SYNERGY

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New Neuroengineering IGERT Program Trains Students How to Do Interdisciplinary Research

TRAINING GROUND

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Research at Beckman serves basic science and future application purposes, but in some cases it also leads to a better understanding of disabilites, diseases and disorders. *Page 4*

The anticipated arrival of a highly advanced, "humanoid robot"recently took place as an i-Cub robot was delivered to Stephen Levinson's laboratory. *Page 9*

Stephanie Ceman of the NeuroTech group got a taste of doing research during medical school and decided to take her career path in a new direction. *Page 10*

Cover image shows a portion of the collage found on the Neuroengineering IGERT program poster.

TRAINING GROUND

New neuroengineering IGERT program trains students how to do interdisciplinary research

The Beckman Institute building was designed in such a way as to enhance interdisciplinary research collaborations. But the human component of those collaborations, which involve researchers from different disciplines with often very different approaches to doing science, can sometimes resemble the famous poem about six blind men taking the measure of an elephant.

Nineteenth Century poet John Godfrey Saxe based his work on a fable from India about six blind men each trying to describe an elephant based only on the part of the elephant – the tusk, the trunk, etc. – they were touching. It was an instructive tale about the problem of trying to understand the whole based on disparate perspectives.

So how do researchers with dissimilar knowledge bases and perspectives work together effectively in an interdisciplinary research project? A new training grant involving a number of Beckman researchers is tackling that very question, while at the same time trying to advance the emerging field of neuroengineering.

A new five-year education and research grant from the National Science Foundation to fund one of their interdisciplinary training programs, known as an IGERT, was awarded to the University of Illinois in 2009 to train future researchers in how to collaborate in interdisciplinary neuroengineering projects.

More than 60 Illinois faculty members are associated with the training program, which is led by Beckman Institute faculty members Doug Jones as its principal investigator (PI) and Monica Fabiani and Todd Coleman as co-PIs, along with Bob Wickesberg. Jones and Coleman are faculty in the Department of Electrical and Computer Engineering while Fabiani and Wickesberg are in the Department of Psychology.

Jones was involved in one of the most successful – and one of the most interdisciplinary – collaborations ever forged at Beckman: the Intelligent Hearing Aid project that encompassed the fields of engineering, computer science, speech and hearing science, and biology.

"Our success there sold me on the idea that, even strictly as an engineer, there is value for to me to collaborate with neuroscientists," Jones said. "So I've continued to collaborate with biologists on different sets of problems.

"The first motivation was simply 'here is this problem that human hearing does just fine, but we engineers couldn't solve it. So maybe we could learn something from the brain.' And we did. There is a lot of possibility for cross-fertilization in these types of connections."

That experience has given Jones a unique perspective on trying to form collaborations between researchers who may have totally different approaches to doing science and who have little to no knowledge of their collaborator's field.

"In some sense we've solved a lot of the problems that were easy to solve working in our own domains," Jones said. "A lot of the problems that are left are kind of just extensions of the same old ones we are hitting walls on. As disciplines mature, you're going to have to bring something new in to address those barriers.

"Now is the time when we have to pick it up a notch or look in another direction. Neuroscience is going to need some new tools, new ways of collecting data and understanding data than they have ever had before. And engineers, if we are going to solve some of these problems that have proved intractable, we're going to have to have some new insights."

That's why the IGERT program for graduate students holds such promise. Engineering students will be learning about neuroscience and students with a neuroscience background will be learning aspects of engineering that could be applied to neuroengineering research.

The Web site (http://igert.beckman.illinois.edu/index.html) for the program says that neuroengineering "has the potential to transform medicine and improve life, but researchers are just beginning to tap the possibilities." In order to reach that potential this unique campus program is "educating the next generation of neuroscientists and engineers to develop tomorrow's technology."

In the end our goal is to get people up to a point where they can collaborate effectively with people from another discipline.
– Doug Jones

Toward that end, graduate students will be going through a program of courses in three successive semesters, beginning with crash courses for the neuroscientists in

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signal analysis and the same for engineers in neuroscience. In the second semester, students will specialize in the three research areas of the IGERT program: audition, brain machine interfaces, and neuroengineering. The third semester will feature pairs of one engineering student and one neuroscience student working on individual projects.

Jones said the idea is to give the students at least a rudimentary understanding of their counterpart's discipline, especially at it would apply in these types of projects.

"In the end our goal is to get people up to a point where they can collaborate effectively with people from another discipline," he said. "It can be frustrating to explain the same thing over and over again, so the idea is to get people at least up to the level where they can talk.

"The second thing I've noticed that can really hinder collaboration is that there are very different cultures in the two disciplines, their way of thinking about things. For me, someone who is very much an engineer at heart and in training, it took awhile to think in a scientific way. I had to learn that culture, how do you do good experiments and understand the basics. Part of our goal is to really get the people in the other discipline up to speed where they can do the basic stuff."

The program had its origins in discussions between Jones and Coleman, whose research involves computational neuroscience, or using statistical and computational approaches to understand brain function.

