Massachusetts Institute of Technology
Fall 2021

Spectrum

TOGETHER

PLUS

The MIT Campaign for a Better World raised $6.24B to help the people of MIT take on humanity's urgent global challenges. Read about the impact of the Campaign starting on **p. 22**.

Madeline Wong '21 put her passions for art and science together at MIT, majoring in electrical engineering and computer science and in music. Shown singing as an undergrad with the Chorallaries, MIT's oldest coed a cappella group, she also plays piano, flute, mellophone, saxophone, and bassoon. Today she is a graduate student at the MIT Music Technology Lab, where she has helped to fine-tune ConcertCue, a mobile web app designed to enrich the audience experience at live performances.

PHOTO: VIVIAN HU '18

(↗)
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Wide Angle

Subjects

SPECIAL SECTION

Together

Inside the MIT Campaign for a Better World

Fall 2021

MIT Spectrum connects friends and supporters of the Massachusetts Institute of Technology to MIT's vision, impact, and exceptional community.

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The Office of Resource Development gratefully acknowledges the leadership of the MIT Corporation in the MIT Campaign for a Better World.

Coming Together in Pursuit of a Better World

Since the moment I arrived at MIT, I have been inspired by this community's constant capacity for inventive change: the same familiar MIT spirit producing endless new wonders.

In the spring of 2016, we launched a new public effort to build support for our students, staff, postdocs, and faculty as they pursued their aspirations to make a better world.

From the impacts of climate change to our national struggle over economic inequality and racial injustice, the five years since have included a range of intensifying societal challenges; the global pandemic imposed the latest painful test. And yet—in areas ranging from discovery to invention, planning to policy, management to music—to a remarkable extent the people of MIT have continued their creative exploration undeterred. Indeed, in many ways, this tumultuous time has brought new energy and purpose.

In this issue of *Spectrum*, you will see that MIT spirit at work in a host of ways, each inspired by our signature willingness to leap boundaries and explore the borderlands between disciplines in pursuit of new answers and positive impact.

Thanks to the uncommon talent, effort, and aspirations of our people—our core strength—MIT remains a magnificent human machine for inventing the future. It has never been more obvious that the Institute's ability to push past the known, the conventional, the ordinary depends on the engagement, support, and encouragement of the great global family of MIT.

In the Campaign for Better World, a remarkable 112,703 MIT graduates, parents, and friends answered the call, raising $6.24 billion in support of MIT's mission. Yet we know that vital needs persist, from building support for graduate fellowships to funding breakthrough technologies to help decarbonize the economy.

For one feature in this issue (starting on page 26), we asked a range of students and faculty how, with the support of the Campaign, they are helping to create a more positive future for all. Their answers capture the distinctive vitality and vision of MIT. It's a force the world needs now more than ever.

Sincerely,

L. RAFAEL REIF

LEARN MORE
betterworld.mit.edu

Library Oasis

For generations of MIT students and alumni, Hayden Library has been more than just a quiet study space. It's a place where visitors search for one thing, look down the row of books, and often find something else: inspiration.

The impressively renovated library and adjoining Building 14 courtyard that welcomed back the MIT community this summer are designed to invite such serendipitous connections.

"We wanted to make Hayden more of a watering hole, a place that drew people from all over campus to encounter ideas and one another," says Mary Fuller, a professor of literature who served on the Institute-wide Task Force on the Future of Libraries. "You'll see open vistas, more entryways, and dramatic improvements to accessibility. Inside the library and around its margins, there is a gradation of spaces, from the outdoor public space of a redesigned courtyard through event spaces and classrooms, all the way to small private spaces where one or two people can work."

A premium has been placed on access. The first floor of the library is now open 24 hours, with eight group-study rooms plus an event space. A library cafe offers coffee and snacks. A central staircase leads to the library's different levels, and there are more bathrooms, all gender-neutral.

Signature bay windows overlooking the Charles River have been refitted with energy-conserving insulated glass, and LEED Gold certification is targeted for the entire project. The courtyard, with a large serpentine walkway, features nine new Katsura trees. A porch blends inside and outside: accordion windows open fully to the courtyard, and a perforated sunscreen creates shadows like dappled sunlight through the trees.

