SYNERGY

SUMMER 2007 BECKMAN INSTITUTE FOR ADVANCED SCIENCE AND TECHNOLOGY ISSUE 6

Honeybees Inspire Former Beckman Fellow to Change Research Paths

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Just what does Beckman's resident philosopher do? For one, Jonathan Waskan gives artificial intelligence researchers something to think about.

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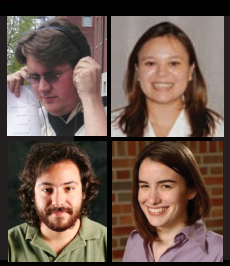

Graduate students play important roles in making research happen at the Beckman Institute.

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Multi-talented Linguistics Professor Roxana Girju is this issue's Faculty Profile.

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ILLINOIS BECKMAN INSTITUTE

Grozinger Found Inspiration at Illinois

Christina Grozinger was well on her way to earning a Ph.D. in Chemistry from Harvard when she began searching for her research muse. She found it on the plains of east central Illinois in the form of a very important insect.

"I enjoyed what I did but I wasn't particularly inspired by it," Grozinger said. "My brother started keeping honeybees as a hobby, and he would tell me fascinating stories about their behavior, (such as) in the fall, the worker bees will drag the male bees outside of the colony to die so they don't waste resources. It was really amazing and I started to read more about bees."

Grozinger began looking for a laboratory to do post-doctoral research where she could use her training in molecular biology (which focused on studying enzymes involved in gene regulation and chromatin remodeling) to study the mechanisms regulating behavior in bees. It turned out there was only one place she truly considered: the laboratory of Beckman affiliate faculty member Gene Robinson, a professor of Integrative Biology and nationally-known expert on the honeybee.

"I realized that with the new molecular tools available like microarrays we would no longer be limited to traditional genetic model organisms and could start expanding our studies to other systems," Grozinger said. "Gene's lab was a perfect fit — he was actually developing microarrays at the point that I contacted him — so the timing was just right. I didn't actually even interview anywhere else."

Grozinger also joined the Beckman Institute Fellows program in 2001, an experience she remembers fondly.

"It was really wonderful to be able to interact with such an interesting and diverse group of people," she said.

Grozinger left Illinois in 2004 to become an Assistant Professor of Entomology and Insect Genomics at North Carolina State University, where she continues and

Christina Grozinger is a former Beckman Fellow who is now an Assistant Professor of Entomology at North Carolina State.

expands the work she started with Robinson into how pheromones regulate behavior. She said Robinson has been a big influence on her.

"Gene was an excellent mentor, and a great role model," Grozinger said. "Often, when I am facing a challenging situation, I think, 'what would Gene do' and that has helped me enormously."

That influence has been especially helpful as Grozinger began her own teaching career and research lab at North Carolina State.

"Gene was able to manage a very diverse group of people and research programs seemingly effortlessly," she said. "Despite having such a large and active group, he made an effort to make you feel important, for example, if you were in a meeting with him he never answered the phone. Now that I have my own research group and realize how hard it is to juggle research, management, and teaching responsibilities, I really appreciate how generous he was with his time. I also appreciated how connected he was with the bee community, and he made a definite effort to make sure we were connected as well."

Robinson said he was impressed by Grozinger's ability to refocus her research interests in a different area after getting a Ph.D.

"Christina made a huge switch in research paths by joining my lab. She had never before worked with a whole organism!" Robinson said. "She adjusted beautifully. We discussed the need for her to get totally steeped in her new area, so that she could not only do the project we designed, but develop the ability to think critically and creatively about the issues that that the work addressed, namely social regulation of brain gene expression. This she did and the evidence for the development of these abilities is very clear."

From what Robinson observed, it seems that Grozinger did indeed find her muse in Illinois.

"Christina was a hard-working and highly motivated postdoctoral researcher," he said. "It was easy to see that she 'fell in love' with the bees and was driven to discover what they could teach us about social regulation of gene expression."

Grozinger's current research on pheromone regulation of behavior focuses primarily on honeybees, but she also has collaborations involving fruit flies and bumble bees, and will be welcoming another former student of Robinson's next spring for a project studying paper wasps.

Even though she is in the early stages of her academic career, Grozinger has already broken new ground in the study of pheromones. Her investigations have shown

that, as opposed to beliefs that responses to pheromones are hard-wired and instinctual, they are actually elicited only when the animal is in the correct state to respond appropriately.

"We have found that changes in hormone levels and other physiological factors seem to be responsible for modulating the response to the pheromone," Grozinger said. "Interestingly, we have also shown that the different responses to queen pheromone can be uncoupled — which means that they may be regulated by different mechanisms."

"It was really wonderful to be able to interact with such an interesting and diverse group of people."– *Christina Grozinger on her time as a Beckman Fellow.*

Grozinger's lab is also studying reproduction, looking at pheromone profiles, gene expression patterns, and physiological factors associated with mating, mating number, and egg-laying.

The dramatic collapse of bee colonies that has made news recently resulted in an emergency "colony collapse disorder" meeting in April that Grozinger attended. Honeybee colonies are a vital part of the food chain, responsible each year for the pollination of $15 billion worth of crops, including a large number of nuts, fruits, and vegetables. There were discussions at the meeting of possible reasons for the loss of the colonies, including factors such as pests, pathogens, pesticides, or poor nutrition due to drought.

