

Joint Department of
**BIOMEDICAL
ENGINEERING**



UNC
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UNIVERSITY

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LETTER FROM THE CHAIR



Dr. Paul Dayton

DEAR BME ALUMNI AND FRIENDS:

The year 2020 finds the world in a struggle to protect human health on a scale not seen in over a century. Rather than being discouraged by the magnitude of this challenge, I am heartened when considering the mission of the UNC / NC State Joint Department of Biomedical Engineering: **to unite engineering and medicine to improve lives**. Thinking of this mission, I am reminded of the exciting research achievements of my

colleagues here in the Joint Department as well as the amazing work of biomedical engineers around the world, and I see better days ahead.

For his 2011 book “Physics of the Future,” scientist and author Michio Kaku interviewed researchers at the cutting edge of various scientific and engineering disciplines and then extrapolated potential technological developments over the next 100 years. At the end he imagines New Year’s Day 2100 with many current human health problems substantially improved by technology. Most of these technologies fell in the area of biomedical engineering. For instance, a typical residence contains an artificially intelligent digital assistant helping the occupant plan a day optimized for safety, productivity and well-being. Hundreds of DNA and protein sensors built into the home’s infrastructure (handles, toilets, sinks, etc.) daily analyze bodily fluids at the molecular level for any sign of illness. Contact lenses provide an always-available visual interface to the Internet. Many of these concepts are already being explored by biomedical engineers. For example, voice interface smartphones with biometric identification for greater security without keys, cards or passwords.

Kaku further speculated specialized robotic surgical tools allowing vascular and neural microsurgeries beyond current capabilities, and scans from home-based cellphone-sized MRIs supporting real-time individualized health care. This potential reality is coming fast, cellphone-sized ultrasound systems now allow physicians to acquire imaging data, and state-of-the-art hospitals now use robotic surgical systems. Kaku suggests disorders such as cancer will be detected years before tumors appear, and treated with nanoparticles targeting the first few hundred disease cells. He proposes tissue engineered organs will replace failing or traumatized originals, and neural-interfaced robotic prosthetics and exoskeletons will restore or increase strength and mobility. These technologies are being moved forward in our department as you read this newsletter.

In the most currently prophetic forecast, Kaku describes a news report: global authorities detect a lethal virus with no known cure emerging from the Amazon; they successfully confine the outbreak to a small area via vigilant rapid screening and contact tracing and so ensure sufficient time for gene sequencing to guide development of effective treatment and prevention strategies.

Based on the breakthrough efforts of our faculty, staff and students, as well as the success of biomedical engineers overall, it seems the above described coming decades of improved health and prevented pandemics is not just speculation but achievable. The following newsletter reports some of our exciting work to specifically fight COVID-19 and generally to promote happier, healthier and longer lives over the 21st century. It contains a wealth of information about our programs and who we are. I encourage you to contact us with questions or comments regarding the exciting educational and research opportunities we offer!

Sincerely,

A handwritten signature in black ink that reads "Paul Dayton".

Paul A. Dayton, Ph.D.

William R. Kenan, Jr. Professor and Interim Chair

UNC / NC State Joint Department of Biomedical Engineering



Startup develops accessible prosthetics

THREE MEMBERS OF THE WOLFPACK are developing life-changing prosthetic kits to help above-the-knee amputees worldwide.

Alumni Lindsay Sullivan and Dustin Prescott and current graduate student Aaron Fleming took a product innovation course together in 2017. Sullivan and Fleming were studying in the Joint Department and Prescott was earning his MBA from NC State.

The multi-disciplinary course introduced them to LifeNabled, a company that provides prosthetics and orthotics to amputees in developing nations.

Five percent of above-the-knee amputees worldwide have access to prosthetics. Traditional prosthetics need to be custom molded for each individual, a process that takes hours and can require thousands of dollars. Learning about LifeNabled's

work inspired Sullivan, Fleming and Prescott to create a new type of prosthetic, one that can be easily adjusted for an above-the-knee amputee.

The three founded OpenGait to take their ideas to the next level.

“One of the reasons I got into biomedical engineering was to solve problems and improve technology to improve quality of life,” Sullivan said. “You can have a direct impact.”

The team identified three key locations on limbs that can withstand the pressure of using a prosthetic and then developed a socket system that can adjust on three axes. That adjustability streamlines the process for amputees, removing the need for custom molding and making it easier to fit a prosthetic.

In 2019, OpenGait was selected for NC State’s I-Corps, a National Science Foundation program that offers researchers entrepreneurial training, funding and support. At NC State’s 2019 Lulu eGames, OpenGait won first place for new venture and for social and environmental impact in addition to second place in design and prototype and audience choice.

While finessing its socket system, OpenGait is also developing a prosthetic kit that will include everything needed to fit an above-the-knee amputee with a prosthetic. It would give amputees access to prosthetics even if they don’t live near a medical facility with prosthetic services.

“One of the reasons I got into biomedical engineering was to solve problems and improve technology to improve quality of life.”

Lindsay Sullivan



In 2019, OpenGait joined LifeNabled in Guatemala, making traditional sockets and testing their socket prototype on two amputees. Using the amputees’ feedback, OpenGait is continuing to develop a prosthetic that can be worn for an extended period of time.

While in Guatemala, Fleming recognized challenges that amputees face around the world. He spent years in West Africa before starting his graduate program and witnessed barriers to mobility.

“In Senegal, people walked everywhere,” he said. “It was so much more common for people to be walking or using a bike, something where you are the one powering it. Amputation can drastically affect one’s ability to get around.”

“We would hope to remove those barriers,” Sullivan said. “You could give a kit to someone in the middle of nowhere.”

