

## 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. Members of the department aspire to solve some of the biggest challenges facing our world—and to train the next generation of mechanical engineers to develop creative products and solutions.

MechE conducts cutting-edge research at the frontiers of mechanical engineering. Faculty members often specialize in more than one discipline, ensuring a fluidity of research that promotes cross-disciplinary discovery. Faculty 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
- Micro- and nano-engineering

The department has identified four unifying MechE grand challenges that address some of the biggest needs and issues facing the world:

- Health of the planet
- Global energy sustainability
- Robotics, autonomy, and intelligent systems
- Design and manufacturing innovation

These challenges build upon our expertise and provide opportunities for making major global impacts through interdisciplinary collaborations. They also reflect MIT's mission to make a better world through research, education, and innovation.

These core disciplines and grand challenges shape MechE's world-class introductory and advanced undergraduate and graduate-level programs. The department has a culture of curiosity that combines a rigorous education with hands-on experience. We educate future leaders in mechanical engineering—leaders who can model, design, innovate, and solve the most challenging problems facing society. Our students and faculty members advance science and technology by discovering solutions, designing products, and engineering workflows that help make our world a better place.

Every year, the department attracts and enrolls top-notch mechanical engineering students. The undergraduate and graduate programs continue to thrive, illustrating a sustained and broad interest in mechanical engineering. MechE had 508 undergraduate students and 524 graduate students enrolled during academic year 2019, for a total of 1,032 students. Our research programs incorporate a growing postdoctoral population of 81 fellows and associates.

This year's report offers an overview of departmental news in academic year 2019. The report includes a synopsis of this year's goals, objectives, and priorities; new initiatives; updates on faculty (new hires, promotions, changes in departmental leadership, and retirements); and selected research highlights. The report also includes an overview of start-ups and products originating from the MechE community. It notes education highlights, with overviews of the undergraduate and graduate programs, and awards and recognitions that provide a small sampling of the diversity, breadth, and depth of achievements across the MechE community. A summary of various communication activities is followed by an overview of space renovations completed on campus.

## Goals, Objectives, and Priorities

### Intradepartmental Research Collaboration: Focus on Grand Challenges

This past year the department engaged in a number of activities in an effort to increase discussions and opportunities for intradepartmental research collaborations in the four grand challenge areas identified in the strategic plan. These efforts included the following:

- Holding a faculty retreat in May 2019 focusing on the health of the planet
- Conducting research faculty brainstorming sessions centered on government funding opportunities, such as the Big Ideas (for future investments) of the National Science Foundation (NSF), the NSF's Emerging Frontiers in Research and Innovation, Lincoln Laboratory, and the US Army's Natick Soldier Systems Center
- Securing funding to launch seed funding of collaborative research on the grand challenges in fall 2019
- Using both issues of the department's biannual newsletter, MechE Connects, to introduce the greater MechE community to two grand challenges—health of the planet, and design and manufacturing innovation—to increase awareness about the work being done in these areas among alumni, faculty, and students, and to foster collaborations in these research spaces

The department will continue this focus on fostering intradepartmental collaboration in grand challenge areas throughout AY2020.

### Mentorship for Junior Faculty

One of the department's main goals has been ensuring the success of our junior faculty through mentorship with senior faculty. Department leadership held individual lunches with all junior faculty members in the spring and had monthly junior faculty group lunches to discuss topics such as funding and promotion. New mentoring guidelines that detail expectations for both mentors and mentees were created this past year. MechE has also ensured that all junior faculty members met with their mentoring group by the end of the spring 2019 term. The department will continue to monitor junior faculty mentoring closely and ensure that it is helpful to junior faculty members.

### **Development of Mechanical Engineering Alliance**

Over the past year, a team of faculty, staff, and alumni worked on launching new programming and hosting events through the MechE Alliance. This included:

- Several “speed mentoring” events where students were paired with local alumni
- Informational talks, panels, and seminars, such as tube fitting training by Swagelok, a tour of Greentown Labs, and an introduction to entrepreneurship from the team of Spyce
- Launch of the Industry Immersion Project Program

Expanding the reach and offerings of the MechE Alliance to add value to our student and alumni communities will continue to be a priority for the department.

### **Fostering a Greater Sense of Community**

This year, the department has made efforts to foster a greater sense of community within the Mechanical Engineering community. Those efforts include:

- Improving onboarding practices for faculty and staff, including the addition of an administrative assistant to lead and coordinate MechE’s training program for support staff and oversee operational training.
- Establishing several staff committees, including an operations group of key roles within the department.
- Creating additional opportunities for extracurricular community building, including a faculty and staff meeting for coffee on Mondays, a faculty, staff, and graduate student kickball game, and an annual MechE Family Day.
- Supporting the launch of two new student groups: MIT FEMME (Female Empowerment Meets Mechanical Engineering) and the MIT MESS (Mechanical Engineering Student Society). The Mechanical Engineering Student Society is charged with promoting community within the department through social events, peer advising, career panels, and more.
- A new position, faculty ambassador for graduate students, was added to help promote a sense of community within the graduate student population. As of February 2019, this position was held by Assistant Professor Betar Gallant.

### **Enhancing Space for Education and Research**

Over the past year, and in collaboration with MIT’s Department of Facilities, MechE has examined various ways to improve its spaces on campus for education and research. Plans to renovate the Newman Laboratory, which will combine research and teaching space, were drawn up, and with funds secured this year, planning to renovate the research and teaching spaces on the fourth floor of Building 3 has begun. Laboratory space construction and renovation for a number of new faculty members were begun and completed this past year. Many of these renovation projects will continue through academic year 2020.

## Initiatives

### Launch of New 2-A Computing Tracks

In response to the growing interest in computing and the launch of the new College of Computing, two new tracks within the customizable undergraduate degree program, Course 2-A, were launched: “Computing and Learning Machines” and “Physical Systems.”

### MechE Alliance Industry Immersion Program

The [Industry Immersion Project \(I<sup>2</sup>P\) Program](#) was launched this year. This flagship MechE Alliance program provides current MIT MechE graduate students with a unique opportunity to participate in a short- to medium-term industry project. The I<sup>2</sup>P Program sustains connections between educators in academia and practitioners in industry while giving students invaluable experience. In the summer of 2019, students will be participating in projects at 3M, Amazon Robotics, and Systems Technology Inc.

### Mentorship Guidelines for Junior Faculty

New junior faculty mentorship guidelines have been developed to enhance mentorship for MechE’s junior faculty and ensure they have the support they need. These guidelines include an overview of two groups that play a critical role in junior faculty’s professional development: a mentoring group and an ad hoc committee.

#### Mentoring Group

The primary role of a mentoring group is to support the professional development and well-being of the junior faculty. The mentoring group is expected to meet with the junior faculty as a group in the fall semester of each year. The mentoring group should provide timely guidance and advice to junior faculty members as they progress through their early academic careers at MIT and offer an environment in which junior faculty members can discuss their concerns in confidence. The group’s role is to cover the four key aspects of faculty development:

- Research, including publications and other scholarly output
- Education, including teaching and student mentorship
- Service
- Community and impact

Although there will be no formal reporting from the mentoring group, the department will ensure that meetings take place and that junior faculty members receive support and advocacy.

#### Ad Hoc Committee

The new mentorship guidelines also help explicitly differentiate the role of the mentoring group and the ad hoc committee. When a junior faculty member is being considered for promotion, he or she is assigned an ad hoc committee. That committee will have only one overlapping member from the mentoring group, who will serve as an advocate for the junior faculty member on the ad hoc committee. The ad hoc committee will consist of a small group of experts in the field within MIT, with the idea that they will know how to best review and advise the junior faculty member.

### **Rising Stars in Mechanical Engineering**

For two days in October 2018, 34 top junior academic women in mechanical engineering in the United States convened on MIT's campus. These female graduate students and postdoctoral associates attended the inaugural Rising Stars in Mechanical Engineering Workshop. The workshop is aimed at women graduate students and postdoctoral associates who are considering future careers in academia. The department hosted the workshop, which was led by Professor Evelyn Wang and Professor Maria Yang.

The program, which is modeled after the successful Rising Stars Workshops in biomedical engineering, physics, civil and environmental engineering, and electrical engineering and computer science, aims to prepare women for the challenges associated with a career in academia. Topics covered included leadership skills, establishing a laboratory as a junior faculty member, and communicating one's research vision.

