SCHOOL OF BIOMEDICAL ENGINEERING

COLORADO STATE UNIVERSITY

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Volume 10, Issue 1 Spring 2022

MESSAGE FROM THE DIRECTORS

Globalization of BME

It is hard to overlook international challenges in our current world. We are facing numerous healthcare issues between the global nature of the SARS-CoV2 pandemic along with ongoing armed conflicts around the world that threaten and cost lives on a regular basis. Some of the first biomedical engineering devices in the world were battlefield improvisations. An international group of leading technological thinkers formulated 14 National Academy of Engineering Grand Challenges and you could argue that 40% of them relate to global health. Local issues just as frequently mirror global needs but perhaps with twists on perspective.

Last fall, we wrote about the School of Biomedical Engineering's global engineering engagements that had started and some that were in planning. While we can provide hands-on experiences to students in Colorado, gaining international perspectives on biomedical engineering practices overseas is essential, as we are seeing our alumni and advisors in industry positions doing more work with international partners. The pandemic provided significantly more experience in the world of remote work and allowed our students to interact with industry participants in countries around the world. The experimental Global Classroom we noted in the fall newsletter became a reality this spring. Individuals from international partner institutions in India, Brazil, Argentina, Rwanda, Ghana, and Kenya provided unique perspectives on biomedical engineering needs and solutions in their unique environments. Industry members in the U.S. provided further perspectives on their international experiences. With the semester drawing to a close, it is clear that the students in the class have gained significant direct exposure, experience, and an appreciation for the global issues of communication and culture. It is likely that this perspective will be just as helpful in understanding these same issues across the United States as well.

With the pandemic easing, we were able to send students once again last summer for experience with a prosthetic project in Ecuador in collaboration with the Range of Motion Project (ROMP). As for previous cohorts of students, the medical relevance and international exposure brought incredible excitement to the study of biomedical engineering. A number of senior design projects were created from their exposure to new technologies, and we expect additional ones in the future. The resources in Ecuador are clearly different than in Colorado, but the need is no less acute. Undergraduate student advisor Deb Misuraca, who helped start the ROMP experience, has gone on to create a new study abroad opportunity for students in 2023—Biomedical Industry and Healthcare in Portugal.

Finally, about a half a dozen years ago we met with a delegation of engineers at CSU led by Dr. Celestin Twizere, the Director of the Regional Centre of Excellence in Biomedical Engineering and eHealth (CEBE) at the University of Rwanda. Since then, we have discussed issues ranging from a new building in Kigali to course curricula in bioengineering. In the last year we extended our interactions to course instruction (Ketul Popat) and MS student advising (Popat and Tobet). Along with our other efforts, we will continue expanding horizons for the CSU School of Biomedical Engineering to global perspectives as much as possible.

Dr. Stuart Tobet
Director, SBME

Dr. Ketul Popat
Director, Undergraduate Programs

2022 Engineering Days (E-Days) in Person

Engineering Days (E-Days) provides undergraduate engineering students an opportunity to showcase their completed senior design projects to faculty, family, industry representatives, and peers. The capstone senior design project teaches students how to succeed in a well-integrated, interdisciplinary engineering design environment and allows students to develop practical, hands-on skills.

For the first time since 2019, E-Days took place in person on April 22. Members of the SBME Advisory Board—Larry Blankenship, Dennis Bruner, Gregory Florant, Ray Goodrich, Gary Johnson, Simon Prakash, Dennis Schlaht, Steve Simske, and Stephanie Salazar—served as judges and provided three biomedical engineering teams with cash awards. Three industry members also served as BME judges—Alan Dean and Seth Flickinger of Beckman Coulter and Michael Floren of AlloSource—critically evaluating student projects on technical content, presentation, creativity, and overall impression.