"It seems likely that it is a combination of all of these factors that led to large-scale losses over the last winter, and it is also clear that large-scale collaborative efforts by scientists and beekeepers will be necessary to find ways to deal with this phenomenon," Grozinger said. "For our research, probably the most relevant studies will deal with queen quality — i.e., queens mated with low numbers of males may be rapidly killed off and superseded, making it difficult for the colony to maintain large numbers of workers — and the effects of pests/pathogens on immune function and social interactions."

Honeybees are also important for another reason. Researchers like Grozinger investigating bee behavior are gaining insight that could have implications for understanding the genetics, physiology, and psychology of human beings.

"Our studies of these model systems make it easier for us to find candidate genes by studying very extreme changes in behavior and physiology, and then these particular candidate genes can be targeted in other organisms like humans," she said. "How an individual's genotypic, physiological state, and environment interact to produce behavior is clearly a fundamental question for science, and our studies with bees give us a malleable and relatively simple system to try to study these things."

Thanks in part to her experience as a Beckman Fellow, Grozinger has an appreciation for disciplines other than her own.

"As Beckman fellows, we had monthly lunch meetings where we discussed our research, and we also hosted a symposium with other fellows from other Beckman institutes," she said. "I never figured out how to apply carbon nanotubes to study honey bee behavior, but just seeing things from such different perspectives was fascinating and made my time at Illinois even more enjoyable."

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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Waskan Melds Philosophy, Neuroscience

The potential of artificial intelligence has always been tempered by the limits of computation, a notion that dates back at least to the 1930s work of Alan Turing and his famous thought experiment that gave us the abstract Turing machines.

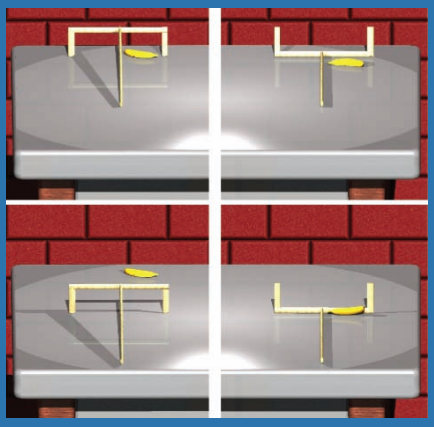
Jonathan Waskan is a professor of philosophy — and the Beckman Institute's lone philosopher — but his perspective on the computational issues surrounding artificial intelligence (AI) is something computer scientists, cognitive scientists, and AI researchers may want to consider.

Waskan is an Assistant Professor of Philosophy at the University of Illinois and a member of the Cognitive Science group at the Beckman Institute. Some may not know, or think it unusual, that Beckman has a philosopher as one of its faculty members. But Waskan's Ph.D. from a unique program at Washington University in St. Louis that combines philosophy, neuroscience, and psychology attests to his interdisciplinary credentials. At Illinois his work focuses on the philosophy of cognitive science, including issues that apply to artificial intelligence.

In his writings, especially in his 2006 book *Models and Cognition* (MIT Press), Waskan delves into the intersection of philosophy, neuroscience, and artificial intelligence. He says that the logic metaphor in philosophy is a proposal stating that "the way we reason is very similar to what we do when we construct formal logic proofs" i.e., deducing conclusions from propositions, and that the metaphor also applies to the workings of computers.

"One of the nice things about computers is that they are able to implement that kind of process, to mechanize that sort of formal reasoning," Waskan said.

Creating a truly effective artificial intelligence system supported by logic-based computing, however, runs into problems that Waskan says are probably "insurmountable." He offers a different approach — one that looks to the kind of computer models used by hurricane predictors and systems designers.



"I was interested in the intersection of philosophy and the cognitive sciences because it seemed like a lot of the questions they were asking (in philosophy) could possibly be answered with cognitive science." — *Jonathan Waskan*

Turing, working in 1936 before the advent of the modern computer, explored the limits of computation through abstract computational devices known as Turing machines. The Turing machines could be used to simulate the logic of computers; these mathematical abstractions later provided clues for computer scientists who, equipped with newer algorithms and ever-increasing processing power, started to contemplate the possibility of creating artificial intelligence systems.

"In the early days of artificial intelligence, a lot of work was being done trying to figure out how we could use this fact about computers to model human cognition," Waskan said. "People were trying to get systems to engage in simple, practical reasoning in real-world environments. Like if a system wants a glass of water you want it to be able to figure out, for example, a situation where it can get a glass of water in its claw, or whatever. You have to give the system a bunch of rules and each of these rules has to have a huge number of qualifications."

As Waskan wrote in *Models and Cognition,* the huge number of qualifications needed in order to compute all the variables involved in a potential task make the qualification problem an overwhelming one for logic-based AI systems: "… in order to embody what we know about the consequences of alterations to the world, not only would an infinite number of rules be required, but each rule would also have to be qualified in a seemingly infinite number of ways."

The qualification problem is but one part of an overall difficulty in getting a logic-based system to respond to all the possible alterations to a situation.

"It's impossible to give a rule-based system, a logic-based system all of the knowledge that we have about alterations," Waskan said.

This is what is known as the "frame problem" which has been defined as "the challenge of getting a representational system to predict what will change and what will stay the same following alterations to the state of the world" (Bechtel, Abrahamsen & Graham 1998).

