Civil and Environmental Engineering

In the Department of Civil and Environmental Engineering (CEE), we use innovative science and engineering to maintain a strong focus on fundamental issues related to infrastructure and the environment. CEE strives to create a better world by conducting research and providing education on delivering sustainable solutions to large-scale societal problems in materials, infrastructure systems and networks, climate, food security, water, and the environment; simply put, we focus on the knowledge needed to achieve sustainable solutions that benefit society from the nano to the global scale. We work in and out of the classroom every day in order to expose our students to small-scale change that produces large-scale global impacts. We strive to create an inclusive and diverse community that provides the resources necessary for success. We appreciate and welcome people who come from various backgrounds and cultures and have diverse ideas.

The department continued to grow during academic year 2021 (AY2021), with notable advancements in research, enriched educational programs and subjects, and local, regional, and global gains in recognition. Through new faculty hires, we continue to enhance our leadership in the fields of structural and environmental engineering. Our new faculty complement our current faculty roster with the intradisciplinary experiences and skills necessary to redefine and challenge the integrated boundaries of civil and environmental engineering in the 21st century.

Our students seek to rework traditional problems and discover unconventional solutions that include new approaches to and insights on existing challenges. Whether students are in the classroom, out in the field, or in the labs, they are at the core of the department's initiatives. Through innovating from the nano to the global scale, our students are always focusing on improving human lives and conditions, anywhere in the world. We believe that the department's research and education will influence lives today and in the decades to come and that these opportunities and teachings will live on through the efforts of our alumni.

In AY2021, despite being remote due to Covid-19, we made efforts to continue outreach and interactions with the MIT undergraduate student population. These efforts included increased outreach to potential students through virtual events, posters, email campaigns, student and faculty panels, and other initiatives such as the student spotlights on the CEE website and social media channels.

CEE is motivated to understand and solve the biggest engineering and scientific challenges facing society. We are exploring how environment, infrastructure, and cyber and human systems can viably work together to benefit society and the planet. Our vision is to create bold solutions for sustainability across scales. We recently launched our new department website to reflect this vision, and we have engaged in continuous efforts to make the content accessible and appealing to all members of the community using the lessons learned and recommendations from the 360-degree audit of the CEE communications strategy in 2019–2020. A new communications officer was hired in March 2021 to further guide the department through strategic branding and communication decisions.

CEE researchers have contributed to groundbreaking methods and are actively designing impressively strong materials, often inspired by nature. These materials will forever alter the landscape of civilizations, creating more sustainability and eco-friendliness.

Due to the Covid-19 pandemic, CEE was not able to travel for our annual offering of Materials in Art, Archaeology and Architecture (ONE-MA^3) and Traveling Research Environmental Experience (TREX). Over the summer, Professor Admir Masic did offer five virtual Undergraduate Research Opportunities Program (UROP) opportunities in topics ranging from engineering, science, and modern technologies to exploring how we can harness the remarkable properties associated with light scattering of the Egyptian blue pigment in the design of modern material solutions and how the self-healing properties of ancient Roman concrete can translate into modern cement solutions. We are looking forward to traveling again for these valuable hands-on learning experiences in the coming academic year.

Our cross-disciplinary research culture also links seemingly dissimilar projects, such as Professor Benedetto Marelli's application of silk fibers to preserve fresh fruit and other research focusing on optimal mechanical devices to effectively coat the fruit. A community working across boundaries toward broad-scale solutions has been a successful way to continue innovating and keeping up with society's immediate and emerging needs.

Realizing a broadly empowered vision for the civil and environmental engineering profession continues to require extraordinary efforts. As educators, our role requires that we anticipate these shifts to improve and provide students more holistic and in-depth learning experiences so they have a well-rounded and solid foundation. This commitment is reflected in the core mission of the department to educate at all levels, from undergraduate to postdoctoral.

The forward-thinking and constantly evolving Course 1 undergraduate program, established in 2014, integrates civil, environmental, and systems engineering into a single program. The program features increased flexibility, allowing students to fulfill Institute and departmental requirements while encouraging personalization of tracks that best match career and research interests.

In AY2021, the Undergraduate Education Committee (UEC) engaged in an effort to provide a comprehensive review of the undergraduate program to consolidate and streamline the educational offerings. Specifically, the committee made headway in reviewing the general departmental requirements, which are a set of five foundational courses common to all tracks in 1-ENG. UEC formed small subcommittees—composed of faculty instructors, UEC members, and peer faculty—to review and make recommendations for each CEE-led subject.