The following BME student senior design projects were awarded:

FIRST PLACE

Expandable Sheath for Minimally Invasive Gallstone Removal
Team: Ashley Daniels, Leslie DeLay, Courtney Doherty, Ryan Pyfrom, Emily Smith
Sponsored by Blankenship Research, UCHealth, and NIH

Gallstone disease is a prevalent issue in our society and has become an increasing issue for patients with multiple comorbidities who are unable to receive surgery. Although lithotripsy and other treatments can be done, there are often reoccurring problems for patients with gallstone disease if the stone cannot be removed entirely. Currently, gallbladder sludge can be removed through a percutaneous drain for patients unable to safely undergo surgery. However, there is not a current method to remove gallstones in a similar fashion. The goal of this project is to create a device that could be inserted through a percutaneous drain and guided to a gallstone to break it down and remove it through the drain in the abdominal wall. Several guiding methods could be investigated to use as well such as a mechanically maneuvering device or interventional radiology. Creating a solution to this common problem in medicine could have the potential to greatly improve long-term care for patients with gallstone disease.

SECOND PLACE

SnifTek
Team: Wendy Perez, Melody Pierro, Luke Rhone, Brandon Rouault, Turner Solheim
Sponsored by Neuvatek, Bert Vermeulen, Kevin Lear

Wouldn't it be cool if you could breathe into your cellphone and have it tell you about any diseases or health issues for which you might need to see a doctor? This project originated as a low-cost Covid-19 tester project in the 2020-2021 academic year. In that project, the BME team chose to pursue the development of an electronic nose (e-nose) that could smell volatile organic compounds (VOCs). The 2020-2021 team identified that this e-nose technology is useful for diagnosis of many human health issues including Covid-19, asthma, COPD, liver disease, and lung cancer. By May 2021, the team had completed a first prototype, tested it, and identified areas for improvement. In the summer of 2021 one of the senior design students stayed on for an internship to further test and improve the prototype. The 2020-2021 proved the concept, but a redesign is needed before the device can be used for clinical testing. For the 2021-2022 academic

year, it is expected that the team will take what was learned from the first prototype and related testing to: (a) Design a second-generation device that can be used for clinical studies; (b) Continue to improve the system used for testing prototypes with known concentrations of VOCs at known flow rates; (c) Perform human subject breath testing in a safe manner; and (d) Develop artificial intelligence (machine learning) techniques for analyzing and classifying test data.

THIRD PLACE

Prosthetic Socket Adapter
Team: Owen Anderson, Maren Baur, Kile Kelly, Aidan Piasentin, Taylor Recaido
Sponsored by Quorum Prosthetics

An issue with a transtibial prosthetic limb today is the reliability of the pyramid socket adapter component. The pyramid piece is placed between the socket and pylon to connect these components. Fatigue and over alignment of the pyramid socket adapter can lead to premature failure. To address this problem the team will explore potential solutions such as a 3D printed pyramid socket adapter utilizing a material to increase the fatigue life. These components are typically made of aluminum with steel. The objective is to increase the fatigue life of the socket adaptor component while sustaining affordability.

HONORABLE MENTION

A Modified Chandler Loop System for Dynamic Hemocompatibility Testing
Team: Sydney Alderfer, Justice Cory, Michael Hernandez, Grace Taylorgoodall
Advisor: Ketul Popat

Augmented Reality Ultrasound with Echogenic Needle
Team: Ethan Barron, Servando Calderon, Kim King
Advisors: Tod Clapp, Stu Tobet, Steven Hsu, Chad Eitel, and Brendan Garbe

If you are interested in viewing the posters and videos of these projects or the projects from all College of Engineering departments, please visit https://www.engr.colostate.edu/current-students/engineering-days/#projects.

THE COMPANY WE KEEP

Each semester, the School of Biomedical Engineering invites distinguished guests from around the world to speak on biomedical engineering research and related disciplines for its weekly seminar series. The Fall 2021 virtual speakers included:

NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY
Dr. Arvind Chandrasekaran
Engineering a 'sophisticated' petri dish

UNIVERSITY OF PENNSYLVANIA
Dr. Arjun Raj
Emergent Cellular Ecosystems in Melanoma Revealed by Single Cell Analysis

UNIVERSITY OF CALIFORNIA SAN FRANCISCO
Dr. Tejal Desai
Designing Nanostructured Materials to Enhance Therapeutic Delivery

UNIVERSITY OF CAMBRIDGE
Dr. Ulrich F. Keyser
Enhancing nanopore sensing with DNA nanotechnology: From polymer physics to detection of CoVID-19

New BME Course Gives Students International Perspective

By Michael Benedict

The world was a much smaller place just a decade or two ago. You probably rented movies from a video rental shop in your neighborhood. You probably bought just about everything from a store near your home. And if you were taking a college course, odds are good that the whole class gathered in the same room, and that you all lived within a few miles of each other.