In *Models and Cognition,* Waskan writes that this is the one great shortcomings of logic-based systems, even if the task is as relatively simple as, in the example he uses in the book, planning your day.

"From an engineering standpoint," he writes, "the problem that quickly arises is that no matter how many alteration/consequence pairs one builds into the knowledge-base of one's model, there will generally be many more that have been overlooked. ... In this case, we are still dealing with a fairly simple physical system; it is far simpler, in fact, than the scenarios that humans generally confront. Where more realistic systems are concerned, the challenge of specifying the consequences of each possible alteration looks to be insurmountable."

Waskan then challenges the notion of using logic-based systems to fashion a viable AI system, writing, "Our knowledge of the consequences of worldly alterations is, however, immeasurably more complex than this. In order to embody what the average human knows about the consequences of worldly alterations, a frame axiom system would have to contain rules specifying how countless objects, both familiar and novel, will behave relative to one another following each of the consequently infinite number of possible alterations. What started off as an engineering problem therefore gives way to serious a *priori* concerns about the viability of the logic metaphor itself, for no finite set of frame axioms would ever suffice to express

what we know about the way the world will change following various alterations."

While there are limits to what even highly advanced computers can do, a human brain is able to account for millions of potential permutations in a given scenario. Even with greatly improved processing power, computers based on sentential reasoning, or the "if this happens, do this" type of logic cannot match the ability of our brains to deal with alterations in a given situation.

In his work Waskan looks at the power of non-sentential based representations — similar to scale models — rather than sentential reasoning, to contend with such alterations. He believes these types of computer models offer a much more promising path to viable artificial intelligence systems.

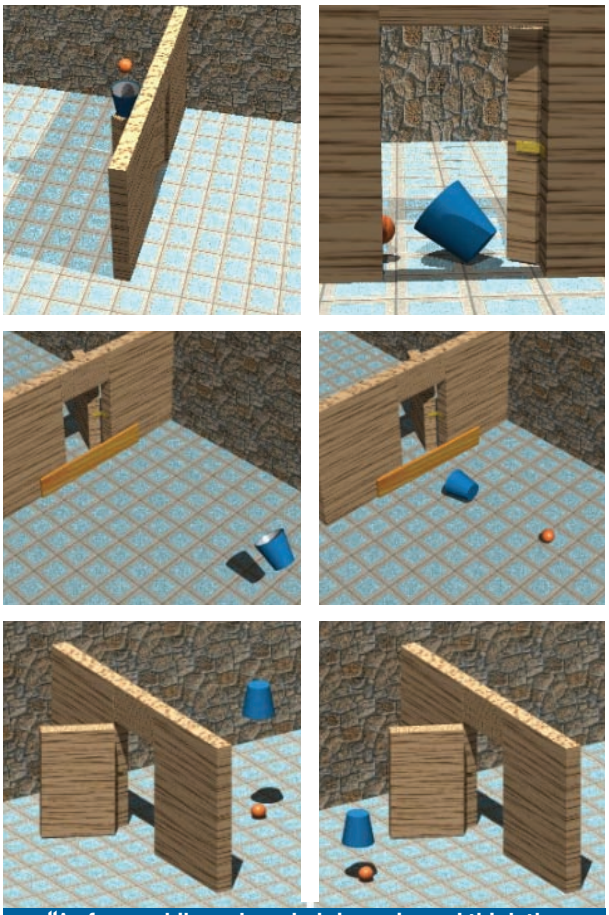
Waskan said neuroscientists know that our brains harbor representational models of everything from tabletops to apples, and can apply rules to those representations in order to predict consequences of alterations, such as the placement of an apple on a tabletop signaling it's OK to eat the apple.

"We know that brains can harbor these sorts of representations and that's the old argument: computers can do this logic-based processing and if a computer can do it, the brain can do it as well," he said. "Now we have computers that harbor models, like the computers over at the National Center for Supercomputing Applications that are harboring really complicated models of physical systems: weather systems, geological systems, automobiles, anything you like. These models are a lot like scale models in that once you've constructed the model you can manipulate it in any of the countless ways in order to predict the consequences of alterations to the physical system."

Representational models can be used to infer consequences from alterations, rather than depending on a multitude of rules required to adapt to millions of possibilities. Waskan says that the representational computer models "don't suffer from the frame problem because they're inferentially productive.

"You don't have to build into the system beforehand what you want to know about the consequences of alterations. You just construct the system and then you let the consequences play out. You let the model produce those consequences for you. Scale models are inferentially productive in a way that these logic models are not."

Waskan's writings on artificial intelligence are one part of his interest in bringing together neuroscience, psychology, and philosophy. He believes that confluence will add to our knowledge in all three areas.



"As far as philosophers helping science I think the answer to that is definitely yes..."
— Jonathan Waskan

"In addition to explaining our limitless knowledge of the consequences of alterations, one thing I'm hoping to accomplish is to make sense for the first time of how it could be the brain could harbor pictures or scale model-like representations," he said. "Philosophers since the beginning have been wondering how it is that the brain can harbor images or scale models. If you look in the brain you just see meat, you don't see any models. What could it mean for the brain to harbor pictures or scale model like representations? There are a whole bunch of researchers in cognitive science who operate on the assumption that the brain does harbor model-like representations."

Waskan said that showing for the first time that the brain "could harbor such representations would obviously be of some benefit to those researchers."

