SYNERGY

WINTER 2008 BECKMAN INSTITUTE FOR ADVANCED SCIENCE AND TECHNOLOGY ISSUE 8

Beckman Trio Creates Model for Research Success

Beckman researchers Nancy Sottos, Scott White, and Jeff Moore sound off on their nearly decade-long success as collaborators.
Page 2

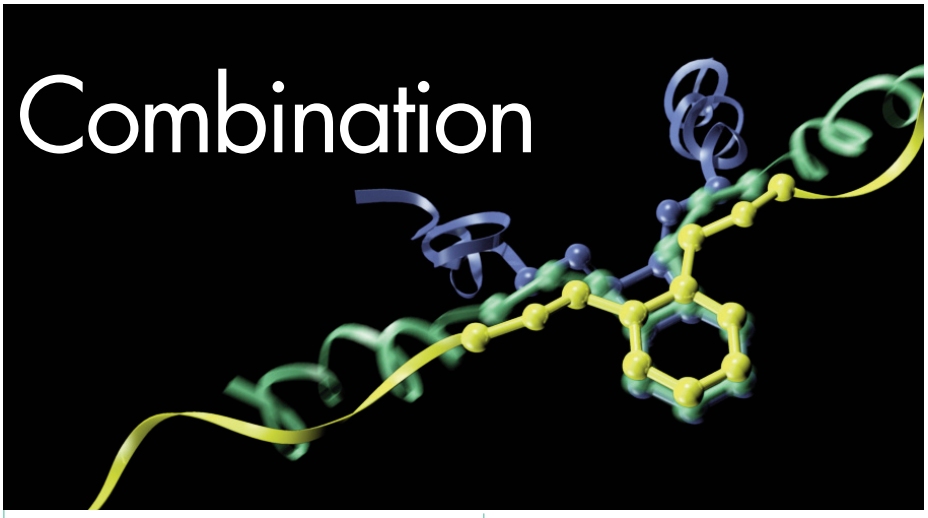
These days Ted Brown is just as passionate about science's role in society as he was about creating an interdisciplinary research center on campus 20 years ago.
Page 5

Emad Tajkhorshid has gone from a post-doctoral researcher at Beckman to a tenure-track professor at Illinois.
Page 7

ILLINOIS BECKMAN INSTITUTE

The Right Combination

Sottos, Moore, White Make Collaborations Productive and Fun



Scott White was a young University of Illinois researcher in 1998, eager to share his excitement about the potential of self-healing materials and possibly initiate a collaboration with a young chemistry professor he had found through a search of the U of I Web site. White found himself sitting with one of his students in Jeff Moore's office, putting on a one-man show for a one-person audience — a silent one person audience.

"He was very pleasant and nice but I was doing all the talking," White said. "I told him this is what we want to do and waving my arms around a lot. He was just looking at us and being pleasant. I think he said something like 'yeah, well, it sounds interesting, I'll think about it.'"

Moore was actually thinking he already had enough projects, thank you, on his plate without adding another. But White isn't the type to give up easily, so after not hearing back from Moore he went to visit him again.

"I guess Jeff just thought 'well I'm not going to get rid of him unless I say something,' so he started saying a few things," White said. "So it just sort of organically evolved from that point forward."

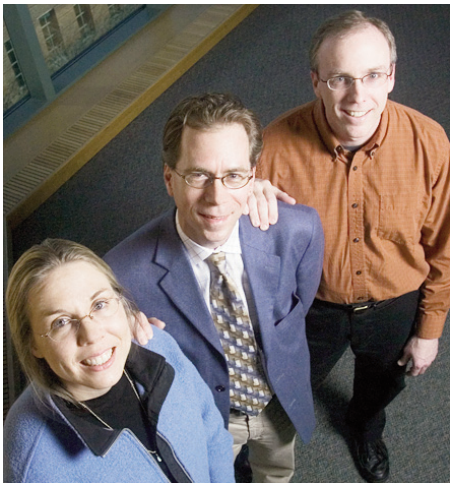
What evolved was a collaboration that not only led to a seminal paper on self-healing materials published in *Nature* in 2001, but also to a longstanding partnership between Moore, White, and Nancy Sottos that could serve as a model for doing interdisciplinary research.

Sottos is a faculty member in the Materials Science and Engineering Department, while White is from Aerospace Engineering, and Moore from Chemistry. They are key members of the Beckman Institute's Autonomous Materials System group who have seen their initial success with the *Nature* paper validated as their work now serves as a pillar for this fast-growing research area. The work has also expanded into a research line for the trio that is generating new discoveries and attracting increased funding.

Sometimes researchers will collaborate over a number of years as these three have, but the approach of Sottos, White, and Moore to research and to working with each other and with students is as distinctive as it is successful. Their students may come from different disciplines but they often become blended in projects as interdisciplinary interactions are the norm in their group. Their research efforts draw a lot of attention but all three are happy to share the spotlight with each other and with students.

In a previous article, Moore described the partnership this way: "After working with someone that long you find mutual interests and I just enjoy being with them. My life at the University of Illinois is greatly enhanced by this group and that's not just lip service. I can tell you honestly there is probably a good chance I wouldn't be here right now if it wasn't for the connections I have with this group."

Recently, the trio sat down for an interview session to talk about the origins of their partnership and their first paper on self-healing materials, as well their approaches to research and working with students and each other.



From left: Nancy Sottos, Scott White, and Jeff Moore. UI News Bureau Photo.

A Collaboration of Opportunity and Necessity

The partnership began when Sottos arrived at Illinois in 1991 just a few months after White, occupying an office at Talbot Lab that turned out to be right next to White's office.