Like most things, education looks a little different in 2022 – more and more students are learning online, and you could sign up today for a class taught on the other side of the world. A particularly innovative example of collaborative, international learning was launched in the School of Biomedical Engineering this spring: BIOM 380A2 – Global Challenges and Collaborations in BME. The course was created by Dr. Ketul Popat, the Director of Undergraduate Programs for SBME, who continues to lead the group and focus on the big-picture concerns. The triweekly classes are led by Dr. Liszt Madruga, a postdoctoral research associate in the Department of Chemical and Biological Engineering. Dr. Madruga explains that this "shrinking" of the world is part of what motivated the development of the course: "the actual working environment is far from what it used to be, [when you might not] interact with other countries during your career… Exposing students to different countries' cultures… contributes hugely to making them more complete professionals."

The educational institutions involved in this course extend far beyond just CSU, or Colorado, or even the USA — this course involves instructors and students in India, Brazil, Argentina, Rwanda, Ghana, and Kenya. It is also a collaboration with North Carolina Agricultural and Technical State University, a Historically Black College with whom SBME has developed a growing relationship.

So how on Earth can so many people be involved, from so many far-flung places? It works like this: The class meets three times a week, with each class being taught via Zoom by a different instructor. For the first seven weeks, all speakers are internationally based. According to Dr. Madruga, "a lot of what is said in the lectures is completely new, which is exciting." And the students aren't just listening to lectures from afar – they're also working closely with these international collaborators. They "interact with foreign students/faculty, and [for] the final project, [the students] interact with the foreign students to help build a complete case and to understand and learn new perspectives."

Naturally, this innovative course structure involves some unique challenges, not least of which is simply finding a time to meet. According to Dr. Madruga, "One of the challenges is the difference in time zones." India, for example, is 11.5 hours ahead of Mountain Time. The class often convenes very early in the morning, outside of their normally scheduled class period, in order to make the collaboration work.

Ross Lohrisch is a fifth-year BME+MECH student who has appreciated the way these complexities have been navigated: "the most surprising part of this course has been the impressive level of coordination in arranging a diverse set of guest lecturers." He sees how big the payoff has been, noting that "Not only are these lecturers diverse with respect to their nationality, but they also come from a surprising range of industries, areas of specialization, job titles, and socioeconomic backgrounds." Sarah Danekind is also a fifth-year BME+MECH student, and she found value in this unique course too: "The most interesting part of the course so far has been talking to the guest speakers from other countries… there's a lot of value in hearing from people with much different experiences than mine."

The course's scope is likely to expand even further in the future: "bringing more guest speakers from different countries… will expand the view of the students when related to international jobs and how to deal with different cultural aspects in work," says Dr. Madruga. Areas for expansion could include "more countries from Europe and Asia which have very different cultures and technological aspects."

The students are thinking about the future too. Lohrisch recommends that anyone considering signing up in coming years should "embrace their curiosity. Whether in the form of asking questions to those from other cultures or doing outside research on topics they find particularly interesting." Danekind has words of advice as well: "I would encourage any student to take this course! [It] is one of the most unique courses that I've taken at CSU… I have learned a lot about healthcare around the world, which is very useful knowledge for a biomedical engineer."

New Short Duration Study-Abroad Program Offered in Lisbon, Portugal

By Michael Benedict

Although most of us never experience it firsthand, we all have a notion of what it's like to be a college student studying abroad: The excitement of a semester (or even a year!) overseas. Getting to know the streets of the idyllic town where you've been placed. Mastering a new language, making lifelong friends.

But for many undergraduates in SBME, a study-abroad experience in this vein just isn't realistic. SBME students must earn nearly 160 credits, and most take five years to do so. The BME curriculum can be extremely difficult – it's one of the most challenging degree paths at the university. And that means that spending a semester abroad (much less a year) often just isn't realistic.