"We exchanged ideas about identifying training grant programs offered through the federal government to train graduate students at the intersection of these disciplines," Coleman said. "We randomly noticed that there was a 'limited submission' campus announcement one day in January, and one of the topics was an NSF IGERT – which is exactly the type of training grant we discussed before."

They wrote a proposal that was one of four of 12 selected from campus to be sent to the NSF, which later requested a full proposal from the Jones-Coleman group. That proposal was later approved and Illinois was awarded nearly $3M to serve as the home for this new IGERT training program, set in a rapidly emerging and exciting field of research.

"It definitely puts Illinois on the map," Coleman said. "A tremendous amount of research has taken place over the years in this area at Illinois, but the campus visibility in highlighting these accomplishments perhaps could be improved. This program will allow us to (a) collaborate with other institutions; medical centers; and companies doing such cutting-edge research, and (b) attract some of the nation's best students to study and solidify these connections so that Illinois is recognized as a key player in this arena nationwide."

"It definitely puts Illinois on the map. A tremendous amount of research has taken place over the years in this area at Illinois, but the campus visibility in highlighting these accomplishments perhaps could be improved."
— Todd Coleman

There are eight graduate students in this first class – four from neuroscience or psychology and four from electrical and computer engineering – who are taking courses this spring titled *Introduction to Systems Neuroscience* and *Principles of Signal Analysis*.

The three research thrusts of the program feature two areas that are strengths at Illinois, audition and neuroimaging, and a third, brain-machine interfaces, that is on the leading edge of where human-technology interaction is headed.

The research into audition will provide insight into how the brain processes sound, in order to advance hearing aid technology, including cochlear implants. The neuroimaging thrust will seek to improve our understanding of the brain, while research into brain-machine interfaces studies how brain signals recognize intent. Possible applications there include rehabilitation, as in thought-driven wheelchairs and visual implants that stimulate the optic nerve and restore sight.

The researchers behind this effort believe that "many of the most important and exciting scientific and technological challenges for the future are centered on neuroscience, the study of the brain." According to the project's Web site, these current and future advances in understanding the brain "depend on engineering new technologies for sensing, imaging, and analyzing the brain and their innovative use by neuroscientists."

One example of the possibilities inherent in the neuroengineering area is the creation of neural prostheses for the disabled, a process that requires engineers to be grounded in the science of the brain. Coleman has been working on creating technology for that kind of neural prostheses.

In order to increase awareness of their program and the field of neuroengineering the researchers will conduct a symposium on "Emerging Topics in Control and Modeling: Biomedical Systems" April 22 - 23 at the Beckman Institute.

Jones said they are looking at the training program as one that will endure and serve as a seedbed for future education and research ventures.

"Our intent is not just to build an IGERT program that serves 33 students and then disappears after five years," he said. "We really want to build a concentration, kind of like a minor at the graduate level. I expect and certainly hope that in five years this will be a sustained program because it will have been working well and the students are receiving value from it."

And there should be great value in a program that teaches researchers how to collaborate in an interdisciplinary project from the beginning.

"The question comes up: how do you build a neuroengineer? What does that mean?" Jones said. "Our goal is not to create someone who is really half and half because we think the disciplines are so big and advancing so quickly and the problems so complex, that it's not really practical to train somebody to be a complete expert in both.

"The idea is we're trying to train people who primarily have a home in one discipline. So the engineers will still be engineers and the neuroscientists will still be neuroscientists. But they will be neuroscientists with a lot of knowledge about the information processing side of engineering. The engineers will have a lot of understanding of how the brain works for specific things. In the end our goal is to get people up to a point where they can collaborate effectively with people from another discipline."

Advancing Science and Helping People Come Together

Beckman Institute researchers are known internationally for advances in fields as 21st Century as nanoscale electronics and the cellular workings of the brain. Some of their discoveries may lead to future applications or they may simply serve the purpose of increasing our basic scientific knowledge. For some Beckman researchers, their work is leading to end products or adding to a knowledge base that directly helps people with disabilities or who are suffering from disease. Their research supports the development of interventions and therapies, has resulted in novel aids for the disabled, and has led to the development of new technologies and methods for understanding disease and disorders.

Researchers Kenneth Watkin, David Clayton, Fatima Husain and Deana McDonagh are examples of the kind of Beckman faculty members who are contributing in very direct ways to helping others. Their methods and areas of study vary, but all are doing work that could have a very direct, beneficial impact on people suffering from disabilities, disorders, and disease, either down the road or in the near future.

Watkin is developing a battlefield helmet that uses sensors to help medical personnel diagnosis the extent of head injuries. McDonagh is educating a new generation of designers, including students with disabilities, to create products for the disabled with the user as an integral part of the design process. Clayton uses the zebra finch songbird as a model organism for studying the brain, including an effort to increase our understanding of the disorder Fragile X syndrome. Husain uses a variety of technologies and methods to gain insight into tinnitus, an effort that could lead to future interventions or therapies for the hearing disorder.

Kenneth Watkin

Bioimaging Science and Technology Group

Kenneth Watkin's research goals always include the mission of helping others.

