

Department of Mechanical Engineering

The [Department of Mechanical Engineering \(MechE\)](#) embodies MIT's motto *mens et manus* (mind and hand)—as well as “heart”—by combining analysis and hands-on discovery with a commitment to making the world a better place. We train the next generation of mechanical engineers to develop creative products and solutions. By leveraging our strengths, we aspire to solve some of the biggest challenges facing our world.

During AY2020, MechE faculty, staff, and students continued to execute the department's research and educational missions while also coming together to address new challenges caused by the COVID-19 pandemic.

Research

MechE researchers conduct cutting-edge research at the new frontiers of mechanical engineering. Faculty often specialize in more than one discipline, ensuring a fluidity of research that promotes cross-disciplinary discovery.

Our research is organized across seven collaborative disciplines: mechanics; design, manufacturing, and product development; controls, instrumentation, and robotics; energy science and engineering; ocean science and engineering; bioengineering; and micro and nano engineering.

The diversity of MechE's research makes us uniquely positioned to tackle the challenges the world now faces as a result of the COVID-19 pandemic. Early in 2020, MechE researchers, faculty, staff, and students quickly swung into action to address the most pressing needs in light of COVID-19. From designing and deploying 600,000 face shields for front-line workers to using a design from a MechE class to build low-cost portable ventilators, many of our researchers quickly pivoted from their usual work and collaborated across various disciplines to find solutions for the urgent challenges caused by the virus.

The work our researchers have done to develop solutions during the COVID-19 pandemic reflects the department's strategic mission focused on four unifying MechE grand challenges facing our world: the health of the planet and the health of the people; global energy sustainability; robotics, autonomy, and intelligent systems; and design and manufacturing innovation. These challenges build upon our expertise and provide opportunities for major global impact through interdisciplinary collaborations. They also reflect MIT's mission to make a better world through research, education, and innovation.

Education

These core disciplines and grand challenges shape our world-class introductory and advanced undergraduate- and graduate-level programs. In March, our faculty and teaching staff demonstrated their agility as they transitioned to remote learning within just two weeks. Remote learning posed a unique challenge for MechE classes, many of which rely on hands-on activities including making, building, and interactive labs.

Our dedicated faculty and teaching staff used a variety of creative approaches to ensure that students still had the best possible educational experience, including sending remote kits to students, hosting virtual lab sessions, and refocusing class content to develop solutions for COVID-19. Our faculty and staff also continued to support students in preparing for their future careers through a variety of virtual programs such as the MechE Alliance and MechE Summer X.

Community

With our students, faculty, and staff dispersed around the world, fostering a sense of community has been a top priority during AY2020. Over the past year, we have come together as a community to address topics that matter to us as individuals and as a department. Our Health of the Planet Initiative asks faculty, staff, and students to adopt habits and conduct research that reduce our footprint and protect our environment. Along with others at MIT and across the globe, we have a renewed focus on creating a more diverse, equitable, and inclusive department and community. The recently launched MechE Diversity, Equity, and Inclusion Task Force, led by our diversity faculty lead, is composed of current MechE students, faculty, and staff who are tasked with defining our community values and developing a five-year action plan to hold us accountable and ensure we are making progress.

In this year's report, we provide an overview of departmental news throughout AY2020. The report includes a short synopsis of this year's goals, objectives, priorities, and accomplishments; administrative initiatives; updates on faculty news (new hires, promotions, and changes in departmental leadership); selected research highlights across the department; education highlights; awards and recognitions to provide a small sampling of the diversity, breadth, and depth of achievements across the MechE community; a summary of various communication activities; and finally an overview of space renovations completed on campus.

Goals, Objectives, and Priorities

While many of this year's goals continued the efforts started in previous years, a number of our objectives and priorities changed in light of the impact of COVID-19 as well as the national conversation on racism. Below is an overview of AY2020 departmental goals, objectives, and priorities:

- Facilitate intradepartmental research collaborations that focus on the MechE grand challenges
- Pioneer new courses and educational programming that shape the future of mechanical engineering education
- Successfully execute our educational mission in the face of challenges associated with remote learning
- Support our students' career and professional development with the MechE Alliance program and pilot programs such as MechE Summer X

- Utilize the breadth and depth of expertise across the department to develop solutions for the challenges the world faces in light of COVID-19
- Foster a deeper sense of community, particularly in light of remote work and remote learning
- Create and promote a more diverse, equitable, and inclusive department and community and reject racism and prejudice in any form
- Enhance spaces for education and research

Accomplishments

Intradepartmental Research Collaborations: Focus on Grand Challenges

This past year, the department continued its efforts to increase discussions and opportunities for intradepartmental research collaborations in MechE's four grand challenge areas. Some of these efforts are outlined below.

Health of the Planet Retreat

On January 29, the department hosted a faculty retreat focusing on the health of the planet. The retreat included presentations from a number of faculty members on their research efforts related to the planet's health. Faculty also presented one opportunity and/or challenge that could be addressed with collaborators in the department. After presentations, there was a brainstorming session focused on ways faculty can work together on these projects.

Collaborative Seed Funding

In spring 2020, MechE launched seed funding to support collaborative research within the department on health of the planet projects. This seed funding has been generously supported by MathWorks. The following projects were chosen:

- Understanding and Suppressing Flammability in Li-ion Batteries for Safe Electric—collaborating principal investigators [PIs]: Assistant Professor Betar Gallant and Professor Ahmed Ghoniem
- A Hybrid Approach to Bridging Participatory Design and CFD Modeling for High Performance Household Energy Products in Low- and Middle-Income Countries—collaborating PIs: Assistant Professor Sili Deng, Professor Maria Yang, and Daniel Sweeney
- Colorimetric Cell Traction Force Sensing with Photonic Hydrogels to Quantify Micro-scale Cell Mechanics for Biomedical Applications—collaborating PIs: Associate Professors Mathias Kolle and Ming Guo
- AI-driven Design Synthesis (ADDS) for Personalized Bicycles—collaborating PIs: Assistant Professor Faez Ahmed and Professor Daniel Frey
- Automated Sustainable Seaweed Aquaculture System—collaborating PIs: Professor David Wallace and Assistant Professor Stephanie Mueller

Launch of International Colloquia on Thermal Innovations

Over 90% of our energy consumption and utilization involves heat, and thus heat will play an indispensable role in solving global challenges such as climate change. Thermal energy is everywhere, from electricity generation to maintaining human comfort, from materials processing to food preparation, and from computer chip cooling to battery operation safety.

In April 2020, a MechE faculty team launched the International Colloquia on Thermal Innovations series, which aims to stimulate and highlight innovations and advances in theory, materials, devices, and systems for efficient thermal energy conversion, storage, transport, and utilization. The online, interactive colloquia include seminars and panel discussions with speakers from around the world and across different disciplines. Professor Gang Chen and Associate Professor Asegun Henry serve as chairs, with Professors John Lienhard and Evelyn Wang as organizers.

Research Strategy Committee

In July 2019, the department launched the Research Strategy Committee. This standing committee serves as the primary custodian of MechE's research strategy and advises departmental leadership on strategic matters regarding the department's research mission.

Education Innovation

This year, much of our focus on education innovation stemmed from the challenges of the COVID-19 pandemic and the need to pivot to remote learning in just a few short weeks. Faculty and teaching staff also focused on what mechanical engineering education will look like in a post-COVID-19 world.