Sullivan received her doctorate in biomedical engineering in May, and Fleming is in his fourth year of the program. The OpenGait team hopes to have a final prototype of the socket system within two years. Then, the goal is to help organizations reach more amputees.

“We would love to increase the number of amputees these organizations can see and reduce the time it takes to produce a device,” Fleming said. “Then we want to work with larger organizations who maybe can’t do much more than providing a crutch or a wheelchair.”

“We get to meet a need that’s very real,” he said. •



ALIGNING

STRENGTHS

TO ADVANCE MEDICINE

COMBATING VIRUSES ISN'T SIMPLE: the COVID-19 pandemic has made that clear. As the virus began taking lives and occupying headlines, NC State scientists across several disciplines came together to explore creative strategies to combat viral infections.

Despite being in different parts of the university, they were able to start this important work quickly because of connections they formed as part of NC State's Comparative Medicine Institute (CMI). This research institute encourages interdisciplinary collaborations among more than 200 biomedical sciences-focused researchers in six colleges and 26 academic departments at NC State, as well as researchers from UNC-Chapel Hill, Duke University and NC Central University.

Scientists in the institute use a team science approach, working together to study a broad range of problems related to human and animal health from the basic molecular level all the way through human and veterinary clinical trials.

"We have exactly the kinds of resources in sciences and veterinary medicine that help us solve problems that are relevant for human health," says Dr. Joshua Pierce, CMI co-director and LORD Corporation Distinguished Scholar in the College of Sciences.

"Our program is the link between what happens at NC State in translational medicine, which uses basic science to investigate new medical therapies or procedures, and the clinical application at UNC and Duke," says Dr. Jorge Piedrahita, CMI co-director and Randall B. Terry Jr., Distinguished Professor of Translational Medicine and Alumni Association Distinguished Graduate Professor in the College of Veterinary Medicine.

MAKING CRUCIAL CONNECTIONS

At a university the size of NC State, connecting with others who share your research interests but have a different skill set or perspective than yours could be

challenging. Like other NC State research centers and institutes, the CMI aims to make it much easier.

Creating and building centers and institutes has been a focus of NC State's research efforts in recent years because of their potential to encourage collaboration.

"Centers and institutes serve a vital research function for NC State, bringing together researchers to solve complex interdisciplinary problems that improve our futures," says Dr. Mladen Vouk, NC State's vice chancellor for research and innovation. "Every day, this is helping the CMI make important clinical and research advances in animal and human disease education and research."

"The mission of the CMI is to bring faculty together to do better research," says Piedrahita. "Everything we do is to promote faculty and students interacting with each other."

One way the CMI encourages collaboration is by providing seed funding to research proposals only if they are from more than one investigator. "Give us a project that brings two fields together, and we get excited," Piedrahita says.

"What the CMI has been useful for is to really gather and concentrate the depth that NC State has to offer on a specific topic that might be cross-departmental," says CMI member Dr. Matt Fisher, an associate professor in the Joint Department.

To help spark these connections, the institute regularly hosts retreats, brainstorming sessions and other types of networking events, which have moved online since social distancing measures were put in place.

One such event helped Pierce make a fruitful connection with a veterinary medicine researcher he previously hadn't known. "A CMI pitch event has led to a startup company, two funded National Institutes of Health grants and a really productive collaboration in ways I couldn't have expected," Pierce says.

TIMELY SOLUTIONS

Once people understand their common interests and find open lines of communication, creative interdisciplinary research can blossom.

After the COVID-19 pandemic started, CMI associate director Scott Laster started receiving calls from faculty who wanted to find others to collaborate with on antiviral solutions. Within weeks, the CMI launched its Center for Advanced Virus Experimentation (CAVE).

"Some viruses are just too smart, and scientists have been in a rut trying to develop vaccines for them," says

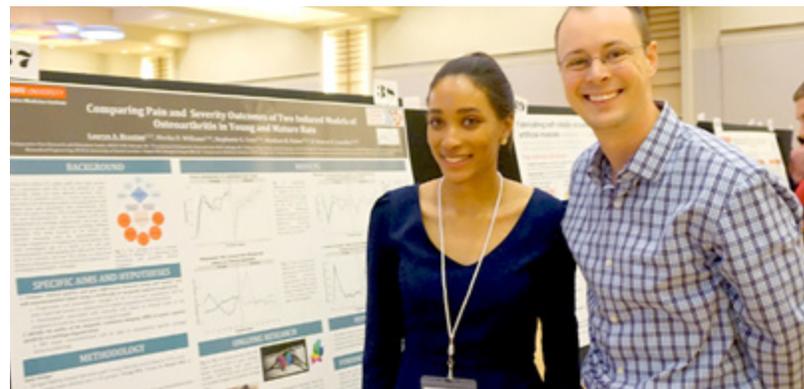
Laster, a professor of biological sciences. "So, we're taking a different angle."

A core team of eight faculty from four NC State colleges is focusing on four approaches: antiviral materials (for things like desks and steering wheels) that would reduce the spread of viruses, new models for studying virus growth, foods that can be engineered to produce antiviral effects, and novel therapies to treat viral infections. Though the research is still in early stages, advances could make a big difference in how the world fights future pandemics.

"NC State hasn't traditionally been a leader in this area, but we've essentially taken the strengths we have and aligned them to tackle this," Pierce says.

Researchers in the CMI are also doing important work with a wide range of other medical applications, including modeling food allergy responses in pigs to better understand how humans respond to the same allergens, developing targeted cancer and antibiotic therapies and designing replacements for musculoskeletal soft tissues.