"That's the principle driving force for all of the things that I do," Watkin said. "The college that I'm in, Applied Health Sciences, that's the goal of all of us, to try and increase the quality of life of individuals in the world. That's the principal reason I got into this."

Watkin's research involves biomedical engineering, with a focus on advancing technology toward applications such as imaging for drug delivery or biosensors for use in health monitoring systems. One such project involves the development of a battlefield helmet that uses biosensors embedded in the helmet pads to record data on blast injuries to the head. Tiny nanocomputers are incorporated in the biosensors to record and analyze real-time information for medical personnel on the extent of a head trauma injury.

The design has been accepted by the Army and the research is funded through a Concept Award from the Department of Defense. The team behind this project has developed a first generation prototype helmet, but Watkin said work is ongoing on the sensors, on signal processing for the device, and on system integration before battlefield condition testing can begin.

David Clayton

NeuroTech Group

David Clayton's work with the zebra finch songbird as a model organism for research is so well thought of that he was selected to write a white paper to the National Human Genome Research Institute (NHGRI) proposing an analysis of the whole genome sequence of the bird. The proposal was accepted, the zebra finch genome was sequenced, and today the bird is a Model Organism for Biomedical Research of the National Institutes of Health.

Clayton, a faculty member in the Department of Cell and Developmental Biology at Illinois, has a research portfolio that merges neuroscience, genomics, and ethology toward a greater understanding of the brain. Clayton's work focuses on the zebra

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finch as a model organism because the animal's unique song-learning abilities give insight into developmental sensory learning and because understanding gene expression in the bird provides clues to behavior in animals, including humans.

An important part of his work involves studying the speech pathology of those suffering from Fragile X syndrome, the most common known cause of autism and the most common cause of inherited mental impairment. In a collaboration with Beckman colleague Stephanie Ceman, the researchers were able to characterize

the fragile X mental retardation protein (FMRP) in areas of the songbird brain, including one analogous to a region in the human brain that has been shown to be involved in speech.

Fatima Husain

Human Perception and Performance Group

Fatima Husain is adept at creating computer models for understanding auditory and speech processing. When she decided a few years ago to take on the study of tinnitus, or ringing in the ears, it was through a path few had done before: perturb her computer models of normal auditory processing to reflect the effects of the hearing disorder.

A professor of Speech and Hearing Science at Illinois, Husain has a research focus on auditory, speech, and language processing in the brain using neuroimaging (fMRI), behavioral experiments,

and computational modeling techniques. By using both computer models and data from experiments Husain is able to study tinnitus from a more comprehensive perspective than what has previously been possible. Tinnitus is a disorder affecting 50 million Americans, with about two million of those being severely debilitated (www.ata.org).

"We want to study a large enough population and then use our modeling and clever statistical analysis of our MRI experiments to try and identify the major sources of variance within the population and see if can we find something that is common for this population – apart from the fact that they have ringing in the ears," Husain said. "What is it that is common? Can we figure out the brain functions, regions, and mechanisms that underlie this disorder? If we can get there, then we are halfway to developing therapies and our own interventions."

Deana McDonagh

Human Perception and Performance Group

If Deana McDonagh has one message for her industrial design students, it is to make the user, including their emotional connections to the products they use, an integral part of the design process. Her approach, called empathic design, has expanded in the last few years to include students with disabilities as part of the design process and eventually as designers themselves.

An Associate Professor of Industrial Design at Illinois, McDonagh created a class a few years ago in which design students worked with students with disabilities toward creating products that better served the needs of people with disabilities. More recently, students with disabilities have joined the class as designers, with some now looking toward careers in industrial design. McDonagh said the experience has been eye-opening, both for her and the students with disabilities.

"What we found is that they had never really had any experience of the impact of design and to be part of the process and, this is my interpretation, is that it was very empowering for them," McDonagh said. "They realized that their voice has real authority. They are the experts in their life experience. Well, suddenly, we took their life experience and their feelings, which are very visceral and difficult to communicate, and we actually responded to them."

ALUMNI PROFILE: Malcolm MacIver

"We live in a society where I think there is a lot of room for improvement of our understanding of science and technology. I'm really motivated to transmit these ideas that have lived in academia in some cases for decades and still haven't really permeated the culture."

Malcolm MacIver

Malcolm MacIver's path from inquisitive undergraduate student taking philosophy and computer science courses to a Ph.D. in neuroscience to engineering professor may seem circuitous, but makes perfect sense to anyone familiar with interdisciplinary research and the Beckman Institute.

Although his Ph.D. from the University of Illinois was in neuroscience and his research focus is on biological intelligence through the study of weakly electric fish, MacIver has faculty appointments at Northwestern in two engineering departments (Mechanical Engineering and Biomedical Engineering). He says his time at Beckman led directly to his current position.

"I have no degrees in engineering but because it is so interdisciplinary at Beckman and I got to do so many interesting engineering type projects, I got trained sufficiently so that I was eligible for a postdoc at Caltech," he said. "That really paved the way to a career that combines science and engineering in a very fun way."