It could also add to the literature in an area of philosophy known as epistemology, which explores the nature of knowledge.

"What sort of things are we meant to know about? To answer that question philosophers from the very beginning have offered theories about how the mind works," Waskan said. "They are trying to figure out what sort of instrument is the mind, such that it can lay hold of knowledge about the world."

The advances in cognitive neuroscience, especially in technological areas such as imaging techniques, may one day provide answers to questions that were once the domain of philosophy.

"With cognitive science just now developing, starting really in the 50s, it was one of the last sciences to develop," Waskan said. "Now that we are gaining knowledge of this mechanism, this strip of knowledge, it can help us figure out some of these answers to epistemological questions."

The knowledge gained goes both ways, Waskan says.

"As far as philosophers helping science I think the answer to that is definitely yes, as well," he said, adding that philosophy could help clarify neuroscience issues such as how the brain harbors scale models.

"The problem isn't really an empirical one, it's a conceptual one," Waskan said. "The frame problem is really a conceptual problem itself. How could you conceivably get a system to embody our boundless knowledge? You really need a conceptual leap of sorts to try to be able to figure out how to answer that question. It helps if you have people who are sort of in tune with developments in lots of different fields and not focused on one. To be able to figure out what's going on with people modeling geological systems might help to answer cognitive science problems."

That's an interdisciplinary approach that fits in well at the Beckman Institute. Waskan's position at the University of Illinois and at Beckman came about because of his unique background melding philosophy and neuroscience, and because of a timely faculty opening. He was looking for a professorship and the Institute was looking to carry on its tradition of having a resident philosopher.

"I'm the third person to sit in this seat," Waskan said.

Waskan said that while the Ph.D. program he completed at Washington is still somewhat rare, it is "becoming less unique. A lot of deans are very interested in interdisciplinary work so we are finding there are more philosophers doing work in cognitive science.

"I didn't know what my research would ultimately be on when I started the program," Waskan added. "But I knew I was interested in the intersection of philosophy and the cognitive sciences because it seemed like a lot of the questions they were asking (in philosophy) could possibly be answered with cognitive science."

And Waskan just might have some answers for those in the cognitive science and computer science fields.

Beckman Graduate Students Paint a Diverse Picture

Piotr Adamczyk was born in Poland, grew up in Illinois, and went from earning bachelor's degrees in mathematics and computer science to studying for master's degrees in both human factors and library information science. **Marcos Sotomayor** came to Illinois from Chile with a degree in physics, but at Beckman he does biological computer simulations. **Danielle Chandler** wasn't satisfied to get one degree at Illinois; she earned three in the spring of 2005. **Maritza Alvarado** has known what she wanted to do since the age of 13: become a doctor. That challenge wasn't quite enough for the Southern California native, however. She's also working toward a Ph.D. in neuroscience.

Sotomayor

Adamczyk

Alvarado

Chandler

About the only thing these four University of Illinois graduate students have in common is that they are all engaged in some type of research at the Beckman Institute. There are more than 600 graduate students from just about every scientific discipline on campus at Beckman who, other than perhaps sharing the look of someone who has spent too much time in the lab and not enough sleeping, defy any attempt to label them as a "typical" grad student.

As a group they do much of the groundwork that makes the research possible, but as individuals they are diverse in their histories, goals, research interests, and in how they ended up at the Beckman Institute.

While there may not be a typical Beckman grad student, Adamczyk could serve as the Institute's poster boy. His approach to science would make Arnold Beckman proud.

"To boil it down, I'm interested in interdisciplinary approaches," Adamczyk said. "All the problems that I'm interested in are ones that need various perspectives. If I come at it from one disciplinary angle, I keep thinking that there are things that aren't being addressed."

Adamczyk is earning Master's degrees from the departments of Library Information Science and Human Factors in order to address issues from different perspectives.

"Library information science deals a lot with how people organize and categorize information. Human factors deals with how they perceive and act on it," Adamczyk said. "Library science helps us make decisions about what information to provide and human factors tells us how we do that." Adamczyk is part of an effort on campus to integrate computer science and the creative arts; he served as a teaching assistant for Professor Kevin Hamilton for a Spring 2007 course called Memory Palaces that dealt with architecture and technology. He also helped organize a conference focusing on tools for incorporating computer science into creative endeavors.

"What we are trying to do is find out how science, technology, engineering, mathematics, and all of that relates to design practices and how the creativity that is coming out of the design practices might be applied," Adamczyk said.

> **"Actually, when I applied to medical school one of the questions during the interview process was 'where do you see yourself in 10 years?' My response was *'still in school.'" — Maritza Alvarado***

The Memory Palaces class looked at interdisciplinary collaborations. Adamczyk said the class's goal was to build collaborative teams of representatives from different disciplines and then observe how they went about the collaboration process.

"When you get a lot of people from the same discipline there is a lot of shorthand, they have a lot of shared background touchstones for their discipline," he said. "But how do people collaborate when they don't have any of that, especially in an educational setting?"

Adamczyk was also an organizer for the Creativity and Cognition 2007 conference. He said it featured people such as architects and professors "who have developed novel uses of technology, especially as applied in these creative domains.

"No one's really explored that intersection of how it is that science information and the methodologies from the arts can come together in that space."

Sounds like a topic that Adamczyk, who said he plans to continue on in academia after earning his Master's degrees, will be perfectly suited to address in the future.