The institute has generated eight patents and four startups, focusing on innovations including new treatments for pain and new drugs for antibiotic-resistant infections and for hypertension in humans and animals.



BME's Dr. Matt Fisher with biochemistry student Lauryn Braxton.

EXPANDING EFFORTS

A major new example of the interdisciplinary collaboration the CMI fosters is the new Chemistry of Life program that launched in July 2020 as part of the institute.

Pierce developed the program after being inspired by the CMI's approaches and considering how they intersected with his own fields, synthetic chemistry and chemical biology.

"After working in the CMI, I realized there was an opportunity to develop team science approaches and

student programs in the life sciences with more of a chemistry focus,” Pierce says.

The new program, which will focus on developing innovative coursework and undergraduate and graduate training, is launching with a cohort of three graduate students. “All of them are exceptional students who decided to come to NC State because of this program,” Pierce says.

In addition to bringing bright new minds to the institute — and the university — the new program brings a molecular-focused component to the work that the CMI has been doing for years.

Provost Warwick Arden sees the Comparative Medicine Institute as a catalyst for interdisciplinary collaboration across campus and the new Chemistry of Life Program as a welcome part of that work. His office has made strategic investments in both initiatives, with a focus on expanding their graduate and undergraduate training opportunities.

“We’re excited for how this program is going to help us take projects to the next level and foster new collaborations,” Pierce says.

SETTING UP SUCCESS

Empowering each member of the institute with opportunities for professional growth so that they can do their best work is a major focus of the CMI, say Piedrahita and Pierce.

As a faculty member still relatively early in his career, Pierce believes he wouldn’t be in the position of launching a major new program and co-directing a large institute of this caliber without the leadership experiences the CMI has offered him since he came to NC State in 2012.

“As a faculty-led initiative, the institute offers so many leadership opportunities for younger faculty that aren’t just administrative,” he says. “They’re able to bring their vision to creating new programs and mentoring students in ways they might not be able to elsewhere.”

As another early-career faculty member, Fisher agrees that the networking opportunities the CMI offers and the chances he’s had to co-lead subgroups and generate research projects have helped his career. “It’s a very supportive environment to gain leadership experience,” he says.

The leadership opportunities don’t stop with faculty.

“Graduate and undergraduate students have really transformed the CMI,” Piedrahita says. “They’ve helped us move from a strictly research institute to a research and education institute.”

Two of the institute’s signature programs, the Summer Interdisciplinary Research Initiative (SIRI) and the Young Scholars Program (YSP), have helped provide both undergraduate and graduate students with unique opportunities in research and mentoring. First- or second-year students selected for this competitive program work with graduate students in CMI labs on projects the graduate students have designed and present their research in the fall. Many of the undergraduates continue to work with their labs until they leave NC State.

“The CMI has opened up a lot of doors for me,” says Nithin Gupta, a recent graduate in genetics who is now working as an associate researcher in Piedrahita’s lab as he prepares to apply for medical school.

“I had always been told what to do in the lab,” Gupta says. “But when I started the SIRI program, Dr. Piedrahita immediately told me that, in his lab, I would be treated as a Ph.D. student. That was really good for me because it gave me the freedom to be able to be independent and form my own ideas.”

Rising senior biochemistry major Lauryn Braxton has worked in two different labs in the CMI since participating in the SIRI program in 2018. She is currently developing a research project that she can carry with her into graduate school.

“My mentors have always invested time into understanding my goals as I developed as a researcher,” Braxton says. “I came in pretty clueless and have learned so much.”

Dr. Jessica Gilbertie, a postdoctoral fellow in veterinary medicine, has mentored undergraduates through the SIRI program for three summers — and all three of these students still work in her lab. She says the CMI has helped her grow as both a researcher and a mentor.

“I love being able to interact with passionate undergraduates and introduce them to science,” Gilbertie says. “It’s awe-inspiring to watch them become more independent and start growing their own hypotheses.”

Piedrahita and Pierce are excited to keep developing future leaders of the CMI, the university and the field of biomedical sciences by creating new leadership opportunities and designing undergraduate and graduate major and minor programs. They also intend to keep bringing bright researchers together.

“Our first five years have been incredibly successful,” Pierce says. “We’re hoping in our next five years we can expand the success we’ve had with interdisciplinary partnerships more broadly across the university.” •

Ligler recognized by **National Academy of Engineering** with **leadership award**



DR. FRANCES S. LIGLER, Ross Lampe Distinguished Professor in the Joint Department of Biomedical Engineering, has been recognized by the National Academy of Engineering (NAE) with its Simon Ramo Founders Award.

Ligler, a member of NAE since 2005, was recognized “for the invention and development of portable optical biosensors, service to the nation and profession, and educating the next, more diverse generation of engineers.”

A biosensor makes use of biological molecules to detect a chemical or biological target. Ligler developed a new chemistry for attaching biomolecules on sensor surfaces that maintained their functionality more efficiently than existing approaches and then integrated emerging technologies from a variety of fields to make optical biosensors smaller, more versatile and more automated. The result: Biosensors are now utilized in several areas, from food production plants to pollutant cleanup sites.

The Simon Ramo Founders Award acknowledges outstanding professional, educational, and personal achievements to the benefit of society and includes a commemorative medal. Ligler received the award on Sunday, Oct. 4, 2020, at the NAE annual meeting, held virtually this year.

Prior to joining the faculties of NC State and UNC-Chapel Hill in 2013, Ligler worked at the U.S. Naval Research Laboratory (NRL) for 28 years, serving since 1995 as the U.S. Navy senior scientist for biosensors and biomaterials. Prior to joining NRL, she worked in the area of cellular immunology for DuPont.

