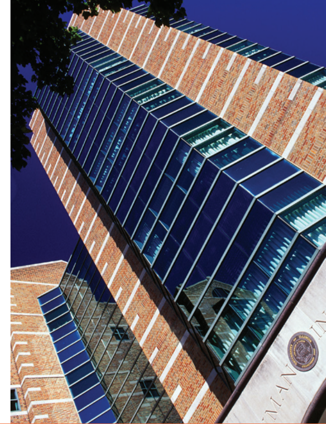
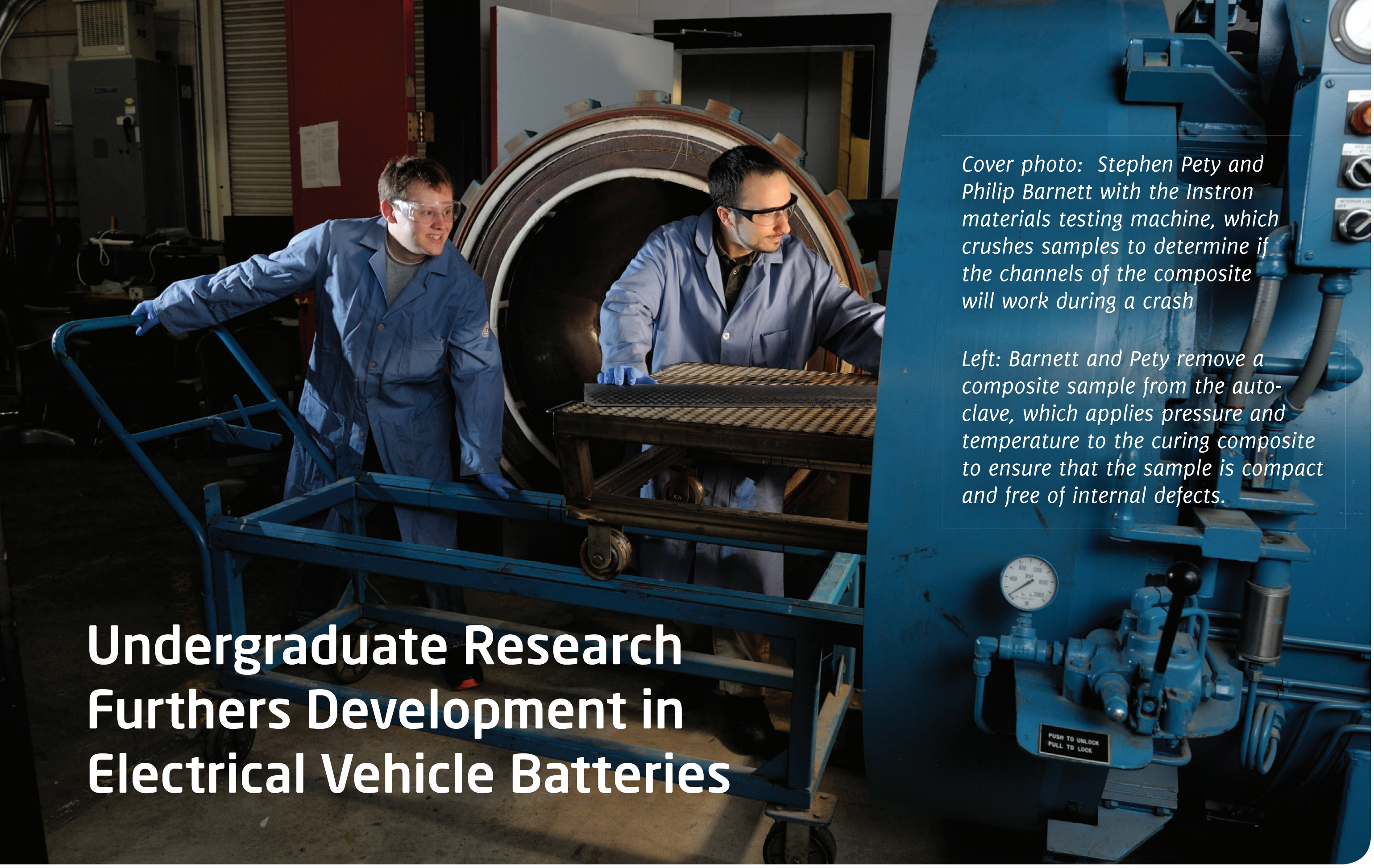
Spring 2016 • Issue 30

SYNERGY



BECKMAN INSTITUTE FOR ADVANCED SCIENCE AND TECHNOLOGY



Cover photo: Stephen Pety and Philip Barnett with the Instron materials testing machine, which crushes samples to determine if the channels of the composite will work during a crash

Left: Barnett and Pety remove a composite sample from the autoclave, which applies pressure and temperature to the curing composite to ensure that the sample is compact and free of internal defects.

Undergraduate Research Furthers Development in Electrical Vehicle Batteries

By Kaitlin Kamp

Because of his interests in rocketry and space camp, Philip Barnett chose to study aerospace engineering at the University of Illinois.

Originally from Good Hope, Illinois, Barnett grew up with a passion for outer space.

"I loved watching shuttle launches, building LEGO spaceships, and having little plastic astronauts roam the surface of the distant planet that was the sandbox in my backyard," said Barnett. After years of 4-H projects and model rockets, Barnett attended Space Camp in Huntsville, Alabama, where he studied space exploration, saw cutting-edge technology, and piloted a simulated shuttle mission.

"It was easy to see that everyone was excited about their work, which made it an easy decision to choose aerospace engineering as my major four years later," said Barnett.

The summer before his junior year at Illinois, Barnett became involved with the Undergraduate Research Opportunity Program (UROP), sponsored by the Illinois Space Grant Consortium, part of NASA's National Space Grant College and Fellowship Program through the Department of Aerospace Engineering at Illinois. UROP pairs undergraduate students with a graduate student mentor. Barnett was paired with Stephen Pety, a fifth-year Ph.D. in materials science and engineering and a member of Beckman's Autonomous Materials Systems Group.

Barnett and Pety work on microvascular carbon fiber composites under the direction of Scott White, the Donald Biggar Willett Professor of Engineering and Beckman faculty member in the Molecular and Electronic Nanostructures Group.

The goal of their research is to develop a method to produce microvascular carbon fiber composites and test their thermal management capability and crashworthiness.

