Carnegie Mellon University | Winter 2021

MECHANICAL ENGINEERING

THERE'S NO STOPPING MECHE

ADAPTING WITH INNOVATION AND AGILITY DURING THE COVID-19 PANDEMIC

A TARTAN AIMS FOR THE MOON

DRIVING AHEAD

Inside

On the Cover A student learns to weld in the Tech Spark maker space during the fall semester when some students returned to campus. COVID-19 safety protocols were strictly enforced.

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MECHANICAL ENGINEERING

Dear Alumni, Students, Parents and Friends,

We've had a tremendously difficult year. My heart goes out to those of you who have lost loved ones to COVID-19 or are struggling because of the economic and personal challenges left in the pandemic's wake. In this edition of MechE Magazine, our feature story reflects the resiliency and creativity that faculty, students, and staff used to rapidly adapt coursework and projects for remote and hybrid learning. It also highlights some research activities that pivoted to focus on innovative COVID-19 related solutions.

This year has also reminded us of how our nation continues to struggle with social and racial injustice. A core strength of our MechE community is the fusion of people with diverse backgrounds, experiences, talents, and ideas. This diversity inspires us and drives us to do better. We have redoubled our efforts over the past year to best support every member of our community's success.

In these pages, you'll meet our newest faculty member, Douglas Weber, who combines neuroscience, engineering, and medicine to develop neural prosthetic technologies. You'll also read about master's program alumni working in different fields.

Over the summer, we emptied the old Scaife Hall in preparation for demolition. The old building is now gone. I'm pleased to share with you the architectural renderings for the new Scaife Hall, a 21st century facility that will propel us toward the future. A large number of faculty, students, and staff have actively worked on the design. It will open in winter of 2023.

I couldn't be prouder of our MechE students—and you'll be, too, when you see a sampling of their awards and tremendous achievements despite the obstacles of the past year.

In closing, I'd like to thank you for being a part of the MechE community. We are here for you and because of you! I always enjoy hearing from you, so please reach out.

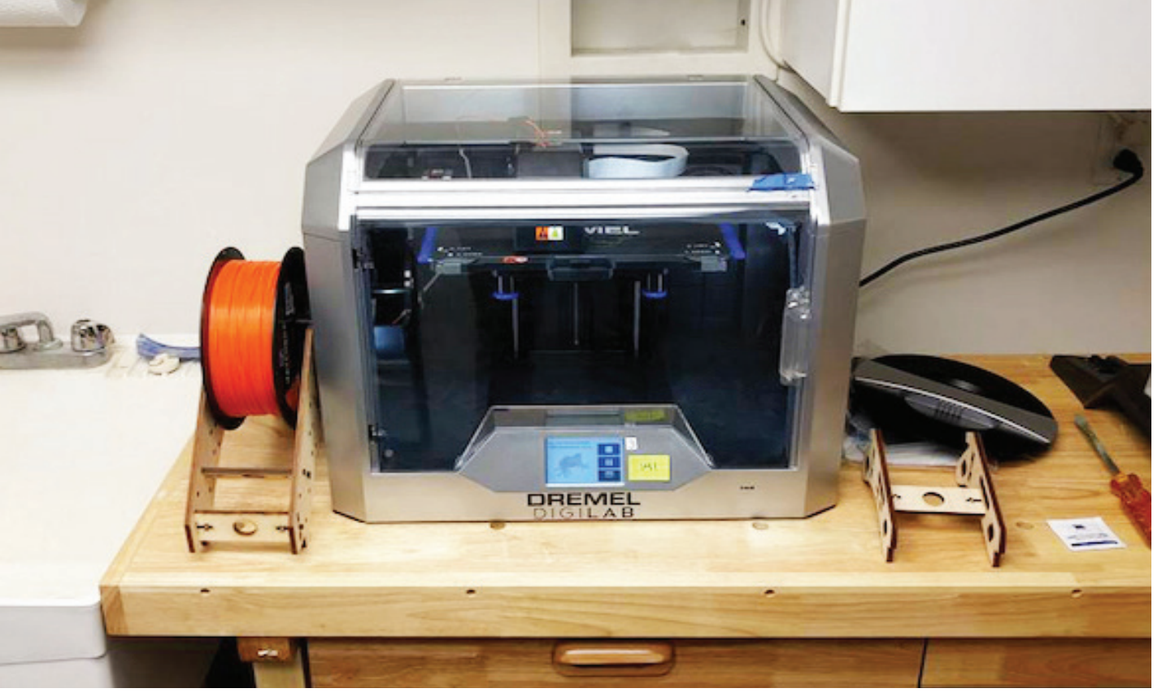
And, stay tuned for information about virtual Spring Carnival 2021.

Sincerely,

Allen L. Robinson
David and Susan Coulter Head and Raymond J. Lane Distinguished Professor, Mechanical Engineering

THERE'S NO STOPPING MECHE

MechE students and faculty adapted with innovation and agility during the COVID-19 pandemic.



A PROFESSOR USED HIS BASEMENT 3D PRINTER TO MAKE PARTS TO SHIP TO STUDENTS.

REASSESS, RECALIBRATE AND TRANSFORM

The world was flipped upside-down by the COVID-19 pandemic last spring. Every industry experienced major changes, and academia was no exception. The Department of Mechanical Engineering pivoted to provide enhanced learning experiences as innovative as those that usually occur on campus.

"With a curriculum that emphasizes hands-on project work, moving to remote teaching and learning for the end of the spring semester posed several challenges," said Allen Robinson, head of the department. "But we did what engineers do best: reassess, recalibrate, and transform the challenges into opportunities."

Here are some examples of how spring 2020 courses were adapted so that students could finish the school year online:

GADGETRY: SENSORS, ACTUATORS, AND PROCESSORS

Students in Assistant Professor Vickie Webster-Wood's course received kits at home to work through circuit problems for hands-on labs. Breakout rooms in Zoom, a videoconferencing platform, allowed for small group discussions and trouble-shooting as the teaching team moved between rooms to answer questions.

The student teams designed and prototyped electronic subsystems and came up with creative ways to convey their mechanical designs.

ROBOT DESIGN AND EXPERIMENTATION

Students in Assistant Professor Aaron Johnson's course had expected to build robots inspired by animals in nature and did not want to move to all simulation. So, Johnson shipped them soldering irons and parts (some of which he had 3D printed in his basement). Final project videos ranged from starfish grippers to brachiating monkey robots. One student on the team 'Operation Stingray' even had his younger sisters help to set up a kiddie pool in their backyard to run tests.

MAKING YOUR PRODUCT AT SCALE

Students created packaging for a fragile product from a fictional company during a remote "pack-a-thon" session as part of Assistant Professor Rebecca Taylor's course. Taylor created an immersive at-home learning experience with mechanical engineering related-games like a Contract Manufacturing tabletop card game. Students received playing card kits in the mail and used Zoom breakout rooms to play long-distance.

CELLULAR BIOMECHANICS

Professor Philip LeDuc substituted a lab from another course he teaches, Culinary Mechanics, because he thought it would work better over Zoom. Eggs, cream, and other ingredients were delivered to students so they could learn about the effects of mechanics by making ice cream. The students enjoyed doing a lab experiment from the comfort of their own homes and enjoyed eating the ice cream together at the end of class.

"One of our main goals last semester was to maintain a high level of hands-on learning experiences for students, because this is at the core of being a mechanical engineer," said Robinson. "We had a productive, impactful semester while keeping students safe."

FALL 2020: FORGING AHEAD

When life throws lemons to mechanical engineers, they make lemonade... and dynamic systems, geometric models, and thermal fluids experiments. There's no stopping mechanical engineers.

As the COVID-19 pandemic spread beyond the spring and into the summer, MechE prepared for a hybrid model of education for the fall 2020 semester where some students would return to campus and some would remain at home. Faculty, instructors, staff, and teaching assistants transformed their courses and instructional activities to make them more engaging, accessible, and relevant to students regardless of their physical location.

While it was uncertain how COVID-19 would continue to impact this academic year, Robinson was sure of one thing. "We tell our students that we are preparing them to solve real world challenges," he said. "And this is as real as it gets."

Highlights from our hybrid-style Fall 2020 courses include:

ENGINEERING DESIGN II: CONCEPTUALIZATION AND REALIZATION

Required for senior mechanical engineering majors, this is a significant capstone course that guides students through the applied design of a practical mechanical system. It culminates in the department's Design Expo at the end of the term.

Building prototypes, an important part of the course, posed the greatest challenge. Students on campus needed to stay six-feet apart while using Tech Spark's fabrication facilities while other students were remote without direct access to the prototyping equipment. And, they still needed to work together in teams regardless of their locations.

