Joint Department of

BIOMEDICAL ENGINEERING

UNC CHAPEL HILL | NC STATE UNIVERSITY

SPRING / SUMMER 2020

IN THIS ISSUE

LETTER FROM THE CHAIR

Dr. Paul Dayton

DEAR BME ALUMNI AND FRIENDS:

The past semester has been unlike anything most of us in my generation have experienced. Eight weeks ago, the department was operating as business as usual, and within about a two-week period, we were asked to transition all class instruction for approximately 600 students from in-person to online due to COVID-19. This was an enormous effort, and I am most thankful for the hard work of our faculty to make this as fluid as possible for the students. Fortunately, with our experience as a two-campus joint department, many BME faculty members were already experienced with remote lectures, videoconferenced seminars and even teleconferenced faculty meetings, and so by all reports the BME department managed this transition much better than many other departments.

What we were not as well prepared for, however, was the almost complete shutdown of a $21-million research enterprise. Due to the rapid spread of COVID-19, the need to keep our faculty, staff and students safe, and with the State Government's orders, all faculty and staff members and students were asked to leave campus. Unfortunately, this meant ceasing most hands-on experimental research, which is a key activity for many BME faculty members and students. We have since transitioned to remote research, focusing on simulations and modeling, preparing papers, writing grant proposals and analyzing data that was acquired before the shutdown, although this online-only research severely limits our capability. We eagerly await a return to campus and normalcy, as I am sure all of you do as well.

With that said, despite the slowdown of our traditional BME research directions, BME faculty members have made an amazing pivot to new directions in support of our health system during the COVID-19 pandemic. As coronavirus cases were growing in North Carolina, UNC Health leaders, along with Duke Health and Wake Medicine, made it clear that they were facing the terrifying reality that health care providers could run out of personal protective equipment and medical equipment to treat COVID-19, just as the pandemic would peak in North Carolina.

Due to the coronavirus impact on China, the supply chain for medical supplies was disrupted. This problem, combined with both a massive increase in consumer purchases of masks and gloves and an increased need of healthcare workers, the healthcare system faced a desperate need of respirator masks, surgical masks, nasal swabs, face shields and ventilators. The Joint BME faculty and students moved rapidly to address these needs, fulfilling our mission: to unite engineering and medicine to improve lives. In this issue of the BME newsletter, we emphasize the rapid-retooling of our biomedical engineering enterprise to fight COVID-19. Please join me in congratulating our faculty and students in this effort, as well as our staff that support us all.

Sincerely,

Paul A. Dayton, Ph.D.
William R. Kenan, Jr. Professor and Interim Chair
UNC / NC State Joint Department of Biomedical Engineering

Senior design teams shift to **COVID-19 projects**

By: Brent Lancaster, NC State Engineering Communications

AS THE SPREAD OF THE COVID-19 respiratory virus took hold in the United States during spring 2020, students in the Joint Department were well into their senior design projects.

They had shadowed local healthcare providers, had developed ideas for devices that would solve a problem they'd identified during their time with the providers and had begun design work. Many teams had already begun fabricating prototypes of their designs.

But as the campuses in Raleigh and Chapel Hill closed and classroom instruction moved online, the teams realized that they wouldn't be able to work together in person again before graduation, making finishing their projects complicated.

Dr. Devin Hubbard, teaching assistant professor and director of the senior design program within the Joint Department at UNC, offered teams a chance to change their focus to projects with a focus on the pandemic.

Meet four teams that made the switch, and how their work could lead to solutions.

AFTER SHADOWING in a physical therapy clinic at UNC, four seniors on a team designed a device and app that would allow a patient to complete therapy at home. The idea was to guide a patient through the rehab process and track their daily exercises, ensuring that the motions were being conducted the right way.

The team (Nathan Guskiewicz, Ari Horwitz, Milo Bis and Amir Sadeghifar) was working with a gyroscope, accelerometer and Bluetooth-compatible microcontroller and writing the smartphone application code. Then, the pandemic hit.

"With the challenges of COVID-19, we didn't have access to some of the manufacturing facilities that would actually continue on with the project," Horwitz said. "Because of that, we felt that shifting to something that was a little more pressing was necessary."

While brainstorming about what to do next, one of the team members remembered from a materials science class that copper has antimicrobial properties. As the entire country places a new emphasis on keeping surfaces clean, they wondered if taking advantage of the material could help make a difference. While no studies have been done on how long COVID-19 can last on copper, studies they found for the previous Severe Acute Respiratory Syndrome (SARS) outbreak indicated that that virus did not remain viable on copper surfaces nearly as long as it did on stainless steel and plastic.

The team's plan is to produce a brochure for businesses around Chapel Hill letting them know of copper's effectiveness and then prototype a copper coating for surfaces such as appliance doors and countertops.

DANLEE BROWN, Caelan Eckard, Mathew Leff, Matthew Lothspeich and Marijose Rodriquez spent time at UNC Hospitals' Spine Care Center and realized that a lead shield used as x-rays are taken during surgical procedures is cumbersome and rarely used by the surgeons. They set out to design a better one.

In the spring, they had received the parts they needed for a prototype and were moving toward a usability study of a new shield design in a clinical setting. With those tests off the table, the team turned to hand sanitizer.

Like other needed supplies, having an adequate supply of hand sanitizer for public and healthcare use was identified early on as a problem during the COVID-19 crisis. The team looked for a way to help and soon was in contact with Mystic Farm Distillery in Durham. The distillery had gone from making bourbon and gin to making hand sanitizer, but was only producing large quantities in barrels and buckets to be distributed in bulk.

The student team has volunteered working with the distillery, filling, packaging and labeling 750 milliliter bottles of the hand sanitizer that are easier for consumers to use. They are hoping to volunteer with other businesses or groups to help meet the need for sanitizer.

"We felt that we were healthy and able to do something within the community, so we should spend our time doing that," Brown said.

THE JOINT DEPARTMENT'S annual i4 competition offers design teams a chance to further their work and compete for cash prizes. The decision for one senior design team on whether to switch their work to a pandemic project was a tough one because their original idea had gotten them all the way to the i4 finals.

The team, made up of Anna Castellano, A.J. Rechenmacher, Catherine Bennett, Brady Anna, Sam Vinogradov and Emiley Joyce, had developed a cast, splint and rehabilitation device all in one. The inspiration came from a car accident last summer, in which Joyce broke her arm.

The group decided to pivot anyway, creating a web site designed to gather reliable information on the outbreak and solutions including how to make reliable hand sanitizer at home or a good homemade mask.

"We were noticing that there were a lot of good solutions that were scattered all over the place," Joyce said.

Joyce, through her work with the North Carolina Translational and Clinical Sciences Institute, also helped find a solution for a lack of surgical mask that would fit pediatric patients. The work involves folding adult masks along a seam and securing two plastic pieces of the mask with a heat sealer. The solution has received good reviews from the UNC Children's Hospital. Learn more on page 5.

Work on the original project continues. Since this spring's i4 competition was cancelled, each of the six finalist teams will receive $5,000 per team to put toward the project. The team members, who had already received $7,000 from the first two rounds of the competition, plan to continue work on the idea after graduation, pursuing provisional and utility patents for the device.

WHEN THEIR TEAM began thinking about a new project, Sameer Bhatti, Kendall Joseph, Kristina Lane and Justine De Grasse began thinking about diagnostic testing, an early problem as the virus spread throughout the United States.

The team had started the fall semester shadowing an interventional radiologist, and was working on a varicose vein removal device that would limit premature breakage of the vein and increase efficiency compared to the current standard. The team was about to prototype their idea when the virus hit. They began looking at a long list of ideas, including face masks and ventilators.

"Given the opportunity to switch, our group really wanted to get into that and make an impact," Bhatti said.

Joseph pointed out to the group what they had recently learned about microfluidics in a class with Dr. William Polacheck, associate professor in BME.

The group soon set to work on a COVID-19 test using a microfluidic chip, building off previous testing chips used for things like influenza.

"The more we thought about it, the more research we did, we thought this could be a really impactful kind of thing," Bhatti said.

The group had designed a chip and hopes to run simulations, then file for a report of invention and have the chip manufactured and tested. •

The Zaharoff research group

From **cancer to COVID-19**

By: Dr. David Zaharoff, Joint BME Department

THE ZAHAROFF LAB has begun development of a vaccine to prevent infection by SARS-CoV-2, the novel coronavirus that causes COVID-19. The lab, which primarily focuses on engineering immunotherapies to treat cancer, is leveraging expertise in enhancing anti-cancer immunity to create a vaccine that generates a strong cellular immune response against SARS-CoV-2. While there are a number of vaccines already in development around the globe, including one in a Phase I clinical study, no vaccine has shown the ability to safely prevent SARS-CoV-2 infection in pre-clinical models.

Development of vaccines against coronaviruses is no easy task. The COVID-19 pandemic caused by SARS-CoV-2 is the third coronavirus outbreak in the past two decades. Attempts to develop vaccines against previous coronaviruses, SARS-CoV and MERS-CoV, demonstrated, in multiple preclinical studies, that vaccination can make a subsequent infection worse. Many vaccinated animals, from mice to monkeys, experienced increased lethal acute lung injury (ALI) and exacerbated acute respiratory distress syndrome (ARDS). Some antibodies that were generated in response to a vaccine can actually facilitate coronavirus infection and provoke undesirable inflammation.

Rather than rely on antibodies to protect us from SARS-CoV-2, the Zaharoff lab would like to engage killer T cells to eliminate the virus. The design of a novel vaccine is a team effort among rotating Ph.D. student Siena Mantooth, postdoctoral fellow Khue Nguyen and second-year Ph.D. student Maura Vrabel. The group hopes to have pilot preclinical data in about a month.