The Academic Programs Office (APO) collaborated with the Undergraduate Education Committee, the CEE Student Association (CEESA), and CEE Communications to promote and publicize the 1-ENG undergraduate program through countless channels including posters and email campaigns, student highlights, career- oriented

brochures, social media campaigns, photo and video projects, and department events. The department continues to provide the three minors introduced in fall 2016: civil engineering, environmental engineering science, and civil and environmental systems.

In AY202,1 the Graduate Education Committee worked to support our graduate programs in a time of Covid, as well as reviewing the core graduate offerings and developing new MEng offerings that are more in line with faculty interests and department priorities. CEE graduate students continued to engage in conferences and research presentations despite pandemic restrictions and also successfully competed for a number of graduate student MIT fellowships. The department continues to build on the success of the graduate student professional development seminar, and a new and robust mentoring practice has been put in place for graduate students in the department.

Goals, Objectives, Priorities

The Civil and Environmental Engineering Department has made great strides this past year toward realizing the full potential of a more integrated and enhanced undergraduate educational program. It is experiencing a transformation similar to the major disruptions of the 1960s and 1980s when the introduction of computation, and then environmental science, genomics and microbiology, influenced its direction. However, now the influences are around climate change, sustainability, food and water security, and building resilient systems.

Our students continue to change the world. From alumni entrepreneurs desalinating ocean waters to engineers designing more resilient, sustainable, and energy-efficient cities, MIT is redefining what it means to work in this increasingly comprehensive field. Other institutions may continue to teach practitioners while we prepare new generations of global thinkers and doers. Working together across disciplines and educational and experience levels, our students, faculty, and researchers address the many questions and challenges civilization faces today.

As engineers, we continue to build, but our direction is now better informed by discovery and innovation at small nano levels. Data characterization, modeling, and analysis also have lent new insights to our work, allowing design experimentation to be accomplished in hours compared to what would have previously taken days, weeks, or months. New tools and instruments, such as high-powered Raman spectroscopy, along with renovated and newly created lab spaces increase our capacities. Collaboration with other scientific and engineering disciplines brings its own rich set of rewards, allowing many types of new research paradigms and relationships.

CEE's five strategic objectives remain the same as we continue our important work and build upon past accomplishments. This report articulates our advancements during the AY2021 with respect to each objective.

- Objective 1: renew, develop, and implement inspiring educational programs
- Objective 2: maintain success within the administration, facilities, and community

- Objective 3: focus on the future of CEE with accelerated faculty hiring and junior faculty development
- Objective 4: show leadership at MIT and beyond through an outward focus
- Objective 5: enhance alumni engagement and resource development

Objective 1

Over the past academic year, 179 students were enrolled in CEE (43 undergraduates and 136 graduate students/doctoral candidates). CEE awarded 13 PhD, 17 SM, 8 MST, and 10 MEng degrees in the graduate program and 19 SB degrees in the undergraduate program. Of the 13 PhD graduates, approximately one third are proceeding to careers in academia.

Undergraduate Programs

The 2021 academic year saw the seventh full-year cohort of students in the department's 1-ENG bachelor of science degree program. The refined undergraduate program, which is accredited by the Accreditation Board for Engineering and Technology, is a comprehensive curriculum that better prepares graduates for their professional lives while emphasizing a strong foundation in math, computation, probability and statistics, data analysis, and design.

The Undergraduate Education Committee, led by Professor Ruben Juanes and composed of faculty from each CEE core (environment, mechanics and materials, and systems), made significant strides in AY2021, refining the undergraduate curriculum through careful review of the CEE general departmental requirements.

The capstone subject (1.013 Senior Civil and Environmental Engineering Design) ran for the full academic year for the first time under Assistant Professor Josephine Carstensen in AY2021. Examples of projects offered in the updated course included mobility in the bay area in response to Covid-19 (supervised by Professor Saurabh Amin), tracking and analyzing the illegal logging of ramin trees in Southeast Asia (supervised by Professor Charles Harvey), and mass timber construction (supervised by Professor Carstensen). These projects and others allowed students to work individually or in small teams in an area of interest related to their 1-ENG core. This new format of the capstone class allows for more systematic scheduling of student work (both team and individual) and is providing a better overall experience to our senior students.

The undergraduate officer also continued the engagement of CEE in the Institute-wide New Engineering Education Transformation (NEET) initiative. CEE's faculty developed NEET tracks that aim to recruit new students to the department through project-centered learning. In AY2021, NEET merged the renewable energy and advanced materials threads into a single climate and sustainability thread in which CEE has continued to engage.