Sottos: It also turned that out that after I met Scott I found out that we had been running in the same circles for years but had never met each other. We had gone to some of the same meetings as graduate students. We both have backgrounds in composite materials but with a subtly different focus. Scott's focus when he first got here was on how to make a composite and how to integrate many things into a composite material, and my focus was on small-scale experimental methods, how the different components in a composite interact at almost a molecular level. Throughout our first couple of years we used to go to lunch and discuss sort of blue sky type research projects and how we might collaborate, because as assistant professors you are kind of in a track doing your own thing. At some point the idea of self-healing came up, which ties in with some of the things that both Scott and I were working on about adding extra functionality, sort of unusual multi-functionality, into composites, into polymers, giving them functions that they don't normally have. … Self-healing became one of those functions and we got a very small research grant from the Army Corps of Engineers to look at concepts for self-healing. That was just an engineering study, though. What came out of that study was that we thought that microcapsules were a good idea, and that microencapsulation was the way to go if you wanted to bring in this self-healing functionality. We quickly tried a couple of chemistries that we knew but they were somewhat limited. Then Scott went to visit Jeff.

White: Nancy and I and Philippe Geubelle worked together for a while thinking about concept development for self-healing systems. We had a small grant around

1995. We started hatching out ideas and the microcapsule concept was one we were looking at. With the concepts that we wanted to pursue, it became very clear very quickly that we were in over our heads in terms of the chemistry involved. Then I looked on the U of I Web site and did some searching for *stellar, outstanding, wonderful* chemist with knowledge of polymers and it came up empty (drawing laughs). But then I found Jeff's name and went over to his office with a student of mine at the time. … I took it at face value that he was actually going to think about it and get back and we left. But he didn't get back, so I said we need to go talk to Jeff again. So we went back.

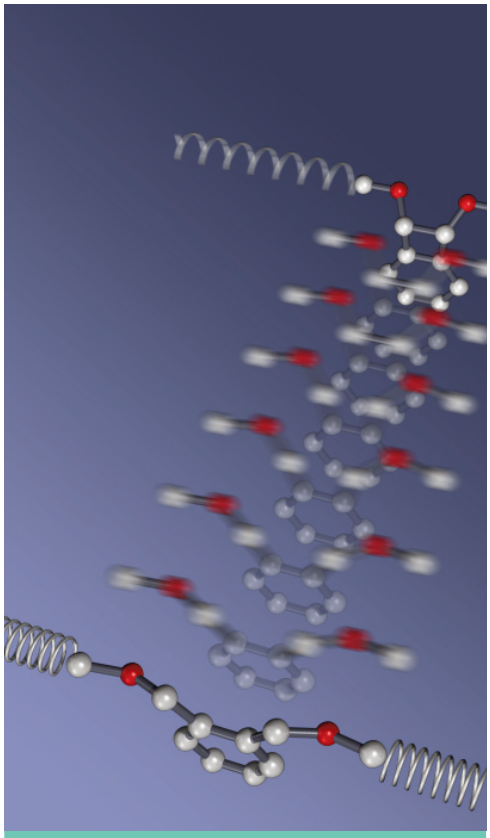
Sottos: As Jeff will tell it, Scott was persistent. Once Jeff got involved, he suggested the chemistry that we eventually used in the *Nature* paper. It was something that Scott and I would never have *dreamed* of using on our own. It was very new, very different, and we just would not have had the experience to work with the catalyst.

White: We put together a proposal, all of us, and the thing that really got us going forward was the Campus Critical Research Initiative award. They gave us some money to actually have students working on it and we collaborated and started having joint group meetings that started evolving the research.

Patience Pays Off with *Nature* Paper

The Nature *paper in February 2001 turned out to be huge news in the scientific and popular press. It reported on using microcapsules for autonomic, or self-repair, of cracks in polymer materials. The process works, according to the Autonomic Healing Research group's Web site by "incorporating a microencapsulated healing agent and a catalytic chemical trigger within an epoxy matrix. An approaching crack ruptures embedded microcapsules, releasing healing agent into the crack plane through capillary action. Polymerization of the healing agent is triggered by contact with the embedded catalyst, bonding the crack faces." The discovery was carried in newspapers and Web sites worldwide and earned a front page story in the* Washington Post. *The work has since expanded to self-healing microvascular composites and recently produced a paper demonstrating a practical application of the microencapsulated system.*

Sottos: This project just sort of percolated from the bottom up, which is not always how projects go. And it wasn't like there was this whole community of people and this whole gigantic literature on self-healing; there were just indications that this is a good idea. Some polymers like asphalt tend to self-heal, that is a word that was used in literature, and there were people who did



My life at the University of Illinois is greatly enhanced by this group and that's not just lip service.
— Jeff Moore

polymer welding but the notion of building this into any material was brand new.

Sottos: I have to say that Scott has been our cheerleader. It was a difficult problem and it took a lot of things to come together correctly. I would say that I was pessimistic more than once along the way. Scott's a good leader in that respect; just keeping everybody moving forward even when it seems like the research isn't going the direction you want it to.

White: I don't give up. That's the problem (laughing).

White: The one thing that gets to the heart of that is that the publication of the *Nature* paper was February of 2001 and we had started in 1995 on these simple tests. The first positive test we got was late 2000. That's five years of failure after failure after failure.

Moore: The key was the 'bullet' test. It's simply an object in the shape of a bullet.

Sottos: It was a little cylinder of polymer that had the microcapsules and the catalyst. It had the healing components in it. So it was easy to make a whole bunch of these and you would just tap a razor blade into them and bring them back together. Then we would have students that would try to pull them apart and we would measure how hard it was to pull them apart on a scale of one to five.