Fortunately, in SBME we pride ourselves on creative solutions, and that extends to questions of curriculum. In recent years, SBME advisors and educators have created short-term study-abroad programs that allow students to take an international trip that's short in duration but high in impact. One such course will be offered for the first time in January: BIOM 382B – Biomedical Industry and Healthcare in Portugal. As CSU Education Abroad explains, students will "hear from and visit with experts in the field on the topics of regulatory affairs and quality control, healthcare, research and development, and biomedical engineering. [Students will] gain an international perspective of these industries." The setting is also a big attraction – Lisbon, Portugal: "The city presents interesting contrasts, from tiny one-of-a-kind shops with fading facades to mega malls; from narrow, steep, cobbled-stoned streets to wide-open vistas. Lisbon's fascinating past can be seen in the faces of its multicultural citizens, food, [and] architecture."

If you're familiar with recent developments in SBME, the structure of this course might sound familiar: the exciting international setting, the short duration, and the timing of the program (held during a break, so that students don't have their attention drawn away by their day-to-day coursework) are all very similar to another BME course: BIOM 350 — Prosthetics in Ecuador. The courses have another commonality, too: they were both created by SBME's award-winning academic advisor Deb Misuraca.

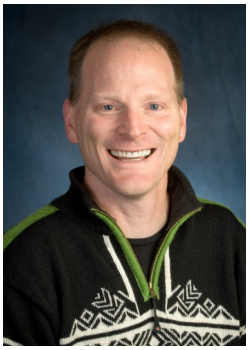
Misuraca's motivation for developing this course actually stems from her own experience in college: "I didn't study abroad during my undergrad but really wanted to. I was scared and didn't have the support I needed." Now Misuraca has created not one, but two courses that are perfect fits for CSU students in a similar situation; they can have a study-abroad experience, and they'll have the support they need to succeed. "Some of our students may have not stepped foot outside the US and that can be daunting. I think, for some, traveling with a group of your peers, faculty, and staff may feel less isolating than going 'alone,'" Misuraca says. "I want to be that support for CSU students."

Of course there are also some differences between the Ecuador course and this new experience in Portugal: the Portugal course will be less "hands on," and requires fewer pre-departure courses. Instead of the Range of Motion Project (ROMP), this course is a collaboration with the Council on International Educational Exchange (CIEE). SBME's senior academic advisor Brett Beal, who — like Misuraca — has served as a Program Leader in Ecuador in the past, explains the difference clearly, and establishes the value of the Portugal experience: "While not as 'hands on' as the Ecuador/Prosthetic Innovation program, [Portugal] provides an important exposure to how Portugal/Europe handles getting products to market, how elements of healthcare and [research and development] are conducted in Portugal, and how this compares to the US. Given the global nature of BME, [it] is an amazing opportunity!"

This new course is in good hands — it's being guided by the same duo that took the first group of students to Ecuador years ago: Misuraca and Dr. Ellen Brennan-Pierce, who will serve as Course Co-Instructors and Program Co-Leaders. Since its inception in 2018, the course in Ecuador has been a huge success: 60 students have made the trip (with another 20 confirmed for the coming summer). They have had unforgettable experiences abroad, learned valuable lessons about biomedical engineering and the nature of healthcare in other countries, and found inspiration to explore new directions in their careers. Who knows how many lives will be touched, and in what ways, in the coming years of study in Portugal?

Systems Engineering Professor Steve Simske Elected to National Academy of Inventors

By Anne Manning



Steve Simske, professor in the Department of Systems Engineering and School of Biomedical Engineering, has been named a Fellow of the National Academy of Inventors, the organization announced Dec. 7.

The NAI Fellows Program highlights academic inventors who have demonstrated a spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on the quality of life, economic development and welfare of society. Being elected as an NAI Fellow is the highest professional distinction accorded solely to academic inventors.

Simske joined the CSU faculty in 2018 following a long career at Hewlett Packard, where he was an HP Fellow, vice president, and director of HP Labs.

Full story: https://engr.source.colostate.edu/systems-engineering-professor-steve-simske-elected-to-national-academy-of-inventors/

Outstanding BME Grad: Janaye Matthews

By Andrea Leland

Janaye Matthews lives by the advice of her mentor: "Don't stop. Ever." That mantra kept Matthews going when she found herself questioning her choice to become an engineer – and it fueled her tireless efforts to make CSU a better place for students with marginalized identities.

