College Hosts Conference with Higher Education Outreach Program Leaders

The College of Engineering hosted a three-day, National Science Foundation–funded conference on September 23–25, 2019, as part of an early-concept grant for exploratory research (EAGER) that gathered 37 university outreach administrators, K–12 administrators, university students, educational researchers and evaluators to discuss ambassador-based, K–12 outreach programs.

"The goal of the conference was for attendees to discuss their outreach programs, make connections with potential collaborators, share best practices and consider ways to make our programs more effective," says Stacey Freeman, director of national outreach initiatives at the College of Engineering.

The meeting kicked off with a welcoming address from Dean Kenneth R. Lutchen and four keynotes from attendees touching on different subject matters, including introducing the discussion of developing a robust model to measure outreach outcomes on a national scale.

This EAGER program had three phases, the first of which launched in September 2018; this conference was the third and final phase. EAGERs are meant to allow initial, exploratory research into untested, but potentially transformative, ideas or approaches.

The first phase included interviews with potential stakeholders and attendees of the meeting. Sandra Rodegher, manager of national outreach programs at BU, compiled the data from those interviews and turned them into the workshop design.

The college's signature outreach effort, the Technology Innovation Scholars Program (TISP), trains undergraduate students to work with middle and high school students, teaching them about engineering as a discipline and a career.

"From our surveys to the students who have participated in TISP, we know that they enjoyed the program, but we don't know if the program made an impact on their educational future," Freeman explains.

She hopes that the foundations laid during all three phases of the program will help administrators and leaders from K–12 schools and universities work together to build tools to understand if programs like TISP are making a difference in student trajectories. "Creating these communities is really valuable. We can all learn from each other to incorporate new ideas into our programs and gain fresh perspectives."

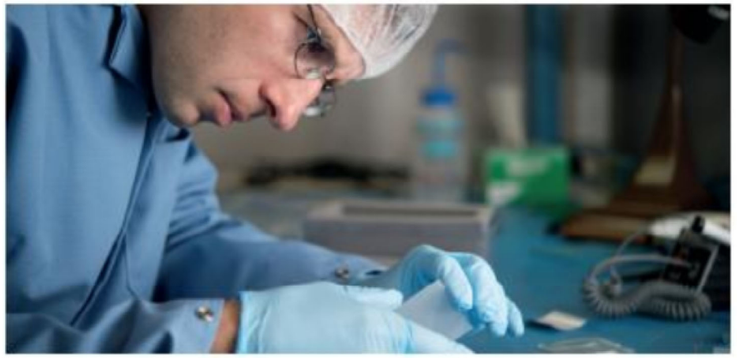
With additional funding, her aim is to continue the meetings annually and eventually develop robust research tools that schools across the nation can use to perform longitudinal studies.

"This first meeting was definitely a success and hopefully just a starting point for what's to come," says Wynter Duncanson, lecturer and assistant dean for Outreach and Diversity. "Learning what my colleagues at other universities are doing and discussing what we think the best evaluation points are for these programs was important and mutually beneficial."—LIZ SHEELEY

A BU X-ray Instrument Is Heading to the Moon

NASA is racing to put humans back on the surface of the moon by 2024 in preparation for an eventual mission to Mars. But between now and then, the moon will have several other visitors, including an instrument built by a team led by the Boston University Center for Space Physics researchers.

Space scientist and engineer Brian Walsh, a College of Engineering assistant professor of mechanical engineering and electrical and computer engineering, is developing an X-ray imager he calls "LEXI" that will be rocketed up to the moon aboard a lunar lander within the next 18 months. From her vantage point on the moon's surface, where she'll sit for two to three weeks, LEXI will peer back at Earth and take the first comprehensive images of our planet's magnetic fields and how they interact with the solar wind.



Walsh examines a lens that will be a component of the X-ray imager.

PHOTOGRAPH BY CYDNEY SCOTT

NASA announced the launch of LEXI (Lunar Environment Heliospheric X-ray Imager) and 11 other lunar science investigations on July 1, 2019.

To meet NASA's aggressive deadline of putting LEXI on the moon within a year and a half, Walsh—who was an engineer at NASA's Goddard Space Flight Center before joining BU—is piggybacking new technology on another X-ray instrument built by the same team, which has already been shot up to space and returned back to Earth.

"We've never had a full view of the Earth's magnetosphere, or known if it changes with time or even if it has holes in it," he explains. "We haven't had a wide enough view of our planet to take those kinds of images."

Just how hard is it to study Earth while sitting on its surface?

"It's like trying to study a whale from inside its stomach."

To build LEXI, Walsh will suit up inside a "clean room" in his lab. He stresses that contaminating LEXI with even trace amount of oils from his fingers or a tiny piece of hair from his head would expel gases during the ride to the moon that could potentially be damaging to the extremely sensitive (and expensive) instruments aboard the lunar lander. LEXI and the other investigations are part of NASA's Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon's Interaction with the Sun (ARTEMIS) Mission.

