



**SCHOOL OF BIOMEDICAL
ENGINEERING**
COLORADO STATE UNIVERSITY



E-Days' capstone projects inspire SBME Advisory Board members to award cash prizes.

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New SBME programs enhance student learning & skills outside the classroom.

— page 4

**Journal of
Materials Chemistry E**
Materials for biology and medicine
ACCEPTED MANUSCRIPT

Exciting research taking place in the award-winning SBME research labs across campus.

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Message from Director

Preparing clinical biomedical engineering students

There are many points of potential contact between biomedical engineering, the practice of medicine, and research that drives improvements in medicine. In a recent report on behalf of the Council of Chairs of Biomedical Engineering (George et al., 2017; Ann Biomed Eng) there were four areas of interest identified between departments of biomedical engineering and medical schools, the fourth, "Events or Activities to Stimulate Interaction," being highly relevant to CSU.

There are several ways in which the School of Biomedical Engineering (SBME) at CSU is actively engaged with clinical education and research. To start with, we are intimately linked with CSU's veterinary school, which is ranked No. 3 in the country according to *U.S. News and World Report*, which is rich in clinical exposure and experience. SBME faculty can be found in three of the four departments in the College of Veterinary Medicine and Biomedical Sciences (CVMB), including Clinical Sciences. Nowhere is this more evident than in the new Wayne McIlwraith Translational Medicine Institute (TMI), expected to open in December, which will draw on established areas of CSU research expertise in orthopaedics, biomedical engineering, immunology, infectious disease, surgical advances, and other medical fields. The newly named Director of the TMI is Dr. David Frisbie, a professor in the Department of Clinical Sciences in CVMB, and a core faculty member in SBME. Additionally, CSU is surrounded by three medical facilities that engage with us on a regular basis: Medical Center of the Rockies, Poudre Valley Hospital, which are both part of the University of Colorado Health System, and Orthopedic Center of the Rockies.

Dr. Julie Dunn, head of the SBME Industry Advisory Board and Medical Director of Trauma Research at Medical Center of the Rockies, teamed with SBME director of Senior Design Ellen Brennan-Pierce to obtain an NIH Training grant (2018-22) to establish a Clinical Immersion Program. This program provides students with an opportunity to visit the UC Health Clinical Education and Innovation Center and participate in clinical simulations for high-level emergency situations and to participate in discussions with clinical providers to address perceived gaps, potential future directions of medical devices, and unmet needs.

Undergraduate student advisor Deb Misuraca also teamed with Ellen Brennan-Pierce to spearhead a CSU field project for prosthetic innovation in Ecuador that combined experiential learning with an opportunity to study abroad for one week. Working closely with the Range of Motion Project (ROMP), students gained experience with patients, from arrival and fitting, through casting and molding, and physical therapy and mobility.

Backed with two degrees (B.S. in BME and B.S. in one of three traditional engineering areas), our students understand the biocompatibility of what they are designing, giving them a leg up in solving medical problems. Between the additional training and clinical programs and resources, our biomedical engineering students are prepared for a multitude of career opportunities after graduation.

I invite you to share your thoughts or ideas on how we can further expand and strengthen our clinical opportunities for students. Start a conversation by emailing me at Stuart.Tobet@colostate.edu.

Built on strong transdisciplinary faculty & research programs



Walter Scott Jr.
College of Engineering



College of Health and
Human Sciences



College of
Natural Sciences



College of Veterinary
Medicine & Biomedical
Sciences

Congratulations to the Class of 2018!