The 1-ENG program prepares students for today's jobs as well as emerging new positions such as chief resilience officer, 3D infrastructure engineer, urban agriculturist, and global system architect. Class discussions in 1.007 Big Engineering: Small Solutions

with a Large Impact showed that students studying civil engineering leaned toward careers in innovating structures, architectural design, material testing, promoting net zero energy buildings, sustainable infrastructure, and geo-technology. Environmental engineering students expressed interest in exploring bio-remediation, atmospheric modeling, hydrology modeling, pollution control, enhancing food security, and mitigating climate changes. Finally, systems engineering cohorts gravitated toward applications in biological networks, traffic and transportation engineering, carbon sequestration, city planning, and mitigating infectious diseases.

To provide students with more accessible opportunities to advance their careers, the department grew its internship program that utilizes connections with CEE alumni in industry to offer high-level internships for students. The Academic Programs Office also works to maintain an alumni mentor network to connect current students with meaningful mentorship experiences. In the 2021 academic year, APO was able to leverage the virtual Zoom platforms to connect with many more companies and hosted roughly 20 company information sessions for both undergraduate and graduate students. Two students received full-time job offers as a result of these sessions, and several internship opportunities were provided.

In fall 2020, with the guidance of then department head Markus Buehler, the department hosted the third annual Young Alumni Panel, bringing recent graduates to the campus to connect CEE undergraduates to the great professions they can pursue upon completion of a civil and environmental engineering undergraduate degree. The event was hosted virtually with students from Boeing and AECOM.

The CEE Student Association's new leadership continued to work constructively with APO and the department's leadership. The CEESA president meets regularly during the academic year with the Academic Programs Office to discuss upcoming events, provide feedback on the undergraduate curriculum and printed materials, and serve as a voice for the undergraduate student body.

CEESA hosted virtual events throughout the year, including game nights and study breaks. The association also continued to organize monthly faculty luncheons at which undergraduate students were invited to have lunch with a CEE faculty member. The lunches, even while virtual, serve as a great way for students to get to know the faculty on a more personal level and gain exposure to areas of research they may not have otherwise considered.

Building on the success of last year's unique mini-UROP, the department again hosted an innovative and robust virtual program during the 2021 Individual Activities Period (IAP). In the program, spearheaded by Course 1 graduate students, graduate students and postdocs are paired individually with first-year students, and the mini-UROP students work at least 30 hours per week in direct research over IAP. Research topics ranged from machine learning to air quality during the pandemic.

As the program has grown, the organizers have realized that there are opportunities to extend program benefits to include not only course credits but also community building.

New projects have been added to build the students' hard science and engineering skills, and other activities are now included to develop soft skills such as collaboration and networking and help improve students' mentoring skills.

The department is offering three undergraduate minors (civil and environmental systems, environmental engineering science, civil engineering) that debuted in fall 2016. The minors are intended to attract MIT students who are majoring in disciplines outside civil and environmental engineering but want to enhance their career path with complementary knowledge and experience. CEE also endorsed and participates in the environment and sustainability minor offered by the MIT Environmental Solutions Initiative.

Graduate Programs

CEE's graduate education programs also saw changes, improvements, and several new activities over the past year. The Graduate Education Committee worked on graduate education program refinement and improvement and reviewed new MEng program proposals. Due to the Covid-19 pandemic, the committee elected to waive the Graduate Record Examination requirement for the 2020–2021 admissions cycle. The committee also heard from faculty in different cores with respect to refining general exam offerings in an effort to improve the process for students. In addition, a new Institute-wide transitional support program process for students seeking support in changing advisors was initiated and is being implemented alongside the previously developed department bridge funding policy.

During this pandemic year, CEE was able to maintain support for virtual conference attendance by funding 20 students to present their research at conferences such as those of the American Association for Aerosol Research, the American Chemical Society, the Ecological Society of America, and the Materials Research Society.

Professor Heidi Nepf, CEE's previous graduate officer, ran a six-unit professional development seminar for second-year graduate students. One of the first at the Institute, the seminar builds on first-year successes with continued engagement with campus partners through the Career Advising and Professional Development Office; the Office of Graduate Education; the Writing, Rhetoric, and Professional Communication Office; and the newly formed CEE Communication Lab. The subject also prepares students for the general exam process and fulfills the breadth requirement for degree completion. In conjunction with the seminar (and virtual in 2020), the second annual graduate student alumni panel was organized, hosting young alumni from New York University, Colby College, Exponent, and the local startup Massachusetts Materials Technology.

In 2020–2021, the Graduate Education Committee and graduate officer Colette Heald piloted an annual review process for graduate students related to the spring term 1.THG grade. The annual review is an opportunity for advisors to provide formal feedback (both positive and negative) on student performance and progress toward graduation and for students to discuss their professional development goals and provide positive and negative feedback on their mentoring needs. The pilot proved beneficial for both graduate students and faculty and will be continued in the future.