Assistant Professor Kate Whitefoot had made several changes to the course, creating a new course module on V-model system and subsystem requirements. "The nice thing about converting the class to a V-model approach is that it is really relevant for the modern day world," Whitefoot said. "In most engineering contexts, products are designed by a large number of people and different organizations or divisions within a large company. This necessitates the ability to decompose the product into subsystems that can be designed separately and in parallel."

This fall's version of the course gave students the experience of designing and manufacturing products in this type of environment where the work is distributed. A critical aspect of this design process is specifying the requirements and interfaces between subsystems upfront and holding to them.

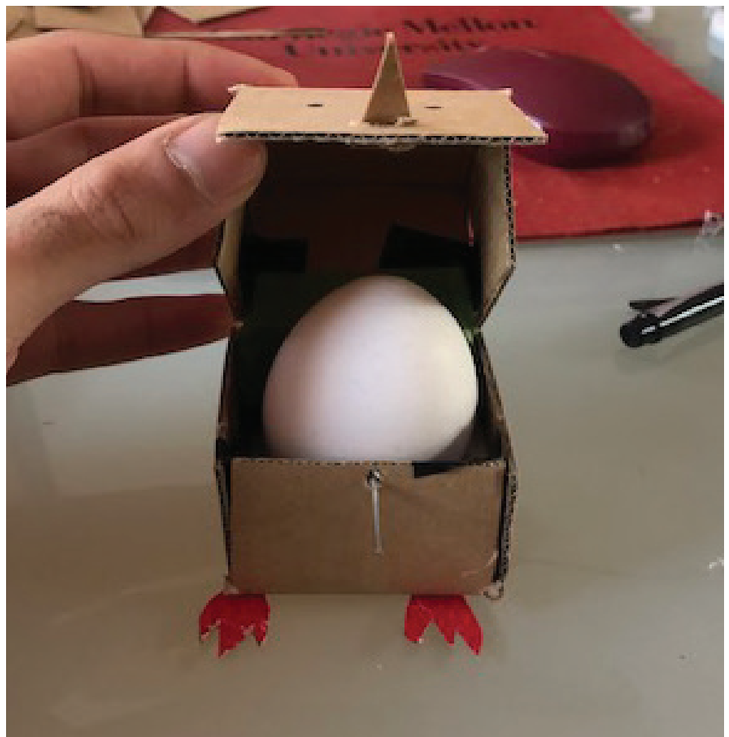
The original version of the course was more entrepreneurial in nature with students in small teams able to work on all aspects of the product at the same time.

"This new version of the course complied with social distancing measures necessary with COVID-19, and it also gave students direct experience with the type of design process experience common among engineering product managers," Whitefoot explained.

Students who were remote assembled their subsystems separately and shipped them to their teammates. If they were unable to machine custom components themselves, Tech Spark staff or a third party vendor produced these custom items and shipped them directly to the students.

The Design Expo was held as an interactive, virtual event in December.

ITEMS FOUND AROUND THE HOME WERE USED FOR A PACKAGING ASSIGNMENT.



"We tell our students that we are preparing them to solve real world challenges. And this is as real as it gets."

Allen Robinson
Head of Mechanical Engineering

DYNAMIC SYSTEMS AND CONTROLS

Professor Burak Kara developed a hands-on module that students could do from home. An avatar-based approach to running experiments in real time and system simulations for further explorations of experiments was used. Students had received "lab in a backpack" kits with an Arduino system and a motor, tackling tasks like studying the time and frequency response of the motor, conducting system identification, and implementing control algorithms.

THERMODYNAMICS I

Associate Teaching Professor Satbir Singh led sophomores through hands-on activities including experiments, measurements, and application of laws of thermodynamics to acquired data, data analysis, and documentation. Students had access to computerized property tables through their smart phones. Additional enhancements included live, in-class, peer-to-peer collaboration through remote breakout sessions and shared online documents.

DYNAMICS

Professor Maarten de Boer added a new aspect to the course with computational modules using SolidWorks, a 3D modeling package widely used in industry and academia, to complement the analytical approaches of the coursework. The exercises enabled students to better visualize their results, to solve more complex dynamics problems, and to reinforce and enhance their SolidWorks skills.

LINEAR CONTROL SYSTEMS

Assistant Professor Ding Zhao built a series of realistic simulation environments to support remote teaching. One assignment had students design controllers for autonomous delivery robots for smart manufacturing to combat the COVID-19 pandemic. Students learned and implemented the Kalman filter, optimal control, and adaptive control algorithms on Robotics Operation Systems (ROS) which were ready to deploy to the physical devices.

AT HOME WITH RESEARCH

While most university research was abruptly halted when the COVID-19 pandemic swept through the country last spring, a few Carnegie Mellon laboratories were able to continue their work or re-shape their focus to aid in the fight against the coronavirus. Here are examples of projects from three different labs:

MOLDING A NEW MASK

With a shortage of protective, N95 masks during the coronavirus pandemic, America Makes launched the Fit to Face Design Challenge. Participants had one week to create a mask that provided continuous contact for a wide range of face types. Professor Kenji Shimada and Ph.D. student Erica Martelly submitted a mask that was named one of two top designs.

The Moldable Mask can be shaped to adjust to the wearer's face, creating a seal to keep the virus out. Martelly had been researching CPAP masks for sleep apnea–specifically how to get a better fit. She shifted her focus to help fight against the coronavirus, seeing the perfect opportunity to test her idea of using hot water to make masks pliable.

"Both Professor Shimada and I knew a good element to include would be the ability to customize the mask in an easy and quick way, which can be achieved using hot water and printing with a low melting point plastic," Martelly said.

The design is accessible to anyone with a 3D printer.

DESIGNING EFFICIENT SWABS

The nasopharyngeal (NP) swabs used for testing for COVID-19 were in high demand and short supply. Professor Burak Ozdoganlar, building on his expertise in medical device manufacturing, pivoted his lab's work to explore how to design a swab that could be manufactured more efficiently and quickly while also providing increased testing accuracy.

His Ph.D. students–Toygun Cetinkaya, Ali Gurer, Yusuf Senturk, Lisha White, and Ant Yucesoy–diligently supported the design and testing process for the new NP swabs.

"Working during the pandemic is particularly challenging because everything needs to be meticulously planned since resources, such as time and supplies, are scarce," said White.

While the research holds promise for future health applications, it is of

critical relevance right now during the COVID-19 pandemic, which continues to infect thousands of people. For mechanical engineering students, tackling real-world problems like this one is what they signed up for.

"This is an opportunity to utilize innovative manufacturing techniques which directly impact our families, our neighbors, and our world," White added.

AT HOME WITH MICROROBOTICS

During the COVID-19 shutdown, researchers in Professor Sarah Bergbreiter's Microrobotics Lab transitioned some of their work out of the laboratory and into their homes. One of the researchers, Ph.D. student Teresa Kent, worked on two prototypes to create robotic tactile sensing systems inspired by the whisker systems found in rodents. A successful prototype will then be used by collaborators to gain insight into the sensorimotor neural pathways of rodents.

Kent applies computer vision techniques to track the movement at the base of a suspended whisker(s). During the shutdown, she was able to do all of her coding from home but had to find creative ways to work without the equipment she would normally have access to.

"Prior to the pandemic, I completed my own rapid prototyping. Now, I submit the designs to third party rapid prototyping companies," explained Kent. "I complete the assembly at my dining room table which has been turned into a lab bench. From this I have been able to continue iterating new designs of the prototypes."

Ph.D. student Regan Kubicek is another researcher in the Microrobotics Lab, working on bio-inspired strain sensors based on the mechanosensors found on the wings of moths. developing efficient sensing to be implemented on unmanned aerial vehicles (UAVs) develop his sensors at his home, he realized that he needed to implement simpler fabrication techniques. And, through trial and error in his garage, he fabricated his first printed circuit board. Kubicek tested the sensors on applications from home.

Transitioning complex research projects from laboratories to homes was challenging, but students and faculty adapted to the task with agility and persistence.

RESEARCH AND BEYOND

Detecting COVID-19 antibodies in seconds

Associate Professor Rahul Panat, in collaboration with UPMC, revealed the fasted known COVID-19 antibody test with high sensitivity and accuracy due to a unique, 3D printed nanotechnology and an electrochemical reaction. Antibody concentrations can be detected at below one picomolar (0.15 nanograms per milliliter) from a drop of blood. A handheld microfluidic device sends results almost immediately to a simple interface on a smart phone. Findings were published in *Advanced Materials*.