"The problems I pick are ones that seem not to have any solutions," he said. "They're always the ones on the periphery that people always talk about at the end of a paper, the part that says 'this is beyond the scope of this research.'"

Danielle Chandler is a member of the Theoretical and Computational Biophysics group who occupies a unique place in an area encompassing computer science, engineering, and physics. For one, she was part of a program in which she earned bachelor's degrees in physics, mathematics, and computer science at Illinois. For another she is a female in fields that are dominated by males. A recent article in the *New York Times* reported that women earned about 28 percent of the bachelor's degrees in computer science in 2003, compared to 38 percent in 1983.

Those numbers haven't stopped Chandler. She is working on two projects with TCB, one involving a protein called cryptochrome, and another on chromatophores (cells that absorb light for photosynthesis).

"The reason why cryptochrome is interesting is people think it might have to do with how birds and, possibly other animals, sense the Earth's magnetic field," Chandler said. "So it's in a good position to be involved in a magnetic compass sense because people know that the birds' compass sense is located in a mechanism in their eye. And cryptochrome is localized in these cells in the retina of birds that they know are active when they are displaying orientation behavior. So we did some calculations to see how a magnetic field might arise to see if such a mechanism is possible."

The project involving the chromatophore is geared toward building a full atomic model of the protein.

"It's quite big," Chandler said. "We want to see first of all, can we understand through a simulation how all the pieces of this chromatophore work together?"

A native of Illinois, Chandler is working toward a Ph.D. in Physics.

While Chandler is quite interested in the molecular workings of proteins, she doesn't give much thought to her trio of bachelor's degrees.

"I don't think it's impressive as much as it is I'm just indecisive," she said with a laugh.

Maritza Alvarado, a graduate student in the Human Perception and Performance group, also laughs when she talks about her schooling. Perhaps that's the best attitude for someone earning a Ph.D. and medical degree at the same time.

Alvarado is in the Medical Scholars Program at Illinois, pursuing a doctorate in neuroscience while working with Beckman researcher Art Kramer on the HALT project, a study looking at aging and exercise. She is also in her second year of medical school and fifth year overall in the grueling Medical Scholars Program, which gives out Ph.D.s and M.D.s after as much as a decade of work.

"Every time I speak to my family they ask me when I am going to graduate," Alvarado said with a laugh. "The MSP program is typically about nine years. Actually, when I applied to medical school one of the questions during the interview process was 'where do you see yourself in 10 years?' My response was 'still in school.'"

Even though it is challenging, Alvarado says the work on the HALT project is serving as a complement to her medical training.

"It works out conveniently well because we work with humans and it's very much on the clinical side," she said. "I've been able to do MRI work, and intervention work, and work with the elderly community. That goes hand-in-hand with my medical education."

Alvarado's work with the HALT project focuses on maintaining cognitive ability in older adults and also looks at preserving brain structure. It's a one-year longitudinal study with a control group that does just stretching and toning and a second group that does aerobic exercise. The project is the latest in Alvarado's list of science adventures that began in the eighth grade.

"Science is something I've always had an interest in and I've always had amazing teachers who guided me to this career," Alvarado said.

That career essentially began with a science project in the eighth grade that got a boost from her science teacher, who is now a close family friend.

"She basically helped me find a research lab where I could do a project for my science fair. Ever since then, from 13 years of age, I've been doing research," Alvarado said.

Obviously, Alvarado is someone who falls in the self-motivated category. She came to Illinois specifically for the Medical Scholars Program.

"As long as I have something set in mind I'm going all out to accomplish it," she said. "MSP is difficult but very, very rewarding. Just the interaction, what you learn from others; the colleagues that I have are amazing."

The highest hurdle for this native of Pasadena hasn't been the academics.

"The biggest adjustment I have to admit is the weather," Alvarado said. "I'm not used to the cold weather nor am I used to the humid weather, so I really only like a couple weeks in the spring and a couple weeks in the fall. In the beginning I was really hesitant about being in the Midwest but as time has progressed I've really learned to like it."

Marcos Sotomayor is another member of the TCB group. When he arrived in Chicago from his home of Santiago, Chile, he was greeted by two strangers — who were also countrymen — in the form of husband-and-wife Ph.D. candidates at the University of Illinois.

Sotomayor is one of 10 students from Chile at the University, and part of the less than four percent of the student body who hail from South America. He didn't know anyone at Illinois when he got accepted into the graduate program for physics, but thanks to the couple who welcomed him in Chicago there was a place to stay until he got situated. Sotomayor soon found himself part of an informal network of Chileans who get together on occasion; the group helped make the transition from his home city of 5 million people to life as a grad student in the Midwest easier.

"Everyone who arrives is received by a Chilean, so the tradition continues," Sotomayor said. "If you know someone is coming, you try to be as helpful as possible."

Almost as quickly as he joined the American melting pot, Sotomayor became part of another diverse group. He came to Illinois because of its reputation in physics, but soon was intrigued by an area he knew nothing about: biology, or more specifically, dynamic computer simulations of biological organisms and processes.

During an orientation and recruiting session, Sotomayor was drawn to the work being described by Theoretical and Computational Biophysics (TCB) group director Klaus Schulten. Sotomayor had earned a Master's at the University of Chile in physics, where he worked on parallel dynamic simulations.