Ligler is currently working in the fields of biosensors, microfluidics, tissue-on-chip and regenerative medicine; she has also conducted research in biochemistry, immunology and analytical chemistry.

Often, as she told an audience of inventors and investors during a talk at NC State in 2017, the work involves identifying real-world problems and working toward a solution.

“It all starts with problem awareness,” she said. “You need a problem to solve.”

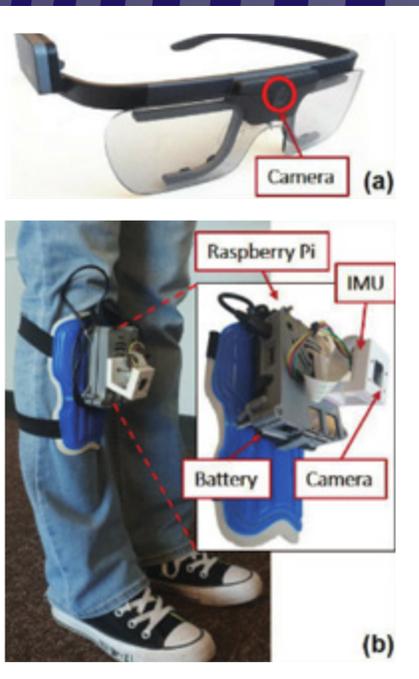
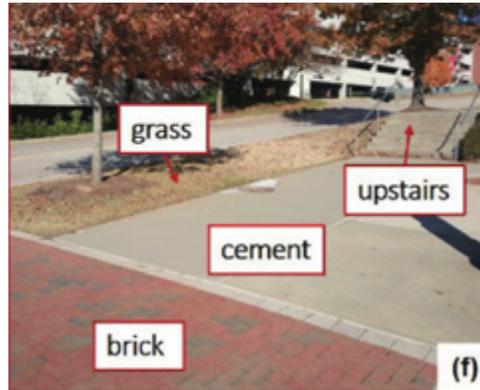
She has more than 400 publications, including 35 U.S. patents and four books, and has served on editorial boards for nine journals. Her inventions have been directly commercialized in 11 biosensor products used in food production plants, clinics in developing countries, pollution cleanup sites and areas of concern for military and homeland security. She has mentored numerous university faculty members and more than 60 postdoctoral fellows, and co-published research with approximately 200 undergraduates.

She is also a Fellow of the American Institute for Medical and Biological Engineering, the American Association for the Advancement of Science, the SPIE, and the National Academy of Inventors (NAI). In 2017, she was inducted into the National Inventors Hall of Fame (NIHF) for her inventions seminal to portable optical biosensors. She actively supports NIHF’s Collegiate Inventors Competition and signature program for K-6 students, Camp Invention.

Ligler is one of just six women who have been inducted into NAE, NIHF and NAI.

In 2003, Ligler was recognized by the Christopher Columbus Foundation with its Homeland Security Award (biological, radiological, nuclear field) and by President George W. Bush with the Presidential Rank of Distinguished Senior Professional. In 2012, she was honored with the Presidential Rank of Meritorious Senior Professional by President Obama.

She has served on the board of trustees of Furman University and currently serves on the academic advisory board for Plaksha University, a new engineering college in India. •



RESEARCHERS
 INCORPORATE
COMPUTER
 VISION,
 UNCERTAINTY
 INTO AI FOR
ROBOTIC
PROSTHETICS

RESEARCHERS HAVE DEVELOPED new software that can be integrated with existing hardware to enable people using robotic prosthetics or exoskeletons to walk in a safer, more natural manner on different types of terrain. The new framework incorporates computer vision into prosthetic leg control, and includes robust artificial intelligence (AI) algorithms that allow the software to better account for uncertainty.

“Lower-limb robotic prosthetics need to execute different behaviors based on the terrain users are walking on,” says Dr. Edgar Lobaton, co-author of a paper on the work and an associate professor of electrical and computer engineering at NC State. “The framework we’ve created allows the AI in robotic prostheses to predict the type of terrain users will be stepping on, quantify the uncertainties associated with

that prediction, and then incorporate that uncertainty into its decision-making.”

The researchers focused on distinguishing between six different terrains that require adjustments in a robotic prosthetic’s behavior: tile, brick, concrete, grass, “upstairs” and “downstairs.”

“If the degree of uncertainty is too high, the AI isn’t forced to make a questionable decision — it could instead notify the user that it doesn’t have enough confidence in its prediction to act, or it could default to a ‘safe’ mode,” says Dr. Boxuan Zhong, lead author of the paper and a recent Ph.D. graduate from NC State.

The new “environmental context” framework incorporates both hardware and software elements. The researchers designed the framework for use with any lower-limb robotic exoskeleton or robotic prosthetic device, but with one additional piece of hardware: a camera. In their study, the researchers used cameras worn on eyeglasses and cameras mounted on the lower-limb prosthesis itself. The researchers evaluated how the AI was able to make use of computer vision data from both types of camera, separately and when used together.

“Incorporating computer vision into control software for wearable robotics is an exciting new area of research,” says Dr. Helen Huang, a co-author of the paper. “We found that

using both cameras worked well, but required a great deal of computing power and may be cost prohibitive. However, we also found that using only the camera mounted on the lower limb worked pretty well — particularly for near-term predictions, such as what the terrain would be like for the next step or two.” Huang is the Jackson Family Distinguished Professor of Biomedical Engineering in the Joint Department.

The most significant advance, however, is to the AI itself. “We came up with a better way to teach deep-learning systems how to evaluate and quantify uncertainty in a way that allows the system to incorporate uncertainty into its decision making,” Lobaton says. “This is certainly relevant for robotic prosthetics, but our work here could be applied to any type of deep-learning system.”