Innovations in Remote Education

By its very nature, the education MechE provides its students is incredibly hands on. This posed unique challenges as we transitioned to a virtual learning environment. In just two weeks, our talented and dedicated faculty and teaching staff completely overhauled the way our courses were taught. They worked to develop solutions and find opportunities that have allowed us to continue executing our educational mission. The following are some examples of how faculty and staff strove to offer students the best possible remote experience:

- In 2.00b Toy Product Design, Professor David Wallace and his teaching team sent students a kit of materials to design and build a toy prototype. Students presented their prototypes in one-minute videos that were broadcast during [a live PLAYsentations event](#).
- Benita Comeau led live remote lab sessions for students in 2.674 Micro/Nano Engineering Lab. Comeau worked to make lab instruments, including a scanning electron microscope and an atomic force microscope, remotely accessible for online lab sessions.
- Although the iconic final robot competition for 2.007 Design and Manufacturing I was postponed, Professor Amos Winter explained in an interview how the

teaching staff has tailored the course to individual students, deepening their design exploration.

- Students in 2.671 Measurement and Instrumentation hosted their own individual Zoom rooms in a class-wide poster session for the final Go Forth and Measure project.
- For the final lecture in 2.12 Introduction to Robotics, Professors Harry Asada and Kamal Youcef-Toumi led a forum on the role of robotics in a post-pandemic world.

Supporting Remote Making

With makerspaces closed to students on campus, [a remote making resource site](#) for students was launched in June 2020 to enable safe making from home. Developed by Professor Martin Culpepper and the MIT Environment, Health and Safety Office, the site functions as a wiki guiding the decisions of students and their faculty supervisors about how to make remotely while still putting safety first.

Faculty Retreat: Imagining MechE Education in the Post-COVID-19 World

On May 27, 2020, the department hosted a faculty retreat that explored the lessons we have learned from COVID-19, especially with regard to teaching remotely and the value of on-campus activities, as well as how we envision MechE education in the post-COVID era. A number of talks were given at the retreat. For example, Amos Winter, Sangbae Kim, Tony Patera, Ian Hunter, John Liu, John Hart, Franz Hover, David Wallace, and Josh Ramos offered insights garnered from remote teaching and perspectives on teaching in the future. Also, Tony Patera and Warren Seering described the work of the Education Strategy Committee, including its focus on computation and engineering decision making in the department's curriculum.

In addition, faculty members were asked to discuss the following questions in the context of MechE education in a post-COVID-19 world: What opportunities does the current situation present? What aspects should in-person education focus on, and what aspects should be done online/digitally/remotely? How do we maintain memory of and sustain improvements in education at the subject, department, and other levels?

Education Strategy Committee

Launched in July 2019, this standing committee serves as the primary custodian of the MechE education strategy and advises departmental leadership on strategic matters regarding the director's educational mission.

The committee's plan is to imagine the professional landscape of 2030 and attempt to understand what and how we must teach in the upcoming decade to prepare our students. The committee is starting with a field that will change dramatically in the next 10 years: computation.

Digital Learning Lab Fellow

John Liu was hired as a new digital learning lab fellow. He is working closely with MechE faculty to support efforts in collaboration with MIT Open Learning to innovate with digital learning in the department. He is also involved in the development and execution of new educational initiatives.

MechE Summer X

In June 2020, the department launched the MIT MechE Summer Knowledge Exchange—or MechE Summer X—which offers students, recent graduates, faculty, and staff an opportunity to share and learn skills through offering and participating in short-term remote activities. Activities will be organized and led by members of the MechE community, and they will be free and not for credit.

Computing and Mechanical Engineering

With the establishment of the MIT Stephen A. Schwarzman College of Computing, MechE continues to explore opportunities for our students to marry the hands-on nature of mechanical engineering in the physical world with computing, artificial intelligence (AI), and machine learning. This includes the launch of classes such as 2.168 Learning Machines, taught by Professor George Barbastathis, and the new 2-A tracks Computing and Learning Machines and Physical Systems.

Schwarzman College of Computing Shared Faculty Hiring

The health of the planet is one of the most important challenges facing humankind today. The new Schwarzman College of Computing presents a unique strategic opportunity to drive collaborations across schools and departments where paradigm shifts in computing will be essential to tackling the complexity of health of the planet issues and providing data-driven solutions without relying only on large-scale experiments.

MechE led 12 departments across MIT in submitting a proposal for cluster hiring at the Schwarzman College of Computing. The proposed shared faculty hiring cluster would energize and coalesce health of the planet efforts at the Institute and enable MIT to lead in new directions, advance knowledge, educate students and the world, and provide solutions with transformative impact so that humans and nature can thrive for generations to come.

MechE Alliance Program

The past year was one of tremendous growth for MechE Alliance programming. Under the leadership of program manager Theresa Werth and faculty lead Brian Anthony, the alliance focused on fostering connections among students, alumni, faculty, and industry. New initiatives were launched to support students in achieving their career goals.

Mentorship

The MechE Alliance has facilitated over 250 one-to-one mentoring conversations between alumni and students in addition to organizing group mentoring through alumni panels.

Industry Visits

The MechE Alliance hosted a number of industry visits wherein company participants met with faculty on potential research collaborations and engaged with students in recruitment and career exploration conversations.

Education

In summer 2019, four mechanical engineering graduate students had the opportunity to gain hands-on experience working in industry. Through the recently launched Industry Immersion Program, students were paired with a company and tasked with tackling a short-term project. Projects in this inaugural year involved a diverse range of industries, including manufacturing, robotics, and aerospace engineering. Participating companies included 3M, Amazon Robotics, and Systems Technology Inc. The summer 2020 Industry Immersion Program was canceled due to COVID-19.

Based on the success of the student projects, the department created the 2.989 Experiential Learning in Mechanical Engineering course to facilitate experiential learning through a wider variety of internships. This is particularly critical in enabling international students who need optional practical training/curricular practical training to participate in internships, a key Institute priority.

The MechE Alliance works with department courses and programs to enlist alumni volunteers and presenters to improve our educational offerings. This spring two alumni panels were arranged for 2.000 Explorations in Mechanical Engineering to highlight career paths in mechanical engineering.

MechE Alliance Seminars

In April 2020, the MechE Alliance launched a weekly seminar series featuring MechE students, postdocs, faculty, alumni, and external partners. Through these seminars, we support the free flow of ideas and the networks of researchers that make up the global MechE community.

Building Your Career Portfolio

In June, the MechE Alliance launched Building Your Career Portfolio, a new workshop series that walks students through the most important career development steps to take in preparation for their job search. Self-introductions, LinkedIn, and portfolio development are particularly emphasized, with specific tips and examples for MechE students. Students are supported in developing their career portfolio with feedback through peer review sessions and reviews by alumni and industry mentors in relevant fields. Sixty students will participate in this inaugural year. Workshops sessions will be offered annually each summer to MechE graduate and undergraduate students.

Focus on Community

During AY2020, a number of issues arose that had great impact on our MechE community. From difficult discussions about funding and sexual abuse to discussions about anti-Black racism in light of George Floyd's murder and COVID-19, departmental

leadership has made it a top priority to listen to and support our community during difficult times. We also launched a number of initiatives and programs to help foster a greater sense of community within the department, including:

- Open office hours hosted by department head Evelyn Wang and administrative officer Joanne Mathias
- The Building Inclusive Lab Cultures training pilot for faculty members and their lab groups
- Community-building activities through the Health of the Planet Initiative
- Weekly community newsletters
- A virtual commencement celebrating graduating students
- Gifts of MechE-branded fleece jackets for all graduating students

Also, we announced the hiring of a new faculty diversity lead, Asegun Henry, and the launch of the MechE Diversity, Equity, and Inclusion Task Force.