Combining science, engineering, and fun seems like a perfect description of MacIver's career as a young faculty member/researcher. He has a deep-seated belief in communicating science to a broader audience, and has done so not only through traditional forms such as talks and media interviews, but also through his art installations, and his work in TV and movies.

MacIver is a scientific consultant on the TV show *Caprica* (which is gaining a cult following on the Syfy cable channel), a gig he got after serving as a consultant on *Tron Legacy*, a sequel to the 1982 film, *Tron*. One of MacIver's art installations under development is an "orchestra" of fish tanks that are "played" by taking advantage of the different frequencies discharged by different species of Amazonian electric fish.

"What drives a lot of this is a real desire to bring science out of the lab," MacIver said. "We live in a society where I think there is a lot of room for improvement of our understanding of science and technology. I'm really motivated to transmit these ideas that have lived in academia in some cases for decades and still haven't really permeated the culture. Through communicating the ideas in cultural ways, via entertainment or through art, we can really improve the overall scientific and technological zeitgeist."

MacIver studied under Beckman researcher Mark Nelson while at Illinois, taking Nelson's work with weakly electric fish as a model organism for understanding neutral mechanism and sensory acquisition (http://nelson.beckman.illinois.edu/), and adding his own layers. MacIver has created a mechanical electric fish that imitates how its biological counterpart moves in water and, to a central point of the research's aims, how the fish utilizes its unique sensory capabilities.

"We want to relate the sensory data to its movement pattern," he said. "The system essentially generates a weak electric field around the body of the robot and then there are sensors embedded on the body of the robot that pick up distortions in that electric field caused by the objects. That's how the electric fish senses.

"We're in the process now of combining movement control with sensory acquisition in the robot and testing various approaches in how to do that in a way that emulates how the fish does it so that we can get insight into the information processing principles and the movement principles that the fish is using."

MacIver's academic journey is based on what he calls his single-minded pursuit of a set of questions he first started asking in undergraduate school and during an internship in his native Canada. He was taking philosophy of mind and computer science courses that sometimes overlapped, especially around areas MacIver found intriguing, such as mechanisms of reasoning, and the nature of cognition, computation, and digital systems.

"They were simultaneously in my philosophy and my computer science classes, and I got more and more intrigued in trying to understand the nature of intelligence," MacIver said. "As time went on, I realized philosophy wasn't going to lead me to the answers that I sought so I needed to do something that was more in touch with

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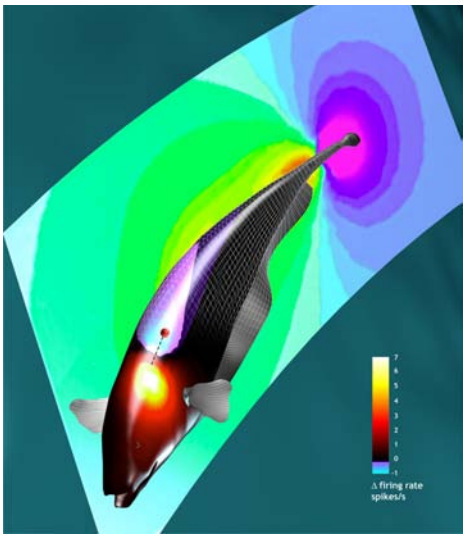


Weakly electric fish image rendered by Malcom MacIver, Mark Nelson, and Ben Grosser.

experimental science."

MacIver tried a double Ph.D. program at Indiana in cognitive science and philosophy, but realized the questions he was asking revolved around understanding the brain. That was when he took a look at the neuroscience program at Illinois and Nelson's Electrosensory Signal Processing Lab at Beckman. (http://nelson.beckman.illinois.edu/)

"I was really convinced after talking to him that this was a really exciting program and a beautiful combination of techniques that would let me pursue my strengths in computer science while at the same time getting trained up in neuroscience," MacIver said.

MacIver writes on his Web site (http://www.neuromech.northwestern.edu/) that the unifying theme of his current research is the multidisciplinary analysis of animal intelligence using three approaches: mechanics/robotics, neuroethology, and computational modeling. The goals are to build understanding of the body's control system, how the body contributes to adaptive behavior, and, as he writes, constructing neuromechanical simulations in order to "gain insight into the fundamental principles underlying the immense success of animal life."

It is an expanding research line that had its genesis at the Beckman Institute.

"So much of this is thanks to Mark Nelson for having a fantastic, dynamic research group," MacIver said. "He trained me on many different things and let me explore the many different options I had at the Beckman."

HONORS & AWARDS

Chasiotis Honored at White House

Ioannis Chasiotis received the 2008 Presidential Early Career Award for Scientists and Engineers in a recent ceremony at the White House.

The award, sponsored by the National Science Foundation, is the government's highest honor for scientists and engineers in the early stages of their independent research careers.

Chasiotis is a faculty member in the Autonomous Materials Systems group at Beckman and an Associate Professor of Aerospace Engineering at Illinois. The honorees are chosen by a rigorous peer review process, and receive five-year grants through the Faculty Early Career Development (CAREER) Program. Chasiotis was honored by President Barack Obama at the White House along with the other award winners from around the country. Obama spoke about their contributions.