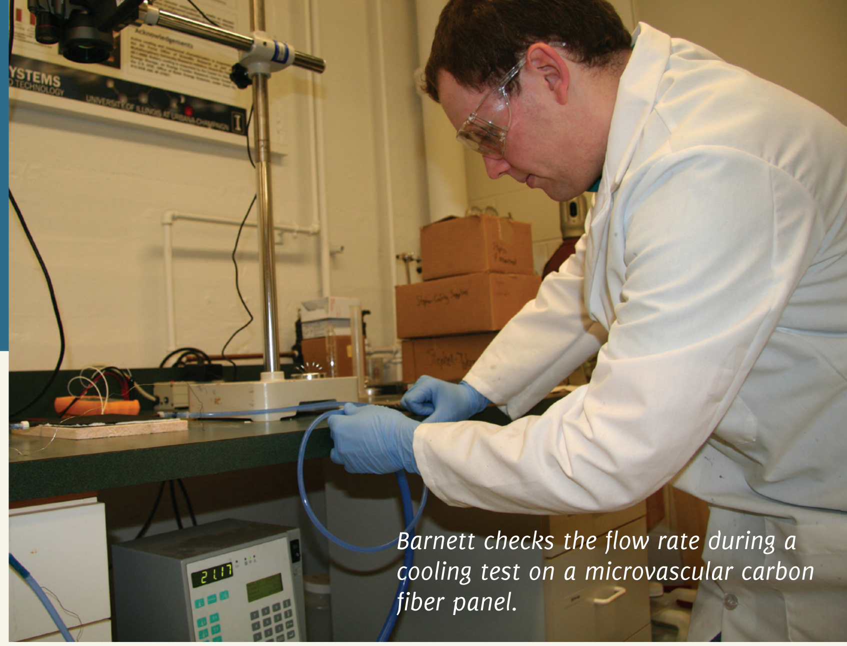
The group's experiments show that microvascular carbon fiber composites could replace the cooling system in electric vehicles, while also providing protection in crashes.

The growing concern of safety in electric cars makes their research very important.

"Electric vehicle battery cooling is an issue you have to be really careful with because if batteries get too hot, they can reach a point of thermal runaway, at which point the batteries keep getting hotter until they catch on fire," said Barnett. The material surrounding the batteries can also reach high temperatures in a runaway scenario, creating a dangerous chain reaction.

In addition, even mild increases in battery temperature lead to decreased cycling performance and lifetime. Ensuring cooling in these batteries is necessary for electrical cars to operate efficiently and safely. Battery packaging material must also sustain itself in a crash scenario to protect the batteries and occupants.

How To Get Involved with Undergraduate Research


Barnett checks the flow rate during a cooling test on a microvascular carbon fiber panel.

Both Barnett and Pety agree that undergraduate research prepares you for what students do in the real world and in graduate school.

"A lot of the engineering curriculum is focused on lectures, homework and problem solving, which is good, you need that. You can go through your whole undergraduate career, though, and never realize how many labs we have and what great research we have going on," said Pety.

Along with furthering developments in science and technology, Pety believes participating in research helps on a practical level as well.

"You don't learn these skills in classes," said Pety. "These very simple, practical skills like how to use hand tools, how to pour chemicals, how to operate various pieces of equipment."

After two years working in a research lab, Barnett and Pety feel very confident about Barnett's future success.

"Now Phillip is as much of an expert in my field as I am … now he's a colleague where he can do his own research and come back to me and discuss it," said Pety.

The many benefits of working in a research lab can help undergraduates, but both Barnett and Pety believe that a lack of awareness of how labs work holds undergrads back from involvement.

Barnett has a list of steps to help students get involved in research:

- Take a course with a professor you enjoy.
- Do well in the course and show that you are interested and dedicated.
- Involve yourself and apply to programs like UROP and ISUR (Illinois Scholars Undergraduate Research).
- Boost your resume with relevant work experience such as a campus job. If professors see you have enough time for a job on top of coursework, they will know you have enough time to invest in their research.
- Lastly, do your research because you love it, not just as a resume booster.

Pety explains that intimidation should not be a factor when deciding to get involved because researchers love having undergraduate help.

"Having undergrads is really useful because there is always a lot of sample preparation and testing to perform. It is also fun to just have someone else in the lab with you to give you ideas," said Pety.

They both believe that once undergraduates start to get involved in research, they will love the experience.

Barnett understands how difficult it can be to balance research and an undergraduate career, but he knows it is worthwhile and wants other undergrads to have similar experiences.

"It is a lot of work," said Barnett. "But if you enjoy it, it doesn't feel like work."

Barnett explained this research could be used in other fields as well.

"Obviously transportation is really important; electric vehicles are an increasingly good option right now. You could also use this technology for electronics cooling, such as putting small microvascular networks inside a circuit board to keep it cool. It could also be applied in the aerospace industry, as a way to prevent aircraft icing, as well as cool transonic aircraft," said Barnett.

Barnett's research includes five main steps: cooling network design, cooling panel manufacturing, cooling panel testing, crush sample manufacturing, and crush sample testing. His first step is to design microvascular networks using the computer program SolidWorks. These networks allow for fluid to be pumped through the carbon fiber composites, similar to the way veins pump fluid through the body.

Barnett then manufactures cooling panels. He hot presses a sacrificial polymer (PLA) into a sheet and uses a laser cutter to cut out a network with the desired shape. He then embeds the network between carbon fiber fabric in a vacuum-assisted resin transfer molding (VARTM) layup. He impregnates the layup with epoxy and cures it in an oven. After curing the panel, he cuts it to size and places it into a high-

continued next page

Electric Vehicle Batteries, continued.

temperature vacuum oven to vaporize the PLA. This technique is known as the vaporization of sacrificial components (VaSC) and it produces a channel network in the shape of the original PLA network.

Once the panel is ready to test, Barnett places it on a resistive heater that heats the panel similarly to how a battery would heat the panel in an electrical vehicle. Coolant is pumped through the panel while the surface temperature is monitored with an infrared camera. Cooling performance is evaluated for different network designs and compared to finite element simulations. Results show that these cooling panels could adequately cool batteries in an electric vehicle.

In addition to cooling tests, Barnett completes crush sample testing. The purpose of these tests is to determine whether or not microvascular channels affect the performance of carbon fiber composites in crash scenarios.

Instead of using dry carbon fiber fabric to form these samples, Barnett uses fabric that has been pre-impregnated with resin ("prepreg"). He stacks prepreg layers over an aluminum mold, with PLA fibers placed between the middle layers to form channels. The mold has a corrugated shape to produce samples that resist buckling. The prepreg assembly is covered with a

New Academic-Industry Center Established for Molecular Imaging of Drugs

By Maeve Reilly

A new industry-supported center at the University of Illinois plans to image molecules, live cells, and tissues in the body before, during, and after drug treatment in order to understand the efficacy of the drugs and the response of the body to treatments.

A collaborative agreement with GSK, a research-based pharmaceutical and healthcare company, and the Biophotonics Imaging Laboratory at the Beckman Institute for Advanced Science and Technology has created the GSK Center for Optical Molecular Imaging. Stephen Boppart (pictured left), professor of electrical and computer engineering, bioengineering, medicine, and head of the Biophotonics Imaging Lab, is the university director of the center, which plans to first investigate skin health by developing advanced optical molecular imaging technologies.