The importance of a vaccine cannot be understated. Non-pharmaceutical mitigation strategies, such as social distancing and shelter-in-place, while effective at 'flattening the curve,' are susceptible to re-emergence of COVID-19 as restrictions are relaxed. Therefore, it is feared that multiple waves of COVID-19 will propagate for many months or years until herd immunity is achieved through infection of 50 to 70 percent of the population. A vaccine capable of inhibiting SARS-CoV-2 is needed to break the cycle of infection and death. •

Students help create masks to **protect pediatric patients**

By: Carleigh Gabryel, UNC Health

MORE AND MORE STUDENTS are answering the call to provide critically needed PPE for UNC Health. The latest efforts — initiated by Carol Lewis, vice president of the Center for Health Innovation — include biomedical engineering (BME) students from both UNC and NC State who are crafting pediatric face masks.

Dr. Paul Dayton, interim chair of the Joint Department, is coordinating teams of engineers to tackle several COVID-19-related projects, including addressing the need for smaller masks to fit patients at the NC Children's Hospital.

"The COVID-19 crisis is unprecedented and scary, but it's been incredible to see so many scientists, engineers, and physicians that have immediately focused their efforts to solve urgent needs in medicine," said Dayton, also a member of the UNC Lineberger Comprehensive Cancer Center. "The BME department is well-positioned to help in these needs, and we are enthusiastic about working with our colleagues at UNC Health, FastTraCS, BeAM (the makerspace), as well as other departments and local industry to make an immediate impact in improving lives."

The pediatric mask design team was led by BME Teaching Assistant Professor Dr. Devin Hubbard, lead design engineer at FastTraCS, a program at the North Carolina Translational and Clinical Sciences (NC TraCS) Institute focused on spurring innovation from existing research and identifying unmet needs at UNC Hospitals.

"It was requested that we find a way to be able to make these pediatric masks using adult surgical masks, along with material that was already available in the hospital," Hubbard said.

Hubbard's design team, led by BME student Emiley Joyce and FastTraCS engineer Nicole Wiley, developed a way to repurpose adult-sized masks into pediatric sizes by folding and then thermally re-bonding them.

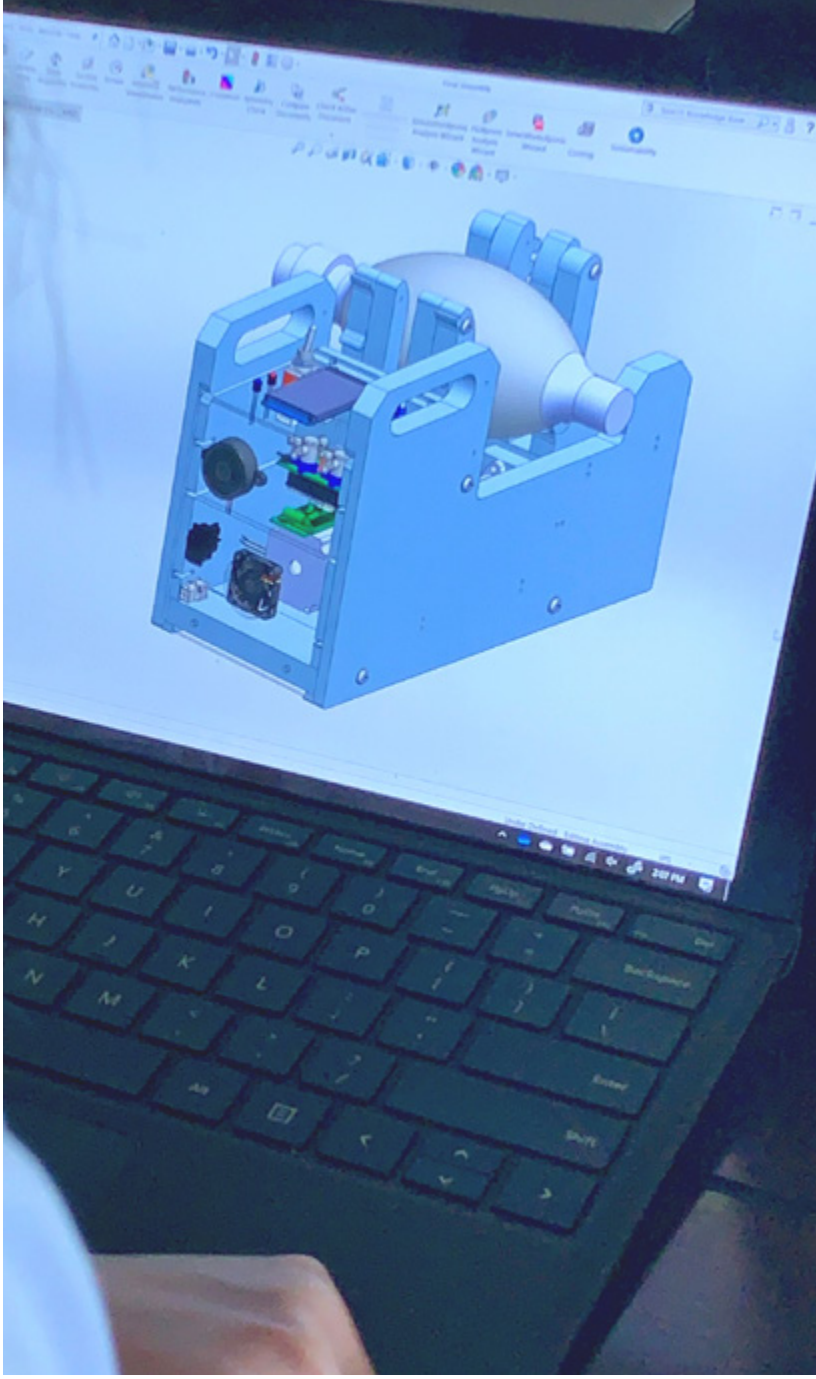
"This is exactly what I wanted to do by getting this kind of degree," Joyce said. "We're finding ways to solve problems that have an impact on people in a positive way."

Two shifts of students, including Christian Griffith, Phil Durham, Lindsay Sullivan, Joanna Lee, Ryan Chen, Kyle Meek, and Anthony Kostov, worked in the BME department design lab while practicing safe physical distancing measures, to manufacture the masks according to the team's design. Hubbard says it takes about one minute to make a pediatric mask.

The teams are working closely with UNC Health to make sure they have enough pediatric masks available. Students have made around 1,000 masks in just over a week and are prepared to make several thousand masks if needed.

"The BME team has provided an invaluable resource for our pediatric patients in the Children's Hospital," said Benny L. Joyner, Jr., chief of pediatric critical care medicine, vice chair of hospital inpatient services, and associate professor of pediatric critical care medicine. "Often, adult masks for small children are ill-fitting, and do not accomplish the intended goal. It is remarkable how quickly the team identified the issue, developed a prototype, refined it and delivered a much-needed finished product that is arguably as effective as what can be found on the market. We are inspired by the BME team's flexibility, ingenuity, and generosity of time and talent." •

Kathlyne Bautista



Engineers at UNC and NC State team up to develop an emergency ventilator

By: Brock Pierce, Innovate Carolina

BIOMEDICAL ENGINEERING STUDENT KATHLYNE BAUTISTA always knew that her coursework and training would set her on a path to make a life-changing difference for people. But before the coronavirus pandemic, she didn't realize just how soon that opportunity would arrive.

Bautista is part of the Carolina Respiratory Emergency – Ventilator (CaRE-Vent) team led by Dr. Yueh Lee, an associate professor at the University of North Carolina at Chapel Hill. His research team is sprinting to design and prototype an open-source ventilator in a matter of weeks that has the potential to help fill a critical equipment

gap caused by a projected spike in COVID-19 patients. The team is designing the ventilator so that it could be manufactured quickly and inexpensively — at less than $1,000 and with only six hours of skilled labor per unit.

And even in the best-case scenario — where the COVID-19 curve flattens to the point that the device is never needed for patients — the team's efforts are advancing knowledge in the biomedical design community about the best way to create emergency ventilators in the future.

> **"This has been a real-world — and much more urgent — implementation of what our students are trained to do."**
>
> - Dr. Paul Dayton

"I'm very grateful to have the opportunity to potentially save lives. As an engineer, it's what you are training for," said Bautista, an undergraduate student in the UNC/NC State Joint Department of Biomedical Engineering who has been creating mechanical designs for the ventilator. "You learn all this math and take all these classes, but in the end, you want to do something that's worthwhile."

The biomedical engineering department, which blends the medical knowledge of researchers at UNC-Chapel Hill and engineering expertise of those at NC State University, has bridged faculty and students from both institutions to work quickly on the ventilator. Other schools and departments at both universities, including the UNC School of Medicine and NC State Department of Mechanical and Aerospace Engineering, have joined the effort, along with UNC Health and multiple industry partners. They share a common charge: figuring out how to develop an emergency ventilator in a time crunch.

"This is what biomedical engineers are trained for — being given a problem in medicine and bringing engineering tools in to solve that problem," said Paul Dayton, interim chair of the biomedical engineering department and William R. Kenan Jr. Distinguished Professor. "The design process and prototyping are all part of our curriculum. This has been a real-world — and much more urgent — implementation of what our students are trained to do."

Dayton says that he's been putting together groups that can collaborate and solve important coronavirus-related problems fast. The CaRE-Vent team headed by Lee, an associate professor of radiology at the UNC School of Medicine and adjunct assistant professor of physics, astronomy and biomedical engineering, is one that Dayton helped forge by connecting complementary talents from UNC-Chapel Hill and NC State.

"The team led by Yueh Lee got together and has been moving full-speed ahead toward developing prototypes." Dayton said.

It turns out that Lee's team didn't have to start completely from scratch. Its new prototype was inspired by a device designed over a decade ago by Dr. Richard Feins, a retired professor who worked in the UNC School of Medicine's Cardiothoracic Simulation Lab. It's here where the mechanism — which employs a resuscitation bag and windshield-wiper motor — helped create a more realistic training environment for surgical students by reanimating pig hearts and lungs.