To train the AI system, researchers connected the cameras to able-bodied individuals, who then walked through a variety of indoor and outdoor environments. The researchers then did a proof-of-concept evaluation by having a person with lower-limb amputation wear the cameras while traversing the same environments.

“We found that the model can be appropriately transferred so the system can operate with subjects from different populations,” Lobaton says. “That means that the AI worked well even though it was trained by one group of people and used by somebody different.” •

Joint Department is back in the lab using **COVID-19 avoidance protocols**



BEGINNING IN AUGUST, researchers in the Joint Department of Biomedical Engineering began returning to their labs at NC State and UNC-Chapel Hill.

This welcome return was facilitated by the considerable efforts of university, college and department safety experts who put in many hours developing simple but effective protocols to conduct laboratory research while minimizing the risk of exposure to the corona virus. These protocols rely substantially on general social distancing, limiting the number of personnel per square foot, workplace hygiene, hand hygiene, and, most importantly, requiring mask wearing at all times.

Thanks to the effectiveness of these protocols, and compliance by BME’s researchers, we are happy to report the Joint Department has not experienced any COVID-19 spread as a result of laboratory research. •

FACULTY AND STAFF NEWS



Dr. Jason Franz

Franz elected program chair for the American Society of Biomechanics

Dr. Jason Franz, BME associate professor, has been elected by the membership as program chair for 2022 annual meeting of the American Society of Biomechanics. The American Society of

Biomechanics (ASB) was founded in 1977 to encourage and foster the exchange of information and ideas among biomechanists working in various disciplines of application, including biological sciences, exercise and sports science, health sciences, ergonomics and human factors, and engineering and applied science. ASB has a membership of approximately 850 academic researchers, clinicians, scientists, students, and industry members working to solve basic and applied problems in the realm of biomechanics and to improve understanding of the workings of biological systems.

The 2022 annual meeting of ASB will also serve as the society's fifth North American Congress of Biomechanics (NACOB) — a collaborative meeting held jointly with the Canadian Society of Biomechanics. As program chair for the meeting and with vote of confidence by the membership, Franz will work with

his co-chair from the Canadian Society of Biomechanics in leading their respective committees to oversee the planning, organization, and dissemination of all scientific content for the meeting.



Dr. Frances Ligler

Dr. Frances Ligler featured among Furman University's greatest

In Spring 2020, Dr. Frances Ligler, BME Lampe Distinguished Professor, was featured among four of Furman University's greatest alumni.

Ligler joined Herman Lay, of the famous brand of potato chips; Thomas Goldsmith, who filed the first patent for an electronic game in 1947; and Charles Townes, 1964 Nobel Prize in physics winner with two Russian scientists for the maser-laser principle.

Ligler studied biology and chemistry at Furman, class of 1972. She finished degrees in both sciences in three years and went on to earn a doctoral degree in biochemistry from Oxford University.

Considered a pioneer in biosensors and microfluidics, Ligler started to design portable sensors to detect agents used in biological warfare in the 1980s, while working at the U.S. Naval Research Laboratory. The resulting sensors have been deployed with U.S. combat personnel since the 1990 Gulf War.

In 2017, Ligler was inducted into the National Inventors Hall of Fame in light of the wide variety of applications of her portable optical biosensors. Ligler says, “I feel very fortunate that I have had a chance to work on very hard problems.”



Dr. Rahima Benhabbour

Benhabbour featured in NC TraCS video

BME assistant professor Dr. Rahima Benhabbour, who is also adjunct professor at the UNC Eshelman School of Pharmacy, was recently featured in the NC TraCS introduction video, after receiving support from the

Institute to develop 3D-printed intravaginal rings for disease prevention and treatment in women. NC TraCS is a service that helps researchers at UNC-Chapel Hill and across the U.S. with education, funding and connections. In the video, Benhabbour explains how the interaction with the NC TraCS staff was a springboard for her career — in particular the guidance she received from a regulatory expert to understand what kind of pathway to go through.

The NIH-funded NC TraCS Institute at UNC-Chapel Hill is a clinical and translational science hub founded as a service to the research community — guiding investigators and study teams through clinical trials and regulatory approval, all the way to implementation in patient care. Check out the video by visiting bit.ly/2FZIYAB.

Bernacki receives Environmental Health and Safety Award

BME research associate and operations manager Dr. Susan Bernacki has received an Environmental Health and Safety Award from NC State’s Occupational Health and Safety Council. Bernacki received one of their six department-level safety awards for her exceptional and consistent attention to safety at NC State.

Courtesy of Eastman Chemical Company and the University, this award is accompanied by \$500 funding for the recipients to use as they see fit in their department for a purpose beneficial to safety. Bernacki is in the process of asking department members for “proposals” to use this money.

“I would be looking for things that addressed a broad safety issue, but if there is a critical issue in a lab or classroom that could also be considered,” she said.



Dr. Ashley Brown

Brown receives 2020 TERMIS-AM Young Investigator Award

The TERMIS-AM Committee has awarded BME assistant professor Dr. Ashley Brown with the 2020 Young Investigator Award. Due to the postponement of the 2020 TERMIS-AM Conference to next

year in Toronto, Canada, each award recipient will be provided with time to present their work via a Zoom webinar on December 8th, 2020. Also, Brown will receive a plaque recognizing her achievement during the awards ceremony at the 2021 TERMIS-AM Conference in Canada.