Walsh, who studies interactions between planetary environments and the sun, is also part of the ongoing European Space Agency and Chinese Academy of Science mission SMILE, which will study how Earth's magnetic fields connect and disconnect with the magnetic fields of the sun. He also leads the CuPID Cubesat Observatory team at BU, which is building a toaster-sized device that will use a wide-view X-ray telescope to examine interactions between solar winds and Earth's magnetosphere. Supported by NASA, CuPID is set to launch into orbit in 2020.

—KAT J. MCALPINE

Magnetic Metamaterial Can Turn Up the Volume of MRI

This array of helical resonators stands at three centimeters tall and is constructed from 3D-printed plastic and coils of thin copper wire.

PHOTOGRAPH BY JACKIE RICCIARDI

Could a small, ring-like structure made of plastic and copper amplify the already-powerful imaging capabilities of a magnetic resonance imaging (MRI) machine? Xin Zhang and Stephan Anderson, and their team at the Boston University Photonics Center, can clearly picture such a feat. With their combined expertise in engineering, materials science and medical imaging, Zhang and Anderson, along with Guangwu Duan and Xiaoguang Zhao, designed a new magnetic metamaterial—reported in *Communications Physics*—capable of boosting the performance of MRI in more ways than one.

MRI uses magnetic fields and radio waves to create images of organs and tissues in the human body, helping doctors diagnose potential problems or diseases. Doctors use it to identify abnormalities or diseases in vital organs, as well as many other types of body tissue, including the spinal cord and joints. "[MRI] is one of the most complex systems invented by human beings," says Zhang, a College of Engineering professor of mechanical engineering, electrical and computer engineering, biomedical engineering, materials science and engineering, and a professor at the Photonics Center.

By combining their expertise, Zhang, Anderson, Duan and Zhao designed a magnetic metamaterial that can create clearer images at more than double the speed of a standard MRI scan.

Depending on what part of the body is being analyzed and how many images are required, an MRI scan can take up to an hour or more. Patients can face long wait times when scheduling an examination and operating the machines is time-consuming and costly for the healthcare system. Strengthening MRI from 1.5 T (the symbol for tesla, the measurement for magnetic field strength) to 7.0 T can definitely "turn up the volume" of images, as Anderson and Zhang describe. But although higher-power MRIs can be done using stronger magnetic fields, they come with a host of safety risks and even higher costs to medical clinics. The magnetic field of an MRI machine is so strong that chairs and objects from across the room can be sucked toward the machine, posing danger to operators and patients alike.

In contrast, Zhang and Anderson say that their magnetic metamaterial could be used as an additive technology to increase the imaging power of lower-strength MRI machines, increasing the number of patients seen by clinics and decreasing associated costs, without any of the risks that come with using higher-strength magnetic fields. They even envision the metamaterial being used →

with ultra-low field MRI, which uses magnetic fields that are thousands of times lower than the standard machines currently in use. This would open the door for MRI technology to become widely available around the world.

"This [magnetic metamaterial] creates a clearer image that may be produced at more than double the speed" of a current MRI scan, says Anderson, a School of Medicine professor of radiology and vice chair of research in Boston Medical Center's radiology department.

The magnetic metamaterial is made up of an array of units called helical resonators—three-centimeter-tall structures created from 3D-printed plastic and coils of thin copper wire—materials that aren't too fancy on their own. But together, helical resonators can be grouped in a flexible array, pliable enough to cover a person's kneecap, abdomen, head or any part of the body in need of imaging. When the array is placed near the body, the resonators interact with the magnetic field of the machine, boosting the signal-to-noise ratio (SNR) of the MRI and, as Anderson says, "turning up the volume of the image."

"A lot of people are surprised by its simplicity," Zhang observes. "It's not some magic material. The 'magical' part is the design and the idea."

To test the magnetic array, the team scanned chicken legs, tomatoes and grapes using a 1.5 T machine. They found that the magnetic metamaterial yielded a 4.2 fold increase in the SNR, a radical improvement, which could mean that lower magnetic fields could be used to take clearer images than currently possible.

Now, Zhang and Anderson hope to partner with industry collaborators so that their magnetic metamaterial can be smoothly adapted for real-world clinical applications.

"If you are able to deliver something that can increase SNR by a significant margin, we can start to think about possibilities that didn't exist before," Anderson explains—such as the prospect of having MRI near battlefields or in other remote locations. "Being able to simplify this advanced technology is very appealing."

—JESSICA COLAROSSI

Floating to the Top

Shipbuilding is not part of the College of Engineering's curriculum, but several teams of students waded into those waters when they built model ships and tested them in a competition on the Charles River.

The College of Engineering hosted the inaugural model shipbuilding workshop and competition during Alumni Weekend. Put on by the Singh Imagineering Lab—where students can put their engineering skills to use on extracurricular projects—the contest drew interest from over 60 students, with nine teams competing in the final event.