"These extraordinarily gifted young scientists and engineers represent the best in our country," President Obama said. "With their talent, creativity, and dedication, I am confident that they will lead their fields in new breakthroughs and discoveries and help us use science and technology to lift up our nation and our world."

Dell Elected AAAS Fellow

Gary S. Dell has been chosen as a Fellow of the American Association for the Advancement of Science. Dell is leader of Beckman's Cognitive Science group and former Co-chair of the Biological Intelligence research theme.

Dell, a Professor of Psychology, is one of six Fellows chosen from the University of Illinois. Election as a Fellow is an honor bestowed upon members by their peers. There were 531 members elevated to the rank of Fellow for their meritorious contributions to science and technology science. Dell was chosen for his groundbreaking work on the production of language using an array of methodologies, including behavioral studies, computational modeling and neurosciences.

Leburton Named IEEE Lecturer

Jean-Pierre Leburton has been chosen as an IEEE Nanotechnology Council Distinguished Lecturer for 2010-2012.

Leburton is the Gregory E. Stillman Professor of Electrical and Computer Engineering at the University of Illinois and a full-time faculty member in the Nanoelectronics and Nanomaterials group at Beckman. IEEE Distinguished Lecturers are chosen based on their contributions to the field of nanotechnology and on their international reputation. Distinguished Lecturers give at least two lectures per year at Nanotechnology Council Chapter meetings and/or at Chapter meetings of the Council member Societies.

King Receives Bergles-Rohsenow Young Investigator Award

William P. King, a member of the Beckman 3D Micro- and Nanosystems group, has received the 2009 Bergles-Rohsenow Young Investigator Award in Heat Transfer. This award is given annually by the American Society of Mechanical Engineers to the top researcher in heat transfer under the age of 36. The award was given "for substantial contributions to the field of mechanical engineering through the development of nanometer-scale thermal processing and thermal measurement techniques, and the new physical insights made possible by these techniques."

Federmeier Wins CNS Award

Kara Federmeier has won the 2010 Young Investigator Award of the Cognitive Neuroscience Society.

Federmeier, a full-time member of the Cognitive Neuroscience group at Beckman, will be honored at CSN's annual meeting in Montreal in April. The award is given "to recognize the outstanding contributions by scientists early in their careers." The Cognitive Neuroscience Society Web site states that it is "committed to the development of mind and brain research aimed at investigating the psychological, computational, and neuroscientific bases of cognition." Federmeier's research focuses on topics such as language and memory. She is an Associate Professor of Psychology and in the Neuroscience Program at the Unviersity of Illinois.

FELLOWS CORNER: Michael Walsh

IT seemed destined. Just about the time that Michael Walsh was scouting around in his native England for postdoctoral research opportunities, applications were being accepted for the position of the first-ever Carle Foundation Hospital-Beckman Institute Fellow.

Walsh, who has a Ph.D. in Biological Sciences from Lancaster University, has a research interest in biomedical applications, with a particular focus on using chemical information toward advancing imaging technology for disease diagnosis. That is also a focus of Beckman faculty member Rohit Bhargava, who Walsh called in February of 2008 as part of his search.

"He really is in the forefront in imaging for biomedical applications," Walsh said of Bhargava. "He had heard of me from my Ph.D. Then he said, 'oh there is this fellowship coming up between Beckman and Carle and I think you would be really well-suited for it.' I looked on the Beckman Web site and as soon as I looked at it, I said 'oh, this sounds perfect for what I am interested in.' It was perfect."

Walsh applied and soon won the position, joining the Beckman Fellows Program in August of 2008. While the position seemed to be a perfect fit, Walsh also wanted to experience working at an interdisciplinary research center like Beckman.

"The other thing is I was really attracted by Beckman, in particular the interdisciplinary aspect of it," Walsh said. "I had never run across anything like it in England, where you have a building just for cross collaboration research. For this type of research, using biophotonics with biomedical applications, you really need a lot of threads. We've got the engineers, the biologists, the mathematicians, really everything in one building, which is really unique."

The new position was launched in 2008 with funding from Carle Foundation Hospital and the Beckman Institute in order to give recent Ph.D.s a postdoctoral/pre-career opportunity to do independent, interdisciplinary, cancer-related translational research. Walsh will serve as the Carle-Beckman Fellow until Aug. of 2011. As with other Beckman Fellows, Walsh will have no teaching or administrative duties, jut a chance to focus full-time on his area of research.

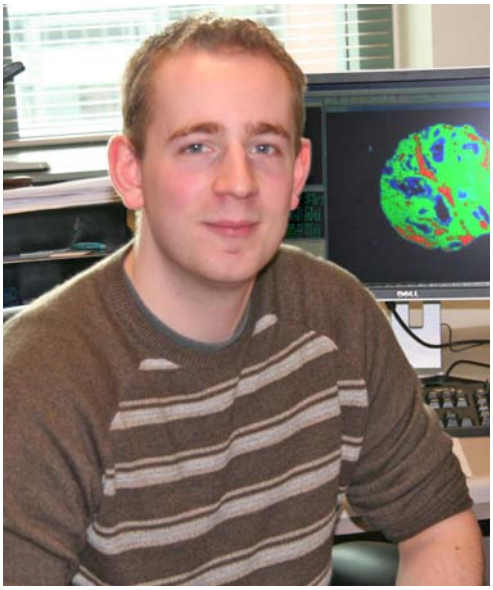
Walsh said his goal as the Carle-Beckman Fellow is to eventually add a new diagnostic approach to the fight against disease, especially cancer.