A two-fold approach to tackling COVID-19

A multidisciplinary team including Professor Burak Ozdoganlar, Pitt's Center for Vaccine Research, Boston Micro Fabrication, Premier Automation and Tiba Biotech developed a novel approach to COVID-19 inoculation that addresses both immunological effectiveness and manufacturing efficiency with a painless, low-dose, inexpensive, hybrid microneedle array technology. The dose is about 1/100th of a traditional vaccine and less cold-storage is required than existing vaccines. The optimized and automated manufacturing process allows for time and cost savings.

COVID and pollution

Research from the Center for Air, Climate and Energy Solutions with Associate Research Professor Albert Presto and Professor Allen Robinson found that Pittsburgh's air pollution levels decreased during the stay-at-home order during the pandemic but the overall impact remained small. While pollution from cars decreased, levels from industrial work sites remained stable. Findings were published in *Environmental Science Technology Letters*.

Outsmarting viruses

Assistant Professor Amir Barati Farimani is using machine learning to accelerate the antibody discovery process to fight highly infectious viral diseases like COVID-19, Ebola and HIV. Machine learning can 'learn' the complex antigen-antibody interactions much more quickly than the current computational and physics-based modeling methods. It can also be faster than the human immune system's response time.

Clear and simple solutions

Professor Burak Ozdoganlar teamed up with Heritage Valley Health System to engineer a clear, acrylic containment box that significantly reduces the risk of spreading COVID-19 to medical workers during intubation procedures in hospitals. Associate Professor Ryan Sullivan and ChemE's Assistant Professor Coty Jen worked on a similar project with Allegheny Health Network and Magee Plastics, incorporating an inexpensive, disposable, multi-layer seal technique to trap aerosol particles.

Behind the shield

Led by Assistant Professor Rebecca Taylor, Assistant Teaching Professor Diana Haidar, Ph.D. student Emma Benjaminson and the Tech Spark team worked with collaborators across campus to repurpose Carnegie Mellon's state-of-the-art design and fabrication facilities to manufacture face shields that were in short supply. Global Links, a medical relief and development organization, distributed these shields to essential workers at the front lines of the COVID-19 response.

PAVING THE WAY FOR THE NEW SCAIFE HALL

OPENING 2023

Known by many as the potato chip for its curved auditorium roof, Scaife Hall is being taken down to make room for a new home for the Department of Mechanical Engineering. The project is supported by a $30 million lead grant from the Allegheny Foundation.

With more than 85,000 square feet, the new Scaife Hall will more than double the size of the original structure. Designed by KieranTimberlake, the building will feature a four-story south wing, a three-story north wing and two levels of labs below the footprint.

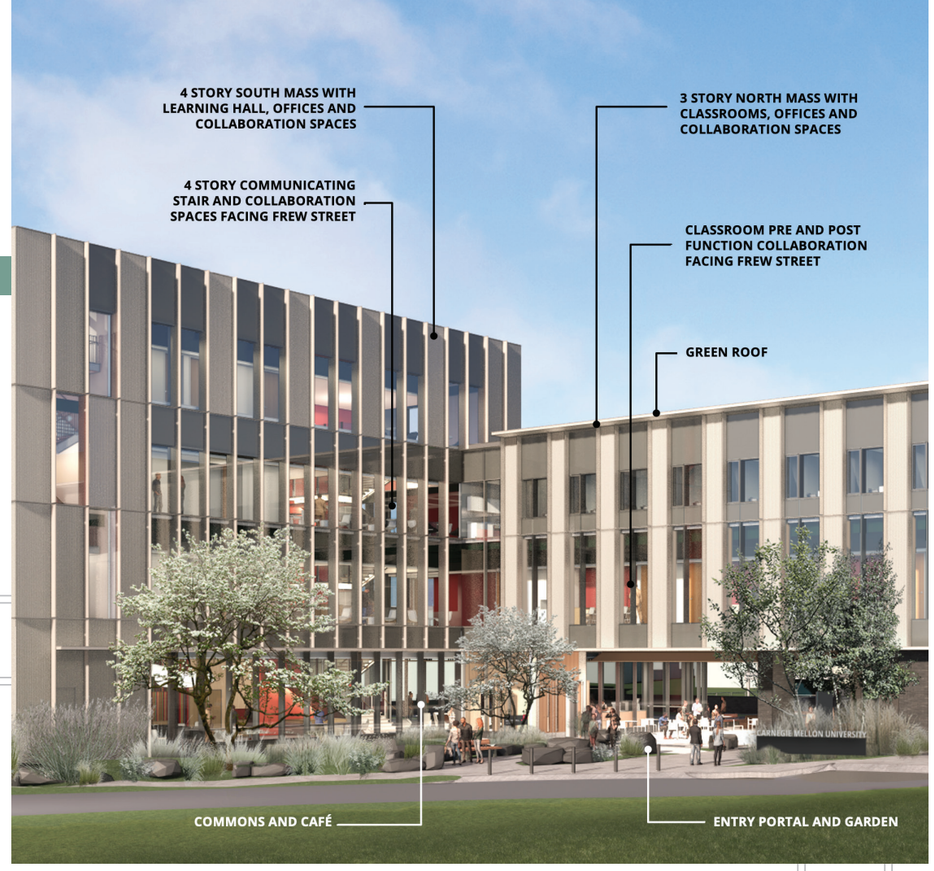
The contemporary structure will include an exterior engineering maker quad and courtyard, a large learning hall and commons area adjacent to the café, flexible classrooms, technology enriched labs, and space for Advanced Collaboration® and partnerships.

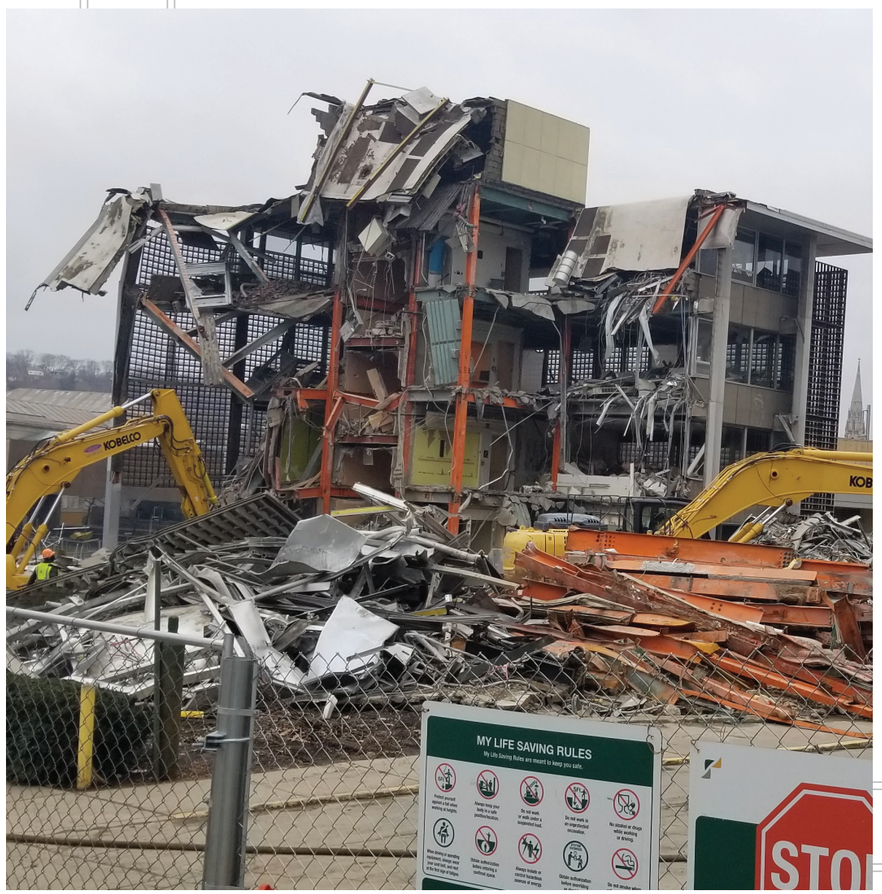
"The unique design of the building will accelerate multidisciplinary collaboration, encourage the development of novel areas of research, and create a stronger sense of community for our students," said Department Head Allen Robinson.

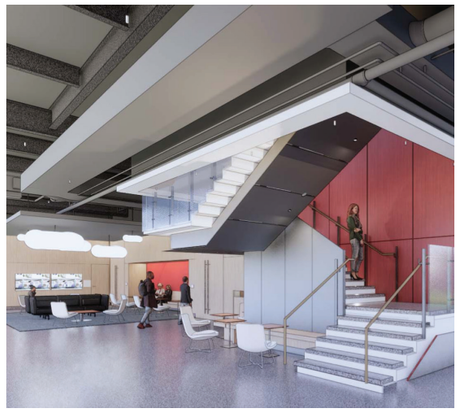
Since the external funding that had been committed to the project was attached to a specific timeline, it seemed prudent to move ahead with new Scaife Hall despite the challenges caused by COVID-19. "We didn't want to jeopardize the funding by delaying the project," explained Robinson.