The striking renovations were made possible with the support of MIT's alumni and friends. Fundraising for the courtyard project is ongoing.
—Mark Sullivan

PHOTO: JOHN HORNER

24/7
Hours MIT ID holders can access the first floor of Hayden Library

672
Average number of Hayden Library visitors per day in the 2018-2019 academic year

"Libraries have always meant to me a place to learn and flourish. I'm thrilled the new Hayden space is available again for the MIT community."

Roger Levy
Chair, MIT Committee on the Library System
Professor of Brain and Cognitive Sciences

3

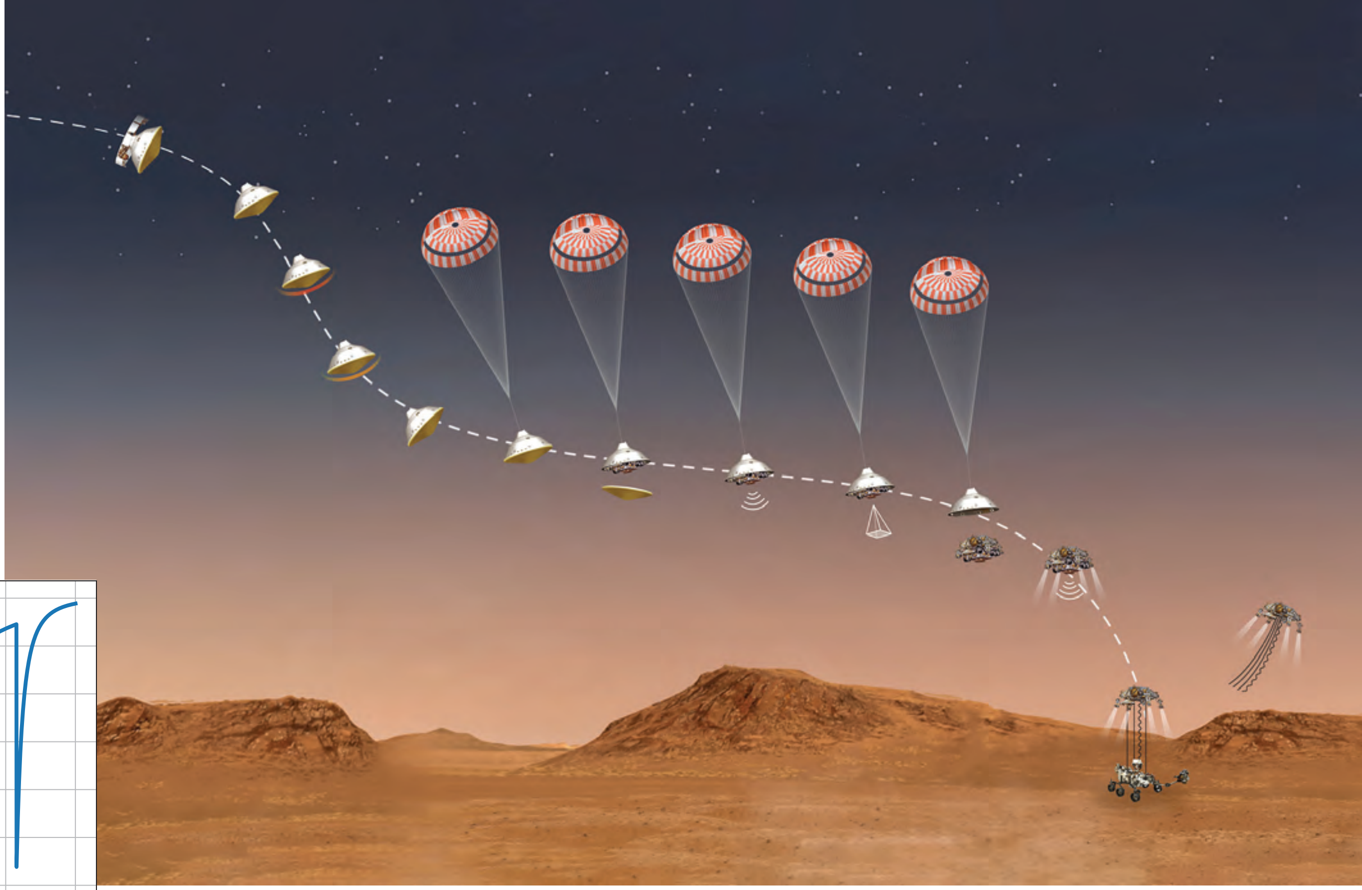
Number of Jacques Lipchitz sculptures from the MIT public art collection reinstalled in the courtyard