"We've had this unit for quite a while sitting in the lab," said Lee, who cites Nabil Khan, a prototype and design engineer with NC FastTraCS, as his project co-lead. "We knew we already had a prototype that could ventilate a lung and said, 'Why don't we start from there?' We were inspired by that as a starting point."

For Lee and his team, next steps happen by the minute. "We want to have something that we can release as open source so others can manufacture it to their own local standards — and we want to release that as soon as possible," Lee said.

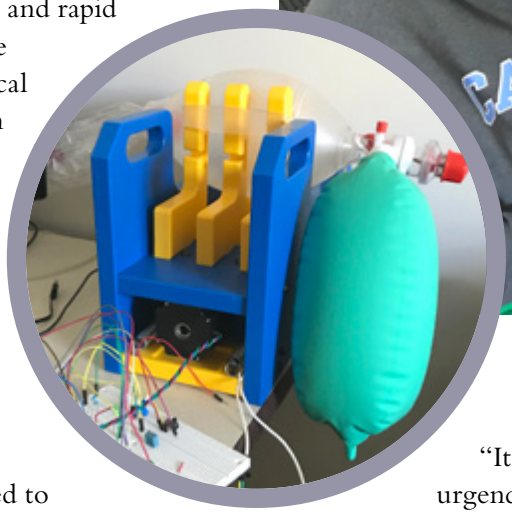
INNOVATING FASTER TOGETHER

Within two weeks of launching the CaRE-Vent project, the team was already testing and validating a ventilator prototype. All members of the team say they would not have progressed so far so quickly if not for cross-university collaboration. Lee's group is working closely with a team led by Landon Grace, an assistant professor of mechanical and aerospace engineering at NC State.

"The CaRE-Vent project is a perfect example of collaboration. There are so many different components of the project that one group would just not have the expertise to do on its own," says Grace. "Because we need to move so fast, you have to find people to join the team

that already have the expertise, know what they're doing and can contribute immediately. And that's what we've been able to do. It's been incredible."

Knowing their individual strengths, the UNC-Chapel Hill and NC State teams rely on each other and expertly perform their respective parts. The Carolina side of the team brings the medical expertise drawn from physicians and researchers at the UNC School of Medicine, plus faculty members and students with advanced knowledge in 3D printing, laser cutting, CNC work and rapid prototyping capabilities. The NC State team is working through the mechanical design, fatigue testing and the creation and testing of a PEEP (positive end-expiratory pressure) valve for the ventilator.



"The NC State team gives us the confidence that if we need a higher level of engineering, or access to a very specific engineering tool that UNC doesn't have, it's a quick phone call," says Lee. "With a background as a mechanical engineer, I know if I need to walk through an engineering principle that I want to verify or validate, it's a quick touchstone to walk through that with Landon's team."

Adds Grace, "The sense of urgency is something we don't really ever see, and I have been amazed as to how it's brought out the best in every member of the team. The communication, collaboration and the speed at which it's happening is something I would not have predicted."

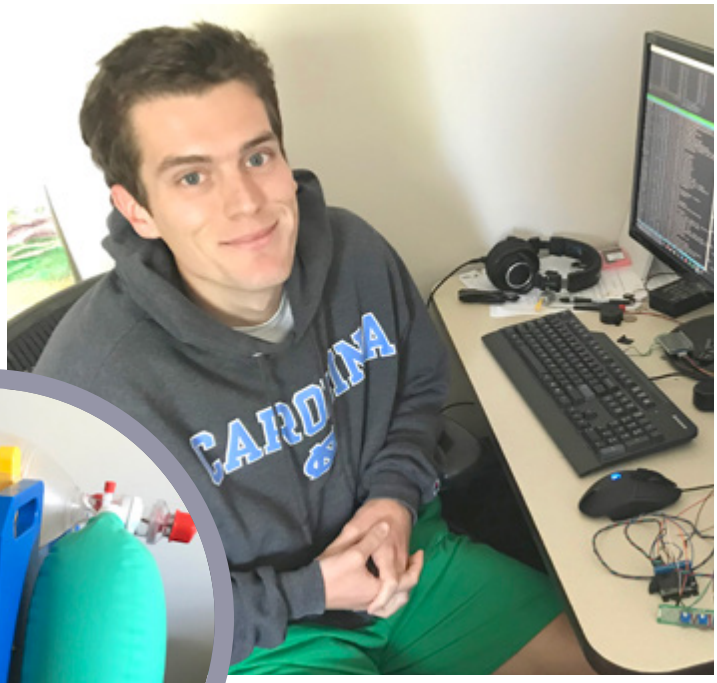
Dayton says the team is rallying together to do something bigger than they could do by themselves.

"The team is working really hard because they think they can make a difference and potentially save lives, and that's been the spirit of everyone working together," says Dayton. "We're going to do our best job as fast as we can because it can make an immediate difference. It's been a really positive environment."

REAL-LIFE LEARNING

To round out the CaRE-Vent team, Lee added several UNC BME students, including Bautista and graduate students Sang Chung and Thomas Kierski. They're all learning in a way that isn't possible in a classroom.

Chung is testing how the system performs, including collecting data and reporting troubleshooting errors that come up during testing.



Thomas Kierski

"It gives me a sense of purpose and urgency, and there is nothing else I would rather be doing now," Chung said.

Kierski, who is tackling the programming and integration side of the project adds, "It's been an eye-opening experience."

The students are embracing the project as a chance to get hands-on training with their faculty mentors on an urgent, ever-shifting project.

"From an engineering perspective, this is it. This is what we live for — solving problems when the stakes are high and the problems are difficult. It's been a learning experience for my team," says Grace. "You can't duplicate it in a classroom or a lab. That's one of the underlying things that's happening that is incredibly valuable outside of the work itself — the lessons the students are learning."

This is the kind of situation, Dayton says, that biomedical engineering students are prepared to tackle.

"Part of our BME educational experience is the design process, which is exactly what we're doing here," says Dayton. "You're presented with a problem, you talk about ways to solve it, you come up with prototypes, you test your prototypes, and you move your design forward."

For Lee, the ability to work across disciplines with faculty colleagues and students has been critical.

"We are very fortunate, and UNC is unique because we have very few silos," he says. "We have a very collaborative culture." •

FasTraCS biomedical engineers are creating **innovative solutions** for the COVID-19 crisis

By: Jennifer Scott, nctracs institute

Dr. Devin Hubbard

LIKE MILLIONS OF PEOPLE ACROSS THE COUNTRY, Devin Hubbard is working from home. The new, makeshift office he has set up in his living room includes the usual items: a small desk, a Mac computer and pages of notes. But he also has equipment and supplies more likely to be found in a research lab: pieces of medical grade materials, mask prototypes, and a certified, quantitative fit test machine for N95 masks.

As an engineer in the Joint Department, Hubbard is accustomed to dealing with unique challenges. But he never imagined he would face some of the biggest challenges of his career from his living room, in the midst of a pandemic.

While his 10-month-old daughter naps in the next room, Hubbard fires up the fit test machine. He straps a mask prototype onto his face while the machine instructs him to "breathe normally." For the next 15 minutes, Hubbard will run through a series of exercises — bending over, turning his head side to side, and breathing deeply.

As the test finishes, Hubbard hears his daughter waking up from her nap. His wife, a physician at Duke, won't be home for another eight hours. During that time, Hubbard will juggle responding to dozens of emails and phone calls, participating in Zoom meetings with colleagues, teaching a capstone medical device design course online, and making adjustments to mask prototypes. And he has been doing this all day every day for over a month.

BEFORE THE VIRUS

On the other side of Chapel Hill, Nicole Wiley signs into a Zoom meeting. Hubbard appears on the screen, and holds up his most recent mask design, fresh from one of the 3D printers in his garage.

Wiley and Hubbard work together at FastTraCS, a small team of biomedical professionals within the North Carolina Translational and Clinical Sciences (NC TraCS) Institute at the UNC School of Medicine. The mission of FastTraCS is to harness engineering expertise and resources to create medical devices and diagnostic tools for UNC Health.

As the first reports of COVID-19 in the U.S. started to trickle out in late February and early March, the FastTraCS team was busy working on prototype projects related to OBGYN, Otolaryngology (ENT), and Gastroenterology.

On March 12th, the team came together for their usual weekly meeting, but instead of discussing prototypes they had been working on, they started talking about an entirely new challenge.

"We were all thinking about this one big question," says Andrew Kant, Assistant Director of FastTraCS. "Should we totally shift our efforts to COVID-19 response?" Three days later, the decision was official. The team put a hold on all their current projects in order to turn their full attention to supporting UNC Medical Center during the pandemic.

FULL SPEED AHEAD

On March 18th, Paul Dayton, chair of the UNC / NC State Joint Department of Biomedical Engineering (BME) department, sent an email to all of his faculty members. The subject line was "Masks."

If any faculty have expertise in technology that could be used as masks — or can suggest people to talk to that might have technology ideas for alternative mask products, please contact me directly.

Hubbard responded immediately: Our team over at FastTraCS is presently looking into this, he wrote. Less than a minute later, Dayton emailed him back: Excellent, thanks Devin. This is a real crisis situation, and the Hospital has reached out to BME to help solve this. Please go full speed ahead on coming up with engineering solutions quickly.

Working under clear directives from Carol Lewis, Vice President of the Center for Health Innovation, Dayton, Hubbard, and many others jumped into action.

"In the BME department, we live to apply engineering to solve problems in medicine — and here are some urgent problems that need to be solved," Dayton says. "We got that call from Carol, I started coordinating with Devin and his team immediately, and we had prototypes of masks within a week."

"The idea was to attack the Personal Protective Equipment (PPE) shortage from every possible angle and explore every nook and cranny," Hubbard says.

Dayton helped spearhead an effort to round up spare PPE from shuttered research labs on campus. FastTraCS team members Nicole Wiley and Emiley Joyce started working on crafting masks for pediatric patients. Hubbard began looking at how to generate an alternative to an N95 mask.