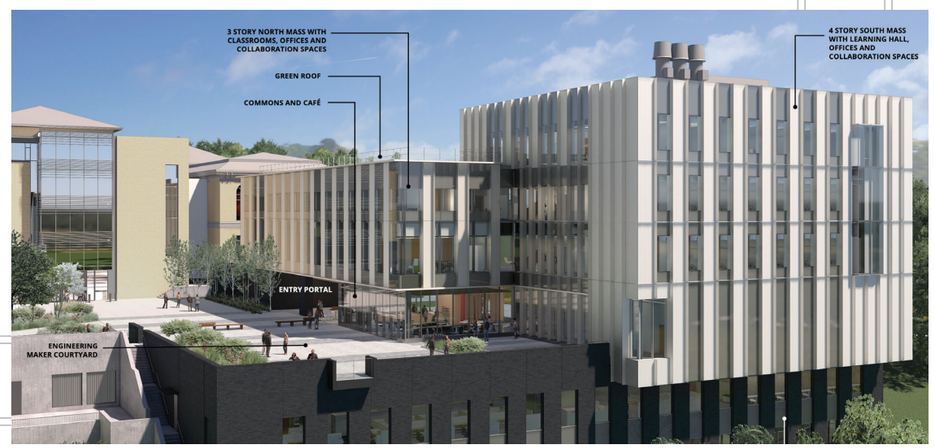
Watch the demolition of old Scaife and the construction of new Scaife:

https://app.oxblue.com/open/pjdick/CMUScaifeHall









MAKING INNOVATION COUNT

In Professor Kenji Shimada's Computational Engineering and Robotics Laboratory (CERLAB), undergraduate Miguel Martinez blazed new trails to build more cost-effective biomedical devices for surgical training. A summer undergraduate research fellowship in 2019 unlocked this powerful learning opportunity for Martinez, who is studying mechanical engineering and biomedical engineering.

"Surgeons use realistic models, called medical phantoms, of human body parts to practice surgical procedures, but they tend to be expensive to produce," Martinez explains. "Our goal is to find a way to create these phantoms at a lower cost."

In 2019, 204 undergraduate research projects like Martinez's received $436,315 in grants, summer fellowships and international fellowships through the Office of Undergraduate Research. Support from CMU donors helps make these awards possible.

Using 3D printing and casting techniques, Martinez constructed artificial hands, complete with realistic joints and skin, to simulate orthopedic hand surgery. He says the new methods he's developing could reduce production costs from thousands of dollars to less than $30 per phantom.

"The thing I enjoy most about research has to be the sheer fact that I am making something," Martinez says. "When nothing I've tried is working, I tell myself to back up and think about new directions to take. That feeling of satisfaction when things suddenly start to click outweighs any frustration from the challenges of research."

Receiving a $3,500 summer fellowship from the Office of Undergraduate Research enabled Martinez to focus on his project full-time during the 2019 summer. He also had the chance to sharpen his communication skills and present his research through CMU's Speak Up! program, where he won both second place and the People's Choice Award.

Martinez continued his research project for course credit during the academic year.

His principal investigator, Professor Shimada, said he appreciates Martinez's positive and proactive attitude in his lab.

"Once undergraduates find a research topic that matches their curiosity and passion, they get excited, work hard and learn a lot in a short period," said Shimada, who is the Theodore Ahrens Professor of Engineering in the Department of Mechanical Engineering. "It is a joy to introduce these undergraduate students to new research areas that are not covered in the traditional curriculum."

Professor Shimada says that tackling open-ended projects with faculty, post-doctoral researchers and graduate students helps undergraduates begin to think about their own careers.

"Undergraduate research is important because it can give students a preview of the ultimate goal of studying – contributing knowledge and impacting the world," he said.

In the future, Martinez plans to attend graduate school and eventually work in either academia or industry. He says this research opportunity been an invaluable part of his education at CMU.

"My experience as an undergraduate researcher has been incredibly rewarding and has played a big role in defining my career path," Martinez says. "CMU supporters helped make all of this possible."

A version of this story appeared on Carnegie Mellon University's Make Possible website.

IN GEAR

When David Ajoku first left home to study engineering, he had no idea how his path would unfold. He wanted to be at the forefront of science, so he turned toward space travel. Since then, however, he's learned that it's not about pushing humans farther, it's about advancing where we are.

Ajoku, who is pursuing a master's in mechanical engineering and engineering and technology innovation management, was awarded the American Gear Manufacturing Association (AGMA) Foundation's scholarship. Ajoku is the first Black student to receive this award since the program began in 2010.

Ajoku was born in Nigeria but came to the United States and received his bachelor of science in aerospace engineering with a minor in mathematics from Western Michigan University. After graduation, Ajoku worked in the automotive industry for about three years, where he learned a lot about real-world engineering.

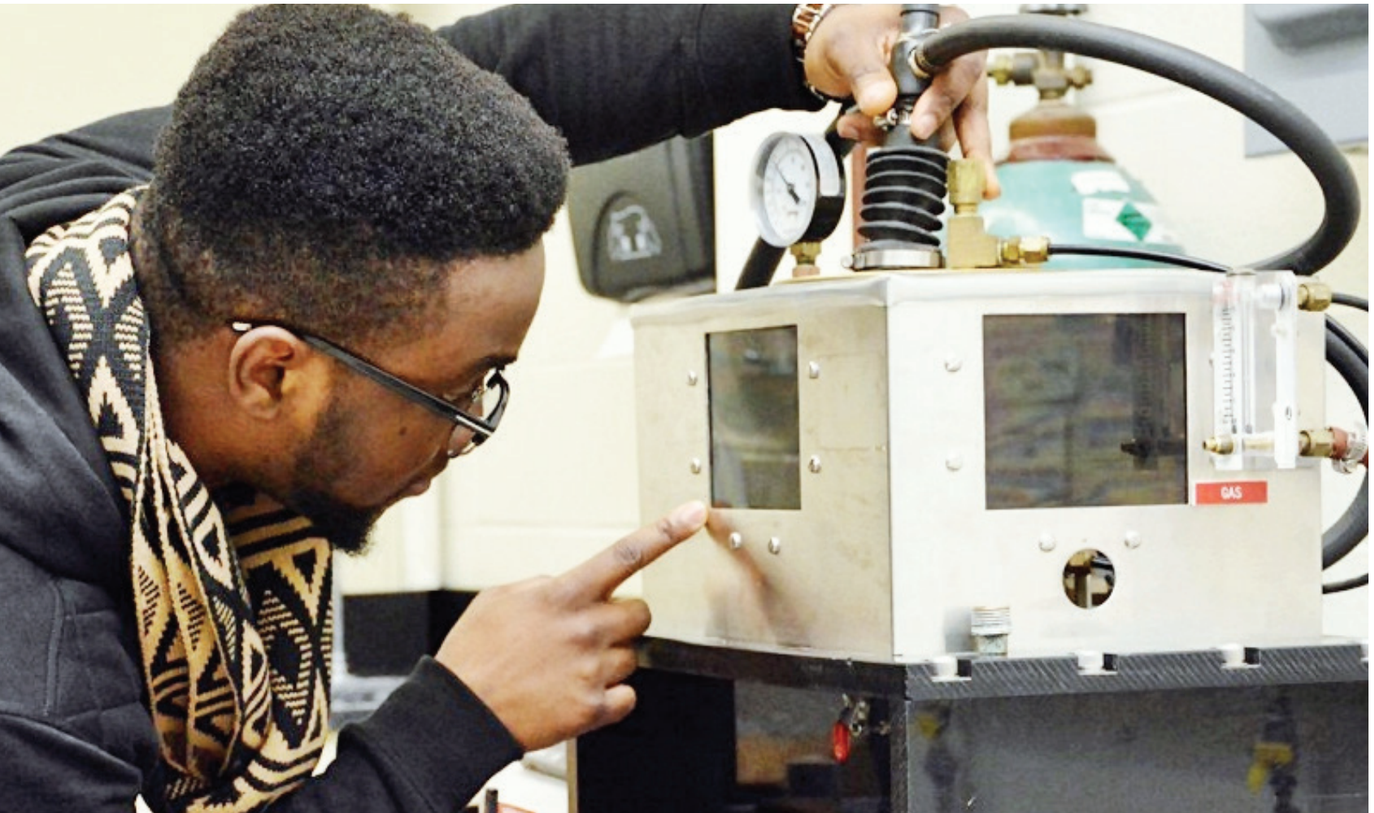
"I got a chance to work in both technical roles and engineering leadership roles," Ajoku said. "It didn't take too long before I fell in love with mechanical design."