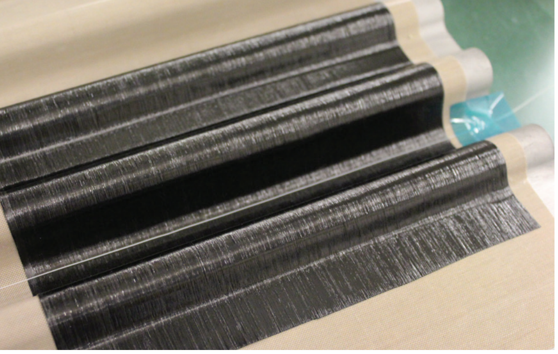
"GSK approached my group a couple of years ago because of its interest in using novel optical techniques and tools to track drugs in the skin. One of the big questions with drugs is where do they go and what effect do they have? There really is no regular way of tracking that at the molecular and cellular level in living tissue, especially with new drugs," said Boppart.

The new center represents a unique academic-industry partnership for not only cutting-edge research, but also educational and training opportunities for Illinois students and GSK scientists.

Zane Arp, U.S. leader for Imaging Technologies at GSK, will serve as the GSK scientific lead of the center.

"A key area that will enable improvements in pharmaceutical development is the ability to track where the drugs go, how they distribute, and the changes they have on tissues at the cellular and subcellular level. GSK believes that optical techniques such as those in Professor Boppart's laboratories will enable improved understanding of these mechanisms and improve our ability to develop new treatments for patients," said Arp.

Boppart's lab at the Beckman Institute has developed numerous optical imaging technologies for diagnosing diseases such as breast cancer, ear infections, and disorders in the retina.



The corrugated sample is created by layering carbon fiber fabric with sacrificial fibers.

vacuum bag and cured with heat and pressure in an autoclave. After being cured, the PLA fibers are removed with VaSC as before to form straight channels.

Barnett crushes the samples using an Instron materials testing machine. The samples absorb energy from mechanisms such as matrix failure, fiber failure, and delaminations. The specific energy absorbed for each sample is calculated using load-displacement data. Results show that composites with small volume fractions of channels perform just as well as composites without channels.

Barnett thinks his time spent as a researcher in the lab at the Beckman Institute has helped him decide on his future career path.

"I absolutely love going into work every day, so I can't really imagine doing anything else," said Barnett. He plans to continue with graduate school and eventually receive his Ph.D.

"Beckman has a lot of really smart and really nice people," said Pety. "We have great equipment and resources and funding, but the people are what really make Beckman work."

"Optics are very good at looking at cellular structure and function, and we have ways of assessing how healthy the cell is: Is it changing its metabolism? How are the cell and tissue responding to treatment?" said Boppart.

Optical imaging also does not necessarily require stains or dyes, so the techniques do not introduce any new materials into a patient. In some applications, it can be performed when a patient is in surgery or non-invasively, yielding results more quickly than traditional histology or pathology tests, which can limit the number of diagnostic surgeries needed for certain diseases.

"Our previous and ongoing work has been done with optical coherence tomography (OCT), which is one optical technique. Much of what we're doing now with the skin and also developing for breast imaging and for other applications is optical molecular imaging," said Boppart.

Boppart says understanding the molecular composition of the tissue is often more important for diagnosing and treating a disease than understanding the cellular structure.

"The example I always give is that we use CT or MRI to find tumor masses, but those are often centimeter size masses representing structural changes that have taken years to develop. But the molecular changes happen very early," said Boppart.

"Getting a look at how the molecules are changing earlier will help with treatment.

"In some of our cancer imaging studies, we're finding microvesicles, a hot topic now in cancer biology. Tumor cells will release these microvesicles, which contain signaling molecules, to go out and condition the microenvironment. The cells in the microenvironment become transformed and are ready to accept the tumor cells that are migrating. We actually have the technology that can visualize this now," said Boppart.

A previous successful clinical trial with the Department of Dermatology at Carle Foundation Hospital brought together the technology from the Biophotonics Imaging Lab, drug development from GSK, and the clinical expertise of Carle physicians, research coordinators, and staff to track where drugs go in human skin. "The collaborative interdisciplinary community of investigators and physicians that came together for this clinical trial demonstrated that this would be an ideal place for a center that integrates imaging advances into GSK's drug development pipeline to understand mechanisms, reduce long term costs, and deliver higher quality medicines to our patients," said Arp.

Boppart's group is refining its technological developments to provide practical uses in a clinical setting.

"Part of the technical challenge is to make these systems compact, because traditionally they have used large lasers that often fill an optical table, so a lot of the work in my group has been to reduce these down to fiber lasers, which are much more compact and user-friendly," said Boppart. "We envision these imaging systems will all fit onto a cart that can be used in clinical settings. Beam delivery can then take many forms. It can look like a microscope, or it can look like a handheld probe, or an optical fiber."

Future directions could involve making the technology even more portable, for example, using diagnostic technology developed in the College of Engineering to create handheld sensing devices through a smartphone.

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Brad Sutton, technical director of the Biomedical Imaging Center.

BIC's New Cloud System Increases Speed and Stability in Research

By Kaitlin Kamp

The Biomedical Imaging Center (BIC) has a new capability that will make research easier and more efficient for BIC users. BIC is a shared resource facility at the Beckman Institute that provides facilities, equipment, and training for research on magnetic resonance imaging (MRI), spectroscopy, ultrasound, near infrared optical imaging, animal bioluminescence and fluorescence imaging along with animal PET, SPECT, and CT.

"Once image data is collected, we need to analyze it and do something with it. It turns out that step can be as important as the first step. We get the best technology, we set it up right, and we perform it correctly. Now, we have to analyze it with the best tools too," said Brad Sutton, BIC's technical director.

In order to analyze and share large data sets, including many images, more effectively, Sutton and Nate Wetter, a former master's student in bioengineering, proposed a shared platform that would enable a user to launch a large number of virtual computers, configured with the appropriate software specifically for that user's analysis purposes. Wetter constructed and configured BIC's new tool, the Biomedical Imaging Center Neuroimaging Computing Cloud (BICNICC).

This new resource contains 60 cores with 18 gigabytes of RAM each, meaning 60 subjects can be analyzed at a time across the 60 computers. Sutton explained that this additional tool for the facility will improve the experience for researchers.

Sutton hopes the BICNICC can accommodate Beckman's variety of users, across ranges of scale and expertise. Some users know exactly what parameters and software they want to use in the scanner, while some do not fully understand how to process the data or use the technology. BIC's new system allows inexperienced users to utilize pre-existing pipelines and experienced users to utilize their own desired processes while scaling for large data sets.

The BICNICC also increases stability in research. While many researchers face the issue of software updates altering processing and data analysis, the cloud prevents those issues from occurring and allows reproducible research.

"We can provide an environment that has specific versions of all the software already installed and working together, and then we can make that software available five years from now," said Sutton. "For example, if you have an R01 grant for five years, the data you got at the beginning has initial promising results. You can still run the same software package at the end and run the exact same analysis. You can feel comfortable that the software hasn't changed during the course of the project."

In addition to stability, the BICNICC also makes research involving images from the facility a lot more efficient.