### **Mechanisms for Collective Funding**

Throughout the year, MechE held research brainstorming events within the department and with external groups to seek opportunities for collective funding.

### **Lincoln Laboratory**

Robert Bonds, chief technology officer of Lincoln Laboratory, along with other researchers from the laboratory, visited MechE and gave a briefing on Lincoln Lab's technology needs, strategic directions, and upcoming funding opportunities. Some of these discussions led to successful collaborations between researchers at Lincoln Lab and Mechanical Engineering.

### **US Army Natick Soldier Systems Center**

Colonel Moore, Chief Scientist Charlene Mello, and Nanomaterials Senior Scientist Nagarajan from the US Army Natick Soldier Systems Center visited the department for a half day to discuss opportunities for collaboration. They met with various junior faculty members individually. During a faculty lunch, Colonel Moore presented some of the challenges that the US Army faces. The discussions were fruitful and opened up opportunities for collaboration between faculty and the center.

### **Brainstorming**

The department held research brainstorming sessions focused on the NSF's Big Ideas and Emerging Frontiers in Research and Innovation proposal calls. These sessions helped to collaboratively strengthen MechE's responses to such calls for submissions.

### **Workshop on Education and Pedagogy**

On January 30, 2019, the department hosted a faculty retreat focused on education and sharing perspectives, the findings of learning science, and educational activities within the department. Speakers and topics included the following.

- Professor Emeritus Woodie Flowers, Professor Anette "Peko" Hosoi, Professor Ely Sachs, Professor David Wallace, and Professor Warren Seering spoke about perspectives in mechanical engineering education.

- Aaron Kessler and Professor Sanjay Sarma made a presentation on applying learning science in instruction in mechanical engineering.
- Professor John Hart and Dawn Wendell '04, SM '06, PhD '11 discussed using a “flipped” classroom in 2.008 Design and Manufacturing II.
- Jose Pacheco, industry co-director of the Master's of Engineering in Manufacturing Program, and Professor David Hardt discussed the Principles of Manufacturing MicroMasters and blended learning in 2.96/2.961 Management in Engineering.
- Visiting Lecturer Captain Joe Harbour spoke about one of MIT's graduate programs, 2N: Graduate Program in Naval Architecture and Marine Engineering.

### **Workshop on the Health of the Planet**

On May 30, 2018, the department hosted a faculty retreat focused on the grand challenge: the health of the planet. The event was organized into four sessions with the following themes.

#### ***Session 1: Our People, Our Cities***

- Challenges and Plans in Boston—Commissioner Carl Spector
- Challenges and Plans in Cambridge—Director Suzanne Rasmussen
- Carbon Neutrality at MIT—Professor Timothy Gutowski

#### ***Session 2: Water and Food***

- Survival in the Anthropocene: Water and Food—Professor John Lienhard
- Food Security: Urban and Ocean—Professor Alexandra Techet

#### ***Session 3: Geoengineering, Energy Sustainability, and Design***

- Harvard's Solar Geoengineering Research Program—Professor Frank Keutsch and Director Elizabeth Burns
- Toward Net-Zero Greenhouse Gas Emissions—Assistant Professor Betar Gallant and Associate Professor Asegun Henry
- A Green New Deal Is Very Doable—Professor Alexander Slocum

#### ***Session 4: Climate, Ocean, and Environment***

- What Is MIT Doing About Climate Change?—Professor Kerry Emanuel
- Climate Modeling: Thoughts, Plans, New Directions—Professor John Marshall
- Sea Grant and Ocean Science and Engineering—Professor Michael Triantafyllou

## Faculty Promotions

### Associate Professor to Full Professor

#### ***Tonio Buonassisi***

Tonio Buonassisi was promoted from associate professor to full professor. Buonassisi is a world leader in solar energy conversion through his fundamental studies on defects limiting solar cell efficiency, especially crystalline silicon solar cells. His work is driven by the goal of reducing the cost of solar cells. His cost analysis of solar cells helped shape US policy for the solar industry, while it guided his own research in addressing scientific problems that can lead to significant industrial impacts. Since receiving tenure, Buonassisi has identified and mitigated the impacts of defects on device performance and reliability and translated the results to industry. He co-developed the first silicon-perovskite tandem solar cells, achieving a record efficiency of 23.7%. Buonassisi has been pushing boundaries with accelerated materials development. He demonstrated improved screening criteria for defect-tolerant thin-film materials, and has been developing faster screening methods for candidate photovoltaic materials.

Buonassisi has been recognized with a number of prestigious awards throughout his career, including the NSF CAREER and the Presidential Early Career Awards for Scientists and Engineers awards. He has a passion for education and mentoring undergraduate and graduate students as well as postdoctoral associates. He introduced a popular course on photovoltaics that attracted students from across the Institute. Within the last four years, he has been actively engaged in the undergraduate core curriculum. He has also been involved with the photovoltaic community and the solar industry. He is an avid supporter of the student-run Energy Club and has served on several scientific organizing committees of international meetings concerning defects in photovoltaic materials.

#### ***Rohit Karnik***

Rohit Karnik has been promoted from associate professor to full professor. Karnik is internationally recognized for his pioneering and innovative work in the area of nanoscale fluid transport. He laid the foundations for rational design of nanoporous, atomically thin graphene membranes, proposed and demonstrated the potential of creating low-cost water filters from plant xylem in sapwood. He created an osmosis membrane with nanobubbles as the selective layer, and measured the mass accommodation coefficient of water. Since being granted tenure, he has focused on the advancement of graphene membranes and on water-related technologies for resource-limited settings. He has demonstrated the successful molecular sieving of gases across macro-scale graphene, realized salt rejection and dialysis across centimeter-scale atomically thin membranes, advanced our understanding of defects in graphene and their control for membrane applications, showed that graphene membranes can withstand remarkably high pressure, and demonstrated a scalable process for fabricating graphene membranes. Meanwhile, his plant xylem-based water filter and “dry” sampling for trace contaminant monitoring have advanced to field testing in India.

Karnik has been recognized with a number of prestigious awards throughout his career, including the NSF CAREER Award, a US Department of Energy (DOE) Early Career Award, the Indian Institute of Technology Bombay Young Alumni Achiever

Award, the Keenan Award for Innovation in Education, the 2018 Ruth and Joel Spira Award for Excellence in Teaching, and several best paper and poster awards. He is a dedicated teacher and outstanding mentor. He is a model citizen and has contributed excellent service to MIT and to his profession. At MIT he served as the undergraduate officer for Mechanical Engineering for two years. He has served on many internal MechE committees, including the Department Head Search Committee, the Graduate Admissions Committee, the Strategic Planning Committee, the Undergraduate Programs Committee, and various faculty search committees. Since July 2018, he has served as the department's associate head for education.

### **Alexandra Techet**

Alexandra Techet was promoted from associate professor to full professor. Techet is an international leading expert in the field of experimental hydrodynamics. Her research expands the state of the art in spatial and temporal imaging of complex flow fields and the use of such measurements in understanding and providing insights into the physics of fluid flow in a variety of important hydrodynamic phenomena. These phenomena include free surface water entry of projectiles, maneuvering and propulsion of marine organisms, and sensing of the water/air interface of breaking waves. Her research addresses complex hydrodynamics problems faced by the US Navy and the ocean science and engineering communities through rigorous experimental investigation and the acquisition of both spatially and temporally resolved data. Since receiving tenure, she has demonstrated unique and important contributions in three-dimensional, three-component synthetic aperture particle imaging velocimetry. Her work has advanced our understanding of the hydrodynamics of extreme jumping maneuvers, from water to air, for aerial prey capture, among others.

Techet has been recognized with several awards throughout her career. She received the Office of Naval Research Young Investigator Award in 2004. She garnered acclaim for her work with four winning images in the Gallery of Fluid Motion, in 2005, 2007, 2009, and 2011. Her work also appeared on the cover of the *Journal of Fluid Mechanics* in 2009. Techet was elected a fellow of the American Society of Mechanical Engineers in 2018. She is a dedicated teacher and she has made sustained contributions in teaching the core Course 2-OE Mechanical and Ocean Engineering undergraduate subjects. She is a strong citizen of MIT and her community. Techet serves as a member of the National Academy of Sciences Study Committee that reviews and assesses the Office of Naval Research National Naval Responsibility—Naval Engineering Programs, which include research and educational efforts at many US universities.