"It was simulations but it was all materials science," Sotomayor said. "I went to Klaus and said 'I like what you presented, I may want to work with you, but I have no idea about biology. I know simulations but I don't know biology.' He said 'that's not a problem.' That's how I joined the group."

Sotomayor soon discovered that he had company as a foreign graduate student at Illinois.

"When I arrived, in the physics department there were 50 grad students, half of them were Americans and half of them were foreigners," he said. "That was very nice because in the beginning it was difficult to integrate. But we had 25 people from other countries that all had the same problems.

"Slowly, I think, we also meshed with the Americans because they got curious about other people who are coming from such different backgrounds. It's very nice in the sense that as you become friends, it's easier to get along with people who are in the same situation with you, and that also facilitates integration with the American people. They started teaching us English, for example, and we would teach them things from other countries."

Sotomayor's research within TCB uses dynamic computer simulations to study proteins involved in mechanical transduction, or the transformation of mechanical stimuli into, for example, an electrical signal.

"One example is the proteins involved in mechanotransduction in the inner ear," Sotomayor said. "The sound goes through the inner ear and eventually will move some structures, cells that are specialized to make a mechanotransduction. These structures that move will generate an electrical signal and that signal will be interpreted by the brain as a sound. What I've been trying to study is some of the molecules that might be in those cells."

Sotomayor has been prolific in publishing papers on his work at TCB, and hopes to complete his doctoral degree by September.

FACULTY PROFILE

Roxana Girju

Girju is One Researcher Who Thrives on Challenges

Beckman Institute researcher Roxana Girju was the perfect faculty member to lead a group of University of Illinois students to victory in an international competition held earlier this year.

Girju is an Assistant Professor of Linguistics and her research area of computational linguistics gave her the knowledge to lead the team, the first-ever from Illinois taking part in a competition sponsored by the Association for Computational Linguistics. Perhaps just as important were two other factors.

The diverse team of students (only one of whom was her student) came not only from Linguistics, but also represented departments such as Computer Science, Electrical and Computer Engineering, and Library and Information Science. Girju's background includes degrees in economics and computer science, and she has several interdisciplinary collaborations at Beckman.

Then there was the competitive aspect of the academic contest. Competition is something Girju seems to thrive on, whether the arena is sports or education. She was the top gymnast in her high school class growing up in gymnastics-obsessed Romania, and believes academic competition serves students well.

"It was very important for us to compete, first of all, and also to win," Girju said. "It was good because it put the university in a good spotlight, but also for the students who participated for the first time in an international competition. It really gave them more confidence in themselves and most of them want to continue in this direction.

"And what is (also) nice is the fact that they belong to different departments, which shows how interdisciplinary the task was."

In addition to her multiple degrees and continually evolving academic interests, Girju speaks five languages, and studies nutrition and military history. As if those challenges weren't enough, she also takes part in several sports, including practicing gymnastics.

"Yes, I think I like to be challenged — not only by other people, but by the task itself and see how far I can get," Girju said.

With faculty appointments at Beckman and at Linguistics and a Center for Advanced Study Award in 2006, Girju has gotten far at the University of Illinois. Her research focus on theoretical and computational models of text comprehension features a particular emphasis on semantic models for textual inference. It's an interest that helped at the international competition called the Semantic Evaluation Series (SemEval 2007).

The students built a "semantic parser" that worked as a classifier to identify the underlying meaning encoded by two nouns in a sentence. Girju said the ability to recognize and classify semantic relations between words in a sentence is an important building block for creating applications such as search engines.

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> **– *Roxana Girju***

One of Girju's earliest interests in computational modeling was not in linguistics, but in finance.

"I've always been interested in building a system which would predict the stock market," Girju said. "Then I came here about seven to eight years ago for my graduate studies and got interested in computational linguistics. I think it worked because I've always been involved in interesting projects, but I've always been interested in natural languages in general."

Now Girju is involved in interdisciplinary collaborations with other Beckman researchers like Richard Sproat and Narendra Ahuja. She is a firm believer in the interdisciplinary approach.

"Having training in different disciplines was very beneficial; it helped me get a broader view of the topic and make connections much easier," Girju said. "Despite the progress that has been done in the last ten years, all these different disciplines are still isolated. Considerable progress can be done only if we look at the problem from different angles. And my opinion is that these angles are different perspectives from various disciplines. Research communities/groups have to start building stronger collaboration bridges and I strongly believe that Beckman is the right place for this."

A sampling of Beckman Institute research receiving national media attention:

Cell Simulation Biosensing Applications for Carbon Nanotubes

July 11 — Beckman affiliate and U. of I. chemical and biomolecular engineering professor Michael Strano and his colleagues have created tiny implantable devices that could one day allow diabetics to continuously monitor glucose levels without drawing a drop of blood.
Earth & Sky

Linear Nanotube Arrays Could Result in New Electronic Devices

July 2 — Researchers at the University of Illinois, Lehigh University and Purdue University have developed an approach that uses dense arrays of aligned and linear nanotubes as a thin-film semiconductor material suitable for integration into electronic devices. "The aligned arrays represent an important step toward large-scale integrated nanotube electronics," says John Rogers, a Beckman researcher and professor of materials science and engineering at Illinois.
AZoNano