Moore: Not scientific. (laughs)

Sottos: There were no forces measured, it wasn't quantitative. Then it became that the strongest student in the group was supposed to pull them apart and if it was a five on his scale then we knew we had healing. We didn't publish that (laughing). It was just a good example of how those initial meetings were actually pretty fun. We've been having fun for quite a long time. We actually got to know each other very well as we were writing the *Nature* paper."

Collaborators and Friends

The three have worked together for more than a decade now, and their collaboration shows no signs of slowing down. White was instrumental is landing a large AFOSR MURI grant in 2005, while Moore was the principal investigator on another MURI grant this past year. Sottos describes herself as the person who looks to the details of the experiments, while Moore is referred to as the group's "rock star chemist." In a previous article, Moore said this about their collaborations: "None of us are trying to focus the spotlight on ourselves; it really is a group activity. We all know we can't do it alone. For me personally this is a level of science that I know I could never do myself but is incredibly enjoyable to be involved in. We all take

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.

Contact information:
Office of External Relations
Beckman Institute for Advanced Science and Technology
405 N. Mathews, Urbana, IL 61801
www.beckman.uiuc.edu

Editor: Sue Johnson, johnso16@uiuc.edu
Writer: Steve McGaughey, smcgaugh@uiuc.edu
Design: CarltonBruettDesign
Web: Rick Valentin, rnv123@uiuc.edu

Photo Credits:
Self-healing images on cover, pages 2 and 3 are courtesy Jeff Moore; Ted Brown photos on cover and page 5 courtesy Ted Brown; Page 7 image courtesy Emad Tajkhorshid; all other photos are from the Beckman Institute.

different leads on different portions of it." He also described White as the team's "self-healing guru."

Sottos: (smiling) I believe in the article Scott White was referred to as a visionary. That is absolutely true.

White: That's what they say when you don't really do much (drawing big laughs).

Sottos: No, having the bigger picture of how everyone fits together is an important part. I tend to be the more detail-oriented person who is going to do the experiment. We all work on the microvascular composites, for example. Rather than bullets with one through five, I will think about how the experiment is going to demonstrate the healing and make sure that it is precise and that it's done correctly.

White: In any of those (research projects), along the way there were all kinds of times where any of us at one point would think 'forget it, this is too hard it's not going to work.' But you see multiple examples of a long process coming to fruition and being successful and it is extremely gratifying. It's really what motivates me to continue to do this.

Moore: I think part of the reason that we can make these long-term projects work is because it's hard to bail when you know you've got two other people who are still there going hard at it. Why would I walk away if they are going to hang in there. We sort of reinforce each other that way.

Sottos: When I started with this, the self-healing and interdisciplinary research was such a small part of my research program. It would be hard to go backwards, I wouldn't want to.

It's very clear that this mode and the Beckman support and the space that we have and everything we utilize here is the model of how to do this. —*Scott White*

Sottos: When we were joking about Jeff being a rock star chemist, which of course he is, one thing that is important about this collaboration is that often engineers are kind of itching to work with scientists but not all scientists want to get involved with technology and engineering because it is a different kind of field. The benefit to engineering is often pretty clear. Jeff is awfully good at working with us non-purists.

Moore: We all have a competitive spirit I would say. We're also pretty unselfish. I think that's a key thing too. It's for the good of the group as opposed to any one individual. People have asked (about our collaboration) because these papers and this topic have gotten a lot of press. There is a lot craziness associated with this topic. Normally when you work in a group it's hard to survive because everyone wants the spotlight. But that actually settles out very well for us.

White: It's very clear that this mode and the Beckman support and the space that we have and everything we utilize here is the model of how to do this. Others are looking at it and trying to catch up. I'm very grateful that we have this opportunity here and it's the way of the future and the way it should be done.

Group Dynamics, Student Interactions Produce Successful Research

Teaching and interacting with students on research projects are vital parts of their work at the University, say White, Sottos, and Moore. In bi-monthly meetings with the Autonomic Materials Systems sub-group that works on self-healing projects, students give power point presentations to 20 to 30 fellow students, post-doctoral researchers, and faculty members, including White, Sottos, and Moore. During the meeting, probing questions about experiment choices, suggestions for improving results, and other contributions flow from the faculty and often from the students present. It's a process that both prods the research forward and gives the budding scientists a chance to test out their work in front of an interdisciplinary audience of mentors and peers. "I think the more chances that I get to present the work the better scientist I am going to be because people ask questions that I never would have thought about," said group member Mary Caruso, a Ph.D. candidate in Chemistry. Caruso was lead author with Moore, White, and Sottos on an important new paper that came out in Macromolecules describing an improved, more practical method for creating a self-healing microencapsulated system. Caruso said she came to Illinois to work with Moore but now "The three of them all play a role in our projects. It's very supportive. I absolutely love it because I was trained as a chemist but now I am doing more materials science. I'm still working on the Ph.D. in chemistry even though I don't really do chemistry every day. I think the collaborative efforts that we have (in the group) are fantastic."

Sottos: I think our approach to research and our academic lives are similar. Even though we are in different areas, we have a similar philosophy about our role in the University, University research, how you interact with students. That's an important part because we interact with students similarly. Getting good research done is more important than the fact that it's my research or Scott's research or Jeff's research. Achieving something new is important, and having students involved, training students in a certain way, building a collaborative group, are important.

White: I think we all subscribe to the belief that the students are the most important thing coming out of here. It doesn't matter if it's my student or Jeff's or Nancy's; in fact we co-advise almost all of the students. We don't claim ownership of a student; it's that person that we're trying to educate, get their feet on the ground and have them succeed.