A NEW N95

Amidst the hundreds of emails that flooded Hubbard's inbox during the second week of March, he received one from Ethan Smith, an undergraduate BME student. He had a question for Hubbard about a potential glaucoma research project.

Though he is only a sophomore, Smith is highly proficient in CAD (Computer-Aided Modeling), the standard professional software used by biomedical engineers for design and simulation of new medical devices — exactly the skillset Hubbard was looking for at that time.

"I have another problem that requires urgent attention," he told Smith. "Would you be willing to work on a new design for a N95 mask?"

As PPE shortages have made headlines across the country, engineers like Hubbard have worked diligently to come up with alternatives. But the designs for these types of masks are generally not public information, and the materials are not widely available.

"We're not trying to reinvent the N95 mask," Hubbard says. "What we come up with is not meant to be a first-line replacement — but this could provide a decent backup plan if the hospital runs out of everything else."

Just two days after Hubbard asked about his interest, Smith sent him a design. For the filter, Smith utilized non-woven material produced by Behnam Pourdeyhimi and his team at NC State's Nonwovens Institute. To create the mask frame, Smith used CAD to generate a shape that can be properly fitted to different faces.

Dealing with variation in human faces turned out to be the most difficult part of the process, according to Smith.

"We're making a product that goes on a face, yet everyone's face is different," he says. "We have to figure out where the greatest amounts of variation exist — around the nose, and cheeks — and make adjustments for that."

Over dozens of Zoom meetings, Smith showed various iterations of the 3D printed mask to the FastTraCS team. Hubbard and Wiley provided feedback, posing questions about materials, mechanisms and logistics.

"We have to think about how will the clinician put this on his or her face? What is the quickest way?" Wiley says. "Do we want the mask to be single-use? How can they take it off without contaminating themselves? Will it be individually packaged? Will it come out of autoclave?"

It takes anywhere from one to five hours to print each prototype. After spending hundreds of hours making design adjustments and printing dozens of masks, Smith remained energetic and eager to help.

"This is why I came to Carolina," he says. "But I never thought I'd have this type of opportunity as a sophomore in college. It really is incredible. The potential to help just one person — even just one medical professional — that's why I want this to be my career."

GOOD TEAMWORK

The row of 3D printers sitting in Hubbard's garage symbolize the collaborative nature of this monumental effort: he borrowed one printer from his research lab, another one from the BME department, and a third from FastTraCS.

Likewise, the N95 fit test machine in Hubbard's living room wouldn't be there if it weren't for the fast-acting leadership at UNC.

After a team of people at the NC governor's office found a company that rents fit test machines, they reached out to Carol Lewis. She connected them with Hubbard, who was able to secure funding from FastTraCS. "It was on my doorstep within 24 hours," Hubbard says.

Even with a house full of cutting-edge equipment, Hubbard knows he wouldn't have made nearly as much progress over the past month without such a hard-working, committed team.

"We're a small team of five, and we've only been together for about a year, but it feels like we've worked together for 20 years," Wiley says. "Even though it's hectic it's really seamless. The positivity is really high. It makes working in a crisis like this actually less stressful."

LASER FOCUS

Late one night, after another long day, Hubbard is on the phone. Again. This time he is talking to an anesthesiologist at UNC who also happens to be a close friend.

"Anesthesiologists are one of the providers at highest risk because they're putting people on ventilators and intubating them," Hubbard explains.

"Inserting an endotracheal tube through the mouth and down into the esophagus puts them at a very high risk for being exposed to droplets."

Despite his exhaustion, Hubbard listens attentively as his friend shares anxieties, as well as new ideas for fighting the virus.

"At one point he tells me about an idea he has for helping patients out," Hubbard says. "Engineering something to make them more comfortable."

With his plate already overflowing, Hubbard knows he and his team must stick to the task at hand: generating vital protective equipment for medical providers.

"It's a good idea," Hubbard tells his friend. "But I have to stay focused on saving you guys first." •

Undergraduate student joins **face shield effort**

By: Jennifer Scott, NCTraCS Institute

TEAMS AT UNC-CHAPEL HILL AND NC STATE are teaming up to solve supply chain and design issues to produce face shields that may aid in the fight against COVID-19. An undergraduate student in the Joint Department has played a crucial role.

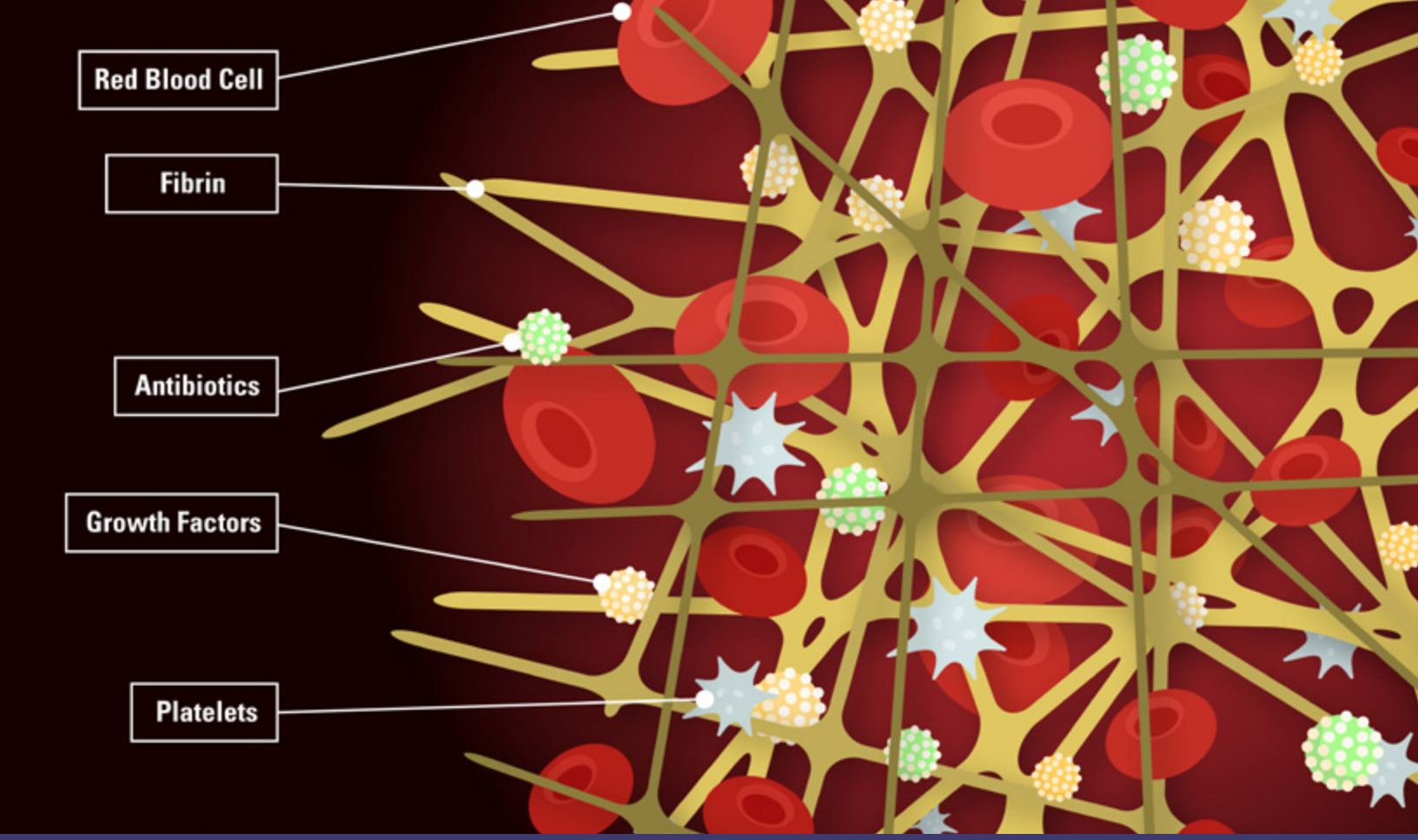
COVID-19 response efforts at the two universities have turned a dedicated group of applied physical science and engineering professors into the closest of collaborators – and yet, they've never met in person.

Drs. Rich Superfine and Glenn Walters at UNC-Chapel Hill and their faculty colleague Dr. Landon Grace at NC State recently connected based on their shared commitment to create personal protective equipment (PPE) desperately needed by hospitals and health care workers during the COVID-19 crisis.

BME health science engineering undergraduate student Olivia Burston has been volunteering at BeAM to assemble face shields against COVID-19.

"I've been helping a lot with making face shields and I got to teach Chancellor Kevin M. Guskiewicz how to assemble one," Burston said.

The efforts of both universities are intertwined and similarly beneficial to hospitals and caregivers in North Carolina. At UNC-Chapel Hill, a team of makerspace staff, volunteers and medical students is producing face shields made of PETG plastic, while a mechanical and aerospace engineering team at NC State is creating much-needed replacement lenses (cuffs) for powered respirators (CAPR) as well as intubation shields. The NC State project is led by the lab team of Grace, an assistant professor of mechanical and aerospace engineering. •



Custom clotting particles could help **heal chronic wounds**

By: Matt Simpson, NC State Office of Research and Innovation

NEW TECHNOLOGY COULD TRANSFORM the way doctors treat chronic wounds, which affect more than six million people in the U.S. each year. Chronic wounds, such as diabetic ulcers or deep-tissue burns, are wounds that heal slowly or not at all and are thus prone to infection. These infections can lead to severe consequences, including amputation or even death.

Inventors in the Joint Department, with support from the Office of Research Commercialization at NC State, are patenting technology that could help heal chronic wounds faster and more effectively.

Wound healing happens in three overlapping stages: clotting seals the wound, inflammation cleans it and tissue regeneration spurs repair. The blood clots in the first stage are made up of two major components: platelets and strands of fibrin, which act as a net that holds the platelets and other cell types together.

For various reasons, there's often a lack of fibrin in chronic wounds, says Dr. Ashley Brown, a co-inventor of the patent-pending technology and the leader of NC State's Advanced Wound Healing Lab.