In addition, Professor Rohit Karnik, associate head for education, has initiated teaching staff lunches to enhance collaboration and community among the teaching staff. There has also been increased inclusion of teaching staff in education-related departmental discussions.

Betar Gallant has been appointed as the faculty ambassador for graduate students. She serves as a liaison to MechE graduate students to support them and to help the department continue to improve students' graduate experiences.

We plan to continue these efforts in the coming year to further enhance and strengthen our MechE community.

Enhancing Space for Education and Research

Over the past year, in collaboration with the Facilities Department, we have examined various ways to improve the spaces on campus for education and research.

We are moving forward with the Newman Laboratory renovation. We developed a comprehensive plan to maximize both the available space and its usability, with the mezzanine level now running the length of the lab. The revised plan will allow existing research groups to continue their full programs while accommodating Sangbae Kim's biomimetic robotics research group and a flexible lab space for one of our flagship courses, 2.12 Introduction to Robotics, taught by Harry Asada and Kamal Youcef-Toumi. We started the detailed design phase over the winter. Once the review is complete, we plan to solicit construction bids. With the complications of COVID-19, there may be some additional delays, but we are working diligently to move the process forward as rapidly as possible.

Lab space construction and renovation for a number of new faculty members were completed this past year.

Student MathWorks Fellowships

This year, we awarded 13 MathWorks Engineering Fellowships. The fellowships are meant to support our graduate students, particularly those who are active users of MATLAB and Simulink. In the upcoming year, MathWorks will provide 10 fellowships directly to MechE students in addition to three School of Engineering fellowships. School of Engineering recipients are Clara Park, Yoonho Kim, and Bernardo Aceituno-Cabezas. MechE recipients are as follows:

Tony Tohme

Baoliang Ge

Rohit Supekar

Shashank Agarwal

Abhinav Gupta

Jerry Ng

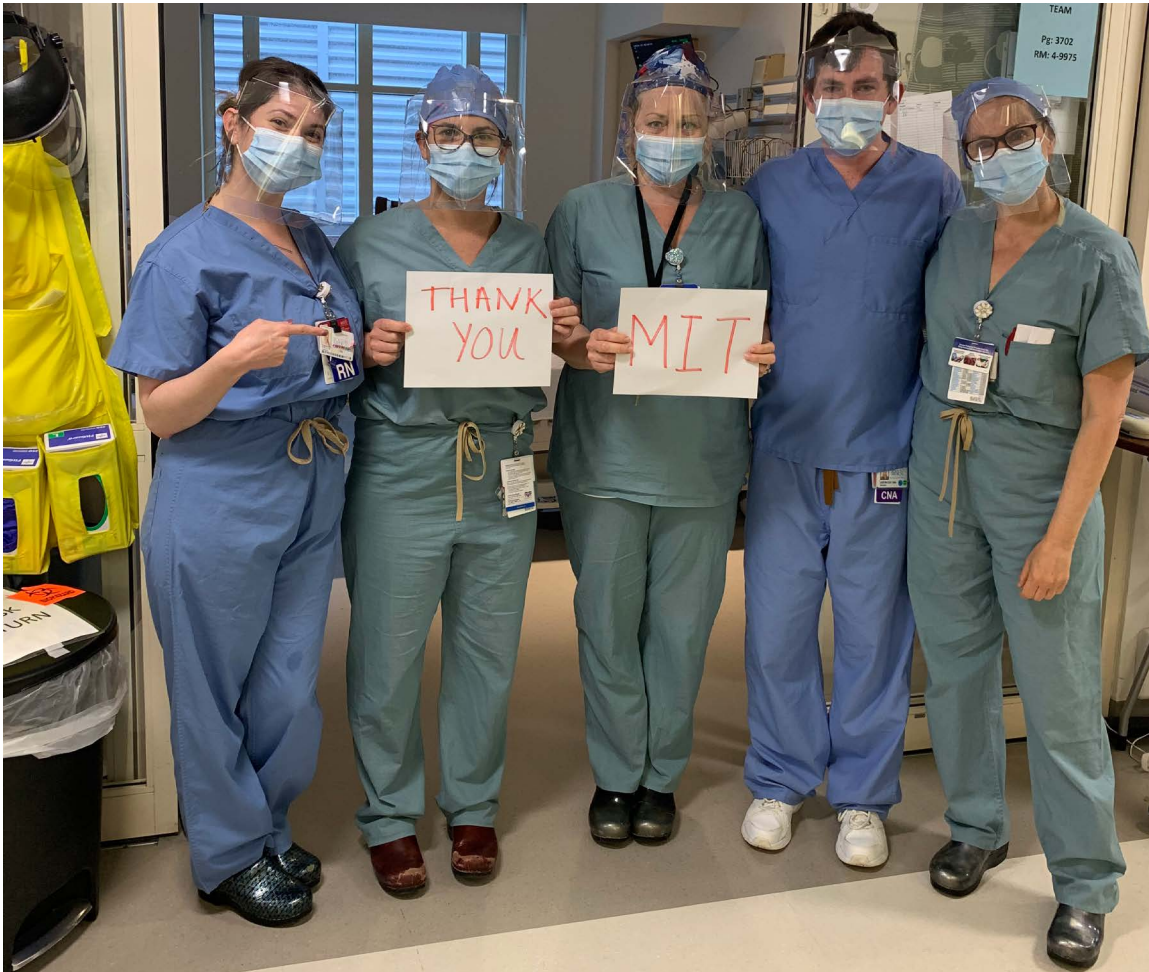
Ryan Penny

Wenhui Tang

Hannah Feldstein

Fiona Grant

COVID-19 Research



Doctors at Boston Medical Center wear a face shield designed by Professor Martin Culpepper's team at Project Manus and donated by MIT. (Photo courtesy of Boston Medical Center)

Early in 2020, MechE researchers, faculty, staff, and students quickly swung into action to address the most pressing needs in light of COVID-19. The following is an overview of some of the COVID-19-related research conducted by MechE researchers:

- A [face shield](#) designed by Martin Culpepper and his team at MIT Project Manus is being mass manufactured to protect health care workers and first responders. To date, 600,000 shields have been delivered to hospitals, health care providers, and first responders.
- An ad hoc team of MIT engineers and doctors—including Professor Alex Slocum and Nevan Hanumara from MechE—has developed a [low-cost, open-source ventilator](#) that is now ready for rapid production. The design was based on a project done in 2.75 Medical Device Design a decade ago.
- George Barbastathis and Raj Dandekar, a PhD candidate in the Department of Civil and Environmental Engineering, developed the [first-ever model](#) that uses data from the COVID-19 pandemic in conjunction with a neural network to determine the efficacy of quarantine measures and better predict the spread of the virus.
- Assistant Professor Giovanni Traverso developed a [rapidly deployable system](#) to expand ventilator capacity by splitting a single ventilator for use by two or more patients. Professor Traverso also developed remote medical diagnostic sensors for a robot that is being used to screen potential COVID-19 patients.
- Professor Thomas Peacock is a member of the UN Global Compact’s COVID-19 Task Force, which recently [issued recommendations](#) for protecting seafarers, the global supply chain, and the shipping and offshore industries during COVID-19.

Administrative Initiatives

New Staff Hiring Protocols

This past year, MechE became the first department in the School of Engineering to ask candidates invited for interviews to complete exercises specific to the duties of the position. This process provides additional data to facilitate decision making. Candidates who participated have responded positively.

Changes in Financial Operations Workflow

The department has standardized and improved financial review and control and adopted the Institute’s best practice guidelines for digital financial record retention.