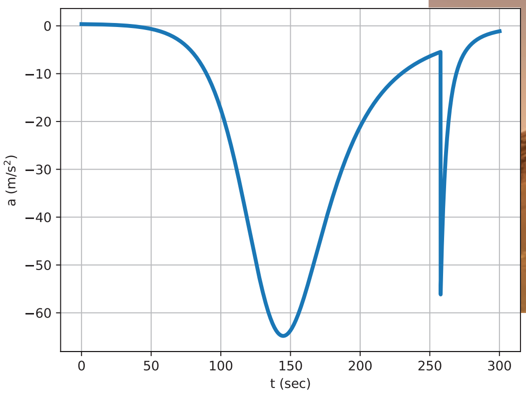
400+

Linear feet of steel used in courtyard construction, in addition to 1,527 bags of concrete

One Computational Science and Engineering problem set focused on how a lander, below, would descend through the Martian atmosphere using a parachute, as illustrated at right. The chart illustrates the lander's simulated acceleration.

MARS ILLUSTRATIONS: NASA/JPL-CALTECH





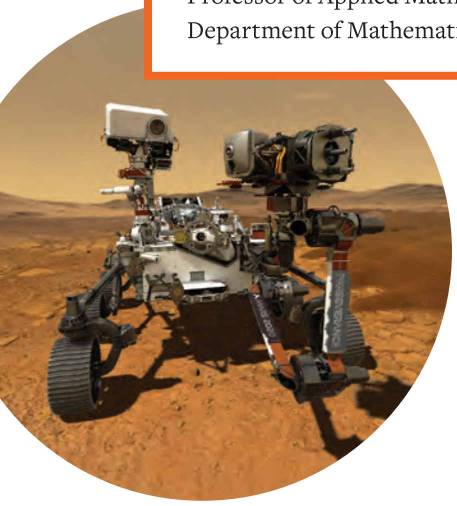
TITLE

16.0002/18.0002: Introduction to Computational Science and Engineering

INSTRUCTORS

David Darmofal SM '91, PhD '94
Jerome C. Hunsaker Professor of Aeronautics and Astronautics, Department of Aeronautics and Astronautics

Laurent Demanet
Professor of Applied Mathematics, Department of Mathematics



Computing the World Around Us

Interdisciplinary class explores algorithms for modeling physical systems

FROM THE CATALOG

This class provides an introduction to computational algorithms for understanding scientific phenomena and designing engineering systems, drawing from diverse applications including mechanics, robotics, climate science, biology, aerospace, and others. Topics include computational algorithms to simulate time-dependent processes, optimization and control of physical systems, and quantification of uncertainty in problems involving randomness using probability and statistics.

THE CLASS

How do different greenhouse gases affect the climate? How does Covid-19 transmission change with or without lockdown measures? Where exactly will a Martian lander touch down given its speed and the atmospheric drag? These are the kinds of questions explored in Introduction to Computational Science and Engineering (CSE), a pilot class of the Common Ground for Computing Education, created through the MIT Stephen A. Schwarzman College of Computing.

Students take a mathematical model of a physical system, approximate it with numerical methods, and implement it through computer programming to solve such problems. The course is broken down into three major applications for CSE theory: solving time-dependent problems, optimization of systems, and accounting for uncertainty in those systems. A main goal, aside from gaining proficiency in computer programming, is to show students how these CSE algorithms apply across a variety of majors.

"For students more interested in physical systems, they will learn the underlying computational thinking and programming more effectively here because they're excited by the **applications**," says Professor David Darmofal.

Teaching assistant Mark Chiriac '24 says, "We have applications to climate science, planetary motion, epidemiology, even space landing."

THE ASSIGNMENTS

Each problem set (p-set) is tied to a key concept in computational science and engineering.

In spring 2021, p-set topics (and their corresponding concepts) were:

- **Martian lander** (initial value problems)
- Geothermal home heating (linear systems of equations)
- Climate modeling (nonlinear and stiff equations)
- Cell tower placement (optimization and gradient descent)
- Covid-19 spread (uncertainty quantification)

Will the lander's parachute open? When? How does that affect landing?

Students revisit the Martian lander during the lecture on probability and statistics and use Monte Carlo simulations to consider how uncertain drag, speed, and orientation could affect landing scenarios.