"Essentially I'm developing an imaging approach which, instead of looking down a microscope, is actually taking the chemistry into account," Walsh said. "So we can measure things like proteins, lipids, DNA, RNA, phosphate, all these sort of things."

Walsh's initial efforts in the position involve doing evaluations of clinical tissue using chemical imaging and data analysis methods, not just toward improving cancer diagnoses but also prognoses.

As part of that effort, Walsh is looking at whether predictions of future cancer recurrence can be made for patients who have had a tumor removed. Walsh said that prostate cancer patients, for example, will have the cancer removed, be treated, and then have a recurrence of cancer at the primary site within five to 15 years.

"No one knows why but there is some biological basis as to why this patient is going to have a recurrence of cancer," Walsh said. "Some biologists have shown in some preliminary work that there are some chemical changes in that original tumor which you cannot tell by standard methods but which will predict whether someone is going to have a recurrence."



"For this type of research, using biophotonics with biomedical applications, you really need a lot of threads. We've got the engineers, the biologists, the mathematicians, really everything in one building, which is really unique."

Michael Walsh

What Walsh wants to do is incorporate chemical information from the tumor into imaging methods in order to make predictions about future cancer growth and treat the patient accordingly. He is starting his project by analyzing imaging data from cancer patients at various clinical locations.

"Of the patients, half had the tumor removed and they are fine; 15 years later they are cancer-free," he said. "The other half, who have had the exact same treatment, the exact same age, they have a recurrence of cancer. There is something unique about these patients, something unique about their original tumor. No one had analyzed this with biophotonics yet."

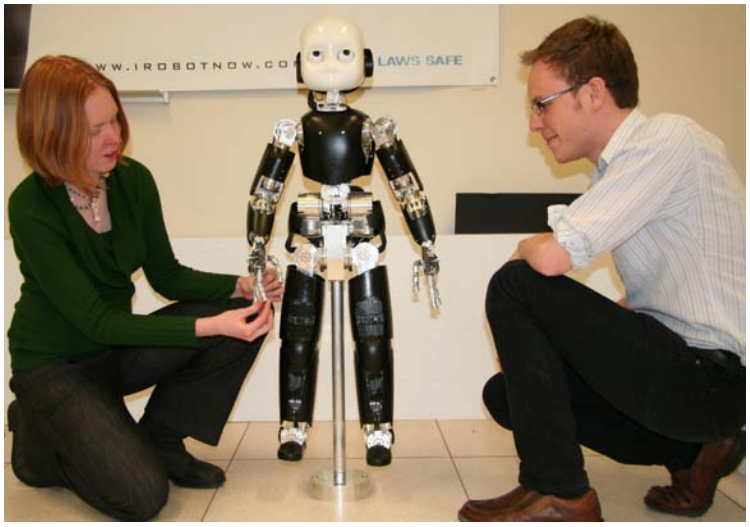
This is where Walsh hopes the method he is developing will prove useful.

"What has been shown is that this chemical information – DNA, protein, – is altered between different cell types or between different disease states," he said. "We can get a lot more information, much more quickly, and cheaper than conventional approaches."

Walsh hopes to eventually set up a research lab at Carle's Mills Breast Cancer Institute and expand on his studies. His long-term goals are to continue his research work as a professor, and eventually integrate the technology he is developing into clinical settings.

As the Carle-Beckman Fellow, Walsh is also getting a taste of what it is like to supervise young researchers for the first time. He has three undergraduate students who are helping with his research.

"It's been really quite nice to mentor undergrads," Walsh said. "And they are really quite smart as well. They've all got distinct projects, so being able to give that out to them has been really nice because there is not enough time in the day literally."



Far Left: The iCub is already at home and on its stand in researcher Stephen Levinson's laboratory shortly after its arrival from Italy on Feb. 10. Left: Graduate students Lydia Majure and Logan Niehaus of the Language Acquisition and Robotics Laboratory are shown checking out the iCub. Majure and Niehaus spent part of the summer of 2009 in a school in Italy working with an iCub.

Levinson Lab Welcomes Rare iCub Robot

A much-anticipated arrival took place Feb. 10 when a rare, highly-advanced "humanoid robot" that was shipped by air from Italy and delivered by truck from Chicago arrived at the loading dock of the Beckman Institute. The delivery ended a more than year-long process that began when Beckman researcher Stephen Levinson put in a bid for one of the coveted research robots from a European Commission consortium project called RobotCub (http://www.robotcub.org/index.php/robotcub).