"Fibrin is the primary protein that's involved in blood clotting, but it also forms an important scaffold to promote healing after clotting stops," Brown, an assistant professor in BME, says. "What happens most of the time with chronic wounds is they get stuck in the inflammatory stage, so you don't have enough of that initial fibrin scaffold for the subsequent cells to come in and rebuild the tissue."

Fibrin forms from the precursors fibrinogen and thrombin. The fibrin-based technologies currently used to stop bleeding introduce fibrinogen and thrombin at unnaturally high levels, which can then hinder long-term healing.

"Fibrin is the primary protein that's involved in blood clotting, but it also forms an important scaffold to promote healing after clotting stops."

- Dr. Ashley Brown

"These materials essentially result in the formation of a thick block of polymer; whereas, during natural healing, your body forms fibrin in a mesh that has some open porosity, which is really important for allowing cells to migrate in," Brown says. "If it's too thick, the fibrin can actually impede cell migration. Ultimately that can have detrimental effects on wound healing."

To address this problem, Brown teamed up with Dr. Frances Ligler, the Lampe Distinguished Professor of Biomedical Engineering at NC State and a member of the National Inventors Hall of Fame. Together, they've discovered how to make preformed fibrin into customized nanoparticles.

The nanoparticles can be made in different sizes, which allows them to integrate with the clotting process that's already occurring naturally. In other words, Brown and Ligler's nanoparticles deliver fibrin in physiologically relevant densities, which is what's needed to mimic the mesh-like substance the body creates.

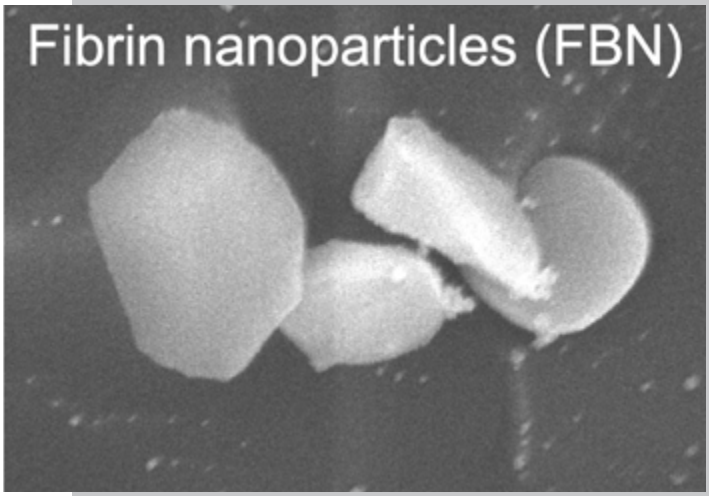
"The beauty of the system is that in a wound environment, there's going to be some small amount of clotting going on, and the particles can integrate with polymerizing fibrin at the wound site," Brown says. "The other great thing about this system is that you can use it as a carrier molecule for drugs."

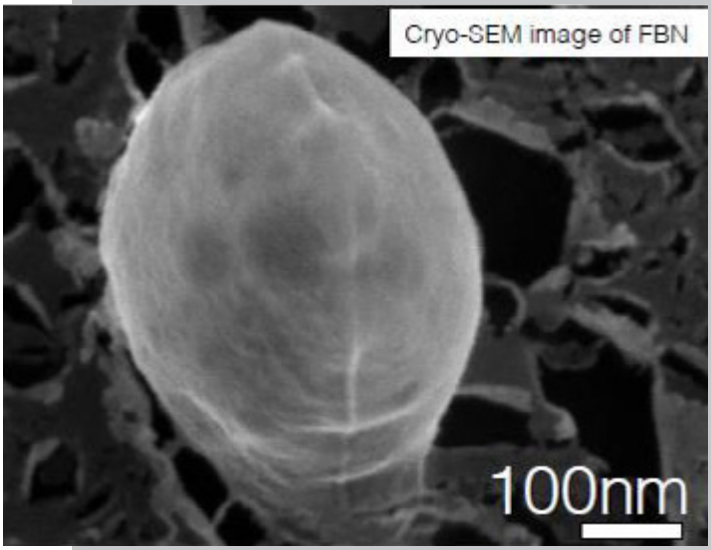
Brown and Ligler have shown that it's possible to attach growth factors, antibiotics or other healing aids to the fibrin nanoparticles. Ligler says this delivery system allows for a slower, more controlled release of these healing aids compared to adding them directly to a wound.

Brown and Ligler's fibrin nanoparticles allow cell migration to occur when tissue regeneration begins. The attached growth factors or antibiotics are able to promote healing in the long term, as they break down more slowly when integrated with fibrin.

"Part of the problem in diabetic ulcers is they're not well-served by the circulatory system," Ligler says. "The oxygen amount is low, and there's not the usual cadre of cells present to do the healing. So, if you can bring in more cells actively, you have a chance of improving the healing."

Globally, the market for wound care is estimated to near $25 billion by 2024 — and diabetic ulcers accounted for the largest share of that market in 2019. The patent application process for Brown and Ligler's technology is projected to run through summer 2022. •





A **SIMPLER** WAY TO SEE THE **COMPLEX**

By: Shellie Edge, Innovate Carolina

Drs. Ryan Gessner (left) and Paul Dayton

UNC-AFFILIATED STARTUP COMPANY SONOVOL is pushing in vivo imaging to the edge. The company's easy-to-use scanning technology allows scientists who are developing drugs and therapies with the potential to cure diseases to spend more time on their science and less time operating imaging equipment. In short, the company's work means getting better drugs to market, faster — with less expense.

To learn more about SonoVol's entrepreneurial journey, keys to success and industry-changing technology, we caught up with Dr. Ryan Gessner, a former BME graduate student and co-founder and CEO of the company; and Dr. Paul Dayton, professor and interim chair of the Joint Department, who is a co-founder of SonoVol and head of the company's scientific advisory board.

What does SonoVol do? And what problem are you trying to solve?

SonoVol is a life science research tools company. Our goal is to make easy-to-use instruments that enable disease researchers and drug developers to have a non-invasive window into the body to better understand incredibly complex biological systems. We operate within the niche market of in vivo imaging technology. A handful of companies make in vivo imaging tools, and they exist on pretty much every major university campus across the world as well as at pharmaceutical companies and government labs. However, usage of these instruments is often low. You can find an imaging center on many campuses with several million dollars' worth of in vivo equipment in it, and many of the systems in there are collecting dust. These are cutting edge tools that allow researchers to better study disease, but they are more often than not extremely underutilized.

Why aren't researchers using traditional in vivo imaging tools?

We've done a bunch of research over the years and talked to hundreds of people to try to answer this because we don't want our products suffering the same lack of usage. We want people to love them and use them all the time to help study disease and develop the drugs of tomorrow. The general consensus is that people get really excited by the capabilities of these tools, but then find out they often have complex workflows, require extensive specialized training, and/or are very expensive both in terms of user time as well as financially to operate. We have spent years building an instrument that's easy to use and can be made cost effective.

Does the name SonoVol hold special meaning for the company?

The name is a combination of "Sono" (ultrasound) and "Vol" (volumetric, 3D). The name arises from our technology originally being based on 3D ultrasound, though

"Our goal is to make easy-to-use instruments that enable disease researchers and drug developers to have a non-invasive window into the body..."

- Dr. Ryan Gessner and Dr. Paul Dayton

we have since expanded into additional imaging modalities through funding from the National Science Foundation and National Institutes of Health.

How did you identify the need for your first product, the Vega?

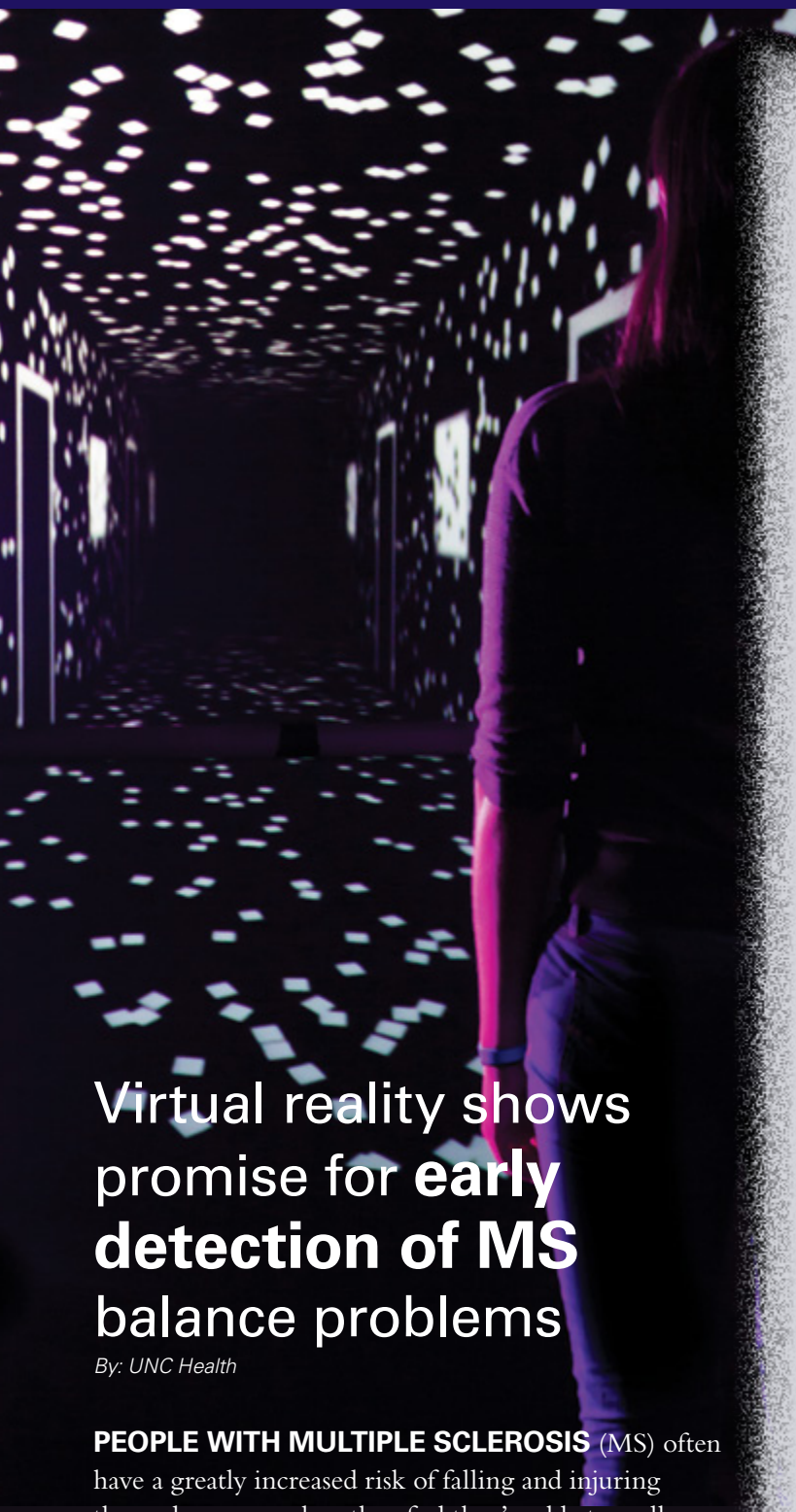
The Vega emerged as the solution to a particular set of problems we faced while trying to support cancer researchers with our imaging methods years ago while Ryan was in graduate school. If the Vega had existed then, I think I would have been able to publish twice as many papers with our collaborators in the Lineberger Cancer Center. As an example, one of the problems I faced was the time required to perform imaging scans; I used to be able to do about eight to 12 scans on a very busy day. Today, one of our Vega customers does about 50 scans in two hours. So back when I was a graduate student, it was that identification of the throughput bottleneck that made us realize that there had to be a better way. Another indication that the market wanted this technology was people asking us at conferences where they could purchase a system that would allow them to capture microvascular images like ours; the answer was they couldn't. So, we built a system to bring this UNC technology to the market.