Eventually, he was able to experience leading a design project as the chief design engineer. This taste of management left him wanting more. He left his first job to work for Tesla in 2019, where he was able to further explore engineering management.

"I got a chance to further embrace my passion for technical work, engineering management, and technology innovation all at the same time," Ajoku said. "I was fortunate to get the opportunity to contribute toward driving large-scale innovations on the Tesla Model 3, Model S, and Model X."

As he looked for the next stage in his career, Ajoku was drawn to the interdisciplinary aspects of CMU's engineering program. By pursuing a dual degree, he is able to explore

Master's student David Ajoku has been awarded the American Gear Manufacturing Association Foundation's scholarship.



both of his passions: technology innovation and engineering. Both of these things are key to surviving in our modern world, Ajoku says. At CMU, he is able to take not only engineering courses, but also classes from the Tepper School of Business and the School of Computer Science.

After one year of graduate school, Ajoku was awarded the AGMA scholarship. Ajoku said he was honored to represent CMU in such a historic way. As the first Black student to receive this award, Ajoku hopes he can inspire other minorities in engineering.

"I hope my story inspires anyone seeing and reading this to dream big—because dreams do come true if you dare to dream," Ajoku said. "Aim for the stars. If I can do it, you can do it too."

After graduation, Ajoku hopes to continue innovating through entrepreneurship. He wants to solve real-world problems using his CMU education. Someday though, he hopes to found his own startup company. Either way, he knows his future lies in technology because he is passionate about it. Ajoku encouraged everyone to find their passions and explore them to their full potential.

"I think the thing that worked for me in my own experience is being bold. You have to have that self-confidence," Ajoku said. "And the way you develop that is through honing your craft. Whether you're working on a small project, in a small team, in a class, do it to the best of your ability. That's how I see it."

> "I hope my story inspires anyone seeing and reading this to dream big—because dreams do come true if you dare to dream."
>
> **David Ajoku, Master's student, MechE/ETIM**

The **Department of Mechanical Engineering** is proud of all our students for their perseverance and remarkable resilience in the face of unprecedented challenges during the COVID-19 pandemic. Here, we recognize some of the many students who have earned additional distinctions.

STUDENT ACCOLADES

Honoring academic excellence in MechE, 2020 Bennett Awards went to **Yutian Cai**, **Mikey Fernandez**, **Jacob Gobbo** and **Michelle Karabin**.

MechE's 2020 Masters Graduate Research Symposium Awards celebrated **Yibo Cao**, **Yu-Chun Chen**, **Angelos Mavrogiannis**, **Walter Parker**, **Eric Rapp**, **Muhamad Suhail Saleem**, **Xin Shen** and **Rohit Subramaniam**.

Graduate students **Susana Beltrán**, **Kevin Dai** and **Varun Shankar**, and then senior **Jessica Yin** ('20), earned National Science Foundation Graduate Research Fellowships while **Alexander Bills**, **Jacob Brenneman** and **Ryan Yeh** were recognized with honorable mentions.

As evaluated by students, the department's Best Ph.D. Teaching Assistant Awards went to **Emma Benjaminson** for Dynamic Systems and Controls (spring 2020) and **Nathan Kong** for Mechanical Systems Experimentation (fall 2019).

Alex Baikovitz ('19), now a master's student in robotics, was awarded MechE's 2020 Forstall Award for academics, leadership and contributions to the department.

Ph.D. students **Alexander Bills** and **Shashank Sripad** co-authored an article in *The Conversation* titled "The road to electric vehicles with lower sticker prices than gas cars – battery costs explained."

The 2020 Undergraduate Service and Leadership Awards went to **Aidan Honnold**, **Frank Andujar Lugo** and **Rosie Zhang** to celebrate their exemplary service and leadership.

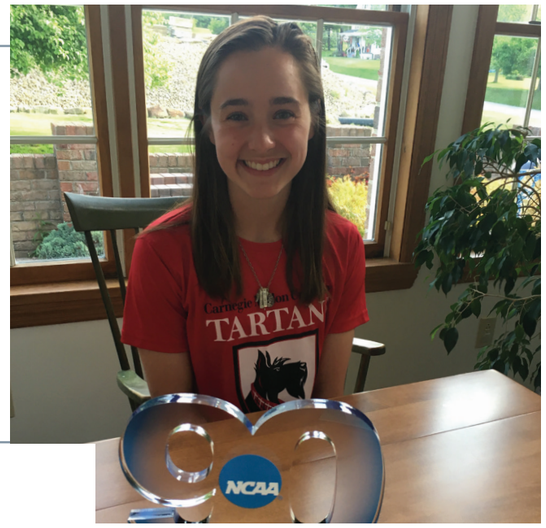
For their quality of work in the College of Engineering Honors Research program, **Cathy Fang** ('20) (pictured), **Rachel Sneeringer** ('20) and **Jessica Yin** ('20) earned 2020 Undergraduate Excellence in Research Awards. **Sneeringer** is now a master's student.

As president of Carnegie Mellon's Graduate Association, Ph.D. student **Josh Gyory** is working to ensure that students feel a sense of community and engage with one another while being socially isolated during the pandemic.

Dhroovaa Khannan ('20) and **Linden Runels** ('20) were part of the team winning second place during the Scott Institute for Energy Innovation's Energy Week 2020 Student Research Poster Competition for investigating electrification of Port Authority buses. **Khannan** is now a master's student in the energy science, technology and policy program.

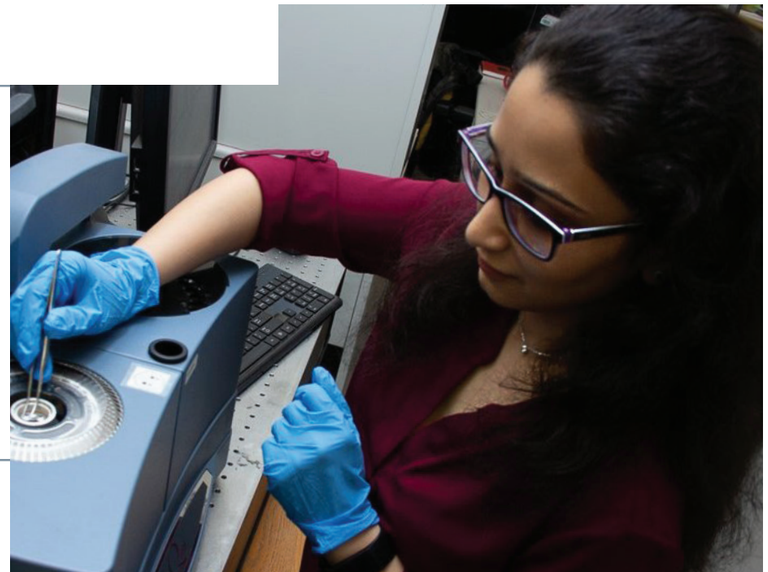
STUDENT ACCOLADES

Michelle Karabin (’20) earned the Elite 90™ Award for NCAA Division III women’s indoor track and field championships, an NCAA Postgraduate Scholarship and the Dr. William Brown Academic Athletic Achievement Award. She’s pursuing a Ph.D. in biomedical engineering at the University of Pittsburgh.



Now a master’s student, **Madelynne Long** (’19) received the Carnegie Mellon Women’s Association 2020 Award for demonstrating commitment to the advancement of women in her academic pursuits.

Ph.D. student **Purva Joshi** won The Peter Steponkus Crystal Award at the 2020 Annual Meeting of Society for Cryobiology for her presentation, “Thermal Analysis of Nanowarming in a Human Heart and a Rat Heart Model.”



Arman Ghaffari-Zadeh and **Uche Agwu** received the 2020 Jeremiah Mpagazehe Graduate Student Service Awards in recognition of their service and contributions to the MechE graduate student community.

Senior **Matt Karee** and **Liam Walsh** (’20) were honored by the College Sports Information Directors of America as Men’s Cross Country/ Track & Field Academic All-District selections. **Walsh**, now a master’s student, had also earned All-American honors for the 2020 NCAA Division III Indoor Track & Field season by the U.S. Track & Field and Cross Country Coaches Association.

Anthony Kennon (’20), now a master’s student, received an NCAA Postgraduate Scholarship for excelling academically and athletically while showing leadership and commitment to the community. He was also named to the 2020 National Football Foundation & College Hall of Fame Hampshire Honor Society with teammates Willie Richter (’19) and Long Tran (’19, ’19).

Laura M. Ochsner (’20) was one of ten students world-wide to receive the Ford Motor Company Alan Mulally Leadership in Engineering Scholarship for the 2019-20 academic year.