Bachelor of Science in Biomedical Engineering and Chemical and Biological Engineering

Alexander K. Bozzo
Mitchell S. Cooper
Andrew T. Fox
Bryant J. Hiraki
Lauren L. Kapushion
Carolyn E. Keating
Alexandra S. Kosmiski
Adam J. Le Jeune
Patrick C. Mannion
Andrew D. Mark
Charlotte R. Mitchell
Morgan A. Schake
Wendy Y. Sunada
Jaron C. Thompson
Colten N. White
Samantha M. White
Jase W. Wyeno

Bachelor of Science in Biomedical Engineering and Mechanical Engineering

Samuel R. Allsup
Courtney R. Barber
Allison N. Baumgart
Anthony J. Behle
Anders J. Booth
Alexander T. Brown
Tori A. Chipman
Valerie P. Cochrane
MacLean Freund
Aidan R. Friederich
Derek J. Frost
William Hawkins
Amy E. Holcomb
Byron J. Irish
Amy R. Kippen
Jason P. Kuiper
Taylor B. Langer
Dominic A. Loffreda
Dominic A. Martinez
Hannah L. Mikelson
Noah G. Mills
Camryn L. More
Nathan D. Nash
Aubrey D. Newsom
Ian P. Scott
Joshua R. Smith
Emily A. Valerioti
Donald I. White

Bachelor of Science in Biomedical Engineering and Electrical Engineering

Jordan L. Bernhardt
Rachel M. Hume
Sarah E. Jordan
Zachary A. Kugler
Asish B. Mathew
Megan N. Miller
Thomas G. Morrison
Robert B. Turner
Thomas A. Weingartner

Bachelor of Science in Biomedical Engineering and Electrical Engineering with a concentration in Lasers & Optics

Jesse D. Ciddio
Connor J. Watkins

Master of Engineering - Biomedical Engineering Specialization

Aaron Paulding

Master of Engineering Online - Biomedical Engineering Specialization

Alyssa Horvat
Josh Sullivan
Shane Wood

Master of Science, Bioengineering

Ahmed Aldohbeyb
Jillian Sirkis

Doctor of Philosophy, Bioengineering

Kristine Fischenich
Jackson Lewis
Christine Lin
Hannah Pauly
David Schwark
Brett Steineman
Lei Wang
Brent Ware

New BME Alumni Scholarship Fund

At the May commencement reception, 2018 BME graduates started a new tradition by making donations for their class' BME Alumni Scholarship Fund . With the undergraduate director's 1:1 matching of each donation, the class of 2018 is over halfway to the goal of raising \$1,000 for the first alumni scholarship.

The director is now challenging the Class of 2019 to likewise donate toward an alumni-funded scholarship and will match 1:1 their first \$500 in donations as well. The goal is to award two \$1,000 scholarships, one from the Class of 2018 and one from the Class of 2019, to support deserving BME students in fall of 2019.

<https://advancing.colostate.edu/SBME>

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 Spring 2018 speakers included:

DR. TIM RUCKH (SBME Alumnus) **Verily Life Sciences**

Verily's Nanoparticle Project: Technical Development Example of Nanoparticle Tracking Analysis

DR. WALTER BESIO **University of Rhode Island** *Tripolar Concentric Ring Electrodes for Two-Way Brain Interaction*

DR. K. JANE GRANDE-ALLEN **Rice University** *Mechanobiology of Heart Valve Disease*

DR. BARBARA S. SMITH (SBME Alumna) **Arizona State University** *Developing Novel Bioinstrumentation and Biomarker Discovery: The Road to Personalized Medicine and Non-invasive Diagnostics*

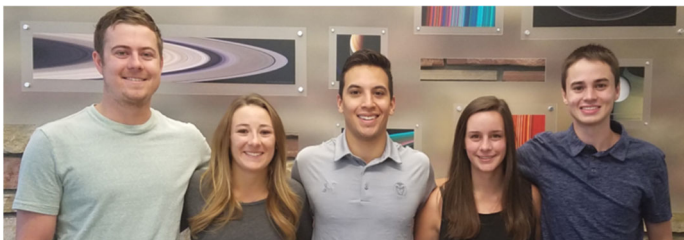
Biomedical Engineering Awards at E-Days

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.

On April 12, 2018, members of the SBME Advisory Board—Dennis Bruner, Julie Dunn, Gary Johnson, Dennis Schlaht, and Steve Simske—served as judges and provided four biomedical engineering teams with cash awards at E-Days.