Staff Wiki Launch

A new wiki was developed and launched to support staff members in their roles and to provide answers to questions about the day-to-day operations of the department.

MechE Virtual Resources Page

In order to help our MechE community upon the announcement that students and staff would be remote in March, the department launched a new [virtual resources](#) page on our website. This page provides information and recommendations for the functioning of our

internal department activities in a virtual or semi-virtual fashion should it be required. It will be updated regularly as new guidelines and information become available.

Department Community and Equity Officer

In June 2020, the department received approval to commence the hiring process for a community and equity officer. Although there is currently a hiring pause across the Institute, with the support of our Institute leadership, MechE has recognized how vital it is to hire an individual with expertise who can help shape our departmental initiatives in diversity, equity, and inclusion. The community and equity officer will be responsible for designing and implementing outreach activities to help attract a diverse population of students, faculty, and staff. The officer will also develop tools, resources, and a range of solutions that enhance diversity and inclusion within the department as well as protect and nurture the mental and physical well-being of each member of our community. Hiring is expected to proceed in the summer of 2020.

New Teaching Assistant Appointment Process

Starting in spring 2020, based on concerns conveyed by graduate students, the department implemented a new teaching assistant appointment process that increased transparency by providing live data on open positions and students seeking teaching assistants and streamlined the selection and appointment process.

Faculty Promotions

Associate Professor to Full Professor

John Hart

John Hart has been promoted to full professor. Hart is an internationally renowned leader in advanced manufacturing, combining the study of new materials ranging from nanocomposites to high-performance metals with the invention of novel manufacturing processes and equipment for varied applications. He is an innovative teacher with a remarkable impact on manufacturing education. Hart redesigned our undergraduate manufacturing course, 2.008 Design and Manufacturing II; created an open digital version (2.008x); and pioneered the use of videos and online material to teach a blended version of 2.008 replacing conventional lectures with interactive hands-on sessions.

Sangbae Kim

Sangbae Kim has been promoted to full professor. Kim is an internationally renowned leader in high-performance bio-inspired robotics. Learning from the magnificent locomotive capabilities of animals, he has developed new design methodologies that extract and systematically exploit relevant biological principles and implement them in novel robotic designs. Kim is a passionate educator who has made significant contributions to our design and robotics curriculum. For nine years, he has been an excellent instructor for our main undergraduate course, 2.007 Design and Manufacturing I, and our 2.009 The Product Engineering Process capstone course.

Xuanhe Zhao

Xuanhe Zhao has been promoted to full professor. An international leader in the field of mechanics of soft materials, Zhao uses both theoretical and experimental approaches to understand and design new soft materials and systems with extraordinary mechanical properties or functionalities that enable new applications. He is a dynamic teacher and speaker and a devoted mentor. He developed a new graduate course, 2.075/2.S997 Mechanics of Soft Materials, that combines polymer physics and polymer mechanics with a focus on designing properties of soft materials for addressing societal challenges. He has been an active citizen at MIT, including co-chairing the MechE general search in 2018 and co-organizing two seminars.

Associate Professor without Tenure to Associate Professor with Tenure***Asegun Henry***

Asegun Henry has been promoted to associate professor with tenure. Henry is a leader and has made significant impact in two areas within the field of thermal science and engineering: nanoscale heat transfer and high-temperature energy systems. Henry is an excellent teacher and mentor and has contributed significantly to the thermal-fluid science curriculum at both the undergraduate and graduate levels at Georgia Tech and now at MIT.

Assistant Professor to Associate Professor without Tenure***Ming Guo***

Ming Guo has been promoted to associate professor without tenure. Guo is a rising star working at the intersection of cell mechanics and soft matter physics. His work aims to understand the fundamental physical principles that govern the behavior of biological systems ranging from sub-cellular processes to multi-cellular organizations. He is an excellent teacher and caring mentor. He is also an active citizen of our department and his community.

New Faculty Hires**Assistant Professor**

Giovanni Traverso started in the department as an assistant professor on July 1, 2019. His present research focuses on developing efficient systems for drug delivery through the gastrointestinal tract, as well as novel ingestible electronic devices for sensing a broad array of physiological and pathophysiological parameters. Traverso is a co-founder of the companies Lyndra, Suono Bio, and Celero Systems, which have been established to accelerate the translation of technologies developed by his team for use in medical care.

Associate Professor of the Practice

Commander Douglas Jonart has been appointed as associate professor of the practice for the Naval Construction and Engineering program, succeeding Commander Andrew Gillespy. Commander Jonart is the most knowledgeable officer in the US Navy on propulsion shaft design and corrosion fatigue of shafts and shaft line components. He

developed this expertise while at MIT completing his SM and PhD research. He has worked extensively and continuously on numerous ship design, construction, repair, and operational billets for the Navy, with a focus on the design and maintenance of nuclear-powered submarines.

Departmental and School Leadership

In July 2019, Martin Culpepper was appointed as graduate admissions officer. Warren Seering and Tony Patera were named co-chairs of the Education Strategy Committee. Gang Chen was named chair of the department's Research Strategy Committee. Maria Yang was named head of Research Area 2 (Design, Manufacturing & Product Development).

Chairs and Professorships

Betar Gallant has been named the ABS Career Development Professor. Wim van Rees was named the MIT Sea Grant Doherty Professor in Ocean Utilization. Mathias Kolle was appointed to the Rockwell Career Development Professorship. Ming Guo has been appointed to the Class '54 Career Development Professorship. Ellen Roche was appointed to the W.M. Keck Career Development Professorship.

Research Highlights

Our faculty are innovators and problem solvers, always with an eye toward developing technologies that will make the world a better place. Much of our research is focused on major global challenges including the health of our planet, design and manufacturing, global energy sustainability, and robotics, autonomy, and intelligent systems. Here we provide a snapshot of the varied and diverse research conducted in the department.

A technique developed by Assistant Professor Irmgard Bischofberger could help [improve the design of soft materials](#) such as toothpaste, hand lotion, and yogurt to withstand jostling during transport or settling due to gravity.

Using a technoeconomic approach, researchers including Professor Tonio Buonassisi found that [thinner silicon wafers](#) could lead to lower solar cell costs and help speed up industry expansion.

A team of researchers at MIT including Gang Chen designed a long-sought device, which they refer to as an [“electrical heat valve,”](#) that can vary thermal conductivity on demand.

A team of engineers led by Ming Guo found that tumors with softer, larger cells at their periphery are more likely to spread. The team's results, reported in the journal *Nature Physics*, point to a [new route for cancer therapy](#) focused on changing the physical properties of cancer cells to delay or even prevent a tumor from spreading.

John Hart has developed a [miniature “electroadhesive” stamp](#) that can pick up and place down objects as small as 20 nanometers wide—about 1,000 times finer than a human hair. The new technique could enable assembly of circuit boards and displays with more minute components.