As a UNC startup, how did you take advantage of resources available on campus to help grow the company? Which resources were particularly valuable?

We worked with Don Rose and Andrew Kant at Carolina Kickstart who helped us set up all the infrastructure to actually become a company, name it, set up a license for the technology from UNC and put together an advisory board. It was really helpful to have their team guide us through those processes since it's uncharted territory for people in the academic world (unless you've started a company before) and there's so much to try to think about when commercializing technology. It's nice to not have to go find a tax accountant, and a graphic design firm for a logo and an attorney, etc. They basically took a big load off of our shoulders when it came to navigating the initial red tape that's involved once a business takes off, at all levels (institutional, state, federal, etc.). They provided support in getting initial funding, for instance, by reviewing our federal grants before submission to improve likelihood of success. They also helped us secure space in the Genome Science building (GSB) and work through UNC's Facilities Use Agreement process.

Has your work led to collaborations with people from different schools, departments or areas of expertise that you wouldn't have expected?

Absolutely. We have secured many different grants from both the NIH and NSF with collaborations in industry and academia. At first, we would limit our collaborations with people at UNC, but over time, our network has grown and we now have collaborations with universities across the country: UC San Diego, Johns Hopkins, University of Minnesota and Duke. We have also discovered an entire new application market for our technology in regenerative medicine, which we've received over $2 million in grant funding to pursue, which we wouldn't have found if not for conversations with people at trade shows. •



Virtual reality shows promise for **early detection of MS** balance problems

By: UNC Health

PEOPLE WITH MULTIPLE SCLEROSIS (MS) often have a greatly increased risk of falling and injuring themselves even when they feel they're able to walk normally. Now a team led by scientists from BME and the UNC School of Medicine has demonstrated what could be a relatively easy method for the early detection of such problems.

The researchers, in a study published in PLoS One, used a virtual reality (VR) system to trick subjects into thinking they were falling as they walked on a treadmill. The scientists found clear differences in reactions between people with MS and people of the same age without MS. These differences were not evident between the groups when they walked in a normal way without the "falling" illusion.

The researchers believe that a VR-based test like this, after further study and development, could be made portable and used widely in neurology clinics to alert MS patients earlier to their balance impairments, allowing them to adopt measures to reduce their risk of falling.

"Our promising results suggest that one can use VR to detect balance problems that usually go undetected until the individual starts experiencing real falls at home or work," said study principal investigator Dr. Jason Franz, assistant professor in BME.

MS is a brain disease that affects about 400,000 people in the United States and more than 2 million worldwide. It's widely thought to be caused by inappropriate immune cell activity in the brain and features the loss of the insulating layer of myelin protein around nerve fibers — a loss that degrades the fibers' abilities to conduct nerve signals. Signs and symptoms of MS include fatigue, numbness and tingling, cognitive impairments, mood instability, and balance and gait problems.

The latter can manifest unexpectedly. People who have MS and show little or no disability may already be at twice the risk of falling, on average, compared to people who don't have MS. Studies also have found that people who have an MS diagnosis fall at least once per year on average. Many of these falls occur during activities such as walking.

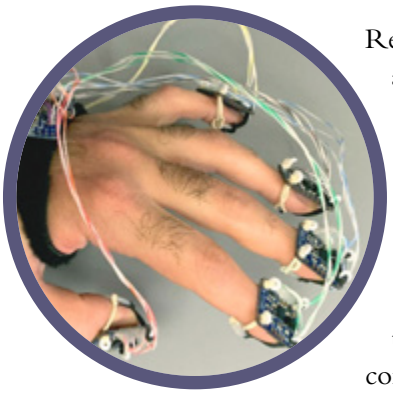
Franz and his colleagues sought to develop a test that would reveal balance and gait impairments even in people with MS who may not be aware of these problems or display them during normal walking.

"When we walk around, our brains use a variety of sensory feedback channels, including force sensors in our feet, to guide our movements and make corrections from one step to the next," Franz said. "But in people with MS, those force sensors can become less reliable, so people need to rely more on other channels, especially vision." •

POWER OF VIRTUAL REALITY

Virtual reality would make attending therapy **easier for stroke survivors**

By: Matt Shipman, NC State University Communications



Researchers have created a virtual reality clinic to make it easier for stroke survivors to attend their physical and occupational therapy sessions. Results from a proof-of-concept study suggest that the technology — and the social connection it facilitates — are effective at encouraging therapy participation.

"Physical and occupational therapy are important parts of stroke recovery, in terms of helping survivors regain dexterity and functional motor ability," says Dr. Derek Kamper, co-author of a paper on the work. "However, stroke survivors often face significant challenges in attending their therapy sessions. For example, many survivors don't live near facilities that offer relevant therapy services.

"Our goal was to create an online, virtual reality platform that allows patients and therapists to interact in what is essentially real time," says Kamper, who is an associate professor in the Joint Department. "Clients could also use the system to work on therapy exercises with loved ones who live far away."

The resulting system, called Virtual Environment for Rehabilitative Gaming Exercises (VERGE), is a software package that makes use of Kinect motion-sensor hardware to track the movement of patients and therapists. The system was developed by Kamper with collaborators at the Shirley Ryan AbilityLab and the University of Illinois at Chicago. VERGE currently supports three different rehabilitation activities, such as hitting a virtual ball back and forth when multiple users are present, or bouncing it off a wall when in single-user mode.

In the proof-of-concept study, researchers worked with 20 stroke survivors to evaluate the system. All participants had chronic impairment; 17 were men; and the mean age of the participants was 60.

For the study, half of the participants spent two weeks using VERGE in single-user mode, while the other half used VERGE in multi-user mode — interacting with other people remotely. The groups then switched modes for an additional two weeks.

Researchers found that study participants attended 99 percent of their therapy sessions when using VERGE in multi-user mode. Compliance was also good in single-user mode, with participants making 89 percent of their sessions.

Participants also spent 22 percent more time — or an additional 7.6 minutes — in their sessions when using VERGE in multi-user mode. And that time was more active, with participants moving their hands about 415 meters per session during multi-user sessions, as compared to 327 meters during single-user sessions.

"This suggests that the social aspect of VERGE has real benefits for stroke survivors in the context of getting them engaged in therapy," Kamper says.

The researchers used the upper extremity portion of the Fugl-Meyer Assessment of Recovery after Stroke score to evaluate the efficacy of the VERGE therapy sessions, and saw a mean change of 3.2 — which is comparable to what therapists would expect to see in chronically impaired patients after four weeks of therapy in a conventional clinical setting.

"The fundamental takeaway here is that VERGE has the potential to be a means of bringing clinical therapy to stroke survivors in their homes," Kamper says. •

‘Wristwatch’ monitors body chemistry to boost athletic performance, prevent injury

By: Matt Shipman, NC State University Communications

RESEARCHERS IN BME and their NC State colleagues have developed a device the size of a wristwatch that can monitor an individual’s body chemistry to help improve athletic performance and identify potential health problems. The device can be used for everything from detecting dehydration to tracking athletic recovery, with applications ranging from military training to competitive sports.

“This technology allows us to test for a wide range of metabolites in almost real time,” says Dr. Michael Daniele, co-corresponding author of a paper on the work and an assistant professor of electrical and computer engineering and in the Joint Department.

Metabolites are markers that can be monitored to assess an individual’s metabolism. So, if someone’s metabolite levels are outside of normal parameters, it could let trainers or health professionals know that something’s wrong. For athletes, it could also be used to help tailor training efforts to improve physical performance.

“For this proof-of-concept study, we tested sweat from human participants and monitored for glucose, lactate, pH and temperature,” Daniele says.

A replaceable strip on the back of the device is embedded with chemical sensors. That strip rests against a user’s skin, where it comes into contact with the user’s sweat. Data from the sensors in the strip are interpreted by hardware inside the device, which then records the results and relays them to a user’s smartphone or smartwatch.