"By the end of the semester, students have a toolbox of concepts they could use for many wider problems," says Darmofal.

COMMON GROUND

Penelope Herrero-Marques '24 says she was glad she took this class in her first year at MIT because it exposed her to a breadth of science and engineering applications. "Taking this class so early opened my eyes to the exciting, powerful, interdisciplinary field of CSE before getting too focused on any particular discipline," she says.

"The magic of CSE is that this framework applies across disciplines," says Professor Laurent Demanet. "It's like a language common to different fields of science and engineering. We provide the grammar for this language, and then students can use it in their own majors later on." —Stephanie M. McPherson SM '11

"The magic of CSE is that this framework applies across disciplines," says Demanet.

Integrating Computing Across Disciplines

Class enrollments in the MIT Department of Electrical Engineering and Computer Science (EECS) are approaching an all-time high. But not all enrollees are EECS majors. Students studying everything from aeronautics to urban planning know that in today's world, programming skills and harnessing the power of machine learning have become fundamental to success in almost any field.

The Common Ground for Computing Education, created through the MIT Stephen A. Schwarzman College of Computing, provides a mechanism for students to pursue that valuable computational knowledge within the context of their fields of interest. Launched in 2019, the cross-cutting college facilitates the melding of computing with MIT's five schools; Common Ground supports the academic portion of that mission by facilitating collaborations among multiple departments to develop classes and curricula that blend computing with other disciplines.

"Common Ground reaches all parts of the Institute, enabling students to frame disciplinary problems using a rich computational framework," says Asu Ozdaglar SM '98, PhD '03, the college's deputy dean of academics, EECS department head, and the MathWorks Professor of Electrical Engineering and Computer Science. "The main objective is to educate computing bilinguals, students who are fluent in both computing methodology and the fundamentals of their disciplines—a core component of the college's mission."

Common Ground was formally announced as a new area within the college in January 2020. By the next school year, students could choose among three pilot offerings: Linear Algebra and Optimization in the fall with the Department of Mathematics and EECS; Modeling with Machine Learning: From Algorithms to Applications in the spring, with disciplinary modules developed by multiple engineering departments and MIT Supply Chain Management; and Introduction to Computational Science and Engineering during both semesters, a collaboration of the Department of Aeronautics and Astronautics and the Department of Mathematics (see main story).

Common Ground offerings will expand in the years to come, Ozdaglar says, adding that the program welcomes ideas for classes. Proposals undergo rigorous review in the Common Ground Standing Committee, a group of 29 faculty from across MIT dedicated to assessing and addressing areas where a multidisciplinary approach would benefit students. "Some ideas currently in the works include classes on causal inference, creative programming, and data visualization with communication," she says.

"MIT has a vibrant community in interdisciplinary research," says Jennifer Donath, program manager for the Common Ground. "These classes are designed to make those same cross-cutting connections, giving students great opportunities to do unique things." —Stephanie M. McPherson SM '11


TOGETH

The whole is greater than the sum of its parts.—Aristotle

The spark of innovation often begins with a surprising combination, whether of materials, people, ideas, disciplines, or technology. At MIT, this alchemy is deliberately fostered, yielding a collaborative engine that continually breaks new ground in research ranging from health care to climate and from education to manufacturing. It's a process powered by the people of MIT working *together*.

Stem Cell Research Zeroes in on Cancer

Collaborators investigate colon health with novel tools

In a building at the edge of the Massachusetts General Hospital (MGH) complex, Ömer Yilmaz, MD, and a group of pathology residents gather around a microscope. A resident reads from a chart: a growth was found in the intestine of a patient who had complained of abdominal pain.

Yilmaz, an MIT cancer researcher and a gastrointestinal pathologist, hoped a closer look at the tumor would reveal a noncancerous collection of fat cells or lymphoid cells.

It had taken a couple of days to prepare the biopsy. Somewhere in the hospital, the patient and her family were anxiously awaiting a diagnosis. Yilmaz leaned forward and adjusted the focus on the microscope.

Ömer Yilmaz, left, and Alex Shalek team up to investigate the fundamental processes at work in colon cancer.