### **Kripa Varanasi**

Kripa Varanasi has been promoted from associate professor to full professor. Varanasi is internationally recognized for his contributions at the intersection of thermal-fluid sciences, nanotechnology, and manufacturing, and for the rapid translation of the corresponding technologies to successful industrial applications. His work emphasizes the broad area of interfaces between liquids, solids, and gases. These interfaces control many important phenomena in industry, nature, agriculture, and medicine. He has advanced our understanding of nanoengineering interfaces that alter thermal-fluid interfacial interactions for significant efficiency enhancements in a wide range of thermal-fluid processes and applications. With his research group, Varanasi



has elucidated how specific interfaces control thermal-fluids transport, wetting, and adhesion processes; tuned interfacial properties such as morphology, chemistry, and charge to control transports; synthesized robust material interfaces for industrial applications; and developed engineering and manufacturing systems to scale up basic research into useful products.

Varanasi has been recognized for his innovative application of interface science to important problems for society. His prizes and awards include the MIT \$50K Entrepreneurship Competition, the DOE Clean Energy Prize, first place in the DOE Cleantech University Prize, first prize in the Rice Business Plan Competition, first prize Harvard Business School Energy and Environment Start-up, and first prize at the MIT \$100K Entrepreneurship Competition. Infinite Cooling, a start-up Varanasi helped found, was named the Boston Diamond Winner at MassChallenge. Varanasi has received the American Society of Mechanical Engineers (AMSE) Gustus Larson Memorial Award.

Varanasi is also an effective teacher and mentor. Four of his students are co-founders or chief executive officers of the companies he has founded. In 2018, he was awarded the Frank E. Perkins award for excellence in graduate advising at MIT. He recently became a faculty director for the Entrepreneurship Internship Program of the Martin Trust Center. Since September 2018, he has also been serving on the Committee on Academic Performance.

### ***Maria Yang***

Maria Yang was promoted from associate professor to full professor. Yang is an internationally recognized leader in design theory and design process, with a focus on the role of design representation in the early stages of the process and its impacts on design outcomes, from consumer goods to complex large-scale engineering systems. Yang has made significant advances in characterizing the relationship between design process and outcome. Her research analyzes and models how the creation and representation of a design are formally linked to its success. Her results and impact help designers choose processes and tools with which to design and innovate more effectively and efficiently. She has developed a quantitative framework for early-stage design that guides the generation of innovative products and systems that address pressing challenges linked to the environment, energy, and global poverty. Her work is crucial to global competitiveness in the sense that her novel use of quantitative methods to analyze and model the design of successful products and systems allows such successes to be reproduced in other design activities.

Yang has brought tremendous value to education at MIT and to design education around the world. Her outstanding record in research, advising, and teaching are complemented by exceptional service. She has won the Earll M. Murman Award for Excellence in Undergraduate Advising, the 2014 Capers and Marion McDonald Award for Excellence in Mentoring and Advising, as well as multiple teaching awards such as the 2014 Ruth and Joel Spira Excellence in Teaching Award, the 2017 Bose Award for Excellence in Teaching, and the highly regarded MacVicar Faculty Fellowship in 2017. Her service in the department and to the Institute is also exceptional. She was the faculty ambassador to undergraduates in MechE from 2015 until fall 2018, when she became MechE's undergraduate officer. She has been a member of the department's Faculty Search Committee in Design and of the extended committee for the New Engineering Educational Transformation. She was the chancellor's designated representative to the

Committee on Undergraduate Programs, and is a member of the Corporation Joint Advisory Committee on Institute-Wide Affairs. She became faculty academic director of D-Lab in 2017. She was the co-organizer of the Rising Stars in Mechanical Engineering Workshop at MIT. Her external service contributions have been equally extensive.

### **Associate Professor without Tenure to Associate Professor with Tenure**

#### ***Themistoklis Sapsis***

Themistoklis Sapsis has been promoted to associate professor with tenure. Sapsis is a leader in the field of stochastic nonlinear dynamical systems, and more specifically the development of analytical and computational methods for predicting and quantifying non-statistical-equilibrium behaviors, such as extreme events and transient dynamics in high-dimensional ocean and mechanical systems. He has developed efficient methods for studying such stochastic nonlinear systems (with thousands, or even millions, of degrees of freedom) that develop extreme events because of internal instabilities, direct forcing, or both. From these studies, he derived major, tangible results, useful in the analysis and prediction of natural ocean phenomena and in the design and safety of engineering systems. Examples include the predictors of rogue waves and of extreme events in 3D turbulent channel flows, as well as the efficient evaluation of the heavy, non-Gaussian probability tails of instability-driven extreme events for the optimization of ocean structures and mechanical vibration absorbers.

Sapsis has made excellent contributions to MechE's core undergraduate and graduate subjects. He led two existing graduate subjects and he redesigned 2.122 Stochastic Systems. In terms of service, Sapsis has been a good citizen of the department and of MIT. He has served continuously on the Graduate Admissions Committee and several times on the admissions committee of the Computation for Design and Optimization Program. He was a member of the committee that reviewed the department's core undergraduate courses in dynamics. Externally, he has organized multiple workshops and conferences and served on editorial boards. Sapsis has received several prestigious awards, including three Young Investigator Awards (from the Office of Naval Research, the Air Force Office of Scientific Research, and the Army Research Office), as well as a Sloan Research Fellowship.

#### ***Amos Winter***

Amos Winter has been promoted to associate professor with tenure. Winter is a leader in the field of development engineering, where he has combined engineering science and socioeconomic insights to create high-value products for the developing world. His research focuses on understanding the unique technical and socioeconomic constraints that underlie emerging markets. Winter adopts these constraints to motivate his scientific research program, which ranges from mechanics to machine design. He then uses the fundamental insights gained from his scientific program to create innovations that deliver high performance at low cost, and serve as global product platforms appropriate for communities that span the economic spectrum. Winter and his group, the Global Engineering and Research Laboratory, have designed and implemented a number of highly impactful technologies for emerging markets, including passive prosthetics, low-power drip irrigation, and low-cost brackish water desalination. He has also commercialized emerging market solutions in the US and developed basic principles for the growing field of reverse innovation.

Winter is a devoted teacher and wonderful mentor. He co-leads 2.007 Design and Manufacturing I, the department's flagship undergraduate introductory design course, and developed 2.76 Global Engineering, a pioneering machine and product design class that teaches students how to apply their technical skills within the particular technical and socioeconomic constraints of emerging global markets. In terms of service, at MIT, he has been serving as the MIT Formula Society of Automotive Engineers (SAE) team's faculty supervisor, as a core faculty and programming committee member for the Tata Center for Technology and Design, and as the faculty lead and organizer for the MechE de Florez Design Competition. Winter is also extremely active in ASME and in his profession. He has been recognized with several prestigious awards including the ASME/Pi Tau Sigma Gold Medal, has been named one of *Technology Review's* 35 Innovators Under 35, been given the McKinsey Award for the best article in *Harvard Business Review*, and received an NSF CAREER Award, the MIT Harold E. Edgerton Faculty Achievement Award, and the Junior Bose Award.

### **Assistant Professor to Associate Professor without Tenure**

#### ***Mathias Kolle***

Mathias Kolle has been promoted to associate professor without tenure. Kolle has made advances to the field of biological and bio-inspired dynamic optical materials and devices. He has been leading efforts that explore synergies between soft and fluid matter, established novel optical design concepts, and gained insight into nature's light manipulation strategies. He has advanced a technique inspired by the colors of a tropical fruit, *Margaritaria nobilis*, for composing ultra-stretchable polymeric photonic fibers to manipulate light for applications such as bandage strain inspection and human body motion visualization. He has developed a new family of optical systems and functionalities based on bi-phasic droplets. He has also demonstrated a highly promising approach to directly observe the in vivo dynamics of butterfly scale formation and associated optical properties that has the potential to revolutionize our understanding of its formation. Kolle received the Brigham and Women's Hospital Stepping Strong Innovator Award. He is an inspirational teacher and caring mentor. He is also a solid citizen of the department and the MIT community.