MIT graduate student Emily Hanhauser demonstrates a new device that may simplify the logistics of water monitoring for trace metal contaminants, particularly in resource-constrained regions. (Photo courtesy of Melanie Gonick/MIT)

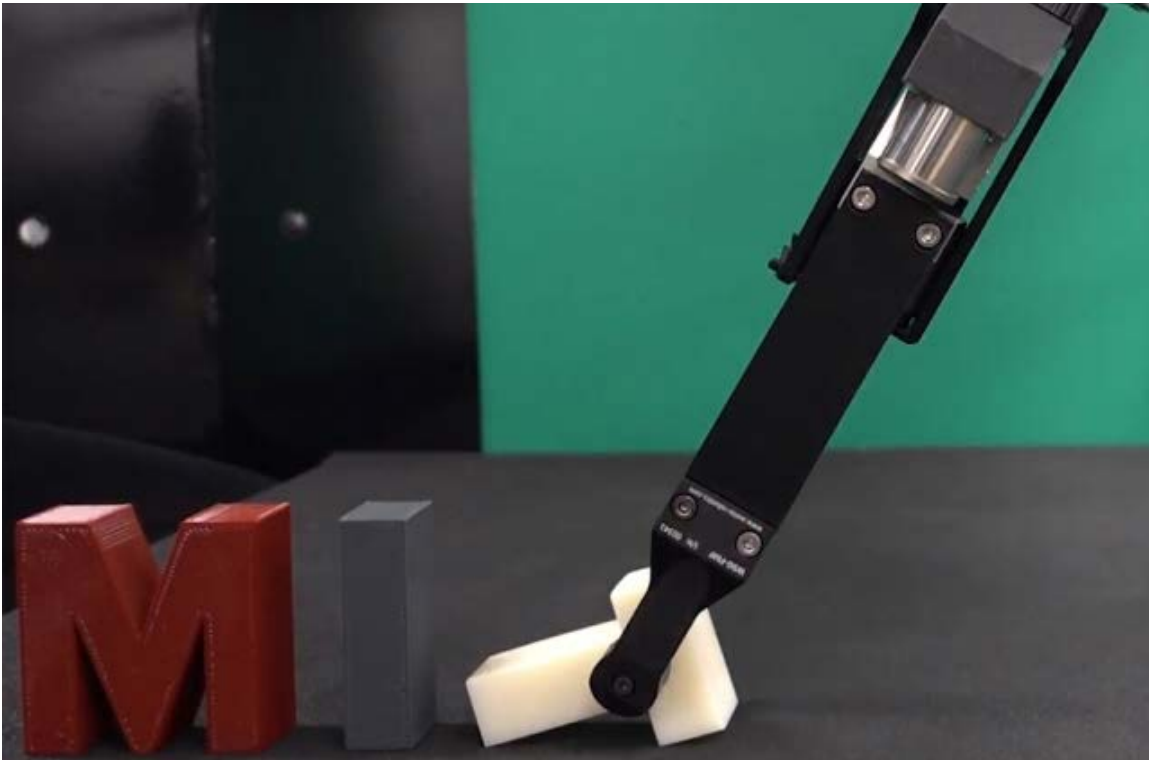
Researchers including Rohit Karnik, John Hart, and graduate student Emily Hanhauser developed a device that [absorbs trace contaminants in water](#) and preserves them in a dry state so that the samples can be mailed easily to a lab for testing.

Associate Professor Jeehwan Kim has developed a [new process](#) that may be the key to manufacturing flexible electronics with multiple functionalities in a cost-effective way.

A passive [solar-powered desalination system](#) developed by John Lienhard and Evelyn Wang achieved a new level of efficiency in harnessing sunlight to make fresh potable water from seawater.

Researchers including Thomas Peacock have developed a technique that they hope will [help first responders quickly zero in on](#) regions of the sea where missing objects or people are likely to be.

Engineers at MIT including Ellen Roche and Xuanhe Zhao have developed a [device made of heart tissue and a robotic pumping system](#) that beats like the real thing.



A robot grasps letters spelling MIT thanks to a new algorithm that enables robotic grippers to manipulate objects using the surrounding environment.

A team of MIT engineers led by Associate Professor Alberto Rodriguez has found a way to significantly speed up the planning process required for a [robot to adjust its grasp](#) on an object by pushing that object against a stationary surface.

MIT engineers including Mathias Kolle and Professor Peter So have developed a [simple chip powered by quantum dots](#) that allows standard microscopes to visualize difficult-to-image biological organisms.

Researchers including Giovanni Traverso have designed a [new coated drug capsule](#) that can carry insulin or other protein drugs and protect them from the harsh environment of the gastrointestinal tract.

A team of researchers including Wim van Rees has designed [3D mesh-like structures](#) that morph from flat layers into predetermined shapes in response to changes in ambient temperature. The materials could be used to design deployable structures such as tents or coverings that automatically unfurl and inflate in response to changes in temperature.

MIT engineers led by Xuanhe Zhao have designed a [double-sided tape](#) that can seal tissues in just five seconds. The tape could eventually replace surgical sutures, which do not work well in all tissues and can cause complications in some patients.

Departmental News

Throughout the year, a number of updates highlighting the latest departmental news were published by MIT News, as outlined below.

Mechanical engineering graduate students get [hands-on experience](#) working on projects across a range of industries through the MechE Alliance's Industry Immersion Program.

MIT has launched a number of programs and initiatives to [lessen its greenhouse gas emissions](#), including the course 11.S938/2.S999 Solving for Carbon Neutrality at MIT, which is co-taught by Professor Timothy Gutowski.

MIT was honored with a [number one ranking](#) in the subject area of mechanical, aeronautical, and manufacturing engineering in the QS World University Rankings.

U.S. News & World Report named MIT's Department of Mechanical Engineering the [number one graduate program in mechanical engineering](#).

Event Highlights

MechE hosts a number of seminal events throughout the year. Below are highlights from some of the larger, more high-profile events in AY2020.



Graduate students, postdocs, and Undergraduate Research Opportunity Program students presented their research to members of the MIT community, alumni, and industry representatives at the sixth annual Mechanical Engineering Research Exhibition. (Photo courtesy of Tony Pulsone)

Mechanical Engineering Research Exhibition

At the sixth annual [Mechanical Engineering Research Exhibition](#) in October, graduate students, postdocs, and Undergraduate Research Opportunities Program (UROP) students sharpened their communication and presentation skills in a poster session-style event.

Envisioning the Future of Technology-Enabled Mobility

In October, the MIT International Design Center and the Edgerton Center hosted a panel ([Envisioning the Future of Technology-Enabled Mobility](#)) that included J. Kim Vandiver, Dan Frey, Neville Hogan, and Jaya Narain.

December 2.009 Final Class Presentations

MechE students in 2.009 Product Engineering Processes presented products and business plans in front of a packed Kresge Auditorium. This year's projects ranged from [beekeeping safety to custom cosmetics](#).

Education Highlights

Undergraduate Enrollment, AY2015–AY2019

	AY2015	AY2016	AY2017	AY2018	AY2019
Sophomores 2	85	88	66	71	64
Sophomores 2-A	85	99	103	94	80
Sophomores 2-OE	7	1	2	2	1
Sophomores subtotal	177	188	173	167	145
Juniors 2	89	83	97	70	86
Juniors 2-A	102	92	90	69	71
Juniors 2-OE	3	3	2	3	2
Juniors subtotal	194	177	189	152	159
Seniors 2	92	81	78	93	70
Seniors 2-A	104	89	94	83	72
Seniors 2-OE	5	6	3	3	3
Seniors subtotal	201	176	175	179	145
5th-year students 2	4	3	8	6	4
5th-year students 2-A	7	7	8	4	9
5th-year students 2-OE	3	0	0	0	0
5th-year students subtotal	14	10	16	10	13
Total	586	551	553	508	462

Graduate Enrollment, AY2015–AY2019

	AY2015	AY2016	AY2017	AY2018	AY2019
Master's	193	213	221	190	187
Doctoral	312	309	302	294	268
MEng	12	15	11	9	11
MechE	0	0	1	0	2
Eng (naval)	34	30	28	31	27
Total	551	567	564	524	495

Honors and Recognition

Each year our department, faculty, and students are recognized for their accomplishments through a number of awards and honors. Here we provide a small sampling of the recognition the department and its faculty and students received this year.