The department continued its commitment to supporting graduate students and doctoral candidates during this challenging Covid-19 virtual year. Our graduate committee, along with other graduate students in the CEE community and CEE faculty and staff, worked closely together during this past year to offer socially distanced, in-person welcome lunches for new students in the fall; virtual game nights throughout the year; and a graduate student town hall.

Postdoctoral Program

CEE's postdoctoral committee has continued its path of success, providing a forum for discussion and involvement with the approximately 56 postdoctoral researchers in the department. The committee has made great progress in understanding and addressing the professional and career development needs of postdoctoral researchers, identifying and improving mentoring networks, providing postdocs with opportunities to contribute to the department's educational programs, and enhancing their MIT and CEE experience. A particular focus has been placed on efforts to diversify the academic and research experience of postdocs and provide career development opportunities and workshops relevant to the broader CEE community. Professor John Williams serves as the postdoc committee chair, working together with three other CEE faculty members including an Institute Professor. Postdoctoral liaisons selected by the committee each year ensure that there is ongoing communication between the postdoctoral community and the department leadership. The connection between the committee and the CEE postdoc liaisons and larger postdoc community continued through the 2020–2021 pandemic year via online (Zoom) workshops, seminars, and social activities.

This year, the committee continued to organize and host the bimonthly Future Leaders in CEE seminar series. The goal of the series is to bring together bright minds from diverse backgrounds to share their research, life journey, and perspectives as a means of provoking thoughts and conversations about future challenges in science, technology, engineering, and mathematics (STEM) research and education. Invited speakers in 2020–2021 represented various backgrounds and areas of research and study such as chemical engineering, online education, and the role of language and cognition in engineering and science learning, particularly for people of color. The seminars, conducted on Zoom, attracted large audiences from the CEE community and beyond.

The customized on-boarding activities for new postdocs who arrived during AY2021 have continued over Zoom, and CEE postdoc teaching fellowship opportunities have been offered via the online learning venues MIT has used during the period of remote teaching and learning. Faculty panels on the topic of grants and academic talks were organized and offered via Zoom with great success. The collaboration on postdoc career guidance with Simona Rosu of MIT Career Advising and Professional Development has been strengthened and elevated to a higher level.

Other specific activities included once-a-semester town halls with the department head, mini-UROP mentoring, workshops on grant writing, and a panel on giving academic talks. The fourth biennial CEE Rising Stars Workshop, which will host women graduate students and postdocs in the area of civil and environmental engineering from all over the world for a two-day packed agenda, is planned for October 2021.

Networking events for CEE postdoctoral researchers and faculty members with a focus on enhancing mentoring networks beyond postdocs' immediate faculty supervisors and research groups have been restricted during Covid but are being renewed as of August. Four postdocs have been trained to serve as communication fellows teaching others how to write for science and engineering through our CEE Communication Lab, launched in June 2020. The communications fellow position is a special opportunity for a select group of CEE postdocs interested in scientific writing as part of their career development. Increasing numbers of CEE postdocs have volunteered to present their research at the weekly Parsons and Pierce seminar series.

There has been a steady rise in the number of women receiving postdoctoral training from the department over the last five years. Approximately 80% of the postdoctoral scholars who leave CEE move on to academic and faculty positions in institutions all over the world, and postdoc certificates are being provided to postdoctoral scholars upon request as they leave the department to pursue next steps in their careers. Postdocs continue to contribute to CEE teaching activities through the postdoctoral teaching fellows program. This program has been very successful for postdocs, faculty, and students, and it continues to provide valuable training for our postdocs. We keep track of the career paths and feedback of exiting postdocs and continue to customize our offerings to the CEE postdoctoral community. All career-related offerings to the CEE postdoctoral community are reflective of the needs and requests of postdocs.

Objective 2

The administrative staff continues to evolve and engage with all communities, including current and prospective students, their parents, faculty, other MIT faculty and staff, external peers, alumni, and news media. We accomplish this outreach through workshops, seminar series, stories in print and online, social media, speaking engagements, and other activities. Additional accomplishments and events are listed elsewhere in this report.

The department strengthened the collaboration between its two laboratories, the Ralph M. Parsons Laboratory for Environmental Science and Engineering (Building 48) and the Henry L. Pierce Laboratory for Infrastructure Science and Engineering (Building 1). The Parsons Laboratory focuses on natural systems and on understanding and engineering human adaptation to a changing environment. The Pierce Laboratory engages in science and engineering research critical to improving living conditions for humankind, advancing the innovation of materials, transportation systems, cities, and energy resources. This increased interaction continues to bind the disparate locations and was apparent at many formal and informal gatherings through the year.