This year, ten industry members representing various companies including AlloSource, Beckman-Coulter, DePuy Synthes, Medtronic, and Terumo BCT, also served as BME judges and critically evaluated student projects on technical content, presentation, creativity, and overall impression. The following BME student senior design projects were awarded:

First Place (tie): Mechanical Bladder Device (faculty advisors: Hiep Nguyen, M.D.; Shawn Smith, Katie Trella)



Group Members: Anders Booth, Valerie Cochrane, Dominic Martinez, Sarah Jordan, and Aidan Friederich

This project aimed to create a complete implantable replacement for the human bladder. In the United States, one million people each year require some form of treatment for bladder dysfunction. Current treatments fail to fully restore bladder function and result in complications including infection, bladder stones, incontinence, and bladder rupture. This device restores the complete function of the bladder by notifying the patient when the bladder is full and facilitating drainage.

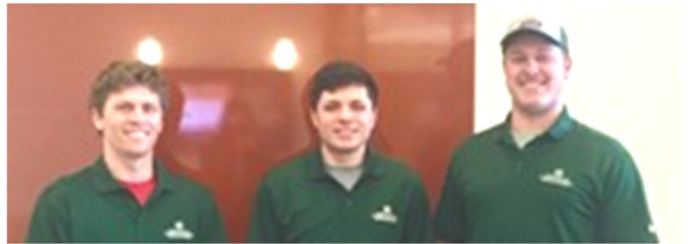
First Place (tie): Paper-Based Microfluidic Device for Global Health (faculty advisor: Chuck Henry)



Group Members: Mitchell Cooper, Jase Wyeno, Sam Allsup, and Taylor Langer

The overall goal of this project was to create a fully automated paper-based microfluidic device for Salmonella detection to be deployed in developing countries to improve global healthcare.

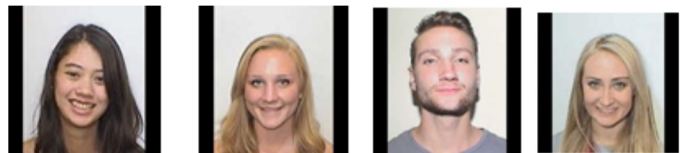
Second Place: Hypoxia Chamber for Biomedical Research (faculty advisors: Zhijie Wang and Jesse Wilson)



Group members: Willie Hawkins, Dominic Loffreda, and Zach Kugler

The purpose of this project was to construct a 'smart' hypoxia chamber that can be monitored and/or controlled by onsite (i.e., in the lab) or remote (i.e., via smart phone) operations. The Chamber creates and maintains a high-precision oxygen deprived atmosphere, providing an ethical and reliable research environment that can be custom tailored and flexibly programmed for a wide variety of applications, from bacterial cultures and animal research to point-of-care therapy.

Third Place: Bone Matrix Electrospinning (faculty advisors: Ketul Popat and Matt Kipper)



Group Members: Alex Kosmiski, Morgan Schake, Alex Bozzo, and Ally Baumgart

This project focused on the creation of a novel regenerative medicine technique to entirely eliminate the need for bone grafts by experimenting with the use of demineralized bone matrix for the specialization production of bone scaffolds using electrospinning and airbrushing methods. Such scaffolds are designed to be surgically implanted in the human body at the immediate site of bone loss and thus must be biocompatible, causing negligible immune reaction/rejection.

Join us Next Year

If you are interested in viewing biomedical engineering senior design projects and interacting with our students, please join us for next year's E-Days event on Friday, April 19, 2019 in the CSU Lory Student Center Ballrooms.

New SBME Programs Enhance Student Learning

Prosthetic Innovation in Ecuador Program



Biomedical engineering students are hard pressed for time and find it exceptionally difficult to squeeze in study-abroad opportunities in their five years of study. The Prosthetic Innovation in Ecuador program is aimed to address this issue by providing students with a short-term, nine-day experience that combines experiential learning with an opportunity to explore prosthetic fabrication and biomedical engineering needs in developing countries. Both undergraduates and graduates of all majors can participate and gain experience with patients.