Faculty/Research Scientist Awards and Honors

Brian Anthony received a [Google Faculty Research Award](#). Anthony, who serves as associate director of MIT.nano and director of the Master of Engineering in Manufacturing Program, won the award for research on machine learning and data mining.

Professor Arthur Baggeroer was elected as a 2019 AAAS (American Association for the Advancement of Science) Fellow. Throughout his career, he has made significant advances in geophysical signal processing and sonar technology in addition to serving as a long-time intellectual resource to the US Navy.

A team of researchers including Irmgard Bischofberger won a 2019 American Physical Society (APS)/Division of Fluid Dynamics (DFD) Milton van Dyke Award for their video [Blooming Patterns in Drying Drops](#). In addition, Bischofberger was presented the Ruth and Joel Spira Award for Excellence in Teaching to acknowledge “the tradition of high-quality engineering education at MIT.”

Professor Daniel Frey has been awarded the [Charles M. Manly Memorial Medal by the Society of Automobile Engineers](#). Frey was recognized for his paper “Evaluating How Functional Performance in Aerospace Components Is Affected by Geometric Variation.”

Ming Guo has been named a [2020 Alfred P. Sloan Research Fellow](#) in Physics.

Professor David Hardt was presented the 2020 Hideo Hanafusa Outstanding Investigator Award at this year’s International Symposium on Flexible Automation. Hardt was recognized for pioneering contributions to dynamic modeling, in-process measurements, and process control for welding, metal forming, and embossing and for outstanding leadership in manufacturing innovation and education. In addition, Professor Hardt has been elected to the [2020 Society of Manufacturing Engineers College of Fellows](#). This level of recognition is attained only after an individual has achieved more than 20 years of significant career contributions in manufacturing.

Neville Hogan has been honored by Science Foundation Ireland with the [2020 St. Patrick’s Day Science Medal Award](#). The award is given annually to a distinguished US scientist, engineer, or technology leader with strong Irish connections.

Professor Anette “Peko” Hosoi won the [2019 Capers and Marion McDonald Award for Excellence in Mentoring and Advising](#), given annually to a faculty member who has demonstrated a lasting commitment to personal and professional development.

Professor Roger Kamm was presented the [2020 Shu Chien Achievement Award](#) at the Biomedical Engineering Society’s Cellular and Molecular Bioengineering Conference in Puerto Rico. Kamm was being honored for his contributions to the field of cellular and molecular bioengineering.

Professor John Leonard was elected as a 2019 AAAS Fellow. His research focuses on long-term visual simultaneous localization and mapping in dynamic environments. In addition to underwater vehicles, Leonard has applied his pursuit of persistent autonomy to the development of self-driving cars.

Ellen Roche has been named associate scientific advisor of science translational medicine. Roche's research focuses on new approaches to cardiac device design, including soft robotic techniques to develop a bioinspired cardiac simulator.

Alberto Rodriguez was given the [IEEE \(Institute of Electrical and Electronics Engineers\) 2020 Early Academic Career Award](#) in Robotics and Automation, which recognizes academics who have made contributions that have had a major impact on the robotics and/or automation fields. In addition, Rodriguez was presented a [Google Faculty Research Award](#) for his project proposal String Manipulation: Learning and Planning with Affordances and Predictive Models.

Ray Rui, a research scientist in MIT's Laboratory for Manufacturing and Productivity, became the youngest recipient of the Society of Petroleum Engineers Distinguished Membership Award. This award acknowledges members who have attained eminence in the petroleum industry or the academic community.

Associate Professor Themis Sapsis received a 2020 MathWorks Faculty Research Innovation Fellowship.

Wim van Rees won a 2019 APS/DFD Milton van Dyke Award for his poster "[Vortex Bursting](#)," which provides an example of the evolution of a vortex simulated on a computer cluster and visualized to highlight the particular structure of the vortex core. Also, the US Department of Energy's Office of Science selected van Rees for its [Early Career Research Program](#). He was awarded for his work on a multiresolution sharp-interface framework for tightly coupled multiphysics simulations.

Infinite Cooling, a start-up run by MechE alumni Maher Damak and Karim Khalil along with Professor Kripa Varanasi, won first place in the graduate student category of the 2019 Collegiate Inventors Competition, organized by the National Inventors Hall of Fame. In addition, Varanasi and graduate students Samantha McBride and Henri-Louis Girard won a 2019 APS/DFD Milton van Dyke Award for their video *Crystal Critters*.

Professor Dick K.P. Yue has been elected to the [National Academy of Engineering](#) for his contributions to ocean engineering and innovation of OpenCourseWare to make higher education freely available worldwide.

Xuanhe Zhao, an expert in solid mechanics and soft materials, was presented the [2020 Thomas J.R. Hughes Young Investigator Award](#) by the American Society of Mechanical Engineers. The award honors young investigators in applied mechanics.

Staff Awards

Leslie Regan, academic administrator for MechE's graduate program, won an MIT Excellence Award in the Serving the Client category.

Shibani Jonsi was presented the Joseph (Tiny) Caloggero Service Award, given annually to a member or members of the support staff for outstanding service to the department.

The H. Sharon Trohon Award is given every two years to a member or members of the administrative staff for administrative excellence. This year's award was presented to Mary Beth Gallagher and Daniel Herrick.

The MechE Covid-19 Hero Awards recognize the extraordinary efforts of teaching, administrative, and support staff members in the department whose ongoing efforts during the COVID-19 crisis have enabled new capabilities and made the transition easier for MechE colleagues, work groups, and the overall community. This year's awards were given to the following staff members:

- Steve Banzaert, technical instructor
- Sara Bonner, program administrator
- Harrison Chin, lecturer
- Anna Churchill, human resources administrator
- Sarah Collins, administrative assistant II
- Benita Comeau, lecturer
- Harris Crist, webmaster
- Adam Eisenstein, computer support assistant
- Mary Beth Gallagher, communications officer
- Tom Graffeo, facilities coordinator
- Dan Herrick, environment, health and safety coordinator
- John Liu, lecturer
- Lisa Mayer, administrative assistant II
- Janice McCarthy, administrative assistant II
- Peter Pflanz, IT (information technology) manager
- Tony Pulsone, administrative assistant II
- Josh Ramos, lecturer
- Norlan Sierra, IT support engineer
- Tasker Smith, technical instructor
- Janak Thapa, technical associate II
- Theresa Werth, program manager

Student Awards

MechE senior [Ali Daher](#) from Amman, Jordan, is a recipient of the new Rhodes Scholarship for the Syria, Jordan, Lebanon, and Palestine region. As a Rhodes Scholar, he will undertake a degree in research engineering science with the Oxford Mechanobiology Group. Daher is passionate about applying mathematical and engineering principles in an interdisciplinary manner to find solutions to biological problems.

MechE senior [Lyndie Mitchell Zollinger](#) was named a 2020 Gates Cambridge Scholar. As a Gates Scholar at Cambridge University, Zollinger will develop mechanical models of the progression of traumatic brain injuries.

Graduating MechE seniors [Max Kessler](#), [Booker Schelhaas](#), [Srimayi Tenali](#), and [Sandra “Sandy” Walter](#) have been awarded 2020 Fulbright Fellowships.

Graduate student Graham Leverick has been named a 2020 Siebel Foundation Scholar for academic and research excellence as well as demonstrated leadership contributions. He works with Professor Yang Shao-Horn in the Electrochemical Energy Lab.

Graduate student James Gabbards has received a MathWorks Engineering Fellowship. He studies computational fluid dynamics under Professor van Rees.