CEE will redefine its strategic focus around four challenge areas: climate and environment, food and water security, sustainable materials and infrastructure, and resilient systems. Our research and education within and across these strategic objectives are imperative to help solve the world's top global challenges and create a more sustainable future.

MIT Context for the Role of Civil and Environmental Engineering

The department's intellectual focus is discovery and innovation to sustain life and society in changing conditions. CEE's two research labs, the Pierce Laboratory and the Parsons Laboratory, conduct research designed to better understand and solve the grand challenges of our time, from problems created by human activity to those that exist as natural systems. Our contributions are at the core of new products and applications that are being developed today in climate and environment, food and water security, sustainable materials and infrastructures, and large-scale resilient systems design. The Department of Civil and Environmental Engineering is committed to playing a central role to support MIT's leadership in these domains.

- Our long-term objective in the area of infrastructure, implemented in the Pierce Laboratory, is to become a center of excellence in the design, manufacturing, and operation of infrastructure. The Pierce Laboratory pushes the frontiers of infrastructure science and engineering by exploring the fundamental issues critical to society and the environment. Through our faculty's diverse expertise and collaborations with others, CEE addresses such critical issues as infrastructure sustainability, resilience to catastrophic events, durability, and improved energy management.
- Our long-term objective in the area of the environment, implemented in the Parsons Laboratory, is to engineer human adaptation to a changing environment. Human activities are affecting the global environment at historically high rates, and the impact of these changes on people and the environment is not known at present. Working from very small discoveries to large-scale solutions, researchers in the Parsons Laboratory aim to better understand global environmental changes in water, agriculture and food, species evolution and coexistence, environmental quality, natural hazards, and public health, among other areas.

Space Renovations

The department's efforts to improve laboratories and other departmental space over the past several years have been extraordinary. With our faculty renewal efforts come new faculty laboratories, and we have a constant flow of renovations including state-of-the-art laboratories and work spaces in both the Pierce Laboratory (Building 1) and the Parsons Laboratory (Building 48). In addition to technical laboratory spaces, other spaces for computation, offices, and general teaching spaces are being renovated at a pace commensurate with the growing needs of CEE. Space updates in 2020–2021 are as follows:

- Faculty space renovation and improvements (Professors Michael Howland, César Terrer, and Franz-Josef Ulm)
- Renovation of the department head and department headquarter spaces
- Various student office renovations and improvements
- Planning phase for renovation of Building 48 student and postdoc spaces and some common areas

Objective 3

Using the momentum of the visiting committee recommendations, the department embarked on aggressive faculty searches over the past few years. There was an unprecedentedly large pool of candidates and, as a result, the department was able to add three new faculty members during 2020–2021.

Our future success depends in large part on internalizing our new vision across our two research labs (Pierce and Parsons), developing our junior faculty, and attracting top new faculty. The following are associated highlights and accomplishments in these critical areas. Our strategic priorities also include fueling emerging frontiers of innovation and creative design and empowering our students and faculty to lead Institute-wide cross-cutting initiatives. Hiring excellent faculty is arguably the most critical component in supporting these activities.

The faculty search process has been changed to focus on several necessary criteria that differ from those of searches conducted in past years:

- Identify the highest-caliber candidates in compelling intellectual frontiers.
- Look for relevance to the vision and domains of CEE, especially those identified as critical needs.
- Build on CEE's strengths and in areas where it can lead. Candidates should be dedicated to educating our students in such a way as to equip them to work as scholars and academic leaders, professionals, and entrepreneurs.
- Find candidates who support and are supported by intellectual communities.

New Faculty Hires

Michael Howland, César Terrer, and Darcy McRose have recently joined the faculty as assistant professors.

Michael Howland was hired in spring 2020 with a start date of September 2021. His research focus is on the intersection of environmental fluid mechanics and climate to understand new renewable energy systems.

César Terrer was hired in spring 2021 with a start date of September 2021. His research focus is on ecology at the interface of plants and soils to inform global vegetation models and improve predictions of climate change.

Darcy McRose was hired in June 2021 with a start date of 2022. Her research focuses on geobiology and microbiology.

Faculty Promotions

Lydia Bourouiba was promoted to associate professor with tenure. Bourouiba's research is focused on the fluid mechanics of disease transmission in plants and humans. Otto Cordero was promoted to associate professor without tenure. Cordero's research

focuses on explaining the cycling of elements such as carbon, nitrogen, and sulfur in the environment. Admir Masic, Tal Cohen, and Benedetto Marelli were also promoted to associate professor without tenure.

Faculty Professorships

Oral Buyukozturk was named the Macomber Professor in Construction Management for five-year term (July 1, 2019, to June 30, 2024). His research focuses on structural engineering, infrastructure mechanics, sustainable materials, and sensing and monitoring.