Gene Therapy

June 26 — William Greenough, a Beckman researcher and professor of psychology and of bioengineering at Illinois, says a recent study by researchers at the Massachusetts Institute of Technology that ameliorated brain damage in mice caused by a genetic disorder known as fragile X syndrome by blocking an enzyme involved in cellular development demonstrates the long-term potential of gene therapy.
Scientific American

Cognitive Function and Aging

June 24 — Researchers say you can take measures to increase cognitive function and delay dementia, even Alzheimer's disease. "My advice: Travel, go to the theater, go to museums, take a dance class," says Beckman researcher and U. of I. psychology professor Denise Park.
The Orlando Sentinel

Visualizing Science

June 25 — A slide show that includes an image of plastic sheets imprinted with electronic circuitry, the subject of research by Beckman faculty member and U. of I. materials science and engineering professor John Rogers.
The New York Times

Inattentional Blindness

June 22 — Experiments done by Beckman researcher and U. of I. psychology professor Daniel Simons and his students using people on the street illustrated inattentional blindness - the failure to notice unusual and salient events when attention is otherwise engaged and the events are unexpected.
The New York Times

Brain Activity Reflects Differences in Types of Anxiety

June 21 — All anxiety is not created equal, and a team at Illinois including Beckman researchers Gregory A. Miller and Wendy Heller now has the data to prove it.
MedicExchange.com

Sugar Into Electricity

June 21 — Researchers from St. Louis University have made fuel cells powered by enzymes. So far, the new fuel cells don't produce much power, but the fact that they work at all is exciting, says Paul Kenis, a Beckman researcher and professor of biomolecular and chemical engineering at Illinois.
The Christian Science Monitor

New Composite Material Built to Repair Itself

June 19 — University of Illinois researchers have made a polymer material that can repair itself multiple times without any external intervention, says Nancy R. Sottos, a Beckman researcher and U. of I. materials science and engineering professor.
The New York Times

Sweet Spark May Hold Clue to How Things Break

June 19 — Last month, U. of I. scientists reported in The Journal of the American Chemical Society that the faint sparks from the "Wint-O-Green Life Saver Effect" were energetic enough to power chemical reactions along the fracturing surfaces. "When you break a pencil, you actually have to have broken chemical bonds," said Kenneth S. Suslick, a Beckman researcher and professor of chemistry at Illinois and one of the paper's authors.
The New York Times

Phantom Cell Phone Rings

June 18 — "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," says Alejandro Lleras, a Beckman researcher and professor of psychology at Illinois.
USA Today

TeraGrid Used to Model Critical Membrane Transport Mechanism

June 18 — U. of I. biochemistry professor and Beckman researcher Emad Tajkhorshid and graduate student James Gumbart have used X-ray data and advanced computer simulation and visualization software to model a critical part of a mechanism by which bacteria take up large molecules.
GRIDtoday.com

Researchers Make Self-Repairing Polymer

June 18 — The next generation of self-healing materials, invented by Beckman Institute researchers at Illinois (Nancy Sottos and Jennifer Lewis, materials science; Scott White, aerospace engineering; Jeffrey Moore, chemistry), mimics human skin by healing itself time after time.
Wired News

Plastic That Heals Itself

June 11 — University of Illinois researchers have made a polymer material that can repair itself multiple times without any external intervention, says Nancy Sottos, a Beckman researcher and U. of I. materials science and engineering professor.
Technology Review

Mysterious Drop in Bee Population

June 7 — According to U. of I. entomology professor and Beckman affiliate Gene Robinson, bees play a vital role in pollinating crops that eventually find their way into one-third of the U.S. food supply, or $14 billion worth of food produced in the U.S.
Daily Herald

Simulations Unravel Outer Membrane Transport Mechanism

June 5 — Using X-ray data and advanced computer simulation and visualization software, researchers at the University of Illinois, including Beckman researcher Emad Tajkhorshid, have painstakingly modeled a critical part of a mechanism by which bacteria take up large molecules. Their findings provide a rare window on the complex interplay of proteins involved in the active transport of materials across cell membranes.
U of I News Bureau

Brain Activity Reflects Variation in Types of Anxiety

June 4 — Beckman researchers and U. of I. psychology professors Gregory A. Miller and Wendy Heller are co-principal investigators on a study that found compelling evidence that differing patterns of brain activity are associated with each of two types of anxiety: anxious apprehension (verbal rumination, worry) and anxious arousal (intense fear, panic, or both).
Medical News Today

Exercising the Brain to Keep It Sharp

May 31 — People can take measures to increase cognitive function and delay dementia, even Alzheimer's disease, researchers say. "My advice: Travel, go to the theater, go to museums, take a dance class," says Denise Park, a U. of I. professor of psychology and a researcher at the U. of I.'s Beckman Institute for Advanced Science and Technology.
Buffalo News

Seeing Smells

May 29 — Beckman researcher and U. of I. chemistry professor Kenneth Suslick has invented a little strip of high-tech litmus paper, called a colorimetric sensor array, that makes it possible, in effect, to see smells and could one day be used to detect diseases faster and more cheaply than current tests.
St. Louis Post-Dispatch

Explosives Detection

May 29 — Beckman researcher and U. of I. chemistry professor Jeffrey Moore is collaborating with Ling Zang, a professor of chemistry and biochemistry at Southern Illinois University, to develop a new type of fluorescent sensing material that could lead to innovative devices for rapid detection of explosives in security screening, criminal investigations, and other applications.
The Southern Illinoisan