PhD student Emily Hanhauser has been selected for the Hugh Hampton Young Fellowship.

MechE students [Smita Bhattacharjee](#), [Jessica Xu](#), and [Nisal Ovitigala](#) won a \$10,000 juried grant at the 2020 IDEAS Awards Ceremony for their project TILT, a universally adaptable wheelchair attachment that allows assistants to move wheelchairs up and down stairs with more ease.

Graduate student Sai Nithin Kantareddy won a best student paper award at the IEEE International Conference on RFID for “Learning Gestures Using a Passive Data-Glove with RFID Tags.”

Graduate student Henri Girard won the 2019 Langmuir Award at the American Chemical Society Colloid and Surface Science Symposium for his project with the Varanasi research group (Waterbowls: Reducing Impacting Droplet Interactions by Momentum Redirection).

Graduate student Aaron Melemed was named a 2019 National Aeronautics and Space Administration Space Technology Research Fellow. Melemed, who works with Professor Gallant, will be working on calcium-based battery development for space technology applications.

PhD candidate Elise Strobach and postdoc Kyle Wilke, who work with Evelyn Wang in the Device Research Laboratory, were named to *Forbes* magazine’s 30 Under 30 list in the energy category. Together they founded AeroShield, which manufactures a super-insulating, porous glass for energy-efficient windows. MechE graduate student Xinyue Liu was named to the *Forbes* 30 Under 30 Asia list in the health care and science category.

She works with Professor Zhao on developing 3D printing techniques and living materials for diagnosis and therapy.

Felipe Oviedo, a graduate student working with Tonio Buonassisi, won the best paper award at the NeurIPS Climate Change Workshop for his research on using machine learning to identify next-generation photovoltaics.

Graduate student Michael Everett; alum Justin Miller SM '11, PhD '17; and Professor Jonathan How of the Department of Aeronautics and Astronautics won the Best Paper Award on Cognitive Robotics at the International Conference on Robots and Systems for "Planning Beyond the Sensing Horizon Using a Learned Context."

Graduate student Jenny Wang won the 2020 MIT Larry G. Benedict Leadership Award for her dedication to empowering her fellow students to develop as leaders.

Graduate student Chun Man Chow was named a J-WAFS (Abdul Latif Jameel Water and Food Systems Lab) 2020–2021 Fellow for Water Solutions. Working in the lab of Professor Karnik, he focuses on developing novel separation processes for environment, health, and industrial applications. In addition, PhD candidate Georgia Van de Zande and graduate student Lenan Zhang received honorable mentions for the fellowship. Van de Zande works with Professor Winter in the GEAR Lab to develop farmer-centered irrigation systems aimed at increasing adoption among smallholder farmers and increasing water and food security in sub-Saharan Africa, while Zhang is working with Professor Wang on a multistage desalination system driven by sunlight to help communities in remote, arid regions across the globe meet their drinking water needs affordably.

Recent doctoral graduate Beckett Colson won the Earl Ewing Hays Award from the MIT/Woods Hole Oceanographic Institution Joint Program in Oceanography and Applied Ocean Science and Engineering in recognition of his efforts in developing a novel sensor for flow-through microplastics detection. This award was established by friends of Hays in memory of his deep devotion to education and his enjoyment of the company and intellectual stimulation of students.

MechE PhD candidate Jaya Narain received a fellowship in artificial intelligence/machine learning through Apple Scholars for her research on AI for health and wellness.

Communications

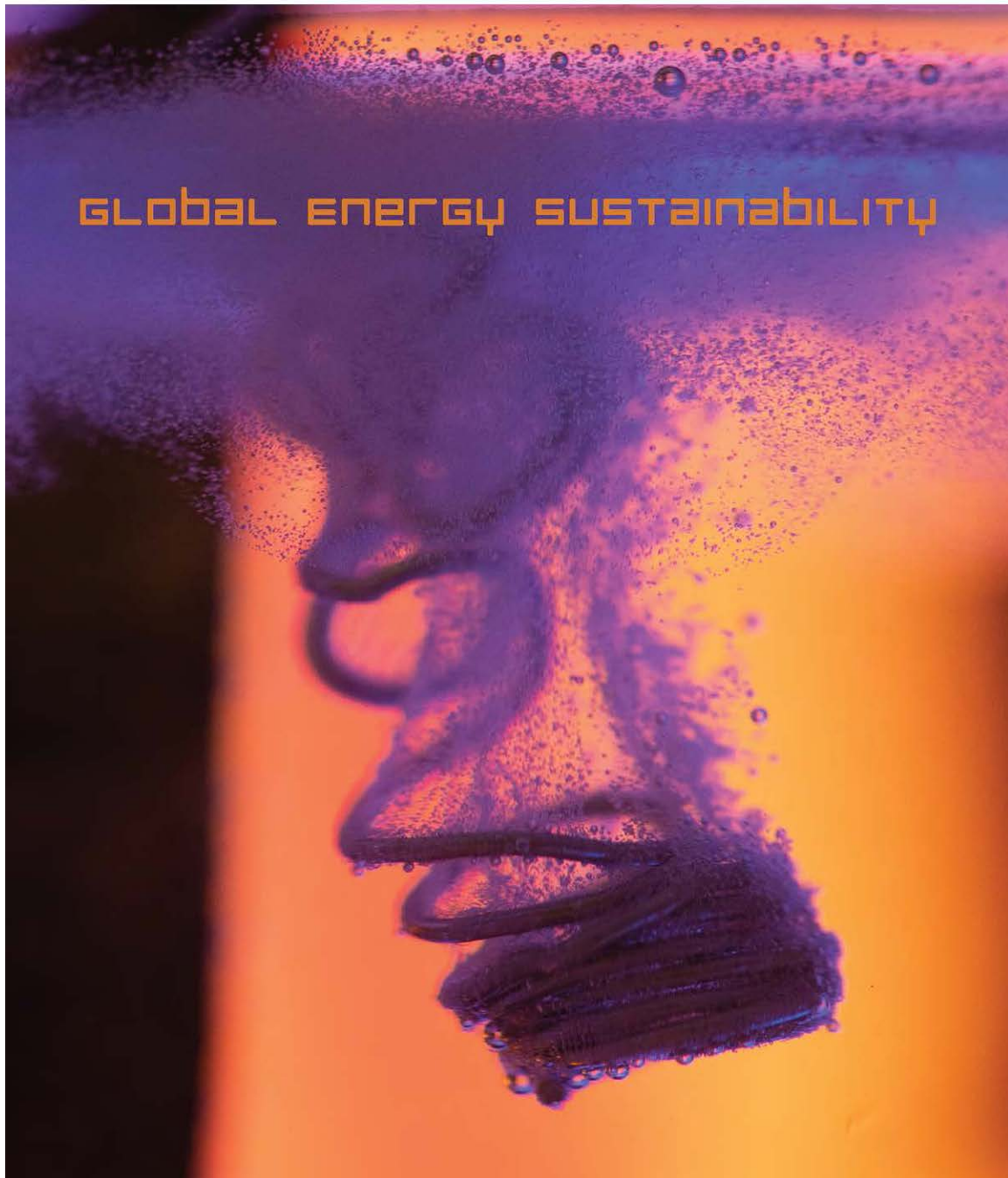
The MechE media team continued to share the department's stories in compelling ways across a variety of channels this past year.

MechE Connects



MechEConnects

Winter 2020



The Winter 2020 issue of MechE Connects focused on the grand challenge of global energy sustainability.

This year MechE Connects, the department's biannual newsletter, focused on the ways our faculty, students, and alumni are having a meaningful impact in solving some of the biggest challenges our world faces.