"Without the cloud, it takes months. With the cloud, it takes days," said Sutton.

Hillary Schwarb, a postdoctoral researcher, works on the INSIGHT project, a multidisciplinary study based at the Beckman Institute to determine what kind of training best improves adaptive reasoning and fluid intelligence. Schwarb utilized BICNICC for three months in order to process a large amount of data and methodologies. Schwarb's data set includes 450 participants with approximately 1200 raw image files, creating a little over a gigabyte per each participant.

"I use the cloud computing to expedite the processing of my data," said Schwarb. "We have some large projects right now where many data sets come through. When I was doing it on a desktop, each data set was taking one to two months for general processing. Now, I can get 200 people processed in three days."

She believes that parallelization within the computational cloud increases the speed.

"It's freed up my personal desktop so I can conduct other work while the information is processed, in a time-efficient way. The cloud allows me to check things regularly and fix issues as they're happening. I know I can get complacent when studies run for a month at a time, but when it's this quick, I check it every few hours," said Schwarb.

One main benefit is the opportunity to share research between disciplines and projects.

"This is a template for the way things should be done in a shared facility like this, where lots of data is generated," said Sutton. "Hopefully, this becomes an example of what can be accomplished when you share a computational resource, and, hopefully, it will bring all biomedical imaging users at Illinois together. BIC can provide an environment where labs can not only acquire data, but also collaborate."

A number of researchers have already utilized the new service, ranging from those in neuroscience, psychology, biomedical engineering, and more.

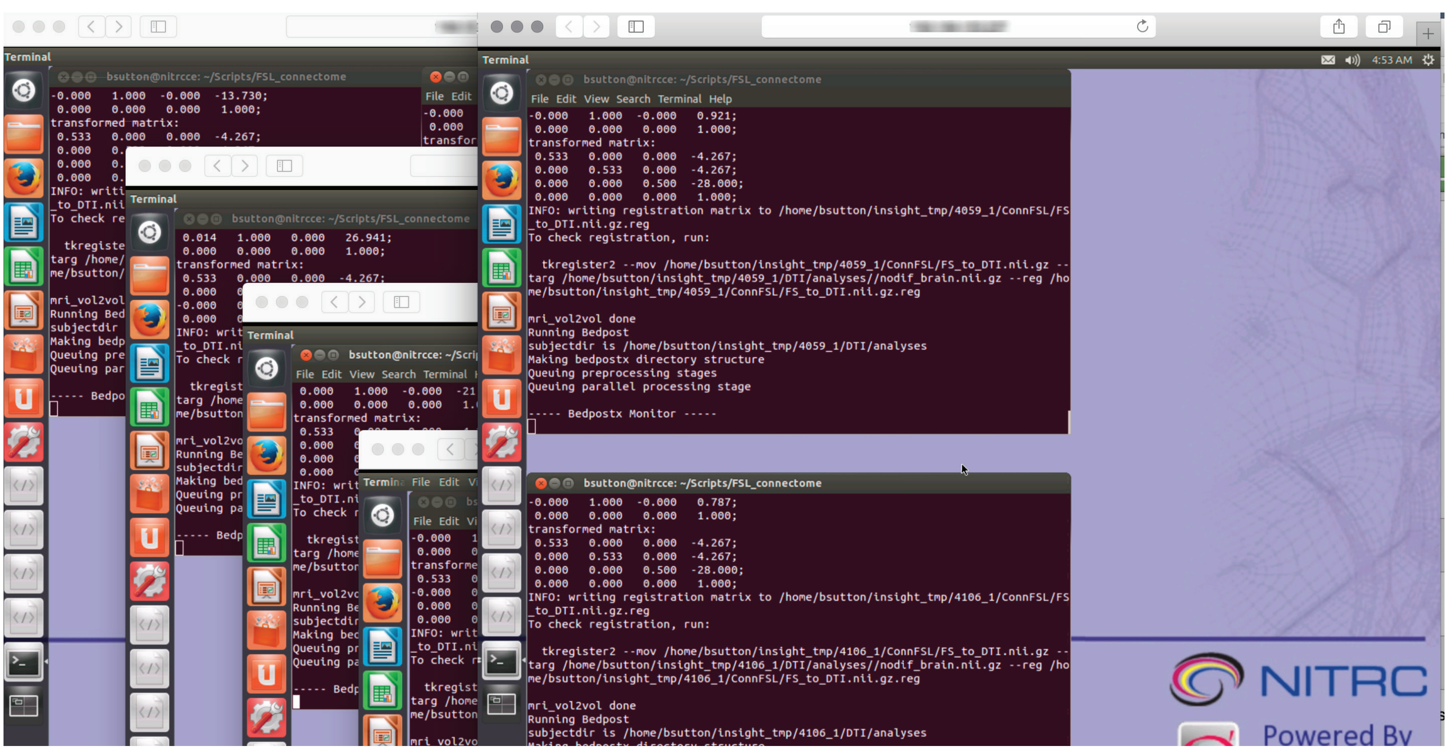
"The comment usually is 'I couldn't have done this in my own lab except with lots of time' or 'There's no way we would've gotten this result in this amount of time with our own resources,' " said Sutton.

Both current users and Sutton believe the new addition to BIC is a great resource for both Beckman research and the research community at large. He hopes to see an increased interest in the system and more researchers participating.

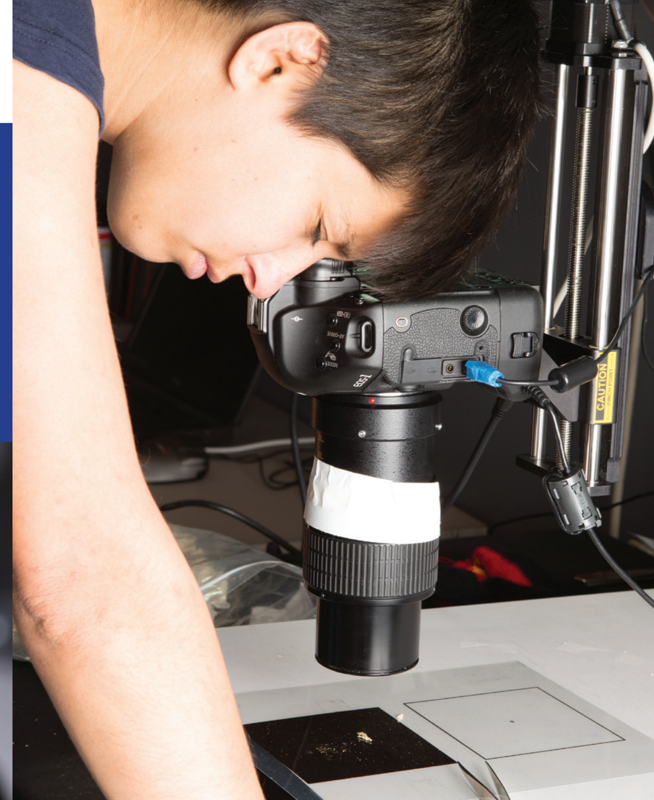
"Having a shared resource is going to bring the community together and make it stronger. It will show neuroimaging at Illinois has consistency and stability. I hope we'll be able to pull a lot of institutional knowledge together," said Sutton.