This past summer, co-leaders Deb Misuraca (BME Academic Advisor) and Ellen Brennan-

Pierce (BME Research Scientist and Senior Design Instructor) led 24 engineering and health and exercise science students on a trip to Quito, Ecuador, where they spent a week experiencing hands-on application of machining skills, interacting with patients, and assisting in the design and fabrication of 22 prosthetic devices. In partnership with the Range of Motion Project (ROMP), a non-profit for-impact healthcare organization, participants tested prosthetic technology in a low-resource setting alongside ROMP personnel and clinicians. Students reported that they were inspired by their experience and their participation solidified their interest in biomedical engineering.

Clinical Immersion Program

In summer 2018, the School of Biomedical Engineering began offering a seven-week full-time summer clinical immersion program at University of Colorado Health Medical Center of the Rockies, in Loveland.

The program is sponsored by the National Institute of Biomedical Imaging and Bioengineering of the National Institutes of Health, providing a stipend for up to seven students while participating in the program. Up to nine additional students are eligible to participate each summer as volunteers.



The clinical immersion program is comprised of rotations through specific specialty areas that rely on medical devices and biomedical technology, such as:

- ◆ Anesthesia
- ◆ Trauma and Acute Care
- ◆ Surgery
- ◆ Orthopedic Surgery
- ◆ Cardiology and Cardiovascular Surgery
- ◆ Interventional Radiology
- ◆ Neurosurgery
- ◆ Intensive Care Unit
- ◆ Bioengineering

Because it is not possible for students to participate in emergent events such as trauma activations and emergency obstetric cases, students also visit the University of Colorado Health Clinical Education and Innovation Center, where they participate in clinical simulation for these high-level emergency situations.

These clinical experiences will help BME students understand the environment and constraints that must be considered for successful design of medical devices. Furthermore, with clinicians being one of the major users of devices developed by biomedical engineers, it is valuable for biomedical engineers to spend time interacting with clinicians and learning the language of the clinical environment. At the culmination of the clinical immersion experience, students participate in a discussion with clinical providers to discuss perceived gaps, potential future directions of medical devices, and unmet needs. As a result of these interactions, students and clinicians co-develop ideas that can be incorporated into senior capstone design projects for the upcoming academic year.

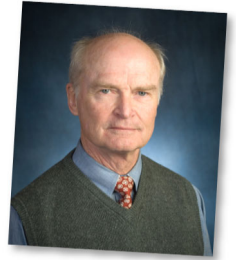
Endowment of SBME Scholarship for Leadership & Innovation

In Spring 2013, the SBME Advisory Board agreed to establish and seed the first-ever biomedical engineering scholarship at CSU. The Scholarship for Leadership and Innovation supports graduate and undergraduate students pursuing careers in biomedical engineering. Set up as a pending endowment, the SBME had five years to raise \$25,000 so that it could provide an annual \$1,000 scholarship in perpetuity. This type of fund allowed for annual expendable gifts while the endowment was growing.

In June 2018, we met our goal and have raised the funds to endow this scholarship. Many thanks to all the contributors who helped make this possible.

CSU Alumnus Establishes New BME Endowed Scholarship

Colorado State University alumnus and SBME Advisory Board Member Dennis Bruner ('61 Mechanical Engineering) recently established the Dorothy and Dennis Bruner Biomedical Engineering Endowed Scholarship. This scholarship will support undergraduate and graduate biomedical engineering students. The first award should be available for the Fall of 2019.



2018/19 Scholarship Winners

SBME Scholarship for Leadership and Innovation

Natalie Rios received the SBME Scholarship for Leadership and Innovation. This scholarship was created to support biomedical engineering students who excel as creative problem-solvers and show a commitment to leadership.