Sottos: Definitely there is a lot of co-advising and of course they belong to their departments but the group has an important role for them. They do need to interact in the group in order to make progress on their projects. The group has a dynamic to itself. I think that's the unique part, that the combined group has a dynamic that is separate from the individual groups that each of us have. We had a couple of students, key students, who crossed boundaries. There is a graduate student chemist who was working with Jeff; he made a full transition to understanding a lot of engineering. He used to ask these amazing questions, really pertinent and insightful, at group meetings. This would lead Scott's engineering students to take a much harder look, dig deeper into the chemistry, and ask in-depth questions so that they can also talk the talk. It's been a nice process to see that happen. It used to be more of us questioning students.

White: This is symptomatic of interdisciplinary research. The questions that you might get from a chemistry student asking a mechanics student about their work opens up new thoughts for the mechanician, and the same goes both ways. It advances the level of everybody. That is key to the success that we have had. The group has grown and meshed so well.

Scott's a good leader in that respect; just keeping everybody moving forward even when it seems like the research isn't going the direction you want it to. —*Nancy Sottos*

Moore: An example of that is some recent progress (with the *Macromolecules* paper). One of my students, Mary Caruso, drew from something that Nancy's student had already made progress on. The two of them started talking and then, instead of us basically driving the research, it's safe to say that the two of them were driving it. The two of them would come and shows us results. Mary is so much in the group; at core she joined my group but I can't say that she is just a member of my group. She's lost her identity (he said with a laugh) and is no longer squarely chemistry, and for this work those are some of the best students. They're willing to give up their identity and do what the problem is demanding.

Beckman's First Director an Advocate for Science

Ted Brown Guided Founding of Beckman, Now Focuses on Role of Science in Society

Ted Brown

All Ted Brown wanted to do back in 1986 was return to the life of a professor and researcher after serving in an administrative post at the University of Illinois. But he found himself being pulled toward a deeper calling: overseeing the founding and operation of a new center dedicated to an interdisciplinary approach to research called the Beckman Institute.

Semi-retired but still active today as an author and editor, Brown is an advocate for the important roles he thinks science and scientists should play in our society. He is putting the finishing touches on a book on science's role in and relationship to government, the law, the public, and many other aspects of society.

"Basically what I'm trying to get at is how does science operate in the larger society?" Brown said. "How does it influence what society does? When science pronounces on something, what causes people to believe or not believe what science has to say and what are the other forces that are competing with it?"

When the book, titled *Imperfect Oracle: The Authority and Moral Authority of Science in Society,* comes out, it's a safe bet people will want to read what Brown has to say. He is a Fellow of both the American Association for the Advancement of Science and of the American Academy of Arts and Sciences, author of a college chemistry textbook that is now in its 11th edition and — in what he says is his greatest accomplishment — the Founding Director of the Beckman Institute.

It was Brown who, as Vice Chancellor for Research at the U of I, circulated a memo in 1983 that floated the idea of a facility that would break down the traditional barriers separating scientific disciplines. The notes from a subsequent meeting about the project quote Brown as saying: "The proposal should be interdisciplinary, not confined to a single department or even a single college."

Ted Brown, left, escorts Arnold and Mabel Beckman through the Beckman Institute during building construction.

It was Brown who nurtured the concept of an interdisciplinary center along, who helped in the appeal for funds to Arnold and Mabel Beckman and it was Brown who, upon returning from summer vacation in 1985, was stunned to hear the Beckmans had donated the then-record amount of $40M to build a facility. He served as the Beckman Institute's interim director during the planning stages, but intended to return to teaching and research once a permanent director could be found.

"I kept getting more and more deeply involved and finally I got to the point where I said, you know I've got so much invested in this and I love this idea so much that I would like to be a candidate to be the director," Brown said. "So I put my name in and after a while — it took longer than I hoped — they finally offered the job to me."

Brown remained director until 1993 when Jiri Jonas took over, but he still has an indirect connection to the Institute as a member of the Board of Directors of the Beckman Foundation. Brown said he made the right decision by switching from full-time teacher and researcher to a directorship because of what he was able to accomplish as head of the Beckman Institute.

These days Brown spends most of the year in Florida and the summer months in the Upper Peninsula of Michigan. In addition to reviewing edits to the latest edition of his chemistry textbook, Brown is thinking and writing about science and society, and he is passionate about one aspect of that subject. When he decided to forgo research on a full-time basis by becoming head of the Beckman Institute, Brown was making a commitment to something larger than his own research interests. And while he doesn't expect or want other scientists to give up their research work, he does wish more of them would broaden their horizons when it comes to public life.

"Scientists are dedicated people, they love their work, but there is always a conflict," Brown said. "If a scientist could have his way, the basic scientists, the ones who are in academe or in these research laboratories, they often wish the rest of the world would go away and let them play.

"But that tendency to isolate themselves from society is actually harmful to science's

relationship with society," Brown added. "You can't have that privilege anymore, if you ever did. Science is part of society, and if science can't explain itself to society in a way that makes the general public understand what it is and how it works and what it does, then scientists can't expect to get support for what they do or to get understanding of their outlook."

Brown said his new book uses historical and other examples to show how science has, over the centuries, had to establish itself as a voice of authority in society while competing with other forces such as government and religion. That effort continues today, he said.

"Look at the struggle that scientists have had in getting the government to recognize that there is such a thing as climate change occurring," Brown said. "So scientific authority rests upon its expertise, but if people refuse to recognize its expertise then that authority dwindles.

"Also there are ways in which politics or other forces can operate to try to diminish the authority of science. For example, saying 'well, we don't have enough evidence' or 'there isn't a consensus.' One of the essential ingredients in scientific authority is that if it's to have authority with the public at large there has to be at least the impression that there is consensus. Well, scientists don't readily arrive at consensus. It is part of science that, internally, things are always in a state of ferment or dispute. Yet when it faces the outside world, science is supposed to give the impression that there is a consensus on matters."

Brown believes too many people today don't understand how science works, something that has implications for our society as a whole. He lays some of the blame for that at the feet of scientists.