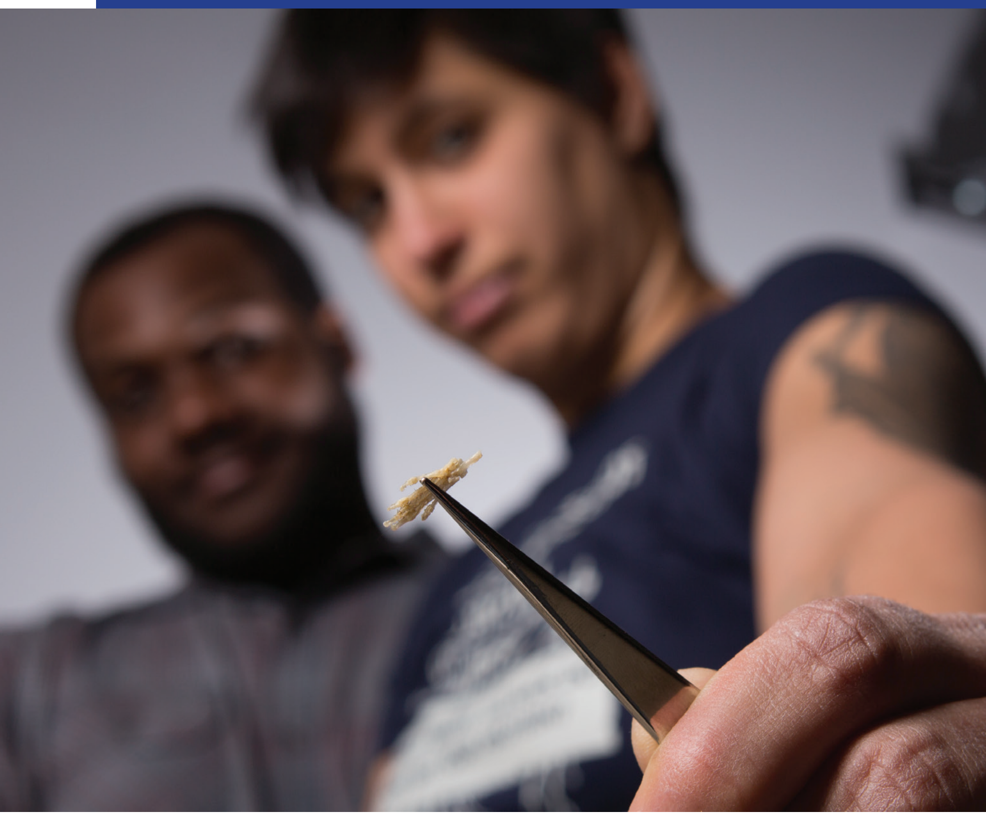
For more information on BICNICC regarding research, please contact Brad Sutton at bsutton@illinois.edu.

Web browser windows separate Linux instances running processing for a neuroimaging study.



Genetic Analysis through 3D Visualization





Above: Natasha Mazumdar examines the metapodials of pedigreed mice to determine how variations arise from natural selection. Photo credit: Travis Ross

Left: Oshane Thomas and Mazumdar, research assistants for Charles Roseman in the department of anthropology, perform genetic analysis on mice bones in the Visualization Laboratory at Beckman. Photo credit: Travis Ross

By Rachel Buller

Charles Roseman, an associate professor in anthropology and an affiliate faculty member in Beckman's Cognitive Science Group, uses computer software to perform genetic analysis on mice bones, which enables him to decode variations that arise from natural selection.

Roseman works with different software functions in the Visualization Laboratory (Vis Lab) to create images or data sets that shed light on the evolutionary process.

"Variations presented to forces of evolution may bias the ways that organisms evolve or don't evolve," said Roseman.

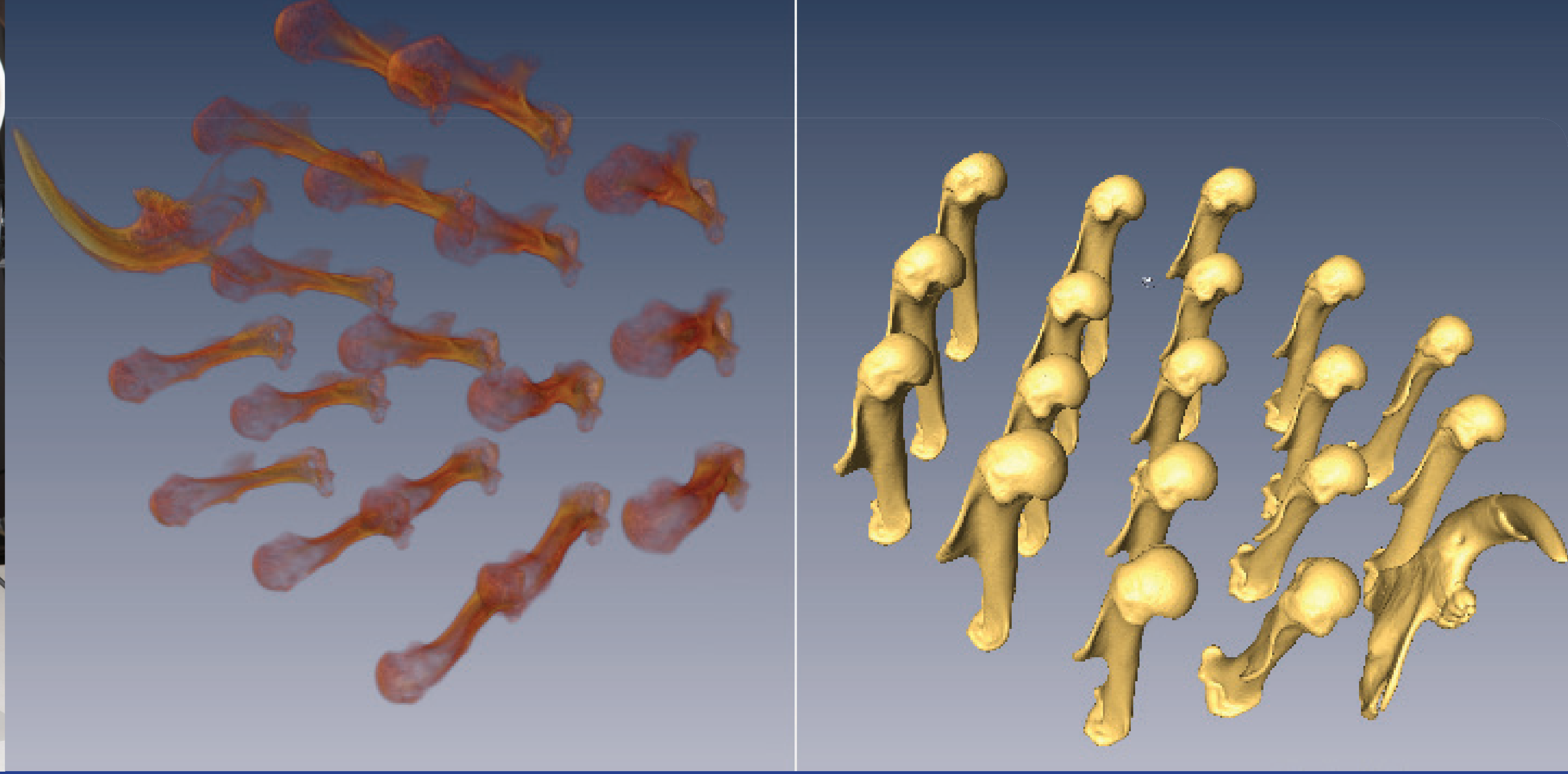
For example, a scapula and hipbone have dissimilar evolutionary origins but display shared functions in fossil records.