“The device is the size of an average watch, but contains analytical equipment equivalent to four of the bulky electrochemistry devices currently used to measure metabolite levels in the lab,” Daniele says. “We’ve made something that is truly portable, so that it can be used in the field.”

While the work for this paper focused on measuring glucose, lactate and pH, the sensor strips could be customized to monitor for other substances that can be markers for health and athletic performance – such as electrolytes.

“We’re optimistic that this hardware could enable new technologies to reduce casualties during military or athletic training, by spotting health problems before they become critical,” Daniele says. “It could also improve training by allowing users to track their performance over time. For example, what combination of diet and other variables improves a user’s ability to perform?”

First author of the paper is Murat Yokus, a Ph.D. student at NC State. Co-corresponding author of the paper is Dr. Alper Bozkurt, a professor of electrical and computer engineering at NC State. The paper was co-authored by Tanner Songkakul, a Ph.D. student at NC State; and Vladimir Pozdin, a postdoctoral researcher in BME. •

FACULTY AND STAFF NEWS

Dr. Ashley Brown

Brown named NC State University Faculty Scholar

NC State recently announced 2019-20 class of University Faculty Scholars. BME Assistant Professor Ashley Brown is among the 24 early- and mid-career faculty members who received this designation based on their significant academic achievements and contributions to NC State through their teaching, scholarship and service to the university and greater community.

Faculty members selected as University Faculty Scholars carry the title for the duration of their faculty appointment at NC State and receive an increase to their base salary. NC State Provost Dr. Warwick Arden and Chancellor Dr. Randy Woodson had planned to host a reception to recognize this year's class in April but the event was postponed because of the COVID-19 outbreak.

Benhabbour's breakthrough in women's health featured

Dr. Rahima Benhabbour

Dr. Rahima Benhabbour, assistant professor in BME and adjunct professor at the UNC Eshelman School of Pharmacy, has been featured in the December issue of *Chapel Hill Magazine* for her use of 3D-printing technology to create drug delivery devices for disease prevention and treatment in women.

"Unlike traditional technology, 3D printing gives us the ability and engineering to play around with the design and properties of a product," Benhabbour says. "We can engineer parts that would not have been possible before. The main goal of developing this 3D technology is to have the ability to change the ways in which women's products are manufactured and designed. And the applications for the technology are endless — including [the] prevention of HIV, sexually transmitted infections and unintended pregnancies."

Since launching her startup company AnelleO in 2016, Benhabbour has been working on the first product, AnelleO PRO, a once-a-month progesterone-releasing ring for infertility and assisted reproductive technology. The goal of AnelleO is to create a more efficient drug delivery that can be customized to women and their individual needs, given that current technology for intervaginal rings is a one-size-fits-all product. The name AnelleO means "a ring for her": "Anello" is "ring" in Italian, and "elle" is "her" in French. The letter "O" represents the ring the company makes. AnelleO just received National Institutes of Health funding through a Phase I Small Business Technology Transfer grant. Also, the UNC Office of Technology Commercialization team

— part of the Innovate Carolina initiative — assisted Benhabbour with guidance on patents and licensing.

Benhabbour's roots in advocacy for women's health issues run deep. "I'm from North Africa," she says. "I'm a woman. The thought of helping women — some who don't have a way of protecting themselves or controlling their lives — that's my ultimate passion. You can read about her startup company and entrepreneurship journey in Chapel Hill Magazine online at **bit.ly/2XcIkq8**.

Dr. Mark Tommerdahl

BME spin-out featured on NC Business News Wire

Local company Cortical Metrics, a spin-out from BME faculty members, has been featured in an article on NC Business News Wire. The story's focus was Cortical Metrics' signature product Brain Gauge, a biomedical device capable of rapidly diagnosing a concussion with better than 90 percent accuracy, and its ability to meet urgent head trauma diagnostic needs in sports and the military.

Brain Gauge's underlying technology was developed in BME Associate Professor Dr. Mark Tommerdahl's laboratory. Two of his former students who now work for the company, Eric Francisco and Jameson Holden, demonstrated the Brain Gauge in action. To see the full story visit **bit.ly/3e1ZtZx**.

Franz receives NC TraCS Pilot Research Grant

BME Assistant Professor Dr. Jason Franz has been awarded a $50,000 Pilot Research Grant from the North Carolina Translational and Clinical Sciences (NC TraCS) Institute for his proposal titled "The peripheral motor repertoire as a neuromuscular constraint on walking balance integrity in age-related falls risk."

This new research is both timely and clinically important — our rapidly aging population is at an exceptionally high risk of debilitating falls which reduces independence and quality of life with an increasingly

Dr. Jason Franz

significant financial burden. With support from this NC TraCS award, Franz and the Applied Biomechanics Laboratory will introduce a novel neuromuscular mechanism for age-associated balance impairment as a target for diagnostic testing and rehabilitation to prevent falls in older adults.

Dr. Helen Huang

Huang appointed Jackson Family Distinguished Professor

In January 2020, the Joint Department's Dr. Helen Huang was appointed Jackson Family Distinguished Professor in Biomedical Engineering.

Members of the Jackson family are generous participants in NC State's William Joseph Peele Lifetime Giving Society. Their philanthropic support over 36 years includes numerous university groups, funds and scholarships; with one of their most recent investments being the establishment of the Jackson Family Distinguished Professorship in Biomedical Engineering.

Hubbard hosts medical device innovation podcast

BME Teaching Assistant Professor Dr. Devin Hubbard, who is also the lead design engineer of the FastTraCS team at NC Translational and Clinical Sciences

Dr. Devin Hubbard

Institute, is the host of a new podcast called GuideWire. The podcast focuses on the behind-the-scenes element of medical device innovation. A team of medical device design engineers from UNC dive into the nuances, challenges and considerations that go into finding and solving high-impact unmet medical needs at the large university hospital.

Since launching in late February, the podcast has uploaded three episodes of about 20-25 minutes each. The first episode focused on Big Picture Innovation in Vascular Interventional Radiology; the second was about Evolving Problem Discoveries Techniques in FastTraCS; the third and last so far shared Embarrassing Stories from Clinical Immersion. To listen to the podcasts, visit the GuideWire Podcast site at **unc.live/2yHliO0**.

Dr. Wesley Legant

Legant named 2019 Packard Fellow

BME Assistant Professor Dr. Wesley Legant is one of 22 early-career scientists and engineers who will each receive $875,000 over five years from the David and Lucile Packard Foundation.

The prestigious Packard Fellowship will enable Legant to enhance his research on new kinds of microscopy techniques to further biomedical discoveries at the UNC School of Medicine, Pharmacology and the Joint Department of Biomedical Engineering. Upon receiving this award, Legant declared "I'm especially excited and grateful for this award from the David and Lucile Packard Foundation. It will allow us to follow new and exciting directions, inspired by what we see under the microscope, and will connect us to an outstanding network of fellows working in very diverse fields."

Microscopy has enabled fields ranging from chemistry and materials science to biology. Work in the Legant Lab spans the development of cutting-edge fluorescent microscopes; machine learning algorithms for intelligent instrument control and image analysis; and applications to fundamental biological phenomena including cell division, cell migration, and cell differentiation. Earlier this year, Legant, who is also a member of the UNC Lineberger Comprehensive Cancer Center, was named a Searle Scholar, Beckman Young Investigator and NIH New Innovator.

The Packard Fellowships are among the nation's largest nongovernmental fellowships, designed to allow maximum flexibility in how the funding is used. Starting in 1988, David Packard recognized that the success of the Hewlett-Packard Company, which he cofounded, was derived from supporting research and development of science and engineering in university laboratories. Since then, the Foundation has awarded $429 million to support 617 scientists and engineers from 54 national universities.

Sharma co-authors feature article in *IEEE Transactions on Biomedical Engineering*

Associate Professor Dr. Nitin Sharma and his co-authors at the University of Pittsburgh — Zhiyu Sheng and Dr. Kang Kim — had their paper titled: *Quantitative Assessment of Changes in Muscle Contractility Due to Fatigue During NMES: An Ultrasound Imaging Approach* selected as a feature article in the March 2020 Issue of IEEE Transactions on Biomedical Engineering.

Sheng is a student mentored by Sharma and collaborator Kim shares a co-corresponding author role with Sharma on this paper. To see the full text of this article, go to **bit.ly/2V36AYY**.

Ligler joins academic advisory board for Plaksha University

A storied group of academics, civic leaders, industrialists and entrepreneurs are sponsoring the creation of a

Dr. Frances Ligler

new engineering university, Plaksha University in Chandigarh, India. The stated purpose of the university is to reimagine engineering education in a manner that will serve the 21st-century needs of India.

Part of this group is Dr. Frances Ligler, Lampe Distinguished Professor of Biomedical Engineering, who has accepted an invitation to serve on the Academic Advisory Board for Plaksha University. Other members of this prestigious board include deans, a provost, a Nobel Laureate/co-founder of J-PAL, and faculty members from Princeton and MIT. The full board roster and more information about the new university can be found at **plaksha.org**.

Plaksha's immediate vision and plans are to achieve a targeted enrollment of 6,000 students by 2035 while providing an education that involves acquiring knowledge of advanced technologies like computing and artificial intelligence, autonomy, robotics and connected systems while cultivating an entrepreneurial mindset, to apply technology for societal impact.

Ligler was invited to be on the advisory board through the strength of her work on the National Academy of Engineering Council (NAE's Governing Body) and the NAE Grand Challenges of Engineering.

Dr. Nitin Sharma

Sharma part of team receiving Control Systems Technology Award

In December 2019, new Joint Department Associate Professor Nitin Sharma and his former colleagues at the University of Florida received the 2019 Control Systems Technology award at the IEEE Conference on Decision and Control.