"Part of the problem is the scientists themselves try to give this impression that we have some special super-rational, objective way of viewing the world and when we come up with scientific evidence it's irrefutable," he said. "This is baloney. Scientists don't have some sort of special access to the truth; they have a rational way of going about trying to understand the world. However, there is always ambiguity and there is always room for flexibility; theories are just models."

One way Brown believes scientists can reach a larger audience is through the use of metaphor. In fact, he wrote a book titled *Making Truth: Metaphor in Science* that explored how theories and models are not objective truth, but simply metaphorical representations of what the world is like. Brown said he came to appreciate the value of using metaphor in science through his associations with cognitive scientists at Beckman.

"They got me interested in the roles of metaphor in science and I kept thinking more and more about how scientists use metaphor to understand the world," Brown said.

Brown said metaphors that are used in science, such as biological examples like protein folding and quorum sensing in bacterial colonies, are not only essential to the doing of science, but also serve as valuable tools in helping people understand scientific concepts.

"There are countless examples in which experience from the everyday macroscopic world gets transferred into the world of the invisible," he said. "The book by (George) Lakoff and (Mark) Johnson called *Metaphors We Live By* was a terrific little book that talked about conceptual metaphor and how our embodied interactions with the world give rise to these metaphorical tools that we all use all the time. I just tried to adopt the same principles and apply them to the ways in which scientists think.

"People say 'well, metaphor is nice, but it's dispensable' especially the people who believe that science approaches absolute truth in some way. For them metaphor is sort of vague and it's not objective. But the truth of the matter is you can't do without metaphor."

Whether it's through the use of metaphor or other means, Brown hopes science's role in society will become more integrated with other facets of how we live.

"I think it absolutely has to become more integrated with society," Brown said. "Scientists as a group, and particularly I'm thinking about academic scientists and those who work in research, have got to do more to explain themselves to society at large and to actually become advocates for things in the society that they believe in. And that means exposing themselves in ways that they'd never had to do before.

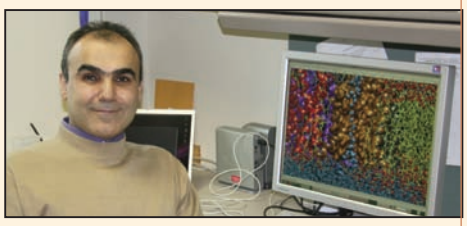
"I think scientists have to realize that we will probably never have a world where scientific rationalism is the dominant mode. It runs too counter to so much of what we learn from infant development onward and to the social forces that bear upon us from earliest childhood. The things that you learn from your surroundings and at a developmental stage get deeply, deeply ingrained. I think scientists have to learn how to live in accommodation with these other things."

Brown will be returning to campus this spring, where he will be sharing his thoughts on science and society during a talk for the School of Chemical Sciences. Brown will deliver the annual Krug Lecture of the Zeta Chapter of Alpha Chi Sigma, the chemical professional fraternity, on April 5. The talk, titled *The Voice of Science in Society,* will focus on science's voice, or lack thereof, in the concerns of our society. It's a topic that is close to Brown's heart these days.

Scientists as a group, and particularly I'm thinking about academic scientists and those who work in research, have got to do more to explain themselves to society at large and to actually become advocates for things in the society that they believe in.
— Ted Brown

FACULTY PROFILE

Tajkhorshid Has Come a Long Way in a Short Time



Emad Tajkhorshid began his full-time career at the Beckman Institute as a post-doctoral researcher with the Theoretical and Computational Biophysics group in 2000, but within the past year has earned a position as a tenure-track professor at the University of Illinois and started his own research group.

Tajkhorshid's research is in the area of computational biology, where his group is doing pioneering research into the biophysics of cellular membranes. He is building a research group from the ground up, so any promising future graduate students who are interested should take note, but with this word of caution: they will have to share the group director's passion for his work.

"I guess I am obsessed with understanding how molecules do their job, how proteins function," Tajkhorshid said. "I really want to understand at the level of atoms how a single mutation in a protein can affect the structure and sometimes perturb the function. I really want to understand how it works in these molecular machines."

And Tajkhorshid wants his students to feel the same way.

"This is what I tell my students: if you're not in love with understanding how these molecules, these single atoms come together and accomplish something at the level of biology, then you're in the wrong business, the wrong department," he said. "That's really my passion."

Tajkhorshid, an assistant professor of Biochemistry, Pharmacology, and Biophysics in the Department of Biochemistry and at the College of Medicine, is a native of Iran whose Ph.D. is in pharmacology, but a research stint at the German Cancer Research Institute in Heidelberg got him started on a path that earned him a second Ph.D. in biophysics. It was this work that led him to cross paths with Klaus Schulten, director of the TCB group, which is considered one of the premier resources in the world for developing and using computational tools for understanding biological structure and function.

After a couple of shorter, months-long collaborations with TCB, Tajkhorshid joined the group full-time in 2000 as an assistant director and immediately began making an impact. In 2002 Tajkhorshid and Schulten published a groundbreaking article in *Science* on water transport through membrane channels, while an image of that process that Tajkhorshid produced won a coveted national award and an accompanying video was used by the Nobel Foundation to illustrate the work of a Nobel Prize winner. Tajkhorshid said that project, done with software developed at TCB, was able to describe a biological process in a way that wasn't possible without molecular dynamics simulations.

I guess I am obsessed with understanding how molecules do their job, how proteins function.
– Emad Tajkhorshid

"We could really make a very strong case by showing something that couldn't even be imagined before our simulations," he said. "There were many, many experiments done on the system but nobody could even think about a possibility of such a delicate mechanism of selectivity in water channels. So that was a really important contribution not only for my career, but also for computational methodologies in general."