David Des Marais was appointed the Walter Henry Gale (1929) Career Development Professor for a three-year term. His research is focused on plant ecology and evolution, physiology, functional genomics, sustainable agriculture, and plant-water relations.

Colette Heald was honored with a new endowed chair, the Germeshausen Professorship, for a five-year renewable term effective July 1, 2021. This professorship was endowed by Mr. and Mrs. Kenneth Germeshausen in 1968 "to support MIT's strong interests in combining humanitarian advance with technological progress."

Elfatih Eltahir was honored with the H. M. King Bhumibol Professorship for a five-year renewable term effective July 1, 2021. The chair was established by the Suksapattana Foundation through gifts from MIT alumni to honor the late King Bhumibol Adulyadej of Thailand, who had a keen interest in water resource systems. The chair was previously held by Professor Dennis McLaughlin.

Faculty Retirements

Dennis McLaughlin retired and was named post-tenure professor as of June 2021.

Annual Research Event

The annual CEE Research Speed Dating event was not held in AY2021 due to Covid-19.

Objective 4

Over the 2020–2021 year, efforts were made to improve and redesign the CEE website, maintain active social media platforms, and curate student articles and spotlights for the website, which invites current CEE undergraduate and graduate students to write about their experiences in the department, including studies abroad, extracurricular activities, internships, and innovative classes. Online as well as offline, we are empowering the department to share new research and happenings and start new conversations.

CEE Communications and the Academic Programs Office collaborated to recruit undergraduate students to share their personal experiences being a Course 1 major. The new spotlights share the undergraduate experience in Course 1 along with personal information about students' passions and hobbies. Students also wrote blogs about their internship experiences this year with the MIT Priscilla King Gray Public Service Center that were shared through social media. Through this new initiative, Communications and APO have strengthened their connection with undergraduate students and created awareness about CEE students among external audiences and prospective students.

CEE maintained its presence on social media in AY2021, with accounts on Facebook, Twitter, Instagram, and LinkedIn. With an increased focus on sharing stories of the students, postdocs, faculty, and staff who make our department go, each account has seen a rise in engagement and followers. The investment in CEE's online presence enhances our ability to connect with alumni, potential students, industry leaders, and news media outlets.

Objective 5

In partnership with Resource Development, the Alumni Association, and friends of MIT, CEE has continued to strive to increase philanthropic support for its students, faculty, and research priorities. Departmental fundraising efforts help support our mission of providing faculty and students with innovative educational and research programs to develop bold solutions for sustainability at scale.

With deep appreciation and gratitude to our loyal and generous friends and alumni, CEE continues to update and renew its commitment to shared laboratory spaces, which help in accelerating and enhancing the groundbreaking work being done by our most promising faculty and students, as well as recruit and retain new talent to further our mission.

CEE Resource Development has worked to increase the visibility of the department's central themes, with a strong focus on climate change and the environment and innovative faculty research, in order to inform and engage both alumni and friends of CEE. While we have all felt the impact of the global health crisis, CEE's goal of making a more sustainable world though innovative solutions continues on through our research, made possible in part by philanthropic support.

Accomplishments

Student Outreach

In 2019–2020, the department formed a new committee to help foster community while students, faculty, and staff were forced to transition to remote learning and practice social distancing due to the Covid-19 outbreak. Made up of students, administration, and staff, the CEE Wellness and Connectedness Initiative was created as an outlet for focusing on health and well-being. The group continued to promote monthly challenges and activities centered around MIT's four pillars for staying well: mind, body, relationships, and purpose. Some of the activities in AY2021 included a book club, a hundred-mile challenge, community murals for the Parsons and Pierce Laboratories, guided meditations, and trivia games and socials.

Faculty Seminar Series

Josephine Carstensen organized and hosted a virtual faculty seminar series in spring 2021. The seminar series was created to raise awareness of the research projects and diverse body of work being carried out in the department. Topics and speakers included:

- "Bypassing the Monster: A Faster and Simpler Optimal Algorithm for Contextual Bandit" with Professor David Simchi-Levi

- "Laboratory Studies of the Oxidation of Atmospheric Organic Compounds" with Professor Jesse Kroll
- "Climate Change and Geotechnical Research Opportunities" with Professor Andrew Whittle
- "The Necromass of Borneo" with Charles Harvey

The CC Mei Distinguished Speaker Series was not held in AY2021 due to Covid-19 but will return in person and online in fall 2021. Tal Cohen will replace Lydia Bourouiba as host of the series.