#### ***Alberto Rodriguez***

Alberto Rodriguez has been promoted to associate professor without tenure. Rodriguez advances the field of robotic manipulation, a fundamental function of robots interacting with a physical world. Within the broad aspects of robot manipulation, his main contributions and focus have been on frictional interactions involved in grasping, pushing, inserting, and throwing. His work ranges from basic modeling, analysis, and learning of interacting rigid bodies, through mechanical design of grippers and end-effectors to motion planning, sensing and perception, and control design. With the theoretical foundation built on the mechanics of frictional rigid-body mechanics, Rodriguez produced a series of award-winning works on in-hand manipulation, grasping, and model predictive control of rigid-body pushing and data-augmented planar manipulation simulation. With his group, he has won several best paper awards, including First Place Award in stowing at the 2017 Amazon Robotics Challenge, Best Cognitive Paper Award at the 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems, and Best Student Paper Award at the 2018 Robotics: Science and

Systems Conference. He was also recognized with the Best Systems Paper Award in Manipulation in 2018 by Amazon Robotics. Rodriguez is a passionate teacher and excellent mentor.

### **Research Scientist to Principal Research Scientist**

#### ***Michael Benjamin***

Michael Benjamin has been promoted to principal research scientist. Benjamin is a renowned leader in the areas of fast multi-objective optimization for principled decision making, schemes inspired by artificial intelligence, and software for marine vehicle autonomy. He has provided the ocean community with a comprehensive, self-contained software infrastructure for marine autonomy. The software now supports a wide range of robotics missions and has been deployed on many types of marine vehicles in both surface and underwater operations. Another of Benjamin's contributions focuses on surface vehicle autonomy and the development of autonomous maneuvering in accordance with the rules of navigation. The set of behaviors and algorithms that he has developed and implemented are critical for collision avoidance in swarm scenarios and for the autonomous operation of commercial vessels.

Benjamin's contributions in education and service at MIT are also outstanding. He led the development of 2.680 Marine Vehicle Autonomy, Communication, and Sensing. Since the summer of 2016, he has run a summer program in marine autonomy for high-school students. He has been instrumental in establishing the marine robotics testing facility at the MIT Sailing Pavilion, a facility now used by several other groups at MIT. Benjamin has received several awards for his research contributions, including the National Scientist of the Year in 2005 from the Naval Sea Systems Command, the grand prize at the first Annual International Maritime RobotX Competition in 2014, and the Scientific Achievement Award in 2017 from the North Atlantic Treaty Organization's Science and Technology Organization for his paper, "Development and Demonstration of Networked Autonomous Anti-Submarine Warfare."

### **Departmental and School Leadership**

#### ***Graduate Admissions Officer—Domitilla del Vecchio***

In February 2019, Professor Domitilla del Vecchio was named graduate admissions officer, effective to July 2019.

#### ***Faculty Ambassador for Graduate Students—Betar Gallant***

Assistant Professor Betar Gallant assumed the new position of faculty ambassador for graduate students in March 2019. In this role, Gallant will serve as a liaison between the graduate students and faculty.

#### ***Graduate Officer—Nicolas Hadjiconstantinou***

In August 2018, Professor Nicolas Hadjiconstantinou was named the new graduate officer for the department.

#### ***Faculty Ambassador for Undergraduate Students—Douglas Hart***

In August 2018, Professor Douglas Hart was named the new faculty ambassador for undergraduate students in MechE.

### ***Communications and Media Faculty Advisor—Kenneth Kamrin***

Professor Kenneth Kamrin was named faculty advisor for MechE's communication and media team. He will lead and help shape the department's communications strategy alongside Multimedia Specialist John Freidah and Communications Officer Mary Beth Gallagher.

### ***Undergraduate Officer—Maria Yang***

In August 2018, Professor Maria Yang was named the new undergraduate officer for the department.

### **Chairs, Professorships, and New Hires**

#### ***Asegun Henry, Noyce Career Development Professorship***

Associate Professor Asegun Henry joined the department on July 1, 2018. His research focuses on novel energy systems concepts that help to mitigate the effects of climate change, including solar energy, energy storage, and transportation. He has been appointed to the Noyce Career Development Professorship.

#### ***Ashwin Gopinath, Assistant Professor***

Assistant Professor Ashwin Gopinath joined the department in January 2019. His research is on DNA origami and design, up to wafer-scale self-assembly with molecular-scale control, and possibilities for microfabricated devices.

#### ***Sili Deng, Assistant Professor***

Assistant Professor Sili Deng joined the department in January 2019. Deng works in the area of combustion, with a focus on understanding flame dynamics and emissions during combustion processes.

### **Faculty Retirements**

#### ***Professor Henrik Schmidt***

Henrik Schmidt, professor of mechanical and ocean engineering, announced his retirement. An expert in underwater acoustic propagation and signal processing, Schmidt received his PhD from the Technical University of Denmark in 1978 and joined MIT's faculty in 1987. He served as associate director of research at the MIT Sea Grant College Program from 1989 to 2002 and also acted as both associate and acting department head for Ocean Engineering at MIT. Schmidt developed a legacy numerical code for underwater acoustic propagation that is still in widespread use and pioneered the development of underwater acoustic sensing concepts for autonomous underwater vehicles. He also led several Arctic experiments to understand how sound propagates beneath the ice cover. Schmidt is a fellow of the Acoustical Society of America and served on its executive council. In 2005, the Acoustical Society of America awarded Schmidt the Pioneers of Underwater Acoustics Medal.

### **Research Highlights**

MechE's faculty are innovators and problem solvers, always with an eye toward developing technologies that will make the world a better place. Much of the faculty's 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. Snapshots of the varied and diverse research conducted in the department follow.

### **George Barbastathis: Deep-Learning Technique Reveals “Invisible” Objects in the Dark**

Professor George Barbastathis has developed a technique that can reveal “invisible” objects in the dark. The researchers reconstructed transparent objects from images of those objects, taken in almost pitch-black conditions. They did this using a “deep neural network,” a machine-learning technique that involves training a computer to associate certain inputs with specific outputs—in this case, dark, grainy images of transparent objects and the objects themselves. The method could illuminate features of biological tissues in low-exposure images.

### **Tonio Buonassisi: How to Speed Up the Discovery of New Solar Cell Materials**

A streamlined system for creating and analyzing perovskite compounds developed by Professor Tonio Buonassisi may cut development time of new materials for solar cells from 20 years to two, achieving a roughly tenfold improvement in the speed of the synthesis and analysis of new compounds. In the process, the researchers have already discovered two sets of promising new perovskite-inspired materials that are worthy of further study.

### **Betar Gallant: New Battery Gobbles Up Carbon Dioxide**

A new type of battery developed by Assistant Professor Betar Gallant could be made partly from carbon dioxide captured from power plants. Rather than attempting to convert carbon dioxide to specialized chemicals using metal catalysts, which is currently highly challenging, this battery could continuously convert carbon dioxide into a solid mineral carbonate as it discharges.

### **Ming Guo: “Nanofiber Yarn” Makes for Stretchy, Protective Artificial Tissue**



*An artist's interpretation of coiled “nanoyarn” designed by Assistant Professor Ming Guo. Photo credit: Felice Frankel.*

Assistant Professor Ming Guo has developed a tissue-engineering design that may enable flexible range of motion in injured tendons and muscles during healing. Small coils lined with living cells could act as stretchy scaffolds for repairing damaged muscles and tendons. The coils are made from hundreds of thousands of biocompatible nanofibers, tightly twisted into coils resembling miniature nautical rope, or yarn.

