions, show reduced cognitive decline for their task of expertise and perform as well as younger pilots.

In all, the Center for Healthy Minds has nearly a dozen faculty members currently affiliated with it. Park said Illinois stands out for this type of research.

"I would say we're certainly among the top three places in the country," she said. "We have a really amazing confluence of people who study cognitive aging and particularly the cognitive neuroscience of aging. We have a lot of depth and cover a lot of ground here."

Park also said having the resources offered by the Beckman Institute adds greatly to the Center's capabilities.

"I unquestionably have the best lab and best facilities I have ever had," she said. "It's the most supportive place I've ever worked at in terms of resources and helping people get the job done. There's a great group of colleagues and we're all interested in related things."

A large pool of older volunteer subjects makes the experiments possible. Many of those volunteers were treated to free admission to Albom's recent talk at the University of Illinois. Reaching out to those subjects and to older adults generally is a key goal of the Center. With a wealth of new research results and published papers, keeping up with the Center's output may pose a challenge in the future. But that just shows the Center for Healthy Minds a leader in the study of cognitive aging.

"Now that we have these imaging tools, we are acquiring knowledge so rapidly it's mind-boggling," Park said. "Even eight years ago, nobody was imaging the brain in older adults. It wasn't available. It's just like a new frontier right now."

A sampling of Beckman Institute research projects receiving national media attention in March through July of 2006:

First Step Toward Guided Self-Assembly of Devices

July 10, 2006 — **Jennifer Lewis,** Beckman affiliate and materials science and engineering professor at Illinois, says a method devised by Harvard University scientists that harnesses the tools of planar fabrication to make 3-D objects with arbitrary shapes is an "important first step toward creating functional devices by guided self-assembly."
Chemical & Engineering News

Training 'Re-Ignites' Brain Areas

July 6, 2006 — U. of I. research has shown that training re-ignites key areas of the brain, offsetting some age-related declines and boosting performance. The findings, involving functional magnetic resonance imaging, provide the first visible evidence for a relationship between behavioral performance and cortical processors involved in dual-task processing, says psychology professor **Arthur F. Kramer** of the Beckman Institute for Advanced Science and Technology.
Xagena, Owensboro Messenger-Inquirer

Cancer Detection

July 5, 2006 — **Kenneth Watkin,** a Beckman researcher and U. of I. professor of speech and hearing science, believes he has developed a means to diagnose oral cancers more precisely. Watkin and a former graduate student, Michael McDonald, found that with tiny particles of gadolinium oxide, tumors show up more clearly on scans. The particles also increase the effectiveness of radiation treatment, allowing the use of smaller doses.
United Press International

Looking But Not Seeing

June 25, 2006 — U. of I. psychology professor **Daniel Simons** has studied inattentional blindness — the phenomenon of looking, but not seeing — in the lab at the U. of I.'s Beckman Institute.
Asbury Park Press

Inorganic Electronics Begin To Flex Their Muscle

June 16, 2006 — The number of researchers trying to marry inorganic electronic devices with flexible substrates remains a fraction of the crowd working on organic circuitry. "But it's picking up steam," says **John Rogers**, Beckman researcher and U. of I. professor of materials science and engineering.
Science

New contrast agents may be on horizon for better medical imaging

June 13, 2006 — Research by **Kenneth Watkin,** a professor in the Department of Speech and Hearing Science and the Beckman Institute for Advanced Science and Technology, and Michael McDonald, a post-doctoral fellow at Stanford University, lead to the development of a new breed of "multi-modal" contrast agents that could work within a host of medical imaging platforms - from ultrasound and computed tomography (CT) to magnetic resonance imaging and molecular imaging.
UIUC News Release | UPI | MedIndia | Medical News Today | MedGadget | Science Daily

Researchers testing videoconferencing system

June 6, 2006 — Tele-immersive Environments for EVErybody, or TEEVE, is a videoconferencing system being test-driven simultaneously across thousands of miles this spring in the labs of **Klara Nahrstedt,** a U. of I. computer science professor and Beckman affiliate, and Ruzena Bajcsy, a professor of computer science at the University of California at Berkeley.
The Australian IT

Robinson quoted on discovery of "altruism" gene.