Vikram Pande (’19) earned MechE’s 2020 Doctoral Research Award. His thesis title was “Design Principles for Enabling High Energy Density Li Metal Batteries.”

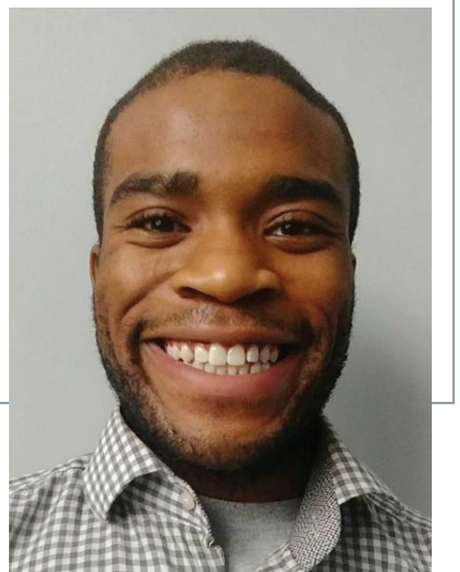
Ph.D. student **Joseph Norby** discussed his experience building robots as a child in an interview with Twin Cities PBS for a video titled “How to Build an Engineer.”

Ph.D. students **Edgar Mendoza** and **Longchang Ni** were selected to participate in Berkeley’s Department of Mechanical Engineering’s ME Rising Stars workshop, which supports senior graduate students and postdocs who are considering careers in academia.

Eli Workman (’19) received the K&L Gates Award for inspiring fellow students to love learning through a combination of intellect, high scholarly achievement, engagement with others and character. He is an advanced trans and drive units project engineer with General Motors.

Ph.D. student **Nathan Nakamura** (’20) earned recognition through the National Institute of Standards and Technology/National Research Council Postdoctoral Research Associateship Program.

Ph.D. student **Uche Agwu** earned first place in the Technical Presentation Competition at The National GEM Consortium 2020 Virtual Annual Conference for “Assessing and Optimizing Tetrahedral Lattice Generation Parameters for Engineering Applications through Finite Element Analysis.”

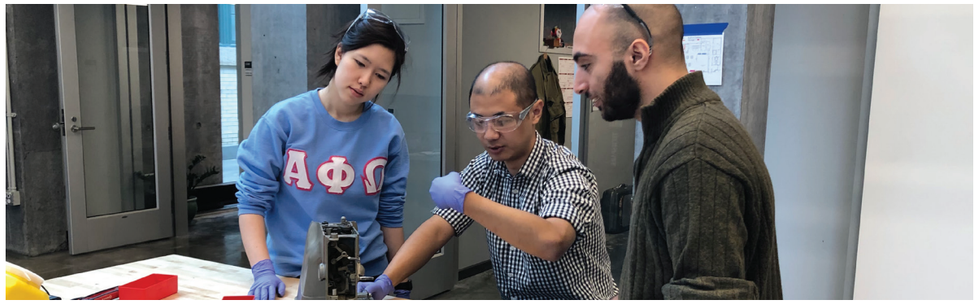


STUDENT SNAPSHOTS

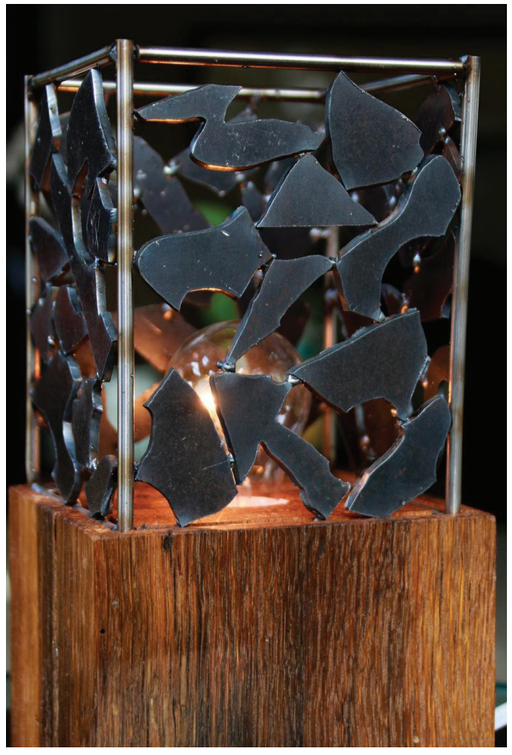
Students in the course Making Your Products at Scale took apart clocks and sewing machines to understand how the components worked together. (Photos were taken last winter prior to the COVID-19 shutdown.)

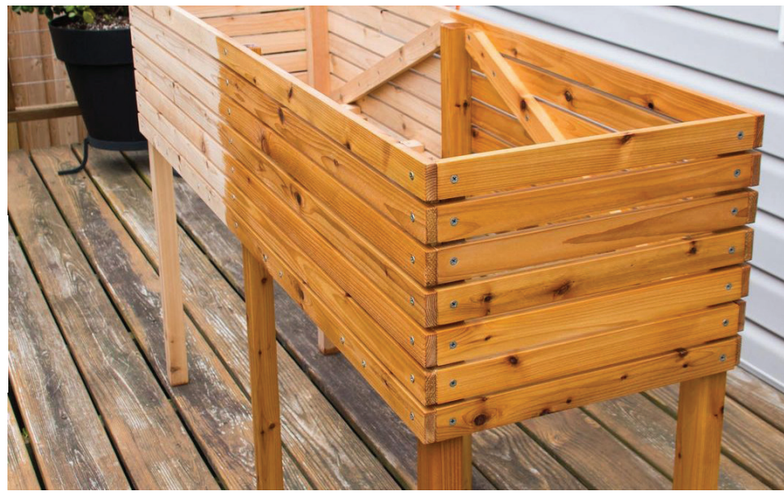
Students built gingerbread houses (and Scaife and Hamerschlag Halls!) in their homes with confectionary construction materials delivered to them before the holiday break.

Professor Paul Steif and his wife Michelle hosted virtual cooking events as study breaks for students. Vegetarian chili with cornbread was a hit!



At home during the pandemic, sophomore Gabriel Botero designed and made furniture including a table, lamp and raised herb garden.





THE FUSION OF HUMAN AND MACHINE

Although Doug Weber joined the faculty in Carnegie Mellon University's Department of Mechanical Engineering this fall, he is no stranger to Pittsburgh. The seasoned professor and researcher spent 15 years working in the Swanson School of Engineering at the University of Pittsburgh. There, he built a multi-disciplinary research program combining neuroscience, engineering, and medicine to develop neural prosthetic technologies to help people recover from stroke, spinal cord injury, and limb loss.

"My research has always focused on studying how the brain senses and controls movement in our arms and legs—the simple act of reaching and grasping a cup of coffee engages dozens of muscles and millions of neurons that communicate with each other through the neural networks in our spinal cord and brain to generate smooth and efficient actions," Weber said.

His approach is to understand how the nervous system processes and communicates information about movement and what changes occur in these neural networks after disease or injury. Such knowledge is crucial for engineering new solutions to restore function to the arms and legs.

"Many injuries result in the loss of function in the arms and/or legs—stroke, spinal cord injury, and amputations are common causes and create huge barriers to independent living," Weber explained. "Fortunately, we can build robotic devices that can assist movement in paralyzed limbs and even build robotic arms that physically replace a missing limb. The actions of those robots can in many ways mimic the actions of the human counterpart."

A challenge in his work is figuring out how to connect the robotic limb to the person so that they can control and feel the robot as if it were a natural part of their body. "In order for these devices to be truly useful, we need to build connections with the nervous system, which is what enables us to move and feel," he said. His goal is to combine engineering and neuroscience research to solve these and other challenges related to control and sensation in humans and robotics.

Robots are already used in limited capacities to protect people from dangerous tasks like disaster recovery operations in hazardous environments. Weber sees a role for them in health care where frontline workers face a higher risk of exposure to infectious diseases. Today's coronavirus pandemic offers an example.

"Dedicated people are performing essential functions in caring for patients, who themselves are exposed to infection risk when they seek care," Weber said. "Wouldn't it be great if we could offer robotic caregivers, operated by humans from a remote location to protect both the caregiver and the patient from infection? Achieving this vision requires innovations, not only in robotics, but in the technology used to connect the human operators to the robots."

A challenge for robotics engineers is in making robots more intelligent and aware. Humans are very sensitive—our entire bodies are loaded with millions of sensory neurons that enable us to see, hear, and feel the objects in our environment. Our brain relies on these sensors to perceive the world and make intelligent decisions about how to move. By comparison, robots are numb and dumb—they have limited awareness of the world and are not intelligent enough to know how to adapt their behaviors to operate safely and effectively in unpredictable situations.