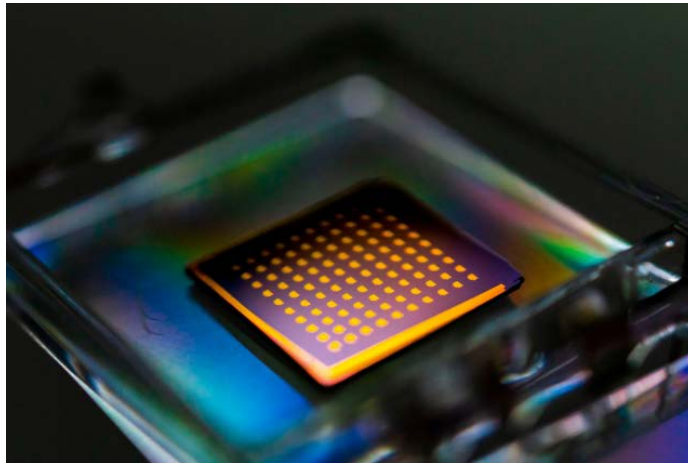
### **A. John Hart and Neville Hogan: Engineers 3-D-Print Flexible Mesh for Ankle and Knee Braces**

Associate Professor A. John Hart and Neville Hogan, Sun Jae Professor in Mechanical Engineering, have designed pliable, 3D-printed mesh materials whose flexibility and toughness can be tuned to emulate and support softer tissues such as muscles and tendons. Hart and Hogan can tailor the intricate structures in each mesh. They envision the tough yet stretchy fabric-like material being used as personalized, wearable supports, including ankle or knee braces, and as implantable devices, such as hernia meshes, that are better matched to a person's body.

### **Asegun Henry: "Sun in a Box" Would Store Renewable Energy for the Grid**

Associate Professor Asegun Henry has developed a system that stores heat generated by excess electricity from solar or wind power in large tanks of white-hot molten silicon, and then converts the light from the glowing metal back into electricity when it is needed. The system could be used to provide electricity on demand around the clock, not just when the sun is shining.

### **Jeehwan Kim: Researchers Quickly Harvest Two-Dimensional Materials, Bringing Them Closer to Commercialization**



*Associate Professor Jeehwan Kim has developed a technique to harvest 2-inch-diameter wafers of 2D material within just a few minutes. Photo credit: Peng Lin.*

Associate Professor Jeehwan Kim has developed an efficient method to harvest 2-inch-diameter wafers of two-dimensional material within just a few minutes. The technique could open up the possibility of commercializing electronic devices made with a variety of two-dimensional materials.

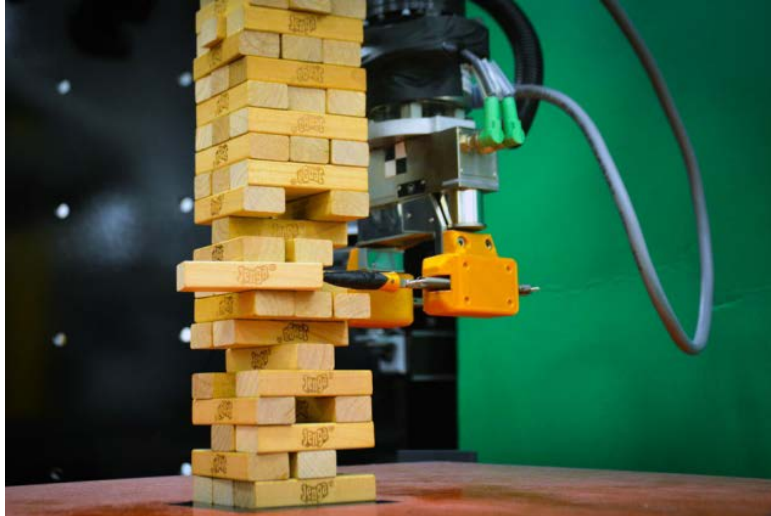
### **Mathias Kolle: Engineers Make Clear Droplets Produce Iridescent Colors**

A team of researchers that includes Associate Professor Mathias Kolle has found that, under the right conditions, ordinary clear water droplets on a transparent surface can produce brilliant colors, without the addition of inks or dyes. The researchers have developed a model that predicts the color a droplet will produce, given specific structural and optical conditions. The model could be used as a design guide to produce, for example, droplet-based litmus tests, or color-changing powders and inks in makeup products.

### **John Lienhard: Turning Desalination Waste Into a Useful Resource**

A new process developed by Professor John Lienhard could turn concentrated brine from desalination waste into useful chemicals—including ones that can make the desalination process itself more efficient. The researchers propose a specific combination of products and chemical processes that could be turned into commercial operations to enhance the economic viability of the desalination process while diminishing its environmental impact.

### **Alberto Rodriguez: MIT Robot Combines Vision and Touch to Learn the Game of Jenga**



*A robot in MIT's MCube Lab learns how to play Jenga. Photo credit: Courtesy of the researchers.*

Using machine learning and sensory hardware, Associate Professor Alberto Rodriguez and members of MIT's MCube lab have developed a robot that is learning how to play the game Jenga®. The robot demonstrates something that has been hard to attain in previous systems: the ability to learn quickly the best way to carry out a task, not just from visual cues but also from tactile, physical interactions. The technology could be used in robots for manufacturing assembly lines.

### **Themistoklis Sapsis: Technique Quickly Identifies Extreme Event Statistics**

A machine-learning model developed by Associate Professor Themistoklis Sapsis provides risk assessment for complex nonlinear systems, including boats and offshore platforms. The technique provides a much faster, more accurate risk assessment for systems that are likely to endure an extreme event at some point during their expected lifetime, by taking into account not only the statistical nature of the phenomenon but also the underlying dynamics.

### **Yang Shao-Horn and Douglas Hart: Extending the Life of Low-Cost, Compact, Lightweight Batteries**

A new design from Professor Yang Shao-Horn and Professor Douglas Hart overcomes the problem of corrosion in aluminum-air batteries by introducing an oil barrier between the aluminum electrode and the electrolyte—the fluid between the two battery electrodes



that eats away at the aluminum when the battery is on standby. The oil is rapidly pumped away and replaced with electrolyte as soon as the battery is used. As a result, the energy loss is cut to just 0.02 percent a month—more than a thousand fold improvement.

### **Kripa Varanasi: New Approach Makes Sprayed Droplets Hit and Stick to Their Targets**

A team of researchers led by Professor Kripa Varanasi has found that using a simple mesh screen may allow farmers to dramatically reduce the amount of pesticides they spray. After deploying the mesh over the crop, pesticides would be broken up by the mesh into fine droplets, greatly increasing their chances of sticking and reducing harmful runoff.

### **Evelyn Wang and Gang Chen: Getting More Heat Out of Sunlight**

A new, perfectly transparent material developed by Professor Evelyn Wang and Professor Gang Chen lets sunlight pass through easily but blocks solar heat from escaping. The key to the process is a new kind of aerogel, a lightweight material that consists mostly of air, with a structure made of silica (which is also used to make glass). The material could be used for home heating or for industrial processes.

### **Xuanhe Zhao and Giovanni Traverso: Ingestible, Expanding Pill Monitors the Stomach for Up to a Month**

Associate Professor Xuanhe Zhao and Assistant Professor Giovanni Traverso have designed an ingestible, Jell-O-like pill that, upon reaching the stomach, quickly swells to the size of a soft, squishy ping-pong ball that is big enough to stay in the stomach for an extended period of time. The device could potentially track ulcers, cancers, and other gastrointestinal conditions over the long term.

## **Start-up and Product Highlights**

MechE faculty, students, and alumni have founded many innovative start-ups and launched a number of game-changing products. An overview of the various start-ups and products that were launched by members of the MechE community and highlighted in *MIT News* over the past year follows.

### **Humon**

[Humon](#), a start-up co-founded by MechE alum Daniel Wiese SM '13, PhD '16, has developed a device that gives athletes real-time data on muscle oxygen levels to guide workouts.

### **Rivian Automotive**

Rivian Automotive, founded by alumnus R. J. Scaringe SM '07, PhD '09, unveiled its first two vehicles, an all-electric pickup truck and an all-electric sport-utility vehicle, at the Los Angeles Auto Show in November 2018.

### **Desktop Metal**

Desktop Metal, a start-up whose co-founders include Professor A. John Hart and Professor Ely Sachs, has developed a 3-D printer that can produce up to 100,000 metal parts at a cost and speed of traditional manufacturing methods.

## Xibus Systems

Xibus Systems has developed a handheld sensor that can indicate the presence of bacterial contaminants in food in seconds. Associate Professor Mathias Kolle, who serves as a technical advisor and collaborator, helped refine the design and serves on the technical advisory team.