The Young Investigator Award is presented to an individual who has demonstrated outstanding achievements within the tissue engineering and regenerative medicine field. The individual is selected based on a publication or a collection of manuscripts focused within a particular area of research. Candidates

for the award must be within 10 years of receipt of their terminal degree and must not be tenured at the time of the nomination (if working within academia). To be considered for this award, the person must be a TERMIS–Americas member and may apply or be nominated by a TERMIS–Americas member.



Dr. Paul Dayton

Dayton wins IEEE Carl Hellmuth Hertz Ultrasonics Award

BME interim chair Dr. Paul Dayton has won the 2020 IEEE UFFC – Ultrasonics Carl Hellmuth Hertz Award. Dayton received the award for contributions to the study of microbubbles and phase change contrast agents in

ultrasound imaging and therapeutics.

The Carl Hellmuth Hertz Award is an international award presented to a single recipient each year by the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society (UFFC). It is bestowed on a mid-career investigator who has made remarkable contributions to the field of ultrasonics resulting in measurable innovation and impact. Recipients have an excellent track record in terms of scholarly publications, technical reports and inventions / patents. The award recognizes investigators for their outstanding mid-career achievements and for promoting the field of ultrasonics.

This award was named for Carl Hellmuth Hertz to honor his pivotal role as both a researcher and as an advisor to others working in the field of medical diagnostic ultrasound imaging.

Caughey awarded \$50,000 pilot grant

BME research instructor Dr. Melissa Caughey has been awarded a \$25,000 pilot grant funded by the Pittsburgh Heart, Lung, and Blood Vascular Medicine Institute, the Hemophilia Center of Western Pennsylvania, and

Vitalant to evaluate a wearable hydration sensor in patients with sickle cell disease and its utility in guiding hydration therapy. The funding will span one year, with a potential renewal up to two years, totaling \$50,000.

Individuals with sickle cell disease are susceptible to fluid loss due to coexisting renal disease. Hypertonic extracellular fluid intensifies water efflux from the red blood cells, which is a precursor to hemoglobin S polymerization, vaso-occlusive events, and excruciating pain crises in patients with sickle cell disease. A rapid and reliable assessment of hydration status is needed to guide fluid resuscitation therapy and maintain fluid balance. Grant co-investigators from UNC and NC State include Dr. John Muth, professor of electrical and computer engineering and Dr. Yong Zhu, professor of mechanical and aerospace engineering.



Dr. Andrea Giovannucci

Giovannucci named Beckman Young Investigator

BME Assistant Professor Dr. Andrea Giovannucci has been selected as a 2020 Beckman Young Investigator (BYI), with a grant award of \$600,000 to support his proposed research, “An optical brain machine interface to track

brain states and connectivity.” The Arnold and Mabel Beckman Foundation selected Giovannucci from a pool of more than 300 applicants after a three-part review led by a panel of scientific experts.

The BYI program was established in 1991 with the mission of supporting the most promising young faculty members in the early stages of their academic careers in the chemical and life sciences particularly to foster the invention of methods, instruments and materials that will open up new avenues of research in science.

“Our newest Beckman Young

Investigator awardees are inspired to address global issues through their research ... we can't wait to see the exciting work from this outstanding group of young researchers," says Dr. Anne Hultgren, the Foundation's executive director and CEO.



Dr. Naji Hussein

Hussein receives two Outstanding Teaching Awards

BME Teaching assistant professor Dr. Naji Hussein recently received two Outstanding Teaching Awards. This year, NC State honored more than 30 faculty members for their commitment to educational excellence. As

recipient of the Outstanding Teacher Award, Hussein became a member of the Academy of Outstanding Teachers for as long as he remains on the NC State faculty.

His second 2020 Outstanding Teacher Award came from the NC State Alumni Association, which since 1968 has been recognizing top-flight faculty members with stipends. This year, the Association awarded 24 faculty members a total of \$70,000. Nominations were made by deans, department heads, peers and students.

Hussein, Petrella receive Teaching Faculty Project Support Award

BME teaching assistant professors Drs. Naji Hussein and Ross Petrella received a Teaching Faculty Project Support Award from the NC State College of Engineering. The

College's Engineering Faculty Advancement (COE-EFA) sponsored Hussein and Petrella to attend and present their papers at the 2020 American Society for Engineering Education Annual Meeting in June 2020.

Because of COVID-19, ASEE held its first-ever virtual conference and exposition. The ASEE Virtual Conference and Exposition is the only conference dedicated to all disciplines of engineering education. It is committed to fostering the exchange of ideas, enhancing teaching methods and curricula, and providing prime networking opportunities for engineering and engineering technology education stakeholders, including deans, department chairs, all levels of faculty, and industry and government representatives.

From June 22 to 26, 2020, ASEE provided a five-day forum for university and college engineering schools, including professors, deans, instructors and students, to present papers, exchange ideas and interact with their colleagues and industry counterparts.

Ligler participates in pandemic higher-ed panel

The pandemic has put unprecedented pressure on universities, which had to find ways to protect the health and safety of faculty members, students, and staff members; migrate to online education; cease non-COVID-19-related hospital operations; and make difficult decisions about which research to halt. Based on data about 37 of American Association of Universities member institutions, the estimated financial losses for each institution ranges from \$74 million to \$153 million just for one semester.

But even as the pandemic magnifies some existing problems, it can prompt the research community to seek new solutions. National Academy of Sciences President Marcia McNutt recently opened a virtual workshop to discuss the challenges and imagined novel solutions for research universities in the context of COVID-19.

"These are challenging circumstances, no doubt, but we also have an opportunity, not only to reimagine and strengthen our research universities but also to help our nation and [the] world be better positioned to respond to inevitable future crises," said McNutt.