June 2, 2006 — The finding of a so-called altruism gene is "exciting," says U. of I. entomologist and Beckman affiliate **Gene Robinson,** a specialist in the genetics of social behavior who was not involved in the research. "It overall demonstrates that comparative genomic analyses, done on the right sets of species, hold great promise" for charting the evolution of sociality.
Science & Theology News

Amir named to IEEE Intelligent Systems' '10 to Watch' list

May 23, 2006 — **Eyal Amir,** a U. of I. computer science professor and Beckman affiliate in the Artificial Intelligence group, is among IEEE Intelligent Systems' "10 to Watch." Amir's research focuses on building systems that reason, learn and make decisions with logical and probabilistic knowledge. IEEE Intelligent Systems is a bimonthly publication of the Institute of Electrical and Electronics Engineers Computer Society and provides peer-reviewed articles on the theory and applications of systems that perceive, reason, learn, and act intelligently.
IEEE Intelligent Systems

Fabricating 3-D nanostructures using two-photon lithography in a single exposure step

May 22, 2006 — Beckman Institute materials science researcher **John Rogers** and former Beckman Graduate Fellow **Seokwoo Jeon** have been working on low cost soft lithographic approaches to fabricating three-dimensional nanostructures in ways that are scalable to large areas.
Newswiretoday

Life experiences can affect brain function

May 22, 2006 — Beckman researcher **Denise C. Park** says that the knowledge people gain from life experience can sometimes compensate for other changes in their brains as people age.
Thousand Oaks Acorn

Beckman Institute profiled by Associated Press

May 13, 2006 — An Associated Press feature story on the Beckman Institute for Advanced Science and Technology focuses on its trail-blazing role in the area of interdisciplinary research.
Belleville News-Democrat | Southern Illinoisan | WQAD

Beckman researcher uses gold nanoparticles to develop biosensor

May 9, 2006— Beckman Institute researcher **Yi Lu** and graduate student Juewen Liu have developed a highly sensitive and selective biosensor that functions in much the same fashion as a strip of litmus paper. Now detecting the presence of hazardous lead paint could become as simple as pressing a piece of paper against a wall and noting a color change.
BioX

Greenough: Brain research backs up 'use it or lose it' advice

May 3, 2006 — Beckman Institute researcher **William Greenough**, Co-chair of the Biological Intelligence research initiative, said he believes in the "use it or lose it" adage, and he has done extensive research with rats to back it up. "The brain is capable of forming new circuits, new pathways of neurons, throughout the life span of the rat," Dr. Greenough explained. His research suggests that exercising the human mind into old age keeps it strong and capable of continued learning, just as in rats. And he points to some related research by others with powerful implications: the onset of Alzheimer's symptoms is much slower in people who have attained a higher level of education.
CBS News.com

Imaging the brain in action

May 1, 2006 — **Monica Fabiani** and **Gabriele Gratton**, U. of I. psychology professors at the Beckman Institute for Advanced Science and Technology, are using a brain-imaging technique to show the brain in action.
ScienCentral News Part 1/ Part 2

Kramer's work cited in WSJ article on mind improvement programs

April 27, 2006 — The Israeli developers of MindFit, which will be available in the U.S. in June, will soon unveil results of a one-year clinical trial, showing the program improves memory, attention, perception and other mental functions, as well as real-world driving ability. Nintendo's Brain Age and the Web-based My Brain Trainer likely improve the skills they train you on, too, say scientists not connected with the products. "There is no doubt that older people can improve their performance on these tasks through training," says U. of I. psychology professor and Beckman Institute researcher **Arthur Kramer.** "What we don't know is whether this transfers to real-world skills and cognitive function."
Wall Street Journal

Enzyme activity modeled on supercomputers

April 14, 2006 — **Zaida Luthey-Schulten,** a researcher in the Theoretical and

Computational Biophysics group, and Rommie Amaro, who recently completed her doctorate with Luthey-Schulten, are using supercomputers to model the workings of an enzyme that helps manufacture the amino acid histidine.
HIGH PERFORMANCE COMPUTING

COATED GADOLINIUM NANOPARTICLES HOLD PROMISE AS IMAGING AGENTS

April 12, 2006 — Gadolinium ions are a popular component of agents used to improve magnetic resonance image quality. Operating on the principle that increasing the number of gadolinium ions loaded into a nanoparticle will improve the ability of magnetic resonance imaging to detect ever smaller tumors, Beckman researcher and U. of I. speech and hearing science professor **Kenneth Watkin,** and Michael McDonald of Stanford University, have created the first water-stable nanoparticle made from gadolinium.
AZNANO.COM | NANOTECHWIRE.COM