Natasha Mazumdar, one of Roseman's research assistants, has been photographing the metapodials (hand and foot segments) of pedigreed mice to determine how these variations arise.

"The aim of this research is to examine the genetics at play in the development of these bones and test a model for this development," said Mazumdar. "This data set will hopefully include around 800 individuals, with both forelimb and hindlimb measurements for most."

While other fields use the word "macro" to indicate large scale, as in macroeconomics, in photography it describes close-up work.

Travis Ross, manager of the Vis Lab, has improved the accuracy of macrophotography at Beckman by creating a tiny calibration plate for the macro-lens, which generates a lens profile that is later applied to the images in Photoshop.



Above: A micro-CT scan of mouse humeri displayed by Amira, a software platform for 3D data visualization.

"We have helped develop a custom workflow for their research where they acquire macro-photographs of tiny specimens and accurately measure dimensions from the photographs.

"With geometric lens distortion removed and camera calibration applied, they can produce repeatable and dimensionally accurate image data," said Ross.

Oshane Thomas, another one of Roseman's research assistants, uses the Vis Lab to quantify geometric properties of bones, specifically mouse humeri. He scans the elements at high resolution in a microCT scanner with the latest protocol.

Thomas then reconstructs these scans in order to create a surface model of each bone using Amira, a software platform for 3D data visualization. He then places 3D points on the exterior of each bone so that a configuration of points can be used to describe that bone's shape.

Amira allows a person to measure the data more precisely than traditional measurements and to discover "how differences in the shape of the humerus across all these mice relate to their genotype or to their environment," said Thomas.

His goal is to discover how habitual movement and kinematics influence changes in bone structure throughout the lifetime of an animal, which would allow "us to more accurately reconstruct the locomotor behavior of extinct primates," said Thomas.

Mazumdar would like to use the knowledge that she has gained from her research at Beckman in upcoming academic endeavors.

"I am interested in how genetics and environment act together to create a whole organism," said Mazumdar. "I'd like to apply what I learn about developmental and quantitative genetics to future research about the evolution of human physical performance capacity."

New membership rates for Vis Lab started Jan. 1

Vis Lab computers:
$2.09/hr

3D scanner:
$28.90/hr

High-speed camera:
$5.34/hr

Still camera:
$2.60/hr

Training and consultation:
$18/hr

Graphics services:
$50/hr

If you have any questions, please contact Vis Lab Manager Travis Ross:
travisr@illinois.edu
217-244-9033
4th Floor, Room 4325
Beckman Institute

The Holy Grail: Automatic Speech Recognition for Low-Resource Languages

By Maeve Reilly

Most people use automatic speech recognition on electronic devices without giving a thought to the complex programming behind the convenience. Computer programs like Siri enable people to quickly and easily get directions, search the web, or find out the name of the song that's playing on the radio.

For those who speak English, or another language that is prevalent in First World nations, Siri or other voice recognition programs do a pretty good job of providing the information wanted. However, for people who speak a "low-resource" language—one of more than 99 percent of the world's languages—automatic speech recognition (ASR) programs aren't much help. Preethi Jyothi, a Beckman Postdoctoral Fellow (pictured above), is working towards creating technology that can help with the development of ASR software for any language spoken anywhere in the world.

"One problem with automatic speech recognition today is that it is available for only a small subset of languages in the world," said Jyothi. "Something that we've been really interested in is how we can port these technologies to *all* languages. That would be the Holy Grail."

Low-resource languages are languages or dialects that don't have resources to build the technologies that can enable ASR, explained Jyothi. Most of the world's languages, including Malayalam, Jyothi's native south Indian language, do not have good ASR software today. Part of the reason for this is that the developers do not have access to large amounts of transcriptions of speech—a key ingredient for building ASR software.

Jyothi and Mark Hasegawa-Johnson, a full-time faculty member in Beckman's Artificial Intelligence Group and professor of electrical and computer engineering, have come up with a novel way to transcribe the low-resource languages: using crowdsourcing, they hired primarily native speakers of English or Mandarin Chinese who don't speak one of the low-resource languages to listen carefully to the speech, and then write down English or Chinese nonsense syllables corresponding most closely to what they think the speaker is saying.

"When Mark first suggested this idea, it sounded very interesting but extremely challenging," recalled Jyothi. "At that point, we didn't know what kind of data we would get from crowd workers.

"So, I designed a pilot experiment to collect data. Then it occurred to me that if we had several people transcribe the same sound clip, even though they are all highly error-ridden, the errors can be made to cancel out with each other, and you will be left with systematic biases. These systematic biases can be removed because they can be learnt from the data using standard machine learning techniques."

Systemic biases, said Jyothi, refer to the differences in phoneme inventory between languages. For example, most Indian languages distinguish between a breathy "b" and a non-breathy "b"; English-speaking listeners write down both sounds using the same symbol, "b."

When Jyothi presented their first results at the Association for the Advancement of Artificial Intelligence conference in January 2015, she included a video clip from YouTube in her talk, in which a Russian song was subtitled using English words that sounded similar. Hasegawa-Johnson used a similar video in his presentation at the conference in which Tamil lyrics had been transcribed using English words. "If you don't know the language, it sounds almost exactly like what's written," said Jyothi.

The videos were not only funny, but they also provided some clues for the researchers. "We don't want to read too much into this one example, but it really represents the patterns we see in the task overall," said Hasegawa-Johnson. "For example, the title of one spoof video is 'Fine, Benny Lava,' which is how the transcriber misheard the Tamil words 'kaayndha nilaavo.' Why did the transcriber hear 'Benny Lava' at the end of the song instead of 'Danny Lava'? I think it's because the 'dh' sound in Tamil is so different from any English consonant, so the transcriber couldn't really figure out what it was—instead of hearing it as 'd,' which would make sense. He just tried to make the best guess that he could. In our experiments, we find that segments that don't exist in English suffer a whole lot more variability than segments that do exist in English, and we have to model that using a probability distribution."