Levinson's bid was accepted, the robot was painstakingly assembled, programmed, and tested, and then donated to Levinson's Language Acquisition and Robotics Laboratory for 99 years. (More about the lab's new acquisition can be found in the Synergy Fall 2009 issue. http://www.beckman.illinois.edu/synergy/Fall2009/iCub)

Now Levinson's group will begin the task that won them the honor of being the only research lab in the Western Hemisphere to be awarded an iCub: training the robot to learn language as a child would and, in an assignment from RobotCub, also train it to learn how to walk.

The iCub's capabilities are special. While it is programmed to do certain tasks, the challenge for the Levinson lab will not be to program the robot but to train it to "learn" to do tasks in the way that a child would. In fact, the iCub is designed to mimic a human child in order to gain insight into human psychology and neurophysiological development, as well as areas such as computer science, robotics, and even philosophy.

The iCub, which costs around $300,000, is about the size of a two-and-a-half year-old child, can crawl on all fours, and can sit up. The iCub has a sense of touch (key for acquiring language, such as when learning to differentiate between a hard object and a soft object), its hands permit dexterous manipulation, and its head and eyes are fully articulated.

Graduate students Lydia Majure and Logan Niehaus of Levinson's lab spent part of their summer of 2009 working with an iCub in Italy, home to several institutions that are part of the consortium. Next up for Levinson and his students is to get the robot working properly and on its way to adding to our knowledge of language acquisition.

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

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FACULTY PROFILE

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Stephanie Ceman

Growing up in rural Wisconsin, Beckman Institute researcher Stephanie Ceman proved to be a whiz at biology and that, the hometown folks said, meant she should go to medical school. Ceman took the advice but while in med school she got involved with a research project, found her true calling, and never looked back.

"The summer after my first year of med school I got into a really good research lab," Ceman said. "It was a genetics lab and I have always liked genetics. I loved that and then I took a leave of absence from medical school to finish a paper. It was then that I decided to get a Ph.D. and never went back to medical school."

Ceman, however, did end up working at a medical school. As a Professor of Cell and Developmental Biology, Ceman teaches medical students at the University of Illinois College of Medicine. But that position hasn't led to any regrets – it simply has confirmed her life choice.

"When I talk to med students I feel like when you're in medicine you need to know a lot about a lot of things," Ceman said. "I prefer getting to know a lot about one little thing. I'm much more interested in a specific problem."

And that specific problem for Ceman is the fragile X mental retardation protein (FMRP).

Ceman's research trajectory began with a Ph.D. at the University of Wisconsin-Madison, and postdoctoral fellowship stints at the University of Chicago and at Emory University, where she was introduced to Fragile X research. Her work has blossomed at Illinois, where she studies topics such as the molecular basis of disease, the regulation of RNA expression, and RNA-protein interactions with a main research focus on the molecular basis of learning and memory, using FMRP as a model system.

FMRP is a protein that plays a critical role in nervous system development. Fragile X syndrome (FXS) is the most common cause of inherited mental impairment and a single gene cause of autism. Ceman, a member of the NeuroTech group at Beckman, had always been interested in understanding disease and disorders at the molecular level but her interest in the vocal phenotype of Fragile X began when she attended a talk by fellow Beckman researcher David Clayton.

"It was an introduction to the power of the zebra finch model," Ceman said of the talk. "I was just enthralled because Fragile X patients, although they are cognitively impaired, they are often ascertained by speech problems. They look pretty normal so their parents, unless they know Fragile X syndrome is in their family, won't suspect it."

Ceman saw an opportunity to tie her interests in the area of molecular and cell biology to a research line that adds to our knowledge of this disorder and could someday lead to interventions for combating it. She approached Clayton, who uses the zebra finch songbird as a model for studying Fragile X, about collaborating with him.

"The speech and language deficits (of Fragile X patients) are remarkable but no one has studied them in a model organism," Ceman said. "I thought that was interesting and we went on to clone the zebra finch FMR gene from a songbird. We made the antibody to it and we did all the studies and showed that FMRP expression is elevated in a pre-motor nucleus."

Ceman has also enjoyed working with Beckman Biological Intelligence research theme Co-chair William Greenough, a neuroscientist and veteran Fragile X researcher.

"Bill has been fabulous for introducing me to the neuronal biology of FMRP," she said. "So thinking about it in the context of neurons and getting Bill's input on how FMRP functions in the brain have just been invaluable because I'm a geneticist and Bill is a neuroscientist.

"Usually I do all of my molecular biology in tissue culture which are just round cell bags. Neurons are like the Cadillac cell and I'm working with the Zip Car cell," Ceman added with a laugh.

Ceman is also one scientist who believes in connecting to the general public, demonstrating that belief over the years by speaking often to different Kiwanis groups.

"People know about DNA and chromosomes and stuff but the brain is viewed as the last frontier. So I try to build on those two things that people are normally interested in," Ceman said. "Then I talk about how the brain is all these interconnected neurons and how they talk to each other at the synapse, and how the proteins that are present there are controlling that. Then I bring in my research."

Ceman feels it is imperative for faculty members to engage in such outreach efforts.

"I think it is really important, especially since we are employed by the state," she said. "Our job is education and I think it is really important to interface with the public and tell them what we are up to and hopefully generate enthusiasm. The fun of science is discovery but the next best thing is telling people about it."