Eleven teams were judged on their ship's weight capacity and average speed through a predetermined course. The winning team, Kaihui Gou (ECE'20) and Andrea Cheng (Chemistry'20), designed the largest boat, measuring 5 feet 2 inches, that could carry the maximum cargo of 38.25 pounds.

The winning team shows off their boat before testing it in the water.

Students construct their boats in the Imagineering Lab.

The idea was sparked by the work of doctoral fellow Alexei Sondergeld (ME) when he began using the Imagineering Lab this past summer as a place to continue one of his lifelong interests—boatbuilding. His sophisticated and impressive designs led the assistant manager of the Imagineering Lab, graduate student Oluwagbebemi Oyeniyi (BME), to ask Sondergeld for help designing the contest.

"All of the teams ended up using distinctly different designs," Oyeniyi notes. "Each one had the same motor, so the speed really depended on the design of the ship."

Because shipbuilding is a unique skill, Oyeniyi and Sondergeld decided to host a workshop the Friday before the contest to teach students the basics. During the workshop, Sondergeld demonstrated how to build a ship twice, once using aluminum and once using popsicle sticks and duct tape.

"The students were able to ask Alexei questions during the demonstration about how and why he was designing the ship in a certain way, and were able to get advice and learn from someone who is an expert in model shipbuilding," Oyeniyi says, adding that because of the success of this first competition, the Imagineering Lab wants to continue hosting this annual event for students across the University to compete.

Second place went to Kali Hamilton, Christian Medina, Tomohiru Shu and Yuya Matsuda, and third place to Siyang Zhang and Lin Fan. The first-place team received $300 as a prize, second place $200 and third place $100.

Associate Dean for Administration Rich Lally, Professor Alice White (ME), Associate Professor Gregory McDaniel (ME, MSE), Research Engineer Aleksander Zosuls (ECE) and two alumni, Aidan Rose (ME'17) and James Wang (ME'17), judged the competition.

—LIZ SHEELEY

BU's Chapter of the National Society of Black Engineers Thrives

Remi Shittu (ENG'19) was recruited into the National Society of Black Engineers (NSBE) at BU early in her freshman year. This past academic year as a senior, she was chapter president. Her leadership pushed the group to create new programs and recruit many more members, resulting in the BU chapter winning more awards than any other in their region last year.

She credits much of the success to letting her executive board run with their own ideas.

"I gave them the freedom to be creative with our weekly meetings and to change things up," she says. "As a leader I knew I couldn't do everything myself, and that there was someone on the board who could execute an idea better than I could."

During the national NSBE convention in March, BU's chapter won six awards in their region, which includes Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, East Canada and West Africa. They were awarded Chapter of the Year, Chapter of the Month for January, Chapter of the Spring Semester, the Pre-Collegiate Initiative Award, the Award of the Colorful Flame (for their community service efforts) and Member of the Spring Semester, which went to Phoebe Ato (ENG'21).

The new programs that drove this attention included STEM Day, a conference hosted by NSBE students that welcomed underrepresented students from area schools to tour the engineering facilities on campus, learn basic engineering principles, hear speakers and participate in an egg-drop challenge.

"I really wanted to plan events that were impactful and involved students outside of engineering," Shittu says. "I noticed there was a large amount of people who we could reach, but who we weren't, and I realized that there was a lot we could learn from the people within the BU community."

She decided to partner with other similar groups on campus to make each group's programming more effective. Instead of repeating the same networking night they had held before, Shittu decided to ask the Society of Hispanic Professional Engineers (SHPE) if they wanted to join forces and host one night rather than conduct separate events; this resulted in the largest networking NSBE chapter event ever, with 14 companies attending instead of six.

The group also held open-forum discussions to discuss pressing issues in the community in a series called Real Talks. Students from outside of ENG could attend, but the topics were still relevant to the group's mission and included topics like technology addiction and internet bullying.

She notes that the NSBE didn't just help her grow professionally, but also gave her a support system.

BU chapter members of the National Society of Black Engineers receive their awards at the society's national convention. (Top row, left to right): Oluwagbebemi Oyeniyi, Abdullaah Robis, Avery Brown (NSBE Region 1 Vice Chair; does not attend BU), Ashaki Gumbs, Ryan Cully, A'zsa Johnson, Abdul Ka; middle row (left to right): Stacey Samedi, Empress Kelley, Fatima Dantsoho, Marybelle Raymond, Briana Mayes, Phoebe Ato, Ciara Allen; seated: Remi Shittu

"There are many points in engineering when certain classes can break you," she says. "But having this gave me a network outside of my family; people who helped me along the way."

When Shittu was vice president of external affairs during her junior year, the chapter had about 15 to 20 active members; under her leadership this past year, they had 40 to 45.

"I didn't want to settle for what had always worked," she says. "I wanted to push the envelope."

—LIZ SHEELEY