The Winter 2020 issue focused on the MechE grand challenge of global energy sustainability. The issue highlighted some of the technologies our faculty, alumni, and students are developing to promote sustainable energy. From renewable energy conversion to energy-efficient windows and cleaner combustion, members of the MechE community are conducting groundbreaking research that could have a lasting impact in the fight against climate change. Due to disruptions caused by COVID-19, the Summer 2020 issue was postponed until fall 2020.

MIT News Stories

Throughout the year, 19 articles originating from MechE and written by communications officer Mary Beth Gallagher were published by MIT News. Seven of these articles were Spotlights of the Day on MIT's main website. A number of these spotlights had a corresponding video produced by John Freidah. Examples of published stories include the following:

- [Celebrating a curious mind: Steven Keating 1988-2019](#) (July 22, 2019)
- [Professor Emeritus Woodie Flowers, innovator in design and engineering education, dies at 75](#) (October 14, 2019)
- [Students present mechanical engineering projects that have global impact](#) (October 29, 2019)
- [Understanding the impact of deep-sea mining](#) (spotlight, December 5, 2019)
- [Using aluminum debris to power desalination after natural disasters](#) (spotlight, December 17, 2019)
- [Professor Emeritus Ali Argon, pioneer in the mechanics of materials, dies at 89](#) (January 3, 2020)
- [Students propose plans for a carbon-neutral campus](#) (January 17, 2020)
- [Understanding the impact of climate change on the ocean](#) (spotlight, March 23, 2020)
- [MIT initiates mass manufacture of disposable face shields for Covid-19 response](#) (spotlight, March 31, 2020)
- [Protecting seafarers and the global supply chain during Covid-19](#) (May 12, 2020)

MechE Videos

Video production continues to be a priority for MechE's communication team. This year, the department released 11 videos on its YouTube channel. These videos, including a full-length feature film on Professor Peacock's deep-sea mining research, were produced by senior producer and creative lead John Freidah.

Additionally, this year Mary Beth Gallagher served as "on-air talent" while interviewing two MechE faculty members for videos that were posted on the main MIT channel as part of the video vignette series about how the community dealt with going remote. Below is an overview of the videos released this year, which attracted more than 113,000 views.

Videos Released in 2019–2020

Release date	Video	Views
October 21, 2019	A Cleaner Burn	3,748
October 30, 2019	Double-sided tape could replace surgical sutures	21,693
November 25, 2019	MIT First-Year Students Learn through Creation	14,894
December 5, 2019	Mining the Deep Sea	26,704
December 9, 2019	Remembering Woodie Flowers	1,054
December 10, 2019	Visualizing Deep-sea Mining	10,896
February 4, 2020	Building the Next Generation of Electronics	6,135
April 9, 2020	Isolating together: Checking in with Anette “Peko” Hosoi	5,542
April 16, 2020	Connecting MIT with Yoga	1,957
May 12, 2020	Design problem: How to teach a hands-on course online	11,000
June 1, 2020	2020 MIT Mechanical Engineering Undergraduate Graduates	2,105
June 1, 2020	2020 MIT Mechanical Engineering Master’s and Doctoral Graduates	1,396
June 1, 2020	Celebrating the MIT MechE Class of 2020	2,303
June 22, 2020	Guided Discovery at MIT	4,175

These videos are *also posted* natively on Facebook and often repurposed by the main Institute channels on both Facebook and YouTube.

Social Media

MechE’s social audience continued to grow throughout the AY2020. Channel-specific strategies were employed to ensure that key demographic groups were targeted on the channel they most often use. The most dramatic increases in followers and engagement were on Instagram and LinkedIn.

Social Media Followers, 2019–2020

Platform	June 30, 2019	June 30, 2020	Change
Facebook	34,841	36,325	4%
Twitter	6,956	10,110	45%
Instagram	7,950	17,258	117%
LinkedIn	3,495	6,583	88%

Website Traffic

The [MechE homepage](#) is constantly *updated* with engaging content, including articles about groundbreaking research, student and faculty profiles, start-up and product news, and award highlights. The website had 1,626,317 page views by 332,343 users in AY2020.

Space Renovations

Completed Construction

- Building 5, Room 029: This room was renovated for Giovanni Traverso. The lab is set up as a BL-2 space.
- Building 5, Room 008: This room is shared by Giovanni Traverso and Assistant Professor Ashwin Gopinath. It is also a BL-2 space with a fume hood and two biosafety cabinets.
- Sili Deng's lab: Phase 1 construction of Professor Deng's lab is complete. The lab has a fume hood and a burner to capture carbon nanoparticles.
- Building 3, Room 144: A small renovation was completed for the MechE staff office space, with the carpet changed, painting done, and new furniture added to accommodate three administrative staff members.

Construction in Progress

- Building 35, Room 018: The old sand table has been removed, and a team is refreshing this room for Professor Jung-Hoon Chun.
- Building 31, Room 399: Changes are being made to this room for Jeehwan Kim. Power, chilled water, and exhaust for his new equipment have already been added.

Construction in Planning

- Building 31, Room 399: The Newman Laboratory renovation is still in the planning stage. It involves Ian Hunter, Neville Hogan, Sangbae Kim, Harry Asada, Lynette Jones, and Igo Krebs. The new space will have a large mezzanine, a teaching/conference space, a chemistry area, machine space, and individual labs for PIs.
- Building 5, Room 030: This will be an extensive change of space from student seating to a clean room for Assistant Professor Vivishek Sudir.
- Building 3, Room 148: The department's underused student lounge will be converted to a much-needed conference/lunch room for MechE staff.
- Building 3, Room 470: Construction of Faez Ahmed's lab near Maria Yang and David Wallace's labs is in the planning stages.
- Building 31, third floor: Construction of Carlos Portela's lab on the top floor of Building 31 is in the planning stages.

Conclusion

MIT's Department of Mechanical Engineering continues to be a global leader in mechanical engineering research and education. A commitment to making the world a better place is at the core of everything we do. As educators, we strive to train mechanical engineers who can think critically, develop creative solutions, and remain flexible in the face of abrupt change. In the coming year, we will continue to develop new educational initiatives and models that better prepare the mechanical engineers of the 21st century.

This past year posed unique challenges for our faculty, students, and staff in light of the COVID-19 pandemic. During this difficult time, our community demonstrated an ability to come together, innovate, and develop solutions for the complex problems we now face.

The 2021 academic year will undoubtedly be a challenging one as the world continues to grapple with the COVID-19 pandemic. In the coming months, our researchers will continue the important, groundbreaking work of solving problems related to the pandemic. Our educators will develop and implement new and innovative ways to educate students, both remotely and in person. Faculty and staff will support students, and one another, during these difficult and uncertain times.

In AY2021, we will continue pursuing research that supports the health of the planet and deepen our engagement with the Schwarzman College of Computing. Through seed funding efforts, we will encourage further research collaborations among our faculty and research staff. With guidance from our Education Strategy Committee and Research Strategy Committee, we will shape our strategy for the coming years. To help us carry out our educational and research mission, we will seek more space on campus. Also, we will further support our students in their career searches and professional development through the MechE Alliance and other initiatives. Finally, we will develop initiatives, programming, and communications that reflect our commitment to becoming a more diverse, equitable, and inclusive department and community.

Evelyn Wang
Department Head
Gail E. Kendall Professor

Pierre Lermusiaux
Associate Department Head for Operations
Professor of Mechanical Engineering

Rohit Karnik
Associate Department Head for Education
Professor of Mechanical Engineering