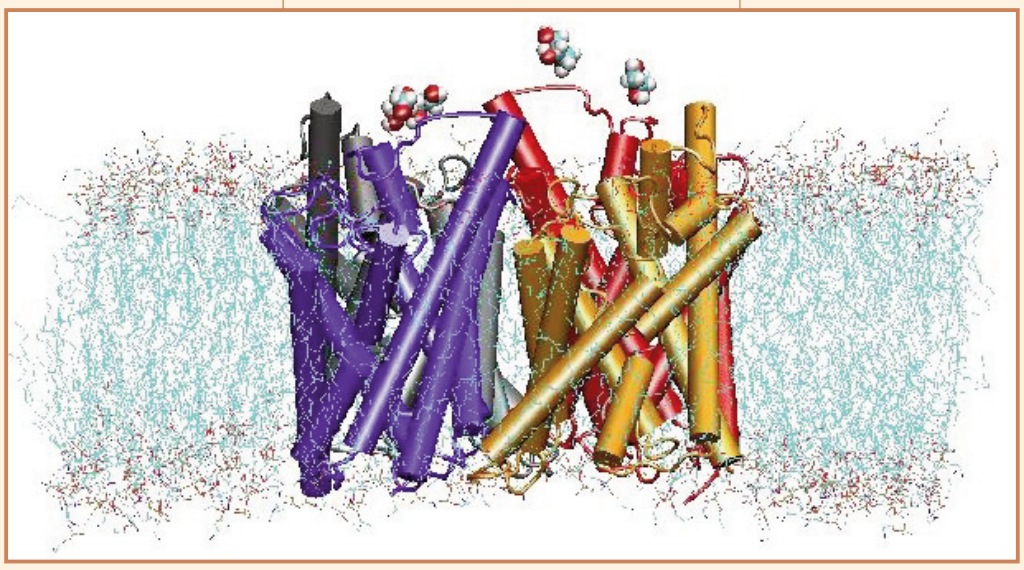
Tajkhorshid credits TCB programmers for giving researchers the ability to customize programs that fit the needs of their research work and credits Schulten for giving him direction.

"That's also something that I owe to Klaus to a large extent because he emphasizes this (point) very much in his group: we are making these tools to, at the end of the day, make discoveries about how biology works," Tajkhorshid said. "I know many other groups develop tools but in terms of applying them to real problems, getting something out of it, they don't even come close to TCB."

Now Tajkhorshid has his own group which has a focus on his current research line involving membrane proteins and events associated with cellular membranes. Tajkhorshid said most of his efforts are concentrated on transport of materials such as ions, nutrients, and waste materials across a membrane, a process that if understood will produce insights crucial for research into genomics, medicine, and science in general.

It's a line of inquiry that Tajkhorshid expects will keep him, and his students, doing research for a long time to come.

"There are many developments there and more are coming out (involving) structures of proteins inside the membrane," he said. "Understanding the mechanism of their selective function is going to keep us busy for at least 20 to 30 years."



Beckman Plays Host to Conference on Landmark Theory

"It's like we started out to build a car and along the way invented the wheel," is how Leon Cooper described the ramifications of the BCS Theory of Superconductivity at the 50th anniversary conference held in October at the Beckman Institute to honor the theory's publication.

Cooper, the "C" in BCS Theory, was a research associate of University of Illinois Professor and co-inventor of the transistor John Bardeen when they and graduate student Robert Schrieffer first published their theory in 1957. The trio won the Nobel Prize in Physics in 1972 for their Theory of Superconductivity, which solved one of the most difficult and longest standing problems in physics. Now considered one of the seminal theories in physics, BCS explained the problem of superconductivity, the phenomenon where some materials show a complete loss of electrical resistance at very low temperatures.

Cooper said that the "wheels" coming from building the BCS Theory "car" have included developments such as quantum computing, SQUID detectors used in astronomy and MRI, and supercomputers. The Beckman Institute is home to basic research, but is also a place where the applications coming from the research are important. During his talk, Cooper stressed the importance of funding basic scientific research, and emphasized the point in an interview afterward.

"If you don't do the fundamental science, it's like eating your seed corn," Cooper said. "You will continue to get results but they will peter out. The countries that continue to do fundamental science, there will be a shift to them. It leads to applications and leads to training new people. It's a tough problem because you have all of the needs of the moment and you have to balance them against what you have to do for the future."

More than 250 people filled the Beckman auditorium for the four days of the conference, which featured Cooper, Schrieffer, and many nationally-known physicists such as fellow Nobel Prize winners Anthony Leggett from the U of I and Steven Weinberg of the University of Texas.

Another featured speaker, U of I Physics Professor Gordon Baym, collaborated with Bardeen in the 1960s and 70s. Bardeen is the only person to win two Nobel Prizes for Physics, also winning in 1956 as the theoretical mind behind the invention of the transistor.

"It was my first experience in doing real physics," Baym said of working with Bardeen. "We would trade ideas back and forth; everybody was equals. Deep down, even though he was one of the smartest people ever, he was just fundamentally a really good human being."

Cooper said in his talk that because of BCS Theory, many real-world applications were developed. Baym later gave examples, such as the magnets with superconductivity material used in Fermilab's particle accelerator, MRI technology, and possible future applications such as superfast, elevated magnetic trains.

"The applications are enormous," Baym said. "But it also was intellectually a tremendously challenging problem. Starting in 1911, all the great men in physics, Niels Bohr, Einstein, Heisenberg, everybody tried to solve it. It really required introducing some new ideas into physics."