PHOTO: M. SCOTT BRAUER

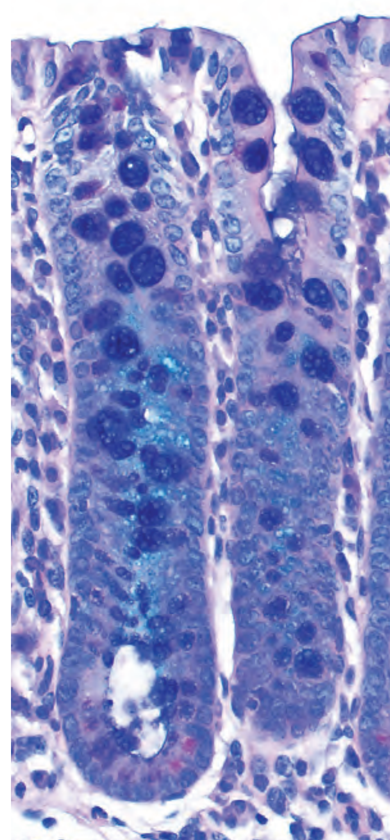
On the tracks of cancer

If the long, twisting tube of the human digestive tract were stretched out straight, it would extend 30 feet, and its absorptive surface area is roughly comparable to the size of a tennis court. A significant chunk of that tube is the large intestine, an intricate place rife with microscopic structures called niches and crypts, evoking an underground cavern or the ocean floor. Besides the skin, the intestines are the body's primary barrier against external invaders.

Yilmaz, an associate professor of biology at the Koch Institute for Integrative Cancer Research, believes certain cancers and diseases such as inflammatory bowel disease originate with a breakdown of the intestine's protective barrier. Diet appears to affect intestinal stem cells; these cells can morph into a variety of cell types, and changes in stem cells can lead to cancer, but no one understands exactly how this occurs.

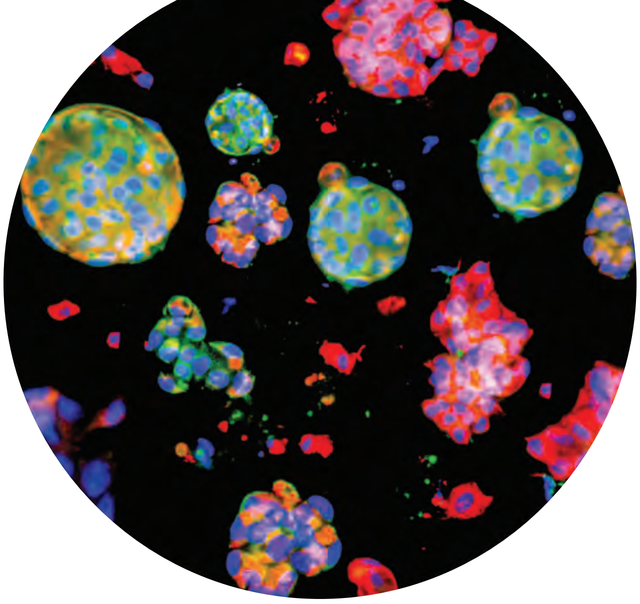
That's where Yilmaz's partnership with MIT biomedical engineer and chemist Alex Shalek comes in. Yilmaz and Shalek are both members of the MIT Stem Cell Initiative, which focuses on fundamental biological questions about benign and cancerous adult stem cells.

Shalek, a core member of the Institute for Medical Engineering and Science (IMES), a member of the Koch Institute, and an associate professor of chemistry, develops experimental and computational tools that provide researchers with detailed snapshots of what's going on inside living cells at a moment in time. Some of these tools, Yilmaz hoped, would enable him to see how intestinal cells



react when they encounter an influx of fat or are deprived of food for hours or days.

"In the past, people would have taken a piece of gut that had many different cell types and said, 'What changes, on average, under different dietary conditions?'" Shalek says. His tools give him and Yilmaz more precise information, providing a window into the discrete molecular responses of individual cells within the colon.



An amalgamation of gastrointestinal organoids are stained to facilitate study. The bottom image shows healthy mouse colon cells.