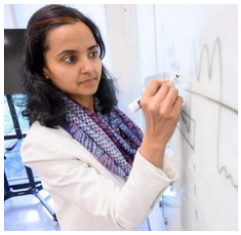
Matthews graduated from CSU with dual bachelor's degrees in biomedical engineering and electrical engineering and minors in mathematics and ethnic studies.

Matthews sees the world through the lens of empathy, from her leadership of multiple student organizations to her humanitarian work in developing nations. Among her many accomplishments, Matthews was named the winner of the 2021 Multicultural Undergraduate Research Art and Leadership Symposium, or MURALS, for her project spotlighting historical and contemporary implications of racial health disparities in the United States.

Full story: https://engr.source.colostate.edu/outstanding-grad-janaye-matthews-walter-scott-jr-college-of-engineering/

CSU Researcher Awarded Grant to Study How to Prolong Safe Driving for People with Alzheimer's

By Jim Herlihy



Every individual's experience with dementia is different. Neha Lodha, assistant professor in Colorado State University's Department of Health and Exercise Science and a faculty member in the interdisciplinary School of Biomedical Engineering, believes that by identifying and measuring behavioral biomarkers, it may be possible to prolong the time when individuals with cognitive impairment can continue driving safely.

To that end, Lodha is looking to use a three-year, $150,000 grant from the Alzheimer's Association to help measure how behavioral changes can predict a decline in driving safety, with a goal of developing rehabilitation approaches to promote and prolong safe driving. "My goal is to enable people to drive longer and more safely," said Lodha. "We currently know much about cognitive changes people with Alzheimer's experience, but less about movement impairment."

Full story: https://chhs.source.colostate.edu/csu-researcher-awarded-grant-to-study-how-to-prolong-safe-driving-in-people-with-alzheimers/

SBME Undergraduate Advisor Receives *Celebrate!* Colorado State Award

Congratulations to SBME Undergraduate Academic Advisor Debra Misuraca for receiving the Office of International Programs Distinguished Service Award. This award is given in recognition of outstanding contributions to the internationalization of CSU.

Misuraca has been instrumental in helping build short-term study abroad opportunities for BME students, including the Prosthetic Innovation in Ecuador program in partnership with the Range of Motion Project (ROMP) and the new Biomedical Industry and Healthcare in Portugal program.

Each year, Colorado State University celebrates the teaching, research, and service achievements of CSU students, alumni and friends, academic faculty, administrative professionals, and classified staff as part of the *Celebrate!* Colorado State Awards.

Full story: https://source.colostate.edu/celebrate-colorado-state-award-winners-for-2022/

GRADUATE SEMINAR SUMMARY: DR. TEJAL DESAI, UCSF

By Zach Cartwright

Dr. Tejal Desai from the UCSF department of Bioengineering and Therapeutic Sciences presented her research in micro/nanostructures in materials and their therapeutic effects on microenvironments on September 20, 2021. Her research involves the complex modifications of materials and structures to alter microenvironments to influence various biological processes.

This includes a wide range of applications spanning from cardiac tissue repair to synthetic DNA scaffolds with efficient and controlled protein loading. She showcased the methods in which material structures can greatly influence the biological response in the body. Regarding cardiac tissue repair, Dr. Desai's research showed the ability of micro-rods to reduce the buildup of scar tissue on cardiac muscle as a result of heart attacks. In the event of a heart attack, the heart undergoes damage and cells die off. As the natural wound healing response begins the cells repairing the damaged cardiac muscle create scar tissue and cause stiffening of the heart. Eventually as the scar tissue enlarges the heart can no longer keep up which can lead to death. The question Dr. Desai answered was "could a materials structure be a therapeutic?" Dr. Desai showed that by using tunable micro-rods of desired lengths they could actually induce tension into the microenvironment which would limit collagen formation and eliminate scar tissue of the cardiac muscles. Dr. Desai took this further to use the material decorin in the micro-rods and showed that not only would it reduce scar tissue but also promote vascular growth.