Fragile X Syndrome Study

May 25 — William Greenough, Beckman researcher and a U. of I. professor of psychology, remains somewhat skeptical of a study with mice at VU University in Amsterdam, the Netherlands, that suggested a stimulating environment might overcome physiological effects of mental retardation. Although he thinks the study provides a "plausible mechanism for overcoming the effects of Fragile X syndrome in mice, when it comes to enriching the environment in a human home, I think many parents have tried to provide stimulation and the effects have been much less dramatic," he says.
ScienceNOW

Inverse woodpile structure has extremely large photonic band gap

May 21 — Researchers at the U. of I., including Beckman researcher Paul Braun and Beckman affiliate Jennifer Lewis, have built an inverse woodpile structure of germanium, a material with a higher refractive index than silicon.
U of I News Bureau

Broad Alzheimer's Plan Urged

May 16 — Government health agencies need more funds for basic and applied research, as well as funds to get the message to consumers about the major role their own lifestyle choices play in whether they'll remain lucid in their golden years, Beckman researcher and U. of I. psychology professor Arthur Kramer told members of Congress this week. "Old minds are like old horses, they must be exercised," he said.
UPI

MEMS student design contest winners announced by Sandia

May 16 — A team from Illinois, led by student Mohammad Naraghi and under the direction of aerospace engineering professor Ioannis Chasiotis, has taken a first place at Sandia National Laboratories' third annual Univer-sity Alliance competition for student microelectromechanical systems designs.
Nanotechwire.com

Sheets of Stretchable Silicon

May 15 — Researchers at Illinois led by Beckman researcher and materials science and engineering professor John Rogers recently showed how silicon can stretch in one dimension, like a rubber band.
Technology Review

Mechanoluminescence Study Yields New Data

May 9 — Researchers at Illinois led by Beckman faculty member and U. of I. chemistry professor Kenneth Suslick report that a new study of mechanoluminescence revealed extensive atomic and molecular spectral emission not previously seen in a mechanoluminescence event.
UPI

Cultural Influences

May 4 — Culture can shape your view of the world, the saying goes. And it might be more than just a saying: A new study suggests that culture may shape the way our brains process visual information, according to U. of I. psychology professor Denise Park of the Beckman Institute and her research colleagues.
New Scientist

Sensitive, Selective Mercury Sensor

May 3 — Compared with other mercury-detection techniques, a technique recently developed at Northwestern University stands out because of its high sensitivity, compatibility with aqueous media, and high selectivity, says Beckman researcher and U. of I. chemistry professor Yi Lu.
Chemical & Engineering News

Neural Response Reacts to Cultural Stimuli

May 2 — A U.S.-Singapore research team has found the aging human brain reflects cultural differences in the way it processes visual information. The new finding is the result of collaboration between Beckman researcher Denise Park and Michael Chee of the Cognitive Neuroscience Laboratory in Singapore.

Beckman Institute Web Site Wins Award

April 27 — The Beckman Institute Web site won the Cool Web Award for Best Content at the 2007 Webmasters Forum on the University of Illinois campus on April 26 The judges used the following criteria for the award: authoritativeness; audience and objectives; error free; web optimized; and the site's accessibility. The Beckman Web site was also a finalist in two other categories including the People's Choice award and the Best Design award. In the past year the Beckman Institute Web site has been completely redesigned and new features have been implemented to make navigation easier and to provide users with more functionality.

Printing Transistors

April 24 — Semprius, a start-up with a new take on device processing, has gained $4.1 million in its first round of venture funding since spinning out of the U. of I. The technology comes from
the research group of John Rogers, a Beckman researcher and professor of materials science and engineering at Illinois, who has licensed the technology to Semprius.
Compound Semiconductor

Collapsing Honey Bee Colonies

April 24 — U. of I. entomology professor and Beckman affiliate Gene Robinson and colleagues, using knowledge gained from the sequencing of the bee genome, will try to find which genes in the collapsing honey bee colonies are particularly active, perhaps indicating stress from exposure to a toxin or pathogen.
The New York Times

Flexible Electronics

April 18 — Flexible electronic structures with the potential to bend, expand and manipulate electronic devices are being developed by researchers at Illinois, including John A. Rogers, a Beckman researcher and professor of materials science and engineering, and at the U.S. Department of Energy's Argonne National Laboratory.
Photonics Online

Biochemistry: A Nanomembrane

April 16 — Beckman researcher Stephen Sligar is co-author of a paper that was as an Editor's Choice selection in this week's issue of Science magazine. The paper reports on Nanodiscs that allow researchers to probe the interactions of the SecYEG complex with its cytosolic partner, the SecA dimer, in a membrane-like environment.

Self-Healing Materials

April 16 — Scott White, a Beckman researcher and professor of aerospace engineering at Illinois, will be one of the keynote speakers at the first world conference on the topic of self-healing materials, to be held at The Delft Centre for Materials of Delft University of Technology in the Netherlands.
FirstScience.com

Electrophoresis and SWNTs

April 16 — Electrophoresis has come to the aid of nanotechnology, by forming the basis of a novel method for separating two different types of single-walled carbon nanotubes (SWNTs). Developed by a team of chemical engineers at Illinois led by Michael Strano, a Beckman affiliate and U. of I. professor of chemical and biomolecular engineering, this method could help usher in the next generation of electronic devices.
separationsNOW.com