RECENT BECKMAN INSTITUTE RESEARCH
IN THE NEWS

Scientists Create Sensors for Subs Based on Fish Anatomy
February 11 – Doug Jones, a Beckman researcher and professor of electrical and computer engineering at Illinois, along with Chang Liu from Northwestern University, have developed a sensing device based on fish anatomy that could someday be used to keep man-made submersibles out of harm's way..
New Scientist

Moving Scientific Research into the Cloud
February 5 – A story about an agreement between Microsoft and the National Science Foundation to offer free access to computer servers uses the work of Beckman Institute faculty member Klaus Schulten (fifth paragraph) as an example of how supercomputing resources can be used to advance research.
Scientific American

Dipstick Test for Toxic Lead
February 1 – Beckman faculty member Yi Lu and colleagues have developed a sensor that uses non-cross-linked gold nanoparticle-DNA conjugates, bound to a lead-activated DNAzyme mounted on a solid dipstick platform that can be used to detect lead levels in paints.
Chemistry World

Financial Times Interview with Richard Powers
February 1 – An interview with author Richard Powers, U. of I. English professor and Beckman faculty member.
Financial Times

Flexible Silicon Panels
January 29 – John Rogers, a Beckman researcher and U. of I. professor of materials science and engineering, says that his research team obtained lightweight, flexible devices that bend without measurable changes in their electrical or mechanical properties by stamping hundreds of these microcells onto plastic substrates. This, says Rogers, makes them ideal for integration on fabrics such as backpacks, clothes and cases.
New Electronics

Flexible Semiconductors
January 21 – John Rogers, a Beckman researcher and professor of materials science and engineering at Illinois, has developed a way in which flat silicon wafers could be replaced so semiconductors can be used to monitor the heart and brain.
Compound Semiconductor

Video Gamers: Size of Brain Structures Predicts Success
January 21 – Beckman Institute faculty member Art Kramer and two of his former Human Perception and Performance group members, Kirk Erickson and Wally Boot, are part of a multi-institutional study showing that the volume of three structures in the brain is predictive of video game performance.
U of I News Bureau

Benefits of Exercise
January 19 – One well-documented way to slow memory decline is through aerobic exercise, says Art Kramer, a cognitive neuroscientist at the Beckman Institute, who found that six months of walking for about an hour three times a week improved memory, attention and decision making among study participants, whose average age was 72.
Times Magazine

Science by Long Distance
December 24 – Warden High School students (in Washington) in Darin Orton's zoology class observed insects under the scanning electron microscope at the Beckman Institute at Illinois. The Warden students scheduled time on the equipment, collected specimens and mailed them to the university. On the appointed day, the class logged in to the microscope through the Internet.
Columbia Basin Herald

Self-healing Networks Mimic Nature
December 22 – Beckman affiliate and U. of I. materials science and engineering professor Jennifer Lewis and colleagues have developed a technique to mimic vascular networks on a polymer matrix. The polymer system makes it capable of self healing, allowing any cracks or tears to be healed making it stronger and more durable than previous attempts.
Chemistry World

Volunteerism and Brain Function
December 16 – Beckman faculty member Arthur Kramer and Beckman graduate student Michelle Voss were among the authors of a study led by Johns Hopkins Bloomberg School of Public Health that found volunteer service, such as tutoring children, can help older adults delay or reverse declining brain function.
Insciences

Mastery of Physical Goals Lessens Disease-related Depression and Fatigue
December 15 – Beckman Institute researcher Ed McAuley led a study showing that a belief an individual has in their ability to achieve certain physical goals plays a role in lessening fatigue and depression.
U of I News Bureau

Development of Synthetic Protein that Mimics Metalloprotein
December 10 – Beckman Institute researcher Yi Lu led a team that designed a synthetic protein that is both a structural model and a functional model of a native protein, nitric-oxide reductase.
U of I News Bureau

Silicon-silk Electronics that dissolve in the Body
December 8 – A research group made up of researchers from the U. of I. and from University of Pennsylvania, including John Rogers of the Beckman Institute, has made electronics that almost completely dissolve inside the body by building thin, flexible silicon electronics on silk substrates.
InTech

Thermochemical Method Developed for Nanopatterning
December 7 – Beckman Institute researcher William King and his collaborators have developed a thermochemical method that offers unique advantages for nanopatterning, especially in the area of protein and DNA nanolithography, as reported in the Dec. 9 cover story of the journal *Advanced Functional Materials.*
Advanced Functional Materials

Forbes on Self-healing Plastic developed at Beckman
December 1 – Beckman faculty member Scott White and his fellow researchers at Illinois have developed a plastic embedded with tiny capsules containing a polymer healing agent.
Forbes

Computational Microscope Peers into the Working Ribosome
November 24 – In two recent and other upcoming studies, Beckman Institute researcher Klaus Schulten and his colleagues are using the computer as a microscope to get a clearer picture of the dynamics of the ribosome, which is perhaps the cell's most essential, and most complex, molecular machine.
U of I News Bureau