At Carnegie Mellon, Weber plans to work closely with collaborators in neuroscience, computer science, and engineering to build machines that can move like humans and also sense and reason, enabling them to work safely and effectively alongside humans or independently. He started his research at CMU this fall and will teach classes in the spring 2021 semester.

While the physical distance from Pitt to CMU may be small, Weber said the move feels like a leap. "CMU has a truly incredible legacy of disruptive innovation—from building one of the first nodes of the Internet to creating cars that can drive themselves, CMU Tartan can be found in the fabric of ideas and technologies that have transformed the way we live, work, and play," he said. "The fusion of neuroscience and robotics has the potential to create not only smarter machines, but healthier, happier people."

Weber earned his bachelor's degree in biomedical engineering at the Milwaukee School of Engineering and his Ph.D. in bioengineering from Arizona State University. From 2013-2017, he served as Program Manager at DARPA where he developed and managed a portfolio of neurotechnology research programs in support of President Obama's BRAIN initiative. He directs the Neuro-Mechatronic Interfaces Lab at Carnegie Mellon University and holds a joint appointment with the Neuroscience Institute.

FACULTY AWARDS & HONORS

Three MechE faculty members received the prestigious **National Science Foundation (NSF) CAREER awards**. These awards support early-career faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization:

Assistant Professor **Aaron Johnson** is improving robots' abilities to walk, jump, and grasp with new control generation, allowing the robots to adapt to changing conditions.

Assistant Professor **Rebecca Taylor** is examining the structure and formation of novel nanostructures made with programmable gamma peptide nucleic acid-based materials.

Assistant Professor **Kate Whitefoot** is bridging engineering design and economics to understand product design in the context of markets and regulations. She has also been named to the World Economic Forum's Clean Air Council.

Professor **Jonathan Cagan** received the American Society of Mechanical Engineers' (ASME) Ruth and Joel Spira Outstanding Design Educator Award.

Assistant Professor **Eni Halilaj** was awarded the American Society of Biomechanics (ASB) Young Scientist Award.

Professor **Philip LeDuc** earned Carnegie Mellon's Barbara Lazarus Award for Graduate Student and Junior Faculty Mentoring.

Professor and Department Head **Allen Robinson** received the American Association for Aerosol Research (AAAR)'s David Sinclair Award. He was also named University Professor.

Professor and Associate Department Head **Paul Steif** has earned the College of Engineering Outstanding Service Award for 36 years of impactful contributions.

Professor **Yongjie Jessica Zhang** was invited to be the Official Nominator for the prestigious international "Japan Prize" and is a judge for the Girls International Three Minute Science Competition.

RECOGNIZED FOR INNOVATION

The American Society of Mechanical Engineers (ASME) featured Carnegie Mellon University's College of Engineering as one of 10 innovative engineering institutes: **https://bit.ly/3ah4wnv**

LISTEN TO SHARED AIR

Associate Research Professor **Albert Presto** launched the Shared Air Podcast to discuss air pollution, climate and science communication. Presto and Ph.D. student Rose Eilenberg interview scientists about a range of topics from shale gas and wildfires to cookstoves and COVID-19. **https://sharedair.libsyn.com**

WELCOME, DR. ALLEN!

In February, Alaine Allen joined Carnegie Mellon University's College of Engineering as the Associate Dean for Diversity, Equity, and Inclusion. As CMU Engineering's new full-time chief diversity officer, Allen will foster an inclusive environment and welcoming culture to advance the college and university mission in DEI. She will also work closely with Engineering department heads and their department DEI committees, supporting department-level DEI initiatives and developing anti-racist practices.

A MEANINGFUL IMPACT

Over the past 30 years, Audrey Fitzgerald (1985) has always quite literally answered the call to support the next chapter of the Carnegie Mellon University story.

Audrey Fitzgerald (1985) remembers one work-study position during her time as a student at Carnegie Mellon University that pushed her out of her comfort zone more than any other.

"Every night for a few hours, I would dial alumni on my rotary phone, and I'd talk to them about making a gift to CMU. It was the hardest work-study job I had," Audrey says with a laugh.

For the past 31 years, whenever she receives a phone call from a current Tartan, she picks up the phone, talks with them about campus happenings, reminiscences a bit – and supports the next chapter of the CMU story with a gift.

"I'm thankful for an education that I probably wouldn't have been able to receive without the financial aid package with scholarships that I was given," Audrey says. "Giving back to CMU just makes sense to me."

While conversations with CMU students started her legacy of giving, a few years ago she and her husband evaluated their will and estate plan and were inspired to make an even more meaningful impact on future generations.

"I realized I was fortunate enough in my life to do something bigger and broader," she explains. "The whole process was very easy."

Audrey also appreciated the flexibility offered with a gift through her will should she desire to alter the amount or purpose of her contribution in the coming years. It also offers continued access to her funds should she ever need them.

Audrey's gift is designed to benefit women in science, technology, engineering and mathematics (STEM) fields to recruit more women to those fields, support them while they're pursuing their education and help them throughout their careers.

"I was at CMU during such an interesting time in computing," Audrey says. "When I was a senior, the freshmen were the first class that was required to have their own computers, so everyone was walking around with Macintosh computers on dollies on Move-in Day. Every student had to pass a basic programming course, and engineering and computer science majors were held to the highest standards."

Her knowledge about how a computer works from the circuits on up – as well as programming languages like Pascal, C and Fortran – served her well during her engineering career with Draper Laboratory near Boston where she developed concept designs of autonomous undersea vehicles.

At Draper, she was one of only a few female engineers, and she's carried that experience with her throughout her life.

"STEM fields are difficult for women to want to be in, stay in and rejoin after they've stepped away for a little while," Audrey shares. "Supporting women in STEM has become a passion of mine."

Her gift will help future scholars forge a valuable path and empower them to benefit from CMU's world-class research environment, laboratories, faculty and classes.

"My CMU education came in very handy during my career," Audrey says. "I did not realize until years later that not all college educations are created equal. The one I got at CMU is in the top of any that I've seen anywhere."

> "My CMU education came in very handy during my career. I did not realize until years later that not all college educations are created equal. The one I got at CMU is in the top of any that I've seen anywhere."
>
> **AUDREY FITZGERALD (1985)**

A version of this story appeared on Carnegie Mellon University's Make Possible website.

A TARTAN AIMS FOR THE MOON

Master's program alum and Blue Origin research engineer Lawrence Papincak is working with NASA on a mission to the moon.

When Lawrence Papincak earned his master's degree in mechanical engineering in 2018, his dreams for the future were out of this world–literally. Today, he is a research engineer at Blue Origin Opens in new window in the Advanced Development Program - Flight Sciences group where he is working on navigation systems for NASA's next moon landing of American astronauts.

As a child, Papincak liked to take apart remote control cars and electronics. "This spawned a lifelong joy in figuring out how each piece of technology around me worked, driven by an insatiable curiosity," he said.

His parents enrolled him in a robotics summer camp at Carnegie Mellon University, where the focus on research and project-based learning became increasingly attractive. "Coupled with the benefit of being taught by some of the worlds leading educators and researchers, I was set on making CMU my home at some point in my life," said Papincak.

Over the years, his tinkering led him to Drexel University where he earned his undergraduate degree in mechanical engineering, focusing on air craft dynamics and control. He returned to Pittsburgh to pursue an M.S. in Mechanical Engineering at Carnegie Mellon.

Papinchak recalls taking the advanced control systems integration course with Associate Teaching Professor Mark Bedillion. Students were given a small quadcopter to develop a project that exercised how the theory they were learning in class applied to the real world.

"My group chose to replicate the traditional children's ball-in-a-cup game with the quadcopter, swinging a small mass and catching it in a small basket atop the quad," he explained. "Projects like this help to develop not only applied skills, but also the confidence to tackle bigger and bigger problems in the future."

As a research assistant for Professor Red Whittaker in Carnegie Mellon's Robotics Institute, Papincak focused on developing robotics systems for inspection of nuclear environments. Through this opportunity, he was able to see a system that he had helped to build go from the whiteboard to deployment inside an old uranium enrichment facility.

"I also had the pleasure of using one of the robots I had worked on in the field right in Pittsburgh, inspecting a collapsed tunnel system near the Strip District," he said. "This experience, along with my project-based work, was paramount in developing the confidence to chase the dreams I am now chasing."

Papincak enjoys working at the intersection of robotics and space today, taking a difficult technical problem and putting it in one of the harshest environments. "I see that as a challenge and it feeds my curiosity to figure out how humanity can extend its reach into the solar system with robotic systems."

DRIVING AHEAD

From hybrid cars to electric aircraft, transportation is getting cleaner and greener. Electric pickup trucks are poised to be the next gamechanger. Stephanie Jennings, a 2018 alumna employed by Ford Motor Company, is working on this transformation.