Their project was selected for the 2015 Jelinek Summer Workshop on Speech and Language Technology held at the University of Washington. The team's goal was to build on the initial successes Jyothi and Hasegawa-Johnson had with recovering information from non-native speakers and develop techniques for using such information in building an ASR system.

"The transcripts we obtain from this process are probabilistic in nature, and cannot be used in the same way the deterministic transcripts from a professional transcriber can be used to train an ASR system," explained Jyothi. "We still needed to figure out the best way in which they can be used. That was the focus of the summer workshop. Before the results from the workshop, it was not entirely clear if we would be able to get significant gains compared to alternatives that do not use the information from the non-native transcribers."

The team developed the paradigm of "probabilistic transcription" as a framework within which to place their new crowdsourcing methodology. According to the Jelinek workshop team, a "deterministic transcript" is a sequence of words or phonemes representing the content of a speech signal—exactly the meaning with which the word "transcript" is used in courtroom reporting, or in television broadcasting. A "probabilistic transcript," on the other hand, is a probability distribution over possible phoneme sequences.

"Experts in machine learning have always maintained this convenient fiction that human labelers provide a 'gold standard,' a label that is guaranteed to be true," said Hasegawa-Johnson. "We have always known that human labelers make mistakes, but we never really had a systematic mathematical framework with which to characterize the mistakes made by human labelers. Probabilistic transcription provides that framework."

The project focused on seven languages: Arabic, Cantonese, Dutch, Hungarian, Mandarin, Swahili, and Urdu. "We were able to get significant improvements on a speech recognition system for the languages," said Jyothi. "The system started with data that was not for that particular language and then we adapted those systems using these transcriptions."

The performance improvements obtained were particularly marked for Swahili. "The pronunciation of Swahili words can be figured out by looking at how it's written, so the correspondence between the letter and the sound is much more systematic than for a language such as English," said Jyothi.

The current project used only native English speakers, but the researchers are hoping to expand upon their transcriber base to include native speakers of other languages whose characteristics better match those of the language being recognized.

"If you want to recognize Cantonese or a dialect of Cantonese, which is only spoken in some remote regions in China, we could expect native speakers of Mandarin to provide more useful information than native speakers of English," said Jyothi. "So, can we choose languages which are closer somehow to the language which we are trying to recognize? Then a research question is what does 'closer' mean?" Jyothi points out that the relevant characteristics are the nature of the sounds in the languages.

"For instance, in Hindi, you have 'cuh' and you also have the sound 'khuh' (aspirated 'k'). A native English speaker may not differentiate between these sounds because such a distinction is not common in English. But there are many other languages in which changing an aspirated sound to its unaspirated version changes the word. So, the language background of the transcribers would have a significant effect on how well different sounds are detected."

In ongoing work supported by an NSF EAGER grant, Hasegawa-Johnson, Jyothi, and Lav Varshney, an affiliate in Beckman's Image Formation and Processing Group and assistant professor of electrical and computer engineering, are investigating how to carefully select a set of transcribers with different native languages, in order to ensure adequate coverage of the sounds in the target language.

The applications for ASR for low-resource languages are multiple, said Jyothi. When a disaster occurs in a remote part of the world, cell phone users would easily be able to report on the crisis, but the usefulness of such reports is greatly multiplied if they are made available as text that can be automatically searched and collated. Further, such a system will continue to empower the society even after the emergency is over, as thousands of

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Postdoctoral Fellow Biggan Works to Prove Exercise Improves Cognition

By Kaitlin Kamp

John Biggan, one of the Beckman Institute's Postdoctoral Fellows, explains that while his research may be complicated, the motivation behind the research is quite simple.

"Exercise is good for the brain," said Biggan.

Originally from Arlington, Texas, Biggan received his bachelor of fine arts in theater with a minor in psychology, and both his master's of science and Ph.D. degrees in experimental psychology from the University of Texas at Arlington. After studying experimental psychology with a combination of cognitive psychology and imaging work, Biggan began focusing on cognitive aging. His interests led to a partnership with a kinesiologist, and their work turned into Biggan's first postdoctoral job in Arlington.

From there, the road to Beckman was a relatively easy choice.

"When I was writing papers and doing research, the same names kept popping up," said Biggan. "I kind of figured if I wanted to work in this field, I should go work with the top people and they were all at Beckman."

Now, after a year in Beckman's Postdoctoral Fellowship program, Biggan has two research emphases: cognitive aging in older adults and the cognitive effects on children whose mothers are physically active during pregnancy.

The first component studies the effects of exercise on cognitive aging. As Biggan explained, cognitive aging is made up of a person's memory and executive functions, such as the ability to switch tasks. Biggan uses exercise interventions to hopefully slow down the cognitive aging process and make life for older adults better.

"We know that exercise works, it helps the brain, but there are a lot of questions about why it helps the brain," said Biggan.

Biggan offered a few explanations. Exercise may help the cardiovascular system move more resources, such as glucose, oxygen, and proteins in the blood, to the brain consistently and effectively. Another reason could be the release of neurotrophic factors during exercise.

"Neurotrophic factors are molecules that help brain neurons communicate with one another, to increase their connections. These have been described as 'Miracle Gro' for the brain when you perform aerobic exercise," said Biggan.

Lastly, Biggan studies how the physiology of musculature in the body affects the brain during exercise. This gives insight into what is causing changes at the brain level.

The second part of Biggan's research came him from a simple thought.

Functional MRI of areas in the brain showing activation in response to a stimulus.

"I had this 'a-ha' moment; I spent so much time with older adults that I forgot older adults have to first be kids, then younger adults, and then middle-aged adults," said Biggan,

This insight led Biggan to think back to the earliest time a person exists, when he or she is still inside the womb. He asked, "What happens when a pregnant mother is engaging in regular physical exercise?" A mother and fetus share so many resources that proteins, like neurotrophic factors, released on the muscular level during exercise should be shared with the baby.

"What are the long-term effects of physical activity on an infant while still in the womb?" asked Biggan.

In order to find an answer, Biggan works with Beckman Director Art Kramer, professor of psychology and neuroscience and member of Beckman's Human Perception and Performance Group; Naiman Khan, assistant professor of kinesiology and community health; and Charles Hillman, professor of kinesiology and community health and a member of Beckman's Human Perception and Performance Group. Most of their research studies 8- to 10-year-old children and their parents. They ask mothers about their exercise level while pregnant and discover if it had any long-term impact on their child's cognitive development. Biggan uses databases of pre-intervention data to collect his research. These databases contain information from previous brain scans, cognitive EEGs, and body scans that can separate lean muscle from fat tissue. He also designs questionnaires for parents asking about their child's physical activity, illnesses, formula intake, and other health factors.

Biggan understands the importance of his research for people concerned about their own cognitive aging or their aging processes.

"Cognitive decline is a really big deal for people; it's something that's very scary," said Biggan.