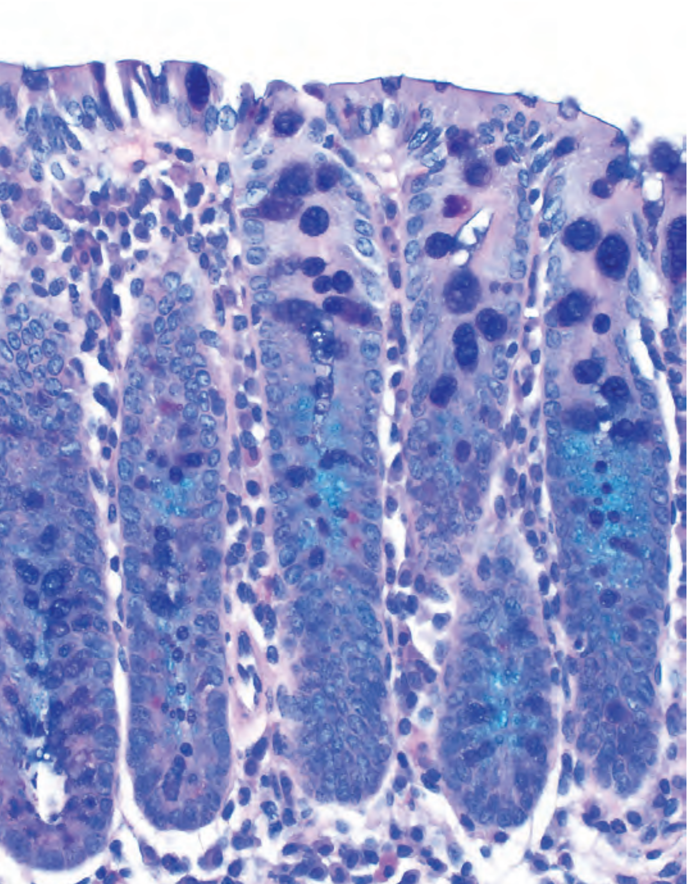
PHOTOS: GEORGE ENG '06

The role of stem cells

Growing up in Battle Creek, Michigan, Yilmaz spent all his free time trailing after his father, a physician who had immigrated from Turkey. He'd make hospital rounds with his dad, visiting the pathology and radiology labs. As Yilmaz grew older, the two would talk about the mechanisms underlying disease.

After completing his MD/PhD at the University of Michigan, Yilmaz did his residency in pathology, the study of disease, at MGH. He began working at the Whitehead Institute with MIT biology professor David M. Sabatini, a pioneer in elucidating the mechanisms underlying the regulation of growth and metabolism in mammals. Yilmaz had long been fascinated with stem cells' seemingly miraculous ability to become any kind of cell the body needed. In adults, stem cells are relatively rare, best studied in bone marrow.

When scientists first found stem cells in the intestine in 2007, Yilmaz shifted his research focus. "As soon as intestinal stem cells were identified, I became interested in understanding how they are regulated by diet and aging," he says.



"We know obesity elevates cancer risk in a wide range of tissues, including the colon, but we don't know exactly how. And fasting regimens have been known to improve organ and tissue health, but this, too, is not well understood."

To better study the transition from healthy to diseased cells in the colon, Yilmaz's team generated colon tumors in mice that closely resemble human tumors. These colon tumors from mice or humans can be grown in culture, creating miniature three-dimensional tumors called organoids.

Subjecting the organoids to different conditions, Yilmaz and Sabatini found that in mice, age-related loss of stem cell function can be reversed by a 24-hour fast. Other studies looked at the type of high-fat diet leading to obesity. Yilmaz determined that a high-fat diet boosted the population of intestinal stem cells and generated even more cells that behaved like stem cells. These stem cells and stem-like cells are more likely to give rise to intestinal tumors.

What's happening inside

In the microenvironment of the digestive system, the single layer of epithelial cells that line the colon die after only a few days of ferrying nutrients into the bloodstream and lymphatic system.

Stem cells sheltered in protected spaces with fanciful names like the crypts of Lieberkühn generate a hundred grams of new intestinal tissue every day. The source of all the epithelial cells as well as the cells of the villi, a velvety layer of fingerlike projections that line the intestine, stem cells repair and replace tissue continually assaulted by stomach acid, pancreatic enzymes, bile, fats, and bacteria.

Nearby cells guard the stem cells by secreting agents that fight off harmful bacteria, fungi, and viruses and help regulate the composition of the microbiome.

Most of the body's stem cells, like those deep within bone marrow, are not nearly as prolific as intestinal stem cells, likely because there's a risk associated with the stem cells' ability to rapidly replace themselves: mutations.