Many consider this annual event the most prestigious conference in the control systems area. The award is given to recognize outstanding contributions to control systems technology either in design and implementation or project management. Sharma's UF collaborators were: Warren Dixon, Matthew J. Bellman, Alan Hamlet, Christian Cousin, Courtney Rouse, Ryan Downey and Victor Duenas. Their project was titled, *For closed-loop functional electrical stimulation control methods leading to successful commercialization and personalized rehabilitative treatment options.*

Two faculty members receive Junior Faculty Development Awards

Dr. Brian Diekman

Dr. Imran Rizvi

BME Assistant Professors Dr. Brian Diekman and Dr. Imran Rizvi received 2020 Junior Faculty Development Awards from the UNC Provost's Office Committee on Faculty Research and Scholarly Leaves.

Support for this award is provided by IBM and R.J. Reynolds Industries funds. These $10,000 awards are to fund research during the January 1, 2020 to December 31, 2020 period. Any permanent, full-time, salaried member of the faculty without tenure who holds the rank of assistant professor or associate professor is eligible to apply for these competitive awards. •

STUDENT NEWS

BME undergraduates awarded NC State Engineering Scholarships


Courtney Odea


Meredith Robbins


Ashley Drew


Alondra Martinez-Arroyo


Seth Kodikara


Ryan Ording

In December 2019, six BME undergraduates were awarded seven NC State College of Engineering scholarships.

Junior Courtney Odea received the Richard Greenwood Thomas Engineering Scholarship. Recipients of this scholarship must maintain a minimum 3.0 GPA, and are preferred to demonstrate need and participate in extracurricular activities. Sophomore Meredith Robbins received the Joseph H. and Mary S. Sherrill Endowed Scholarship. Recipients of this scholarship must maintain a minimum 3.0 GPA, and are preferred to be residents of Alleghany County or Forsyth County. First-year students Ashley Drew and Alondra Martinez-Arroyo both received the need-based William Jackson Goodrum Scholarship. First-year students Ashley Drew, Seth Kodikara and Ryan Ording all received the Dean's Circle Merit Scholarship. Recipients of this scholarship must maintain minimum 3.0 GPA.

Segule receives 2020 Payne International Fellowship

BME undergraduate student Naila Segule, who is also completing interdisciplinary studies in Global Health Communication and Development, is among the nine 2020 Payne Fellows. The Payne Fellowship Award is extremely competitive, with 526 national applicants this year. Candidates are selected based on rigorous criteria, as the next generation of U.S. Agency for International Development (USAID) foreign service officers.

The Payne Fellowship Program provides awardees up to $48,000 annually for a two-year master's degree plus an annual $16,000 stipend for housing, transportation and related expenses. Fellows who complete the Payne Program and USAID Foreign Service entry requirements will receive appointments as foreign service officers with the U.S. Agency for International Development.

Entering NC State as a Park Scholar, Segule engaged in campus leadership and civic engagement, including interning as a Leader for Change. Later she became a Juanita Bryan Scholar, an Abram's Scholar and a College of Engineering ambassador teacher's assistant, among many roles.

BME announces 2020 Lucas Scholars

BME is proud to announce the 2020 Lucas Scholars. All of the nominees were outstanding, so special congratulations


Margaret Stanley


Truc Tran


Maggie Wagner

to those who were selected. The department also thanks Dr. Carol Lucas for her inspiration and support of the program.

The program was named to honor Lucas, UNC's Biomedical Engineering Department founding chair, and also to recognize her contributions to the field of biomedical engineering.

The scholars and their mentors for this year are:

- Margaret Stanley mentored by Dr. Imran Rizvi
- Truc Tran mentored by Dr. Koji Sode
- Maggie Wagner mentored by Dr. Jason Franz

Learn more about the Lucas Scholarship Fellowship by visiting **unc.live/2JL81Gn**.

Students take home top prize from E(I) Lab

BME graduate students Alison Schaefer and Dina Yamaleyeva received E(I) Lab's top prize at its recent annual awards ceremony. Their team, LiRA, was announced as the winner of E(I) Lab's fifth annual awards ceremony for solving challenges in healthcare. Yamaleyeva said of her experience, "It makes a difference to work on a problem that is a true need and with people who are motivated to solve it."

Dr. Sam Lai, founder of The E(I) Lab, set this experiential program up specifically for graduate students from various disciplines around campus to tackle unmet healthcare needs, gain first-hand training in prototype development and product design, learn about the latest methods in entrepreneurship and receive coaching and mentorship from the innovation community at UNC.

Each team was given six months to develop a marketable innovation that would serve an unmet need for health-care providers and patients. The winning team was made up of a group of five graduate and professional students representing the School of Medicine, the Gillings School of Public Health, the Kenan-Flagler Business School, and the Joint Department. They worked on a project to restore voice to aphonic patients through the development of lip-reading technology.

The E(I) Lab is an entrepreneurship and innovation lab launched by the Eshelman School of Pharmacy over five years ago and was the first inter-disciplinary lab of its type at the time.

BME students take home graduate research fellowships

This year's National Science Foundation (NSF) Graduate Research Fellowships have been announced, and the Department is pleased to announce that seven BME students have been selected as recipients.

The recipients were undergraduate student Taylor Abele and graduate students Michaela Copp, Zachary Davis, Jordan Joiner, Rahul Patel, Jacob Thompson and Maura Vrabel. In addition, Amanda Munsch and Sandra Stangeland-Molo, both current graduate students, received Honorable Mentions.

The program is the oldest graduate fellowship of its kind, recognizing outstanding graduate students in science, technology, engineering and mathematics disciplines who are pursuing research-based master's and doctoral degrees.

BME hosts Industry Networking Night

For the first time, BME hosted an Industry Networking Night at The Frontier to introduce the program and students directly to local industry. More than 90 students attended and had the opportunity to interact with 13 companies, many represented by BME alumni. There was only positive feedback from the companies, reporting that it was a great opportunity to speak to students to learn about their skills, research experience and future goals. Several students have reported that they have secured summer internships from these companies, despite the coronavirus economic and health impacts.

Thanks to all of the companies, large and small, for their participation including Advanced Animal Diagnostics; BD; BentonNewell Communications Group; BioMedomics, Inc.; BioMerieux; FujiFilm Medical Systems, U.S.A., Inc.; Invoy, LLC; Jericho Sciences, LLC; Nocturnal Product Development, LLC; Pfizer; Sequence Inc.; Yukon Medical, LLC; and Zeroto510.

If you would like to participate in future Industry Networking Nights please reach out to Laura Schranz, lschranz@unc.edu. •

ALUMNI NEWS

Scott Jarnigan

Alumnus **SCOTT JARNIGAN** was among the first class graduating from the Joint Department of Biomedical Engineering at NC State University as an accredited program in 2004. Since then, Jarnigan has worked in medical device design and briefly was the owner of a new start up, Aurora Product Development. He closed his business within six weeks after receiving an offer from Simplexity Product Development to support the opening of a Seattle-based office. As the director of business development, Jarnigan has helped the office grow to a dozen employees. He has worked with large companies and small entrepreneurial start-ups.

The elements of his work consistently incorporate the skills he learned in BME — everything from biomechanics used in the design of a medical device to basic presentation skills. Simplexity has recently been awarded Quality Management System ISO 13485:2016 certification for Product Design and Development related to medical products. This new certification milestone will help Jarnigan reach out and continue to build Simplexity's customer base and help develop life-changing products such as medical wearables, patient monitoring devices, endoscopy and catheter-based devices, surgical tools and home health products. Jarnigan is yet another alumnus helping to support the advance of these innovative products.

The COVID-19 crisis has disrupted normal life as we know it, and it has been encouraging to see those in the medical field rallying around solutions to combat not only this current situation but potential catastrophes in the future. Jarnigan is proud to be part of a company like Simplexity that has the ability to support these relief and preventative efforts in conjunction with medical devices companies around the country. By helping quickly develop and distribute tools and equipment for on-the-ground health care providers and adding additional resources to companies that want to get ahead of the curve by developing better diagnostic equipment for future outbreaks, being involved in a relief effort role during these times is a rewarding experience and a great reminder of why the biomedical program was a good career path.

Ryan Facer

Design is one of the key elements of the BME experience and alumnus **RYAN FACER** '18 is making excellent use of the skills he learned as a student.

As a product development engineer for AccuMED by Lear (a division of Lear Corporation), Facer's team was called upon to design a new face mask to enable colleagues in China to return to work safely amidst the coronavirus outbreak back in February. Within three days of design approval, the company was ready for production. As it turns out, his team's design has become a critical piece of the fight against coronavirus globally as the company is providing mask donations throughout the world.

Facer is proud to have been designated as the lead engineer on the design, production and distribution of this new mask. He reflects on preparing for junior and senior design, knowing that the skills he learned there — everything from what to use on your slide deck and the order of presentation, to speaking to your audience — prepared him for his global presentation on the new mask design.

His colleagues claim it was practically his destiny, having nicknamed the design "The Facer." Ryan Facer is helping to coordinate efforts of donations of the mask here in North Carolina as the state's residents fight the coronavirus together. •

Joint Department of

BIOMEDICAL ENGINEERING

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M.S. Biomedical Engineering Translational Innovation and Entrepreneurship (MS-TraIn)

Our professional Master's curriculum is an 11-month (Summer II, Fall, Spring) program for students interested in acquiring the skills necessary to lead biomedical-related early stage ventures or to drive new product development in healthcare industries.

Our curriculum utilizes clinical immersion to identify healthcare opportunities, teaches design and innovation of FDA-regulated medical devices and facilitates new product development and commercialization strategies for innovative biomedical technologies.

Students receive mentorship from biotech entrepreneurs, legal scholars and venture partners.

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** 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 AND INNOVATION	PRODUCT DEVELOPMENT
• Design thinking • Clinical immersion • Needs filtering	• User requirements • Design requirements • Design controls/QMS • Prototyping • Verification & validation	• Design for manufacture • Project management • Funding strategy • Regulatory strategy • Operating strategy