## Inkbit

Inkbit, co-founded by MechE alum Davide Marini PhD '03, is overcoming traditional constraints to 3D printing by giving its machines “eyes and brains” — that is, machine vision and artificial intelligence.

## Departmental News

Throughout the year, the department saw change and new developments in a number of areas, from personnel changes to funding. Many were covered by *MIT News*.

“Department of Mechanical Engineering Announces New Leadership Team”: In July 2018, MechE Department Head Evelyn Wang announced that Pierre Lermusiaux will serve as associate department head for operations and Rohit Karnik will be the associate department head for education.

“Meet the Women Shaping Science and Engineering in Saudi Arabia”: The Ibn Khaldun Fellowship for Saudi Arabian Women offers Saudi women with science and engineering PhDs an opportunity to conduct research at MIT and develop their professional skills over the course of one year. In July 2018, current and former fellows convened for the first-ever Ibn Khaldun Fellowship reunion.



*In July 2018, current and former fellows convened for the first-ever Ibn Khaldun Fellowship reunion. Photo credit: Tony Pulsonne.*

“Giving Early-Career Women in Mechanical Engineering the Tools to Succeed in Academia”: In October 2018 the department hosted the first-ever Rising Stars in Mechanical Engineering Workshop, which aimed to prepare 34 participants for the challenges associated with a career in academia.

“MIT Receives \$30 Million to Help Address Energy Challenges in Egypt”: An award from the US Agency for International Development will support research collaborations through the new Center of Excellence in Energy in Cairo, Egypt. The center will be led by Ahmed Ghoniem, the Ronald C. Crane Professor in MIT’s Department of Mechanical Engineering, and Daniel Frey, a professor of mechanical engineering and the faculty research director for MIT’s D-Lab.

“Projects Advance Naval Ship Design and Capabilities”: At the 20th annual MIT Ship Design and Technology Symposium in May 2019, naval construction and engineering students presented their work on real-life naval design projects.

### Event Highlights

MechE hosts a number of seminal events throughout the year. Below are highlights from some of the larger, higher-profile events throughout academic year 2019.

#### ***Mechanical Engineering Research Exhibition—September 28, 2018***



*Graduate student Daniel Gonzalez demonstrates his extra robotic legs system at the Mechanical Engineering Research Exhibition. Photo credit: Tony Pulsoni.*

In its fifth year, the Mechanical Engineering Research Exhibition, which is hosted by the Department of Mechanical Engineering and the Graduate Association of Mechanical Engineers, gives mechanical engineering graduate students, Undergraduate Research Opportunities Program participants, and postdoctoral associates a chance to present their work to alumni, faculty, and fellow students.

#### ***Product Engineering Processes Final Class Presentations—December 9, 2018***

Students in subject 2.009 Product Engineering Processes spent a semester developing and designing a product prototype centered around this year’s theme: “Danger!” In different ways, two of this year’s inventions addressed the problem of people falling or being swept overboard from a boat at sea—one by facilitating immediate rescue and the other by extending the survival time for someone floating in frigid water.

The Product Engineering Processes final presentation has become a seminal event each year at MIT. For the past 23 years, Professor David Wallace has been at the helm of the class, which serves as a capstone for seniors. He leads a triple-digit team of dedicated teaching assistants, course instructors, and support staff to ensure students leave this class with an understanding of how products are created and launched.

### ***Assistive Technologies Hackathon—March 2, 2019***

The sixth annual Assistive Technologies Hackathon paired students with client co-designers to create innovative solutions to the everyday problems they face.

### ***2.007 Final Robot Competition—May 9, 2019***

Over four often nail-biting hours, 32 student finalists in 2.007 Design and Manufacturing I, winnowed from a roster of 165, competed head to machined head in the course’s annual robot competition, held in the ice rink at MIT’s Johnson Athletic Center. This year’s theme, “Moonshot,” was an homage to the Apollo 11 moon landing, made 50 years ago in 1969.

## **Education Highlights**

The department’s undergraduate (Table 1) and graduate (Table 2) enrollment figures have been relatively consistent over the years.

**Table 1. Undergraduate Enrollment, AY2014–AY2018**

	AY2014	AY2015	AY2016	AY2017	AY2018
Sophomores course 2	87	85	88	66	71
Sophomores course 2-A	86	85	99	103	94
Sophomores course 2-OE	4	7	1	2	2
<b>Sophomores subtotal</b>	<b>177</b>	<b>177</b>	<b>188</b>	<b>171</b>	<b>167</b>
Juniors course 2	94	89	83	97	70
Juniors course 2-A	102	102	92	90	69
Juniors course 2-OE	4	3	3	2	3
<b>Juniors subtotal</b>	<b>200</b>	<b>194</b>	<b>178</b>	<b>189</b>	<b>142</b>
Seniors course 2	73	92	81	78	93
Seniors course 2-A	66	104	89	94	83
Seniors course 2-OE	8	5	6	3	3
<b>Seniors subtotal</b>	<b>147</b>	<b>201</b>	<b>176</b>	<b>175</b>	<b>179</b>
5th-year students course 2	11	4	3	8	6
5th-year students course 2-A	12	7	7	8	4
5th-year students course 2-OE	1	3	0	0	0
<b>5th-year students subtotal</b>	<b>24</b>	<b>14</b>	<b>10</b>	<b>16</b>	<b>10</b>
<b>Total</b>	<b>548</b>	<b>586</b>	<b>552</b>	<b>551</b>	<b>498</b>

**Table 2: Graduate Enrollment, AY2014–AY2018**

Degree	AY2014	AY2015	AY2016	AY2017	AY2018
Master's	230	193	213	221	190
Doctoral	310	312	309	302	294
Master's of Engineering	18	12	15	11	9
Mechanical Engineering	0	0	0	1	0
Naval Engineering	33	34	30	28	31
<b>Total</b>	<b>591</b>	<b>551</b>	<b>567</b>	<b>564</b>	<b>524</b>

## Honors and Recognition

The department, its faculty, and its students are all recognized for their accomplishments through a number of awards and honors each year. A small sampling of the recognition the department and its faculty and students received this year follows.

### Rankings

- No. 1 in 2020 *US News & World Report* Rankings. In its annual university rankings, *US News & World Report* named MIT's Department of Mechanical Engineering the number one graduate program in mechanical engineering for 2020, tied with Stanford University.
- No. 1 in 2020 QS University Subject Rankings. In its annual rankings for 2019, QS World University Rankings rated MIT's Department of Mechanical Engineering the number one mechanical engineering program in the world.

### Faculty Awards

#### *Gang Chen*

##### **Web of Science 2018 Highly Cited Researcher**

Professor Gang Chen was named a Web of Science 2018 Highly Cited Researcher.

##### **Frank Krieth Energy Award**

ASME presented Chen with the 2019 Frank Kreith Energy Award, which was established to honor an individual for significant contributions to a secure energy future with particular emphasis on innovations in conservation or renewable energy.

#### *Martin Culpepper*

##### **Class of 1960 Fellow**

Professor Martin Culpepper was named Class of 1960 Fellow for his distinguished leadership in upgrading campus makerspaces and fostering maker communities at MIT.

#### *Domitilla del Vecchio*

##### **NSF Understanding the Rules of Life Award**

The National Science Foundation awarded Professor Domitilla Del Vecchio one of the first Understanding the Rules of Life awards for her research on the principles of modular organization in resource-limited biological circuits

***Betar Gallant*****ARO Young Investigator Program**

Assistant Professor Betar Gallant received an award from the Army Research Office Young Investigator Program for her work investigating activation and catalysis of high-energy reduction–oxidation molecules at electrodes for advanced electrochemical power systems.

***Linda Griffith*****National Academy of Inventors Fellow**

Professor Linda Griffith was named a 2018 fellow of the National Academy of Inventors. Griffith co-invented a 3D printing process for the creation of complex biomaterial scaffolds.

***Asegun Henry*****ASME Bergles-Rohsenow Young Investigator Award in Heat Transfer**

ASME awarded Associate Professor Asegun Henry with the Bergles-Rohsenow Young Investigator Award in Heat Transfer, given to a young engineer (less than 36 years old) who has demonstrated the potential to make significant contributions to the field of heat transfer.