At the heart of a cell's behavior is its messenger RNA, or mRNA, the technology used in the Moderna and Pfizer Covid-19 vaccines. These mRNA vaccines teach cells how to make a protein that triggers an immune response to the virus. Each mRNA transcript, a single strand of RNA carrying a specific genetic instruction from the DNA in the nucleus to the cell's protein-making machinery, determines which protein gets made to help support the cell's activity.

"From a snapshot of all of the cell's mRNA, its transcriptome, we can see how it is trying to respond to change," Shalek says.

Shalek's tools help him and Yilmaz measure the properties of multiple types of intestinal cells—immune cells, stem cells, and epithelial cells, to name a few—at once to see precisely how these otherwise invisible, minute features collectively orchestrate tissue-wide responses to external signals.

Sequencing a cell's mRNA makeup requires smashing the cell open and collecting all of its transcripts. Shalek jokingly likened the process to an alien invader beaming human specimens up to a spaceship and investigating what's happening inside them.

One of the methods Shalek helped develop tags each mRNA within a cell so that it can be traced back to its cell of origin even after it's been ripped apart. The inexpensive, portable system, called Seq-Well, looks like an ice cube tray. Around the size of a stick of gum, it contains roughly a hundred thousand miniature wells, each approximately 50-by-50-by-50 microns.

Each cell is deposited into its own well, which contains a bead coated with uniquely barcoded DNA molecules; those DNA molecules are designed to latch onto mRNA and ignore the rest of the cell's components. The wells are sealed and the cells broken apart. The beads are then extracted, processed, and analyzed, providing a record of each cell's intentions in its last living moments.

The fact that the system can look simultaneously at thousands of individual cells of any type allows Shalek and Yilmaz to check the effect of nutrients on epithelial cells, immune cells, and stem cells all at once. The Shalek lab is also developing screening tools that are particularly useful for exposing the Yilmaz lab's organoids to hundreds of nutrients or drugs at one time, potentially reducing the effort needed to identify substances that boost or hinder stem cell function.

Already, Yilmaz and Shalek have used Seq-Well to identify an enzyme that could be a potential future target for a drug that would counter the negative effects of a high-fat diet on intestinal stem cells. More broadly, Yilmaz says, their collaboration is helping develop a very nuanced understanding of a very complex organ.

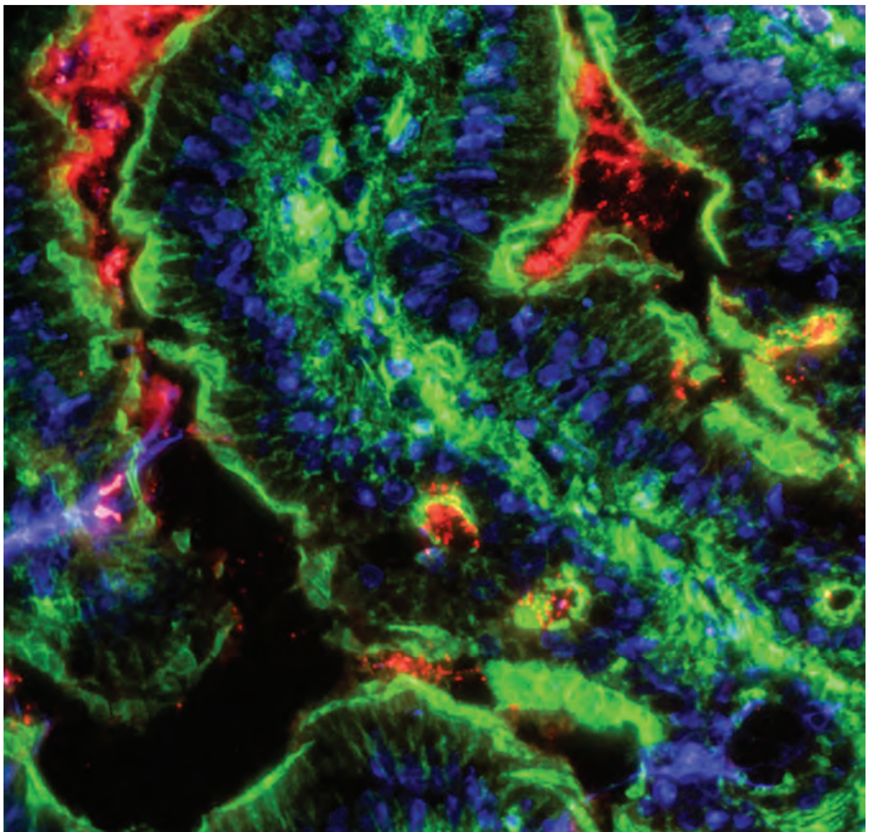
"Understanding that complexity is what has really driven our collaboration," Yilmaz says. "Alex has developed the tools that enable us to dissect out individual cell populations and start to understand how environmental factors impact gene expression."