Diversity, Equity, and Inclusion Committee and Speaker Series

As noted, CEE continued to organize and host the Future Leaders in CEE seminar series, designed to foster diversity, equity, and inclusion. Each event brought together more than 60 attendees from MIT and beyond. The seminar series helped provoke thoughts and conversations about future challenges in STEM research and education. Topics and speakers in 2020–2021 included:

- "Transit User Mode Choice Behavior in Response to Rapid Transit Service Disruption" (Teddy Lin, IBI Group)
- "From Nigeria to America: The Untold Story of a Nigerian-Canadian" (Alade Ahmed Tiamiyu, MIT Department of Materials Science and Engineering)
- "On the Subject of Needs: Indebted Gestures and Other Acts of Inclusion" (Misty De Berry, MIT Literature Section and Program in Women's and Gender Studies)
- "Mobility and Epidemics in Urban Typologies" (Jimi Oke, University of Massachusetts Amherst)
- "Barriers & Bridges: Inclusivity in Higher Education" (Darcy G. Gordon, MIT Department of Biology)
- "Towards Network-driven Human-centered Infrastructure Resilience & Sustainability: Insights on Diversity & Inclusion" (Arif Mohaimin Sadri, Florida International University)
- "Self-Healing Materials: Toward Smart and Adaptive Materials for the Environment" (Bezawit Getachew, Rice University)
- "Expanding Engineering Education through Developing Contextual Social Awareness" (Greses Pérez, Stanford University)

Research Highlights

The department's research is diverse and crosses many disciplines. Over the past year, CEE had 76 research proposal submissions.

In September 2020, Professor Marelli published results in *Advanced Functional Materials* describing how Velcro-like food sensors made from silk microneedles can pierce through

plastic packaging to sample food for signs of spoilage and bacterial contamination, limiting food waste.

In October, Professor Masic and graduate student Hyun-Chae "Chad" Loh were collaborators on research demonstrating an improved methodology to test nacre, a natural material found in beach shells; the results could lead to new possibilities for engineers designing nature-inspired materials.

In November, Professor Juanes was part of a team that published research helping to explain how and why columns of methane gas can stream out of seafloor formations known as methane hydrates.

In May 2021, collaborators from the MIT Concrete Sustainability Hub, the University of Massachusetts Dartmouth, Birzeit University, and the American University of Beirut created a solution to give departments of transportation a cheaper means of collecting high-quality data on how road quality affects fuel consumption. The solution, the Carbin app, was co-developed by a CEE PhD candidate.

Also in May, research conducted by Professor Carstensen examined the complex challenge of using topology optimization for the design of rigid interlocking assemblies to lock components into place without use of adhesives or fasteners such as mortar, glue, bolts, nails, or screws.

In June Professor Masic, Professor Ulm, and Hyun-Chae Loh introduced an imaging technique that could enable new pathways for reducing concrete's hefty carbon footprint as well as for three-dimensional printing of concrete.

Finally, in June researchers in Professor Kroll's lab demonstrated an alternative approach for monitoring extreme air-quality events with the use of low-cost sensor networks.

Awards and Recognition

Faculty Awards and Recognition

The faculty in CEE have received numerous significant awards, reflecting their excellence and impact within the Institute and beyond.

In September 2020, Otto Cordero received funding supported by the Simons Foundation to develop the MIT Integrative Microbiology Initiative as a means of stimulating environmental microbiology research. The new initiative builds on the rich history of the Parsons Laboratory as a leader in the environmental science space and will help identify and develop the next generation of leaders in the field.

In October 2020, Professor Tami Lieberman was honored with the prestigious National Institutes of Health New Innovators Award. The award supports up-and-coming researchers and encourages them to take on high-risk challenges.

Also in October, David Simchi-Levi was awarded the INFORMS Impact Prize. The prize is presented every two years to an Institute for Operations Research and the Management Sciences (INFORMS) member who has played an integral part in the practice of operations research.

In January 2021, Jesse Kroll was one of two MIT faculty members honored with Committed to Caring Awards for their dedication to students' well-being and futures and their ardent advocacy for student needs.

David Des Marais and Benedetto Marelli received Abdul Latif Jameel Water and Food Systems Lab seed grants aimed at catalyzing their food and water research.

In March 2021, Josephine Carstensen received a National Science Foundation CAREER Award for outstanding research and education.

Associate Professor Desiree Plata was presented the 2021 Edgerton Faculty Award, the highest honor bestowed to a junior faculty member at MIT.

Department head and JR East Professor of Engineering Ali Jadbabaie was honored with the 2021 Hybrid Systems Computation and Control (HSCC) Test-of-Time Award for his research on a novel methodology for safety verification of hybrid systems. The award recognizes research published at the HSCC conference more than 10 years ago that has proven to be the most visionary and impactful, leading to new directions of research or new applications in the hybrid systems research community.