Rios serves as the outreach coordinator for the Society of Women Engineers (SWE) and manages 12 team members. She uses the Gallup Strength Finder curriculum to organize subcommittees based on identified strengths so members can collaborate and thrive. Rios was instrumental in utilizing *Slate*, CSU's admission platform, for their annual *Introduce a Girl to Engineering Day* event registration. Through this platform, SWE can gauge the effectiveness of their outreach to middle school girls by identifying which participants apply to CSU for engineering.

Joan C. King Memorial Scholarship Award



Awarded to students with an interest in biomedical sciences or engineering, this year's Joan C. King Memorial Scholarship Award was given to Mallory Knudsen and Jordan Nelson at the Women of Vision Gala in July, hosted by the Colorado Women of Influence.

Knudsen, a first-generation, BME+CBE transfer student, works full time while completing a full load of courses. In addition, she found time to participate in the week-long Prosthetic Innovation Program in Quito, Ecuador this summer.

Nelson, a biomedical science student at CSU, began an osteopathic medicine club on campus, volunteers in a biochemistry lab, takes part in organ presentations, and Anatomy Camp.



Samson Design Biotechnology Innovation Scholarship

Mark Greenwood is this year's Samson Design Biotechnology Innovation Scholarship recipient. Greenwood began his Doctorate in Philosophy in Bioengineering in fall 2018. Greenwood was overjoyed upon hearing the news. "I'm just feeling very fortunate," he stated.

This annual \$2,500 scholarship was created to support a new SBME graduate student who demonstrates an interest and talent in biotechnology innovation and shows promise in innovative thinking.

Look What's Happening in the SBME Research Labs



Synthetic biologists get \$1.7 million to engineer world's strongest biomaterial

By Anne Manning

It's the most durable biological material you've never heard of: sporopollenin. Synthetic biologists at Colorado State University are attempting to manufacture sporopollenin in the lab using plants, and to control its properties using gene parts designed for specific functions, known as genetic circuits.
Full story: <https://natsci.source.colostate.edu/synthetic-biologists-get-1-7-million-to-engineer-worlds-strongest-biomaterial/>



Research team makes cover of prestigious journal

In June, the *Journal of Materials Chemistry B—Materials for Biology and Medicine* featured research from Associate Professor Melissa Reynolds' Therapeutic Materials and Biointerfacial Research team (Janet P. Yapor, Bella H. Neufeld, and Jesus B. Tapia). Reynolds holds a joint appointment with the School of Biomedical Engineering.

Full story: <https://pubs.rsc.org/en/content/articlelanding/2018/tb/c8tb00566d#!divAbstract>



Munsky's groundbreaking advancements to predictive biological modeling published in PNAS

By Sona Srinarayana

By developing advanced computational tools to recover precise, reproducible, and predictive biological models, Munsky and his collaborators have advanced the field of systems biology.

Full story: <https://enr.source.colostate.edu/brian-munskys-groundbreaking-advancements-to-predictive-biological-modeling-published-in-pnas/>



Boettcher Investigator uses virtual biopsies to improve melanoma detection

By Andrea Leland

Wilson's research leverages ultrafast and nonlinear optical phenomena for microscopic imaging contrast, with a specific focus on biomedical applications. As a Boettcher Investigator, Wilson will develop a new laser technique to enable the first-ever direct observations of mitochondrial respiratory chain function in living cells and tissues. Wilson's MRA award is focused on the development of an inexpensive "virtual biopsy" technique for early, noninvasive screening and detection of melanomas.

Full story: <https://enr.source.colostate.edu/using-virtual-biopsies-to-improve-melanoma-detection/>



Bark's research in cardiovascular biophysics receives recognition

David Bark, assistant professor in the Department of Mechanical Engineering and core faculty in the School of Biomedical Engineering, was recently announced as the recipient of the American Heart Association Career Development Award. In addition, he was awarded a grant from the National Science Foundation to study how platelets respond to mechanical loading, and how that response helps regulate hemostasis and thrombosis.