BRAINS COMPENSATE FOR AGING

April 6, 2006 — Beckman researchers **Denise C. Park** and **Brad Sutton** are two of the authors of a study that found our brains compensate for aging by becoming less "specialized." The report, titled "Decreased neural specialization in old adults on a working memory task," will appear this month in the journal NeuroReport.
PHYSORG.COM NEWSMEDICAL.NET |

RESEARCHERS QUESTION CLAIMS OF VIDEO GAME MAKER

March 28, 2006 — Beckman researcher **Denise C. Park** of the Cognitive Neuroscience group shoots down Nintendo's claims that its "Brain Training" mental exercises will keep aging minds youthful and healthy.
WASHINGTON POST |

LIGHT-SENSITIVE PARTICLES CHANGE CHEMISTRY AT THE FLICK OF A SWITCH

March 27, 2006 — A light-sensitive, self-assembled monolayer that provides unique control over particle interactions has been developed by Beckman Institute scientists **Jeffrey Moore** and **Jennifer Lewis** of the Advanced Chemical Systems group. Particles coated with the monolayer change their surface charge and chemistry upon exposure to ultraviolet light.
UI NEWS RELEASE

FACULTY PROFILE

Brad Sutton brings know-how to the U of I's Bioengineering Department.

When University of Illinois students attend Brad Sutton's class in magnetic resonance imaging this fall, they'll be learning from a professor with hands-on experience.

Sutton recently became an Assistant Professor in the University of Illinois' Bioengineering Department after spending two-and-a-half years as one of three engineers at the Beckman Institute's Biomedical Imaging Center. Sutton said that his time at BIC prepared him well for passing on MRI knowledge to students.

"During your doctoral research you focus on a single problem," Sutton said. "Coming to BIC, where there's a lot of variety of research, you get to see the broad spectrum and see how what you're doing fits into the big picture."

> Looking at the big picture is why Sutton has found a home as a faculty member at Beckman and the U of I.

Looking at the big picture is why Sutton has found a home as a faculty member at Beckman and the U of I after earning his undergraduate degree in engineering here in 1998. He completed his Master's and Ph.D. at the University of Michigan in the emerging field of biomedical engineering, but returned to Champaign-Urbana when the opportunity arose at BIC. He took that job with an eye toward becoming a professor in the recently-formed Bioengineering Department.

"When I came here to interview for the research scientist position, I talked with Bruce Wheeler, who was the head of Bioengineering at that time, and had that in mind," Sutton said. "It was an opportunity to come in and see what's going on at BIC and at Beckman, and how I can contribute and how my interests fit in with those of everyone else. I'm glad I did that."

Not only will Sutton be teaching as a full-time professor for the first time this fall, he'll be doing it at a department that just started accepting students in the fall of 2004. Being part of a new area of study at the U of I is something he's looking forward to.

"The Bioengineering department being brand new, I can only imagine in five to 10 years what it's going to look like," Sutton said. "There's only a few faculty right now and we are designing curriculum from scratch, trying to think about what a bioengineering undergraduate needs, what a bioengineering graduate program needs to look like. It's exciting."

At BIC Sutton was the chief engineer for the 3T Allegra headscanner magnet, which has become an indispensable tool for several Beckman psychologists studying brain function. He says his primary focus as a researcher is on neural imaging and trying to improve MRI signal processing.

"It's a slow process and not very well coupled to neural activity," Sutton said. "So I'm trying to both fix that method and develop new methods to image brain function that are faster, more accurate, and more localized to neuronal activity."

One current focus for Sutton is dynamic imaging of speech for a project in conjunction with Carle Hospital aimed at aiding surgeons performing cleft palate reconstruction surgery. Whether it's using imaging for medical purposes or to gain a better understanding of cognitive functioning, Sutton feels bioengineering at the U of I and bioimaging at BIC and Beckman will be providing frequent research breakthroughs — and sooner than might be expected.

"Everyone is really working together well and looking at how we can leverage this imaging strength and target certain areas," he said. "So I think it's going to be exciting. We don't even have to look five years down the road. In the next couple of years, things are really going to take off here."