Biggan hopes his research motivates people to improve their lifestyles to benefit their future selves.

"Most people know that exercise is good for them, but they still don't do it. The benefit of what we're doing here is that we can give people one more reason to go out and take care of themselves physically because they realize this will also help them mentally," said Biggan.

Biggan plans to spend another year finishing his fellowship at Beckman before finding a faculty position at a research institute.

Molecular Imaging, from page 3.

"Someday, we can give these handheld units to doctors in the clinic. So when they apply a drug to a patient, they can track it to make sure enough is there, and confirm that the drug is working. Every patient is going to metabolize these drugs differently. So you can't just apply the same dose to every patient. You need some way of monitoring to understand did the patients get the right amount of drug, did their cells respond appropriately; that's where personalized medicine could be achieved. These methods fit with GSK's mission of improving patient health.

By reducing the need for invasive testing and giving better, earlier indications as to whether a drug is having any effect, patient outcomes and new drug development will both benefit," said Arp.

"As we're building our new engineering-based college of medicine, this is one example where engineering faculty, researchers, and students are working with Carle physicians on research that's of interest to industry and the broader community for developing new drugs and improving healthcare," said Boppart.

Holy Grail, continued from page 10.

citizen journalists would be able to share their reports in a useful form.

ASR can also improve business practices in emerging economies like India, which is home to a large number of low-resource languages.

"Already, in India, there are experimental projects which let farmers find prices for their agricultural commodities using automated telephonic services," explained Jyothi. "Such systems will be much more powerful if they covered the vast populations in remote parts of the country who speak languages and dialects that are truly low-resourced."

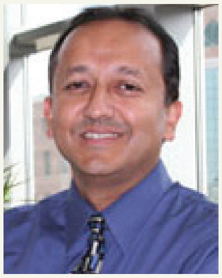
Durbin Visits Beckman Institute

On Friday, January 15, 2016, U.S. Senator Richard Durbin visited the Beckman Institute to highlight his interest in providing National Institutes of Health (NIH) funding for research. Emad Tajkhorshid, from the Theoretical and Computational Biophysics Group, Princess Imoukhuede, from the Bioimaging Science and Technology Group, and Paul Hergenrother, from the Department of Chemistry, gave brief presentations to the senator, thanking him for championing funds for research and providing some details of how that funding has impacted their work.

Durbin also toured the Autonomic Materials Systems lab, led by Scott White (pictured with Durbin, above) from the Autonomous Materials Systems Group.

Adesida Receives 2016 TMS Functional Materials John Bardeen Award

Ilesanmi Adesida, affiliate faculty member in the Nanoelectronics and Nanomaterials Group, has been recognized by the Minerals, Metals and Materials Society (TMS) for his contributions to the field of electronic materials.



Bashir Elected Fellow of BMES

Rashid Bashir, affiliate faculty member in 3D Micro- and Nanosystems, recently was named a Fellow of the Biomedical Engineering Society (BMES). Fellow status is awarded to BMES members who demonstrate exceptional achievements and experience in the field of biomedical engineering with a record of membership and participation in the Society. A portion of a Fellow's annual dues funds BMES activities and student awards.

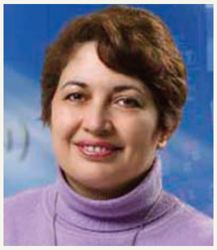
Christian Receives Whitehall Foundation Grant

Catherine Christian, an affiliate in the NeuroTech Group, has been named the recipient of a three-year $225,000 Whitehall Foundation grant. Christian will use the grant to study the inner workings of astrocyte cells within the brain to gain an understanding of how they may aid in the formulation of behavior.

Honors & Awards

Diagnostic Photonics Business Plan Competition Winner at the 2015 Chicago Innovation Showcase

Diagnostic Photonics, a medtech company that is developing a handheld, high-resolution imaging system for cancer surgery, won the 2015 PROPEL Business Plan Competition at the 2015 Chicago Innovation Showcase. Founded in 2008, Diagnostic Photonics' breakthrough medical imaging technology was created by Stephen Boppart and Scott Carney, of Beckman's Bioimaging Science and Technology Group.



Hovakimyan Receives 2015 SWE Achievement Award

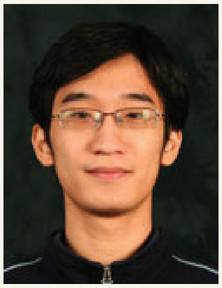
Naira Hovakimyan, affiliate in the Human Perception and Performance Group and professor of mechanical science and engineering, has received the Society of Women Engineers 2015 Achievement Award—the society's highest honor. The award recognizes Hovakimyan's significant contributions to mathematical control theory and its application in safety-critical systems.

Image Formation and Processing Team Top U.S. Finisher in Global Image Challenge

A group of graduate students from the Beckman Institute was the top U.S. finisher and third overall in one category of the ImageNet Large Scale Visual Recognition Challenge. Illinois' Image Formation Processing team (pictured left), led by Thomas Huang, claimed third in the video category, while another team formed by IFP and Microsoft Research Redmond placed 11th overall in the very large-scale scene classification competition.

Jin Receives IEEE Award

Jianming Jin, from Beckman's Science and Technology Group, has received the Chen-To Tai Distinguished Educator Award from the IEEE Antennas and Propagation Society.

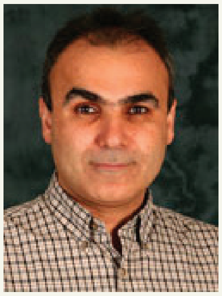


Lam Wins Best Paper Awards

Fan Lam, a Beckman Institute Postdoctoral Fellow, won two best paper awards at the 2015 IEEE International Symposium in Biomedical Engineering in New York and at the 2015 International Society of Magnetic Resonance in Medicine Annual Meeting in Toronto, Canada.

Pan and Team Receive Translational Research Award

Dipanjan Pan, assistant professor of bioengineering and member of Beckman's Bioimaging Science and Technology Group, and his colleague, Pritesh Patel, M.D., Department of Hematology, University of Illinois at Chicago, are developing a highly novel therapy for multiple myeloma. Their project was selected for a 2015-16 Translation Research Award by the Michael Reese Foundation



Tajkhorshid and Knobloch Named University Scholars

Emad Tajkhorshid, full-time faculty member in the Theoretical and Computational Biophysics Group, and Leanne Knobloch, affiliate in Human Perception and Performance, have been named University Scholars in recognition of excellence in teaching, scholarship, and service.

Varshney Receives Bloomberg Data for Good Exchange Paper Award

Lav Varshney, Beckman affiliate in the Image Formation and Processing Group, and his former student Hongyang Bai recently were recognized as prize winners of the NYC Media Lab - Bloomberg Data for Good Exchange (D4GX) Paper Award. In an effort to combat the rise in obesity rates, Varsheny and Bai used Big Data from the location-sharing social media app Foursquare to find that areas with lower obesity rates tended to have more opportunities for social interactions.

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