***John Heywood*****Lloyd L. Withrow Distinguished Speaker Award**

Professor John Heywood received the Lloyd L. Withrow Distinguished Speaker Award at the Society of Automotive Engineers Congress and Exposition in Detroit in April 2019. The award recognizes those who have demonstrated outstanding presentation skills at Society of Automotive Engineers technical sessions.

***Anette “Peko” Hosoi*****American Physical Society Stanley Corrsin Award**

Processor Anette “Peko” Hosoi was honored with the American Physical Society’s Stanley Corrsin Award for her creative analysis of locomotion, contributions to the development of soft robotics, and her ability to combine mathematical analysis with physical insights.

***Jeehwan Kim*****Defense Advanced Research Projects Agency Young Faculty Award, 2019**

Associate Professor Jeehwan Kim Jeehwan Kim was selected for the Defense Advanced Research Projects Agency Young Faculty Award Program.

***Sangbae Kim*****Defense Science Study Group**

Associate Professor Sangbae Kim has been named a member of the 2020–2021 class of the Defense Science Study Group. The prestigious group introduces outstanding science and engineering professors to security challenges faced by the US and encourages them to apply their talents to these issues.

***Mathias Kolle*****The Stepping Strong Innovator Awards**

Associate Professor Mathias Kolle was awarded the Stepping Strong Innovator Award by Brigham and Women's Hospital for his research on revealing optimal pressure in compression therapy using color-changing fibers.

***John Lienhard*****American Association for the Advancement of Science Fellow**

Professor John Lienhard has been named a fellow of the American Association for the Advancement of Science. He was honored for his distinguished contributions to thermal science and engineering, particularly for developing energy-efficient desalination technologies.

**ASME Edward F. Obert Award**

ASME has given Lienhard the Edward F. Obert Award in recognition of an outstanding paper on thermodynamics. Lienhard was honored for "Entropy Generation Minimization for Energy-Efficient Desalination."

***Gareth McKinley*****National Academy of Engineering Election**

Professor Gareth McKinley was elected to the National Academy of Engineering for contributions in rheology, understanding of complex fluid dynamical instabilities, and interfacial engineering of super-repellent textured surfaces.

**Fellow of the Royal Society**

In April 2019, McKinley was elected as a fellow of the Royal Society.

***Ellen Roche*****NSF CAREER Award**

Assistant Professor Ellen Roche won an [NSF CAREER Award](#) for her project, "Hybrid Biorobotic Matrices to Simulate Diaphragmatic and Myocardial Biomechanics."

***Yang Shao-Horn*****Web of Science 2018 Highly Cited Researcher**

Professor Yang Shao-Horn was named a Web of Science 2018 Highly Cited Researcher.

***Alexandra Techet*****ASME Fellow**

Professor Alexandra Techet was named a fellow of the American Society of Mechanical Engineers.

***Kripa Varanasi*****MassChallenge Award**

Infinite Cooling, a start-up from the Varanasi Research Group that captures and reuses water vapor from power plants, was one of two local start-ups to be named a \$100K Diamond Winner at the MassChallenge Awards.

***Xuanhe Zhao*****Materials Today Rising Star Award**

Associate Professor Xuanhe Zhao received a Materials Today Rising Star Award, given to early-career researchers in materials science and engineering who have demonstrated themselves to be exceptionally capable researchers with the potential to become future leaders in the field.

**Web of Science 2018 Highly Cited Researcher**

Zhao was named a Web of Science 2018 Highly Cited Researcher.

**Student Awards*****Rhodes Scholar***

Sarah Tress, a senior studying mechanical engineering, has been named a Rhodes Scholar. She will commence graduate studies at Oxford University in fall 2019.

***Marshall Scholar***

Crystal Winston, a senior in mechanical engineering, was named a Marshall Scholar. She will embark on a PhD in aerospace materials and structures to further develop her skills in redesigning transportation systems.

***Fulbright Fellows***

MechE seniors Alexis D'Alessandro and Hope Chen have been named 2019 Fulbright Scholars. As a Fulbright Fellow, Hope Chen will go to Taiwan as an English teaching assistant. Alexis D'Alessandro will develop an educational program and chemical sensing tool to promote water safety in Brazil.

***MIT's Clean Energy Prize***

Aeroshield, a project developed by a team led by graduate student Elise Strobach, won the grand prize of \$100,000 at the MIT Clean Energy Prize competition. Her team has developed a new transparent, lightweight material to be sandwiched between glass panes. This produces a window that is 50% more insulating than conventional double-pane windows, lasts five to 10 years longer than conventional windows, and can be manufactured at low cost.

***J-WAFS Fellows for Water Solutions***

Doctoral students Krithika Ramchander and Andrea Beck were awarded fellowships for the 2019 academic year to pursue water resource solutions. Doctoral students Sahil Shah and Peter Godart have been awarded fellowships for the 2020 academic year to pursue water resource solutions.

***Forbes 30 Under 30***

MechE graduate students Scott Tan SM '18 and Hyunwoo Yuk SM '16 were named to the 2019 *Forbes* list, "30 Under 30," in the science category.



***Simons Foundation Postdoctoral Fellowships in Marine Microbial Ecology***

Four current and former MIT-Woods Hole Oceanographic Institution Joint Program students have been awarded Simons Foundation Postdoctoral Fellowships in Marine Microbial Ecology. They include B. B. Cael, Matti Gralka, and Bennett Lambert.

***Facebook Emerging Scholar Awards Program***

PhD Candidate Maria Bauza is the recipient of a Facebook Emerging Scholar Award. The program is designed to support talented students from traditionally underrepresented groups in the technology sector.

***2019 Spring Material Research Society Graduate Student Award—Gold***

Graduate student Hyunwoo Yuk was awarded Gold in the 2019 spring Material Research Society Graduate Student Awards at the society's meeting.

***First Place, 2019 Patagonia Case Competition***

A team of MIT students, including MechE graduate student Jordan Landis, worked on cost-effective and timely biodegradation of apparel polybags and everyday food packaging. The team won first place in 2019 Patagonia Case Competition.

***Martin Family Society of Fellows for Sustainability***

PhD candidate Yvana Ahdab was selected as a member of the Martin Family Society of Fellows for Sustainability. She works on monovalent selective electro dialysis with Professor John Lienhard.

Graduate student Peter Godart was selected as a member of the Martin Family Society of Fellows for Sustainability. His research with Professor Douglas Hart focuses on using recycled aluminum to power both desalination and electricity generation.

***Ho-Ching and Han-Ching Fund Award***

Graduate student Leixin Ma has received the Ho-Ching and Han-Ching Fund Award. She studies the fundamentals and applications of a variety of fluid structure interaction problems.

***Design of Medical Devices Grand Prize in Student Showcase***

Graduate students Sarah Southerland and Steven Burcat won the grand prize in the Student Showcase at the Design of Medical Devices conference for a prototype endoscopic delivery tool for pectin-based soft tissue patches. Along with fellow students Yiling Fan and Valerie Peng, they developed the tool in subject 2.75 Medical Device Design.

***Google Cloud Academic All-America At-Large Honoree***

Rising senior Bouke Edskes and recent graduate Brandon McKenzie from the swimming and diving team have been named Google Cloud Academic All-America At-Large Honorees.

## Phi Beta Kappa

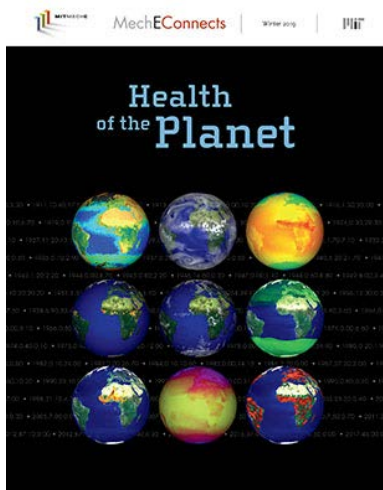
The following undergraduate students were voted into Phi Beta Kappa, the nation's oldest honor society: Fidel Cano-Renteria, Riley Davis, Kyung-Eun Han, Ryan Koeppen, Liliann Mueller, Sarah Tress, Daniel Weiss, and Crystal Winston.

## Communications

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

## MechE Connects

This year's issues of MechE Connects, the biannual newsletter for the Department of Mechanical Engineering, focused on the ways in which the department's faculty, students, and alumni are contributing to solving some of the biggest challenges the world faces.