Dr. Desai further demonstrated her structural research around nanowires with the ability to stimulate local immune systems or release specific growth factors. These wires were made of poly(caprolactone) and could be modified by attaching antibodies and injecting them for therapeutic responses. Dr. Desai demonstrated the relevance of this technology in the treatment of mice with an autoimmune skin disorder. The study showed that mice that received nanowires with the proper antibodies displayed no signs of illness unlike the non-nanowire receiving mice which showed the disease. Her work shows these modified nanowires can stimulate T-regulator cells to enrich an area of the body quite rapidly and these cells are needed to heal a multitude of diseases.

Dr. Tejal Desai displayed the ability to use the micro/nanostructure of materials to alter biological processes. This research directly showed the potential to use material structure to treat a multitude of illness and finely tune the material properties to generate the desired biological response. Dr. Desai also mentioned the potential future for material surfaces regarding treatment of tolerance-based illnesses like diabetes or other autoimmune diseases such as rheumatoid arthritis.

GRADUATE SEMINAR SUMMARY: DR. ARVIND CHANDRASEKARAN, N.C. A&T

By Jacob Schweizer

On August 23, 2021, Dr. Arvind Chandrasekaran gave a presentation of his research on "Engineering a 'Sophisticated' Petri Dish." Dr. Arvind Chandrasekaran is an Assistant Professor in the Department of Bioengineering and is the Principal Investigator at the Bio-Inspired Microengineering Laboratory at North Carolina A&T State University. The main goal of his research is to see how microengineering can be used as a tool in the discovery of new drugs.

One of the main issues in the pharmaceutical industry is the drug discovery process. For a drug to be considered for use in patients it must pass benchtop testing, then animal trials, and finally human trials. It is estimated that for every 5000 benchtop discoveries, only 1 drug will make it to the market. Additionally, the process of a drug going from the benchtop to the market takes about 12 years and costs roughly $10 billion. Dr. Chandrasekaran's research is concerned with creating a solution to help make this process more efficient, and he hopes to do this through the engineering of robust biomimetic platforms which can imitate human organs in-vitro, a.k.a. the sophisticated petri dish. These artificial "organs-on-chips" would hypothetically be able to screen out drug candidates that would fail during animal and human testing, thus saving both time and money in the drug discovery process.

Several tools are needed to engineer these sophisticated petri dishes. These tools include accessible microfabrication, biomaterials, tissue engineering principles, and automated handling. A good, sophisticated petri dish would integrate all four of these tools, be able to undergo high-throughput screening, and accurately simulate in-vivo conditions.

Dr. Chandrasekaran gave a few examples of sophisticated petri dishes which have been developed in his lab. The main example he described revolved around the study of neutrophils, which are the first immune responders to inflammations or infections. A 3-D sophisticated petri dish was constructed in the lab which would shed light on neutrophil involvement in tumor development. This platform consisted of a 3-D, microfluidics integrated tumor-immune microenvironment-on chip which allowed neutrophils to flow through it. A similar sophisticated petri dish platform could be used to observe the flow of a drug through an artificial organ-on-chip system.

Dr. Chandrasekaran's research has the potential to make the drug discovery process more efficient with the implementation of his sophisticated petri dish designs to model human testing. This work also has implications that are even larger than just the drug industry because successful mass-modeling of human organs in the lab could lead to many useful discoveries in the medical field.

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FIND US ON:

Study Abroad in Portugal—NEW!

In January 2023, students will have an opportunity to travel to Lisbon, Portugal for a CSU faculty-led program offering a rich opportunity to gain first-hand experience observing and interacting with biomedical engineering in a professional setting. Students will hear from and visit with experts in the field on the topics of regulatory affairs and quality control, healthcare, research and development, and biomedical engineering. This course provides an opportunity for students to gain an international perspective of these industries, and to understand key differences between the US and European Union's practices and standards in these fields. Learn more through CSU Education Abroad.

SCHOLARSHIPS

Scholarship support at all levels provides critical aid to our students. We strive to help as many students as possible with the financial obligations of their engineering education.

Donate to an SBME scholarship today and know that your gift will make an impact for years to come.

https://advancing.colostate.edu/SBME

Biomedical Engineering Alumni Scholarship

Dorothy and Dennis Bruner Biomedical Engineering Scholarship

Joan C. King-Tobet Memorial Scholarship

Samson Design Biotechnology Innovation Scholarship

SBME Scholarship for Leadership and Innovation