BME Lampe Distinguished Professor Dr. Frances Ligler participated in the online workshop, and she proposed that schools and faculty members set an example by creating a "revolving door" to encourage faculty members to take leaves of absence to work temporarily in industry, government, and nonprofits.

"Not only will this enrich the experience of the faculty level, but it will have incredible impact on

showing students that you can have a diverse and flexible career,” said Ligler. “You can do research in all kinds of environments, not just an academic research lab.”

To read the full feature and watch the workshop sessions recordings, visit the National Academies of Sciences website at bit.ly/2Ek7Ken.



Dr. Roger Narayan

Narayan becomes senior member of National Academy of Inventors

The National Academy of Inventors (NAI) recently announced the 2020 class of senior members: BME professor Dr. Roger Narayan is among the 38 accomplished academic inventors

representing 24 research universities, governmental entities and nonprofit institutes worldwide. They are named inventors on 397 issued U.S. patents.

NAI senior members are active faculty, scientists and administrators from NAI member institutions who have demonstrated remarkable innovation and produced technologies that have the potential for a significant impact on the welfare of society.

Each senior member will receive a certificate honoring their achievements and a senior member Challenge Coin at NAI’s annual meeting.

Frances Ligler cited as female role model in analytical chemistry

A recent editorial article in the *Journal of Analytical and Bioanalytical Chemistry* names BME Lampe Distinguished Professor Dr. Frances Ligler among a handful of world-class female role models in analytical chemistry “whose excellence we aspire to emulate.”

The article highlights how these female role models have accomplished many “firsts” in their own universities and countries, having been recognized by

their respective countries’ premier scientific academies, and having contributed in major ways to their fields through seminal books and pioneering research.

The authors of the editorial are themselves four eminent professors of chemistry from four different countries: Antje J. Baeumner from the University of Regensburg in Germany; Hua Cui from the University of Science and Technology of China; Maria Cruz Moreno Bondi, Complutense University in Madrid, Spain; and Sabine Szunerits, Université de Lille in France. The full editorial can be read at bit.ly/362JY1Q.



Darlene West

West wins 2020 College of Engineering Award for Excellence

BME administrative support associate Darlene West is one of the College of Engineering’s two SHRA winners of the 2020 Awards for Excellence.

The Awards for Excellence program recognizes the accomplishments and achievements of permanent NC State employees at both the unit and University levels who do not hold faculty rank. Awards are given in two employment categories: those exempt from the Human Resources Act (EHRA) and State Human Resources Act (SHRA) employees, who carry out a wide range of activities in support of NC State’s mission. West’s selection for one of this year’s awards was based on recognition that she is not only excellent at her assigned tasks, but also excels at treating everyone she assists with respect and making sure that each person she serves has what they need to succeed.

Further, it was noted that she exemplifies outstanding overall service, and in particular efficiency and innovation for the department, the College of Engineering and the two universities. •

STUDENT NEWS



Anthony M. Kyu

Kyu awarded 2020 Astronaut Scholarship

Biomedical and health sciences engineering student Anthony M. Kyu has been awarded this year's Astronaut Scholarship. It is awarded to students in their junior and senior year

of college studying science, technology, engineering, or mathematics, with the intent to pursue research or advance their field upon completion of their final degree. In the 2020 Astronaut Scholar Class, Kyu is the only North Carolina student selected among 56 scholars from 41 universities across the country.

Kyu has a particular interest in prosthetics and robotics. He is currently the vice president of NC State's Cybathlon Team, leading the design of a prosthetic leg for the Cybathlon Competition in September 2020. He is also the chief technology officer of NC State's chapter of Helping Hand Project and has been part of the design team responsible for 3D printing hundreds of body-powered upper-limb prosthetics for children with upper-limb differences.

After he graduates, Kyu plans to pursue a master's in electrical engineering to gain further knowledge and advance the field of robotics

and prosthetics. As part of this scholarship, he will be presenting his work at the Scholars Technical Conference in Washington, D.C., where he will meet fellow scholars, company sponsors, and astronauts.

Kyu will also be assigned a mentor who is either a scholar alumni, C-suite executive, or former astronaut.



Dr. Becky Krupenevich

Krupenevich awarded NRSA from National Institute on aging

Postdoctoral research associate Dr. Becky Krupenevich has been awarded a three-year National Research Service Award (NRSA F32) from the National Institute on Aging

for her proposal titled "The Role of Foot Structure and Function on Walking Mechanics and Energetics in Aging."

Krupenevich will be sponsored on the project by Dr. Jason Franz, an assistant professor in the department, and co-sponsored by Dr. Helen Huang, Jackson Family Distinguished Professor of Biomedical Engineering. She also has a mentoring committee that spans engineering, orthopaedics, physical therapy and exercise science.

The premise of her project is that the interaction between foot-ankle structure and function is a poorly understood, yet vastly important, biomechanical

mechanism that influences walking ability and may be uniquely compromised with aging. Anticipated outcomes from her research in the applied biomechanics laboratory will increase our understanding of musculoskeletal mechanisms underlying age-related mobility impairment and support improving the health and welfare of our aging population.



A.J. Rechenmacher

BME student among UNC 2020 top 10 scholar athletes

Recent BME graduate A.J. Rechenmacher is among this year's UNC Top Ten Scholar-Athletes. This honor recognizes five male and five female

seniors who have maintained the highest cumulative grade point averages while representing the university as a member of a varsity team.

A member of the wrestling team, Rechenmacher majored in biomedical and health sciences engineering and minored in chemistry. He was inducted into Phi Beta Kappa and named the winner of the Wells Fargo Postgraduate Scholarship. In the fall, he is attending Duke School of Medicine, as he plans to become an orthopedic surgeon.