Nobel Laureate Leon Cooper speaks to the BCS Theory of Superconductivity 50th Anniversary Conference held at the Beckman Institute in October. Cooper shared the 1972 Nobel Prize for Physics for formulating the groundbreaking theory along with fellow conference attendee Robert Schrieffer and the late John Bardeen. The four-day conference drew several Nobel Laureates and other celebrated scientists to honor the publication of what is considered one of the most important theories in the history of physics.

A sampling of Beckman Institute research receiving national media attention:

Mystery Mechanism Heals High-tech Composite

December 6 — Self-healing composite materials that can fix small cracks in the structures of planes, bridges, and wind turbines could become more cost-effective thanks to a new bonding mechanism discovered by researchers at Illinois led by U. of I. chemistry professor and Beckman faculty member Jeffrey Moore.
New Scientist

Rx for the Brain: Move

December 5 — Researchers from Illinois, including Beckman faculty member and U. of I. psychology professor Art Kramer, were among the first to use functional magnetic resonance imaging to show changes in the brains of subjects they studied.
The Washington Post

Sensing Collision Mode

December 4 — Mark Nelson, a Beckman researcher and professor of molecular and integrative physiology at Illinois, collaborated on a Northwestern University study that is the first to clearly quantify the stopping motor volume (the amount of space it takes for an animal - including one in a vehicle - to come to a complete stop) and sensory volume (the amount of space an animal senses around it) for any animal.
Photonics

Exercise and Be Happy

December 3 — Researchers at Illinois led by psychology professor and Beckman faculty member Arthur Kramer showed in 2006 that the effect occurs in people, too, so that even a hour a day of mall-walking increases the amount of gray matter in the brains of the elderly. It also makes you feel better.
Newsweek MSNBC

Catalyst-Free Chemistry Makes Self-Healing Materials More Practical

November 27 — Beckman Institute researcher Jeffrey Moore, graduate student Mary Caruso, and their collaborators are reporting on a new approach to creating self-healing materials that is much less expensive and much more practical than the original system developed by Moore and Beckman colleagues Nancy Sottos and Scott White.
U of I News Bureau

New Life Inside the Depressed Brain

November 19 — At this month's giant Society for Neuroscience conference in San Diego, one challenge to the neurogenesis theory came from Shawn Kohler, a graduate student at the Beckman Institute. William Greenough, a Beckman faculty member, is beginning to be able to label neurons in animals by when the cells were born and follow them through time.
The Boston Globe

GPU Computing

November 14 — John Stone, a senior research programmer at the U. of I.'s Beckman Institute, comments on the efficiency of turning graphics processing units into supercomputers.
CNN Money.com

The Key to Unlocking the Secret of Highly Specific DNAzyme Catalysis

November 12—Using an extremely sensitive measurement technique, researchers including Beckman faculty member Yi Lu have found clear evidence that a lead-specific DNAzyme uses the "lock and key" reaction mechanism. In the presence of zinc or magnesium, however, the same DNAzyme uses the "induced fit" reaction mechanism, similar to that used by ribozymes.
U of I News Bureau

Exercise Affects Generation Of New Brain Cells

November 9 — Frequent physical exercise on activity wheels, which are a rat's equivalent of a treadmill, was found to stimulate the birth of new brain cells in young laboratory rats with brain damage resembling the prenatal effects of binge drinking by pregnant human females. U. of I. neuroscientist William Greenough reports that new brain cells, including neurons as well as supportive glial cells, were generated at much higher rates in the physically active rats than in the rodents whose cages were not connected with activity wheels. "These findings in animals are expected to lead to treatments for humans with brain damage caused by their mother's alcohol consumption," Greenough says.
Science Daily

Phantom Cell Phone Rings

November 5 — According to Alejandro Lleras, a psychology professor at the U. of I.'s Beckman Institute, learning to detect cell phone rings and vibrations is part of a perceptual learning process. "When we learn to respond to a cell phone, we're setting perceptual filters so that we can pick out that (ring or vibration), even under noisy conditions," Lleras said
Las Cruces Sun-News

On the Job with Nancy Dodge

November 2 — Nancy Dodge, the coordinator of medical radiography at the Beckman Institute's Biomedical Imaging Center, gives some perspective on her work and her life in an "On the Job" Q&A in the November 1, 2007 issue of Inside Illinois.
Inside Illinois

Pedestrian Safety Study

November 2 — Beckman's Integrated Systems Laboratory and psychology researchers have combined to create a novel experiment for studying pedestrian distraction during traffic situations. WCIA reporter Sara Jindra interviewed Beckman's Hank Kaczmarski and Jim Crowell to discuss how the Cube is making this research possible.
WCIA

Scientists Examine Wint-O-Green Effect

October 31 — U. of I. chemistry professor and Beckman researcher Ken Suslick and a graduate student examine the so-called Wint-O-Green Lifesaver effect.
Earth & Sky

A Synthesis Between Architecture and Electronics on Display in the Beckman Atrium

October 30 — To some the colorful, eye-catching big screen displays that will be appearing in the atrium this fall may seem like a case of art meeting technology, but the wall-sized screens are first and foremost real-world examples of what can result from research that takes place at the Beckman Institute.