Professor Yossi Sheffi was featured in a CNN article describing why ending pandemic lockdowns created new shortages for US supply chains.

Oral Buyukozturk received the 2020 Hojjat Adeli Award for Innovation in Computing for his paper "Collaborative Duty Cycling Strategies in Energy Harvesting Sensor Networks," published in the *Journal of Computer-Aided Civil and Infrastructure Engineering*.

Markus Buehler was awarded the 2021 Daniel C. Drucker Medal by the Applied Mechanics Division of the American Society of Mechanical Engineers (ASME). ASME selected Buehler to receive the medal for his "contributions to the use of molecular mechanics and chemical principles to elucidate the mechanics of natural and bio-inspired materials, and the design of mechanically optimized composite materials through hierarchical structuring from nano to macroscales."

Student Awards and Recognition

Senior Jarek Kwiecinski received the Henry Ford II Scholar Award in May 2021. The award is given annually to a senior who is in high academic standing and shows "exceptional potential for leadership in the profession of engineering and in society."

In June 2021,Fatima Hussain PhD '20 was one of four MIT researchers honored with the prestigious Schmidt Science Fellowship to pursue new research on mucosal immunity.

Also in June, postdoc Jian Li was the lead author in a study with Tal Cohen and Professor Chockalingam Senthilnathan that reported a proof-of-concept experiment that makes it possible to track atom by atom how a shockwave propagates. The study, "Observation of Ultra-Slow Shock Waves in a Tunable Magnetic Lattice," was published in *Physical Review Letters*.

The Chi Epsilon honor society inducted seniors Stephanie Baez, Marcin Hajduczek, Jarek Kwiecinski, Anna Landler, Isabel Munoz, and Rovi Porter. Chi Epsilon is the oldest civil engineering academic honor society in the United States.

2021 Annual Awards: Faculty, Staff, and Students

Due to the Covid-19 pandemic, CEE was forced to cancel many of the traditional in-person events and celebrations held throughout the year. In response, the department administration worked quickly and diligently to re-create digital versions of many of these ceremonies.

In June 2021, CEE hosted a virtual hooding ceremony for PhD students who completed their program and a virtual commencement. The department also held a virtual awards ceremony to honor our entire community, from students and faculty to postdocs and administrators; these awards celebrate all that is CEE.

Senior Jarek Kwiecinksi received the CEE Best Undergraduate Research Award, which recognizes an undergraduate student who makes exemplary contributions to research.

Senior Aron Brenner won the Leo (Class of 1924) and Mary Grossman Award for his strong interest in transportation and impressive academic record.

Senior Luke Bastian earned the Juan Jose Hermosilla (1957) Prize for demonstrating exceptional talent and potential for future contributions at the intersection of mechanics, materials, structures, and design.

Junior Selma Sharaf was awarded the Paul Busch (1958) Prize, given to an undergraduate student in environmental science and engineering for academic achievement and contributions to the CEE community.

Graduate student Annika Gomez was awarded the Trond Kaalstad (Class of 1957) Fellowship, which recognizes an outstanding graduate student who has displayed leadership and/or contributed significantly to the well-being of the CEE community. Annika played an integral role in defining and leading CEE's diversity, equity, and inclusion efforts.

Linda Seymour won the Maseeh Award for Excellence as a Teaching Assistant, which recognizes the most outstanding teaching assistant in the past academic year. Linda was chosen for being fantastic in her role, proactively addressing the needs of students, and adjusting her office hours to make schedules work.

The Best Doctoral Thesis Award was given to Isabelle Su. This award honors scholarly and academic excellence and a high level of distinction among CEE graduate students.

The CEE Postdoctoral Scholar Mentoring, Teaching, and Excellence Award recognizes mentoring, teaching, and other exceptional contributions by a postdoc. Matti Gralka received the award in recognition of his exemplary skills as a role model for the students he worked with and for inspiring those around him to be better.

Josephine Carstensen received the Maseeh Excellence in Teaching Award, given annually to the most outstanding faculty instructor in the past academic year.

Markus Buehler was presented the Distinguished Service and Leadership Award. This award recognizes outstanding departmental service and leadership contributions on the part of a CEE faculty member. Professor Buehler was chosen for his leadership, dedication, and commitment to the success of the department in his role as the previous department head.

Two staff members received CEE Excellence Awards for their excellent contributions to the CEE community, including their commitment to professionalism, dedication, and best practices and their fostering of a culture of diversity, inclusiveness, and innovation. The recipients were Kathleen Briana and Bori Stoyanova.

Ali Jadbabaie
Department Head
JR East Professor of Engineering