When asked who among the faculty had a significant impact in his development and success at Carolina, Rechenmacher chose BME teaching assistant professor Dr. Naji Husseini: "He has been an example of selflessly dedicating oneself entirely to a career in all aspects, both big and small," Rechenmacher said. "This has made a significant impact on how I hope to approach my future career as a doctor."

Four BME undergraduates named Grand Challenge Scholars

The College of Engineering at NC State and the National Academy of Engineering's Oversight Committee have named four BME undergraduates as 2020 Grand Challenge

Scholars: Michael Clark, Emily Pierce, Matt Traenkle and Leslie Uy. These Grand Challenge Scholars participated in the Grand Challenges Scholars Symposium in August.

The NAE Grand Challenge Scholars Program (GCSP) at NC State is a premier association of students who network with high-achieving, highly motivated engineering students across the nation so they can work together to face the Grand Challenges of Engineering in the 21st century. The program aims to turn Grand Challenge Scholars into global leaders in discovery, learning, and innovation. The framework for engaging GC Scholars in problem-solving for the Grand Challenges is based on five competencies: talent, multidisciplinary, entrepreneurship, multicultural, and social consciousness.

Ok awarded NRSA F30 award

Meryem Ok, BME graduate student in the UNC-Chapel Hill M.D. - Ph.D. program, recently received a four-year National Research Service Award (NRSA F30) from the National Institute of Diabetes and Digestive and Kidney Diseases for her proposal titled, "A Novel Planar Crypt Microarray for Real-Time Evaluation of Human Intestinal Stem Cell Fate." Ok is sponsored by Dr. Scott Magness, BME associate professor and director of the Center for Gastrointestinal Biology and Disease Advanced Analytics Core.

The premise of Ok's project is that the mechanisms underlying inflammatory bowel disease (IBD) are poorly characterized and involve a complex interplay of altered gut microbial environment, cytokine activity, and impaired intestinal stem cell (ISC) self-renewal and differentiation. Her proposal seeks to investigate the effects of the microbial metabolite butyrate and the cytokine interleukin (IL)-22 on asymmetric division of primary human colonic ISCs using a planar crypt microarray platform and CRISPR-integrated biosensors for live-imaging and transcriptomic analysis. Anticipated outcomes from her research in the Magness Lab will shed light on the utility of this in vitro intestinal model and the potential role of butyrate-IL-22-signaling in IBD pathogenesis. In addition, she will work closely with Dr. Ajay Gulati, UNC pediatric gastroenterologist, to gain a better clinical understanding of IBD as part of her integrated physician-scientist fellowship training. •

ALUMNI NEWS



Dr. Tojan Rahhal

Rahhal named CEO of Engineering World Health

The Board of Directors of Engineering World Health in Durham, NC, (EWH) recently named BME alumna Dr. Tojan Rahhal as its next president and CEO. Dr. Rahhal is very excited to be in this new role as it

enables her to incorporate her passion for engineering and science along with her goals of creating a more inclusive culture and building diversity in STEM in academia and industry.

As an undergraduate student, Rahhal participated in the Initiative for Maximizing Student Diversity at NC State. This experience inspired her to always think of opportunities to bring in and support underrepresented students into the sciences. She also was a student representative on the Undergraduate Affairs Committee. This committee works to address curriculum changes, student issues, student awards and other functions for

the BME Department. This experience was instrumental in helping her to see the strategy and decision-making process for curriculum development and served her well in her future role as the assistant

dean of inclusive excellence and strategic initiatives and as adjunct assistant professor at the University of Missouri College of Engineering, Columbia.

She went on to earn a Ph.D. in pharmacoengineering and molecular pharmaceuticals at UNC-Chapel Hill, working in the lab of Dr. Joseph M. DeSimone. Focusing on nanotechnology and translational medicine, Rahhal developed micro- and nanoparticle therapeutics for pulmonary delivery using the PRINT fabrication technique. Also, while earning her Ph.D. she helped to develop a diversity curriculum for graduate students which has been replicated at other pharmacy schools across the nation.

Dr. Michael P. Tracey, chair of EWH's board and a vice president of Ethicon, a Johnson and Johnson company, stated "After a thorough search and a review of several highly qualified candidates, we are convinced that Dr. Rahhal will lead EWH forward with exceptional vision and know-how about engineering and about international learning." Indeed, Rahhal is excited to be able to provide opportunities to students in global settings that will help broaden their perspectives on science, health and education. Students can view opportunities at ewh.org/apply-now.

Rahhal holds two patents, one is the outcome of her BME senior design project. She continues her own education journey through the pursuit of a Master of Law program that will enable her to better address equity matters in an amicable way and facilitate dispute resolutions. These skills will be incorporated into her company practice and teachings at Alliance Professional Development, alliance-professional.com.

In response to her new role, Rahhal said, "I am thrilled to have been chosen as the new CEO of an organization that combines my passion for expanding the scope of engineering education and developing a new generation of global leaders in the field." •

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The program’s inaugural cohort of eight students is designing prototypes.

To learn more about the program, contact Dr. David Zaharoff at [dazaharo@ncsu.edu](mailto:dzaharo@ncsu.edu) or zaharoff@email.unc.edu.

If you are interested in supporting the program with a gift, contact director of development Laura Schranz at lschran@ncsu.edu or lschranz@unc.edu.



NEEDS DISCOVERY

- Design thinking
- Clinical immersion
- Needs filtering

DESIGN AND INNOVATION

- User requirements
- Design requirements
- Design controls/QMS
- Prototyping
- Verification & validation

PRODUCT DEVELOPMENT

- Design for manufacture
- Project management
- Funding strategy
- Regulatory strategy
- Operating strategy