Semantic Memory

October 29 — "Semantic memory is relatively resistant to the effects of aging," says Beckman researcher and U. of I. psychology professor Arthur Kramer.
Daily Herald

Self-Healing Plastic

October 22 — U. of I. researchers including Beckman faculty member Scott White have created a self-repairing plastic by inserting tiny beads of "healing agent" into a material, which activated by impact, like a glow stick, patched up any fractures.
Wired News

A New Nanogenerator

October 22 — Researchers at Illinois led by Beckman affiliate and mechanical science and engineering professor Min-Feng Yu have taken the first step toward building a nanogenerator out of barium titanate.
Technology Review

Hillman Honored

October 18 — Charles Hillman, a U. of I. professor of kinesiology and community health and of psychology at the Beckman Institute, has been named one of the 100 Most Influential Sports Educators in America, the Institute for International Sport announced Wednesday.
TheTigerNet.com

Charting the Agony Of a Brain as It Struggles to Be Fair

October 12 — Researchers at the California Institute of Technology, led by Ming Hsu, who now is at the U. of I.'s Beckman Institute, explored the neural anatomy of indecision.
The Wall Street Journal

Sol-gel Inks Produce Complex Shapes With Nanoscale Features

October 12 — New sol-gel inks developed by researchers at Illinois can be printed into patterns to produce three-dimensional structures of metal oxides with nanoscale features. "Using this new family of inks, we have produced features as small as 225 nanometers," said Jennifer Lewis, a Beckman affiliate and the Thurnauer Professor of Materials Science and Engineering at Illinois. "Our goal is to get down to 100 nanometer feature sizes."
Science Daily

New Force-Fluorescence Device Measures Motion Previously Undetectable

October 12 — A hybrid device combining force and fluorescence developed by U. of I. physics professor and Beckman affiliate Taekjip Ha and researchers at Illinois has made possible the accurate detection of nanometer-scale motion of biomolecules caused by pico-newton forces.
Nanowerk News

Fast Direct-Write Litho Technique Could Be Used In Chip Making

October 10 — Heated atomic force microscope tips designed and fabricated by a group led by William King, a Beckman researcher and professor of mechanical science and engineering at Illinois, are key to a new technique for nanolithography developed at the Georgia Institute of Technology.
Electronics Weekly

Physics Conference to Celebrate 50 Years of Superconductivity Theory

October 3 — Published in 1957, the Bardeen-Cooper-Schrieffer (BCS) theory of superconductivity provided the first analytical solution to the problem of superconductivity. To celebrate the theory's golden anniversary, scientists from around the country will converge on the Beckman Institute on the U. of I. campus for a physics conference devoted to superconductivity.
U of I News Bureau

Improved e-Jet Printing

October 3 — By combining electrically induced fluid flow with nanoscale nozzles, a team of researchers at Illinois have established new benchmarks for precision control and resolution in jet-printing processes. "We have invented methods for an electrohydrodynamic jet (e-jet) printing process that can produce patterns and functional devices that establish new resolution benchmarks for liquid printing, significantly exceeding those of established ink-jet technologies," says John Rogers, Beckman researcher and a professor of materials science and engineering.
The Future of Things

Nanowire Generates Power By Harvesting Energy From The Environment

September 27 — Researchers at the University of Illinois, including Beckman affiliate Min-Feng Yu, have shown that a single nanowire can produce power by harvesting mechanical energy. Made of piezoelectric material, the nanowire generates a voltage when mechanically deformed. To measure the voltage produced by such a tiny wire, however, the researchers first had to build an extremely sensitive and precise mechanical testing stage.
U of I News Bureau

Cystic Fibrosis Patients May Breathe Easier, Thanks To Bioengineered Antimicrobials

September 27 — By better understanding how antimicrobials bind and thereby get inactivated in the mucus of air passages, researchers at Illinois may have found a way to help cystic fibrosis patients fight off deadly infections. "While not a cure, this work has potential as a therapeutic strategy against bacterial infections in cystic fibrosis," said Gerard Wong a Beckman affiliate, a professor of materials science and engineering, of physics, and of bioengineering at the U. of I., and a corresponding author of a paper accepted for publication in the Proceedings of the National Academy of Sciences.
Science Daily

Cognitive Processes Affected By Eye Movement

September 26 — Beckman Institute researcher Alejandro Lleras of the Human Perception and Performance group and Ph.D. candidate Laura Thomas have made a groundbreaking discovery with their study of eye movement and problem solving.
Medical News Today

Teenage Behaviour: It's Not Teenagers' Fault, It's Their Brains

September 26 — U. of I. psychology professor and Beckman affiliate Janice Juraska studied adolescent rats and found a dramatic loss of brain cells in the pre-frontal cortex during the transition to adulthood. This neural pruning may leave adolescents more sensitive to their environment, and more prone to over-amplify the appeal of a reward. "I would agree that the socio-emotional and cognitive control networks are not well meshed during adolescence," Juraska said.
The Daily Telegraph

Deciphering Mechanism Behind Antimicrobial 'Hole Punchers' Paves Way For New And More Potent Antibiotics

September 25 — In the battle against bacteria, researchers have scored a direct hit. They have made a discovery that could shorten the road to new and more potent antibiotics. Researchers have now deciphered the molecular mechanism behind selective antimicrobial activity for a prototypical class of synthetic compounds. "We can use this as a kind of Rosetta stone to decipher the mechanisms of much more complicated antimicrobial molecules," said Gerard Wong, a researcher at the U. of I. Beckman Institute.
Medical News Today

Cultural Differences May Impact Brain's Wiring

September 24 — Using magnetic resonance imaging, Beckman researcher Denise Park, Beckman graduate student Joshua Goh, and collaborator Michael Chee in Singapore have shown that cultural tendencies may actually affect the brain's way of functioning over time, particularly the region in the back of the brain where visual processing takes place.
Daily Herald

Exercise and the Brain

September 20 — Arthur Kramer, a Beckman researcher and professor of psychology at Illinois, has been getting sedentary adults, 60 to 80 years old, to exercise three times a week. The volunteers start by walking for 15 minutes and progress to an hour. After six months to a year, "they're walking farther and faster than they ever did," he said.
The Baltimore Sun

Solid-State Membranes

September 18 — Researchers at Illinois, led by Beckman faculty member Jean-Pierre Leburton, the Stillman Professor of Electrical and Computer Engineering, have designed a semiconductor membrane that could offer more flexibility and better electrical performance than biological membranes.
Technology News Daily