Full story: <https://www.engr.colostate.edu/david-bark-awarded-american-heart-association-career-development-grant/>



Dinunno examines chemical that could improve circulation, tissues oxygen levels

By Jeff Dodge

Professor Frank Dinunno is taking a closer look at a chemical that seems to be critical to the dilation of blood vessels and oxygen delivery in the body—and it could prove to be a game-changer for older adults, diabetics, and others with circulation problems.

Full story: <https://chhs.source.colostate.edu/csu-researcher-examining-chemical-that-could-improve-circulation-tissue-oxygen-levels/>

Awards & Activities: SBME Faculty, Staff, and Student

Congratulations to BME graduate student **Alec Richardson who received the **Shrake/Culler Scholarship**, a \$3,600 award!**

Graduate student **Tara Wigmosta received the **Sjostrom Family Scholarship**, an \$1,800 award for demonstrating research in improving the quality of life in less industrialized communities.**

In May 2018, the Career Center hosted its first annual Career Impact Awards, an award show and lunch event in which members of the campus and Fort Collins community celebrated those who have made a significant impact on students' careers.



Senior Academic Advisor **Brett Beal** received the **Distinguished Staff Member** award for weaving career into all of her conversations with fellow staff, faculty, and students.

BME Undergraduate Director **Kevin Lear** received the **Distinguished Faculty Award** for successfully integrating career into his classroom, working individually with students and intentionally connecting students to career preparedness and readiness opportunities that foster professional growth outside of the classroom.



2018 Senior Design Team Invited to International Design Competition

The Physically Pulsating Organ Model senior design team (Charlotte Mitchell, Amy Holcomb, Megan Miller, and Anthony Behle) sponsored by Applied Medical has been selected as finalists in the UBORA Design Competition 2018.

The prototype has been developed to aid in training surgical residents. It consists of a vascular network capable of being remotely activated to create a rupture (a bleed). Surgical residents training on this system will be able to practice and perfect ligation techniques such as clamping and suturing on living beings.

In early September, Amy Holcomb traveled to Pisa, Italy to represent the team and participate in a five-day design school working on an international team of biomedical engineers to create a prototype of a medical device and document in the online UBORA e-infrastructure platform. Between the conference and the design school, all participants presented their original posters submitted to UBORA.



Holcomb's design school team worked to create a kit for treating fractures and sprains of the hand (fingers and thumb), calling the project "Modular Multi-Finger Splint Kit." To learn more about this project visit the UBORA platform at <https://ubora-kahawa.azurewebsites.net/projects/4e503390-79bb-4786-8544-92c1c0cc87ea>.



Nicole Ramo received the **Best Paper in BME Division** at the **American Society of Engineering**.

Congratulations to our SBME faculty who were awarded early-career awards!

David Bark received the Career Development Award from the American Heart Association.

Arun Kota received the Faculty Early Career Development Program (CAREER) from the National Science Foundation.

Brian Munsky received the Maximizing Investigators' Research Award for Early Stage Investigators (MIRA) from the National Institutes of Health / National Institute of General Medical Sciences.

Jesse Wilson received the Boettcher Early Career Investigator, Boettcher Webb-Waring Biomedical Research Award from the Boettcher Foundation.



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FIND US ON:



Save the Date

NOVEMBER 2018

SBME Seminars

103 Behavioral Sciences, 12-12:50 p.m.

Nov. 5: Dr. Preethi Chandran, Howard University

Nov. 12: Dr. Christie Peebles, CSU

Nov. 26: Jessi Vlcek & Tara Wigmosta, SBME Ph.D. Students

DECEMBER 2018

SBME Seminar

103 Behavioral Sciences, 12-12:50 p.m.

Dec. 3: Dr. Chris Ackerson, CSU



BME Fall Commencement Lory Student Center Grand Ballroom, 4:00 p.m.

Dec. 15: Walter Scott, Jr. College of
Engineering

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.

Biomedical Engineering Alumni Scholarship

<https://advancing.colostate.edu/SBME>

Joan King Memorial Scholarship

<https://advancing.colostate.edu/KingScholarship>

SBME Scholarship for Leadership and Innovation

<https://advancing.colostate.edu/SBME>

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