In an early career rotational program at Ford, Jennings is a project manager for the battery electric F-150 pickup truck which will be on the market in 2022. Prior to her current role, she worked with powertrain plastics suppliers to ensure the quality of Ford's products.

Her first experience at Ford was an internship the summer after her first year in the master's program at Carnegie Mellon University's Department of Mechanical Engineering.

What led this Carrollton, Texas native to Pittsburgh?

While exploring potential master's programs, she was drawn to the interdisciplinary nature of the courses and research available at Carnegie Mellon. She had completed her B.S. in Mechanical Engineering at Rice University and worked professionally for a few years before applying to graduate school.

As she pursued MechE's master's program, Jennings learned how to tackle real world problems through hands-on projects in the research lab and classroom.

"A lot of manufacturing quality involves applying statistical methods to look for defects, analyze outliers, and predict process reliability and capability. For example, checking to see if a certain process is normal to determine capability," she said. "I found the stats I utilized in my research with Katie Whitefoot and Jeremy Michalek to be very helpful."

Michalek and Whitefoot, who each hold joint faculty appointments in Mechanical Engineering and Engineering and Public Policy, had developed and taught a course titled Quantitative Entrepreneurship. A team project experience for the course stands out in Jennings' mind.

"We worked with a startup trying to assess commercial viability of a technology," Jennings recalled. It was an interesting project since we learned how to work with a sponsor and directly applied methods we had learned in class to the sponsor's project."

Another course that she found very applicable was Materials Selection for Mechanical Engineers taught by Professor Maarten de Boer. It prepared her well for dealing with thermoplastics at Ford.

At Carnegie Mellon, Jennings also took advantage of the opportunities outside of the classroom by joining the All University Orchestra. "It was an invaluable source of stress relief and got me back into playing the cello," she said.

> "A lot of manufacturing quality involves applying statistical methods to look for defects, analyze outliers, and predict process reliability and capability."
>
> **Stephanie Jennings, Project Manager, Ford**

To new students, Jennings recommends that they get to know their classmates outside of coursework and that they reach out to the faculty. "Don't be afraid of the professors–they're all approachable," she said.

Jennings continues to build on her experiences. Currently, she's enrolled in a part-time MBA program at the University of Michigan through Ford's sponsorship. "I found that the M.S. MechE program prepared me for that very well."

ALUMNI NEWS

Several alumni were named fellows of the Association for the Society of Mechanical Engineers (ASME) for their contributions to the field: **Matthew Brake** ('07), **Matthew Campbell** ('95, '97, '00), **Frank DelRio** ('98) and **Sreekant Narumanchi** ('03).

Chaohui Gong ('15) of BITO Robotics was a speaker with other Carnegie Mellon alumni during a webinar titled "Redefining Industrial AI in a New Age," held remotely last spring.

Thomas Healy ('14) and his company Hyliion, which develops electrified powertrain solutions for the transportation industry, made headlines in Forbes, The Motley Fool, Truck News and the Washington Post by merging with Tortoise Acquisition Corp.

Raj Kapoor ('92) teamed up with health-tech startup Clara Health to create and launch World Without COVID: a free, global, public health initiative that matches volunteers with opportunities to participate in COVID-19 clinical trials such as vaccines, treatments, antibody testing and blood plasma transfusions.

Ranga Pitchumani ('88, '92) was named the George R. Goodson Jr. Professor of Mechanical Engineering in the College of Engineering at the Virginia Polytechnic Institute and State University.

Maggie Scholtz ('08) was named to the Society of Women Engineering's 2020 Women Engineers You Should Know. She's the founder of First Mode, a consultancy that applies the tools and technologies of planetary and deep space exploration to the world's challenging problems.

Margaret-Anne Smith ('17, '17) was featured in "Real Humans of Harvard Business School MBA Class of 2022" by Clear Admit, an online resource for business school applicants.

Clement Wong ('19) started Social Distance Buttons https://socialdistancebuttons.com to help people communicate about maintaining social distance. Profits are donated to your choice of organization that is helping people affected by the COVID-19 pandemic.

Iryna Zenyuk, ('11, '13) received the 2021 Energy Technology Division Supramaniam Srinivasan Young Investigator Award from the Electrochemical Society. She also earned tenure and a promotion to associate professor at the University of California, Irvine, where she holds a joint appointment in the Department of Chemical and Biomolecular Engineering and the Department of Mechanical and Aerospace Engineering.

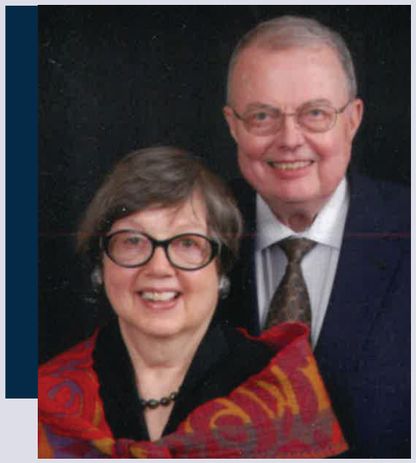
We want to hear from you!

Email your news to

me-alumni@andrew.cmu.edu

IN MEMORIAM

JOHN M. HALLGREN



John M. Hallgren ('60) passed away on April 14, 2020. John earned bachelor's degrees in mechanical engineering and printing management–both of which would guide his path. After college he served in the 921st Engineer Group at Ft. Leonard Wood, MO and then continued in the ROTC with the Army Corps of Engineers. John had a long and successful career in the printing business, working for 39 years with RR Donnelley & Sons Company. John and his wife Audrey (who is still living) were also generous supporters of Carnegie Mellon University and have left a lasting legacy through an endowed scholarship. We extend our deepest condolences to his family and friends.

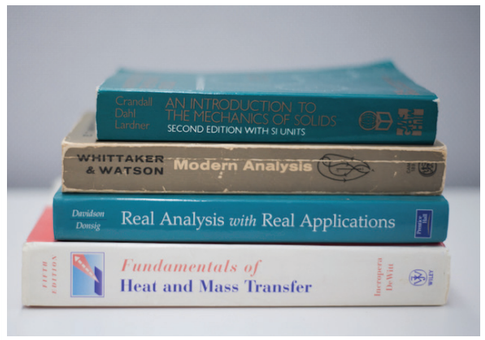
JOHN M. SANT

John M. Sant ('48) passed away on July 20, 2020 at the age of 97. Prior to majoring in mechanical engineering at Carnegie Tech, he flew 32 missions as a pilot in the U.S. Army Air Corp during WWII before being held at a Nazi prisoner-of-war camp. Earning the distinction of Professional Engineer (PE), he worked in the field of manufacturing of machinery for Federal Machine and Welding and Berkley-Davis. He received the Resistance Welders of America Lifetime Achievement Award. An active citizen, he was involved in many professional, charitable and civic organizations. We join his family and friends in heart-felt sympathy.

IN CASE YOU MISSED IT

PATHWAY TO STEM

ASME asked universities if the nationwide emphasis on STEM education over the last decade has moved the needle. MechE weighed in: **https://bit.ly/2ZLT5A6**



MECHANICAL ENGINEERING + MACHINE LEARNING

MechE told *U.S. News & World Report* that the emergence of data science has increased the number and variety of job options available to mechanical engineers: **https://bit.ly/3qZ8zMx**

SPRING CARNIVAL & REUNION WEEKEND

April 15-17, 2021

Spring Carnival 2021 will be held virtually from April 15 - 17, and in keeping with tradition there will be no classes on those days. **http://bit.ly/cmu-spring-carnival**

AUDREY (HAMORI) FITZGERALD
MECHE ’85

Audrey remembers her time as a student as an interesting era in computing. Personal computers were becoming more common, changing the way people learned and worked.

She spent her engineering career at Draper Laboratory where she developed concept designs of autonomous undersea vehicles.

At Draper, she was one of only a few female engineers. Supporting women in science, technology, engineering and mathematics (STEM) fields is a passion of hers.

Audrey and her husband Bill have given a gift to the College of Engineering in their will to recruit more women to STEM fields, support them while they’re pursuing their education, and help them throughout their careers.

Giving back is important to Audrey because she says she wouldn’t have been able to go to Carnegie Mellon if it wasn’t for scholarships.

Audrey enjoys spending her time skiing, traveling, boating, running, and going to baseball games.

GIVE STRATEGICALLY, SUPPORT GENEROUSLY.

Learn how easy it is to achieve your philanthropic vision through a planned gift by visiting giftplanning.cmu.edu.

Contact the Office of Gift Planning today at 412.268.5346 or mickkoster@andrew.cmu.edu.

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