*The Winter 2019 issue of MechE Connects had the theme "Health of the Planet."*

The **Winter 2019** issue centered around one of our grand challenges—the health of the planet. From minimizing greenhouse gas emissions to protecting our oceans and developing sustainable agricultural practices, the members of our community who are featured in this issue are committed to finding solutions that make our world a better place. Using their diverse expertise, these MechE faculty, students, and alumni are developing technologies that aim to solve problems such as climate change, resource depletion, access to food, and the destruction of ecosystems.



*The Summer 2019 issue of MechE Connects had the theme "Designing the Future of Manufacturing."*

The Summer 2019 issue also focused on one of our grand challenges—design and manufacturing innovation. In the issue, we explore new technologies our faculty, students, and alumni are using to innovate in the realm of design and manufacturing. In particular, we explore how advances in manufacturing have revolutionized the design process and unlocked new possibilities in terms of the materials we use and the scale at which we can produce products.

## MIT News Stories

Throughout the year, 25 articles originating in MechE, written by Communications Officer Mary Beth Gallagher, were published by *MIT News*. Five of these were the Spotlight of the Day on MIT's main website. A number of these Spotlights had a corresponding video produced by John Freidah. Stories included:

**Table 3. MIT News Coverage of Stories from the Department in AY2019**

Date	Title
July 23, 2018	Featured Video: Pulling Drinking Water Out of Thin Air
July 27, 2018	Department of Mechanical Engineering Announces New Leadership Team
August 5, 2018	Meet the Women Shaping Science and Engineering in Saudi Arabia
August 30, 2018	Shih-Ying Lee, Long-time Mechanical Engineering Professor, Inventor, and Entrepreneur, Dies At 100
September 7, 2018	Yo-yo Champion Pursues His Passions at MIT
September 21, 2018	George Hatsopoulos, Senior Lecturer Emeritus and MIT Corporation Life Member Emeritus, Dies at 91
October 5, 2018	Showcasing Solutions for Land, Sea, Space—and Everywhere in Between
November 2, 2018	Giving Early-Career Women in Mechanical Engineering the Tools to Succeed in Academia
November 26, 2018	Ernst Frankel, Shipping Expert and Professor Emeritus of Ocean Engineering, Dies at 95
November 27, 2018	Toy-making Offers Seriously Fun Introduction to Engineering
December 4, 2018	Blending Medicine and Mechanical Engineering
December 7, 2018	Alumni Team Tops Collegiate Inventors Competition
December 20, 2018	Improving Crop Yields While Conserving Resources
December 27, 2018	Exploring New England's Coastal Ecosystems in the Dead of Winter
January 7, 2019	Tackling Greenhouse Gases
January 24, 2019	Richard "Dick" Lyon, Acoustics Expert and Professor Emeritus of Mechanical Engineering, Dies at 89
February 13, 2019	Finding Love in the Lab
April 3, 2019	Professor Emeritus T. Francis Ogilvie, Former Ocean Engineering Department Head, Dies at 89
May 5, 2019	Scaling Solutions for the Developing World
May 8, 2019	Professor Emeritus David Gordon Wilson, Expert in Human-Powered Transport and Gas Turbines, Dies at 91
May 13, 2019	Where Design Meets Assembly for Three MIT Alumnae at Microsoft
May 16, 2019	A New Era in 3-D Printing
June 4, 2019	Q&A: David Hardt on Teaching the Principles of Manufacturing
June 10, 2019	Solving Equations to Design Safer Ships
June 25, 2019	Projects Advance Naval Ship Design and Capabilities

## MechE Videos

Video production continues to be a priority for MechE's communication team. This year, the department released five videos on its YouTube channel. These videos were produced by Senior Producer and Creative Lead John Freidah.

**Table 4. YouTube Videos Produced in AY2019**

Title	Category	YouTube Views
MIT Device Pulls Clean Water Out of Thin Air	Research	9,492
MIT Student and Reigning National Yo-Yo Champion	Student profile	19,167
Serious Fun at MIT	Class profile	4,983
MIT Robot Learns How to Play Jenga	Research	138,945
MIT D-Lab Students Design for the Developing World	Class profile	3,704
<b>Total</b>		<b>176,291</b>

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

## Social Media

MechE's social audience continued to grow throughout academic year 2019. Channel-specific strategies were employed to ensure that key demographics were targeted on the channel they most often use. The most dramatic increase in followers and engagement was on Instagram and LinkedIn.

**Table 5. Social Media Channels and Followers, AY2019**

Social media channels	Followers as of July 1, 2018	Followers as of June 30, 2019	Percent increase
Facebook	31,908	34,841	9%
Twitter	5,247	6,956	33%
Instagram	2,427	7,950	228%
LinkedIn	427	3,495	719%

## 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 2,145,481 page views by 346,408 users in academic year 2019.

## Space Renovations

### Completed Construction

#### ***Associate Professor Asegun Henry's Laboratory***

This work changed an existing dry laboratory into a wet laboratory for Asegun Henry. This was a challenging renovation because of the lab needs. Researchers required a large amount of power that had to be brought from the other side of the building, and a labsink that drains to the waste water treatment system on the first floor. Henry studies heat transfer by using large furnaces, which have to be cooled with chilled water and a backup chiller system. Piping needed to run the length of the laboratory for both systems.

#### ***Associate Professor Jeehwan Kim's Laboratory***

This project created a dry laboratory with multiple nonflammable gases for Jeehwan Kim. Kim also has access to the shared chemical fume hoods and laboratory sink in Room 31-398.

### Construction in the Planning Stage

#### ***Newman Laboratory Renovation***

The Newman Laboratory renovation is currently in the design stage. The renovated space will accommodate Professor Neville Hogan, Professor Ian Hunter, and Associate Professor Sangbae Kim, who will all have space here. This lab will combine robotics with chemistry, biology, and electronics. The plan is to remove the existing non-code-compliant mezzanines and replace them with one large new one that meets all Massachusetts building codes. A glass window will be added to the hallway to showcase the laboratory's work. Because of this project's size and complexity, there will be renovations throughout the building, including fire alarm and sprinkler upgrades and improvements to provisions for compliance with the Americans with Disabilities Act.

#### ***Laboratory for Assistant Professor Ashwin Gopinath and Assistant Professor Giovanni Traverso***

Shared laboratory space for Ashwin Gopinath and Giovanni Traverso will be built. The lab will be brought up to biosafety level 2 status to permit researchers to work with human tissue. Upgrades will include biosafety cabinets for each professor.

#### ***Laboratory for Assistant Professor Giovanni Traverso***

Extensive renovation of Giovanni Traverso's laboratory is required. Some upgrades include new power lines, a chemical fume hood, and exhaust ductwork from the laboratory, which is in the basement, through the building to the roof. This lab will have biosafety level 2 status.

#### ***Lab for Assistant Professor Sili Deng***

A laboratory for Sili Deng will be built. Deng works with flammable gases to study nano particles; the laboratory will require a chemical fume hood, other specialty exhaust systems, and a sink. Due to code restrictions for flammable gases, the gases will be stored in Room 31-167A and brought via stainless welded pipe through the hallway to the lab.

### ***Student Seating Area***

A student seating area will be made out of an existing dry laboratory in Room 31-370. When the department was looking for space for new principal investigators, it was discovered that most utilities were too far away from this lab, and that to bring them in would be very costly. It was decided instead that this area will serve the department better as 16 seats for students in Associate Professor Amos Winter's laboratory.

### **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 the department does. As educators, its faculty members 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, MechE will continue to develop new educational initiatives and models that will better prepare mechanical engineers of the 21st century.

Our students benefit from the diverse expertise of our faculty, many of whom are recognized as global leaders in their areas of study. We have a unique opportunity as a department to address the grand challenges our society faces.

In academic year 2020, the department will continue to focus on developing mechanisms and initiatives that support our educational mission and the collaborations needed to increase our global impact. These will include the launch of the MechE Education Strategy Committee—which will advise departmental leadership on strategic matters regarding the educational mission—and the MechE Research Strategy Committee—which will advise departmental leadership on research matters regarding the research mission. MechE will also deploy seed funding in grand challenge areas in the hope that the MechE community can further advance MIT's mission of making a better world.

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