"Scientists have spent the past 40 years delineating the genetic drivers of colon cancer, and we still have more to learn. But we've now entered the era in which we want to understand the impact of environmental and host factors," Yilmaz says.

Yilmaz hopes to identify nutrients and metabolites that can enhance stem cell function to repair damage after injury, or to identify mechanisms that dampen tumor formation. In addition, biomarkers such as levels of certain substances in the blood could be a key to early intervention, he says. "Can we identify which obese patients are more prone to developing colon cancer? If so, can we identify therapies that go after weaknesses in their tumors?"

Ketone metabolites are highlighted in red in this image of mouse intestine. Researchers have found that diet can affect the level of such metabolites, which can in turn affect stem cells.

PHOTO: GEORGE ENG '06



Battling colon cancer

During the time Yilmaz spends at MGH, he looks at slide after slide of biopsied cells. Normal epithelial cells line up in a single, orderly row. After 15 years in medicine, the twisted appearance of diseased cells still shocks him. "You know, in most cases, the number one predictor of how bad a tumor is going to behave isn't its genetic signature," he says. "It's how deep they invade into their organ of origin, whether they have spread to distant organs, and how bad they look under the microscope." The cells of this patient's tumor are misshapen, haphazardly stacked on top of each other.

The patient is in her forties. Yilmaz recalled that when he was a resident, colon cancer in a 40-year-old or 30-year-old was a rarity. He now sees such cases almost weekly. Colorectal cancer is among the top three leading causes of cancer-related deaths in the United States, according to the American Cancer Society. It's expected to cause around 53,000 deaths during 2021.

Yilmaz writes up his diagnosis: invasive cancer of the sigmoid colon. The patient's oncologist will consult with Yilmaz, radiologists, and the surgical team to come up with a treatment plan.

Ultimately, Yilmaz wants to develop strategies to prevent and reduce the growth of tumors in the intestinal tract. The fact that increasingly younger patients are being diagnosed highlights, for him, the importance of diet. "It's very worrisome," he says. "We're at the beginning of a trend where we're going to see more and more young people afflicted with what can be a fatal disease if not caught early." Diet could be an important place to start.

He says, "If you can prevent cancer, that's the best treatment." —Deborah Halber

Better Conforming Medical Devices

Canan Dagdeviren works to adapt technology to the human body

Imagine you're a patient being treated for Parkinson's disease, which causes tremors. The disorder kills brain cells that produce the neurotransmitter dopamine, so you take medication to increase dopamine production. Rather than swallowing a pill, which disperses the drug throughout your body and potentially causes unpleasant side effects, you have a computerized implant that infuses just the right amount of medication directly into your brain. Meanwhile, a flexible patch on your knee uses ultrasound to continuously measure the cadence of your gait, minimizing the possibility of a life-threatening fall.

These treatments don't exist yet, but they're part of a future that Canan Dagdeviren envisions and is already starting to build. Her Conformable Decoders group at the MIT Media Lab focuses on developing "mechanically adaptive" electronics: medical devices that can flex and fit with any surface of the body, inside or out.

"The form factor changes depending on the target, so that we can achieve an intimate integration with the soft tissue," says Dagdeviren, the LG Career Development Professor of Media Arts and Sciences. The group's goal, she adds, is to design devices that "can conform to your brain wrinkles, or the wrinkles on your face."

Breast cancer work

Conformable devices will make it possible to monitor a patient's health more comfortably, Dagdeviren says, noting that screening today typically takes place in medical offices with devices that are flat, bulky, or rigid. Breast cancer, for example, is often diagnosed with an ultrasound probe, a hard wand rubbed over soft tissue. But a conformable ultrasound patch could surround the breast tissue and even be comfortable enough to wear under clothing, enabling both better images of the underlying soft tissue and a more personalized understanding of its long-term health.

Earlier this year, Dagdeviren received a five-year, $500,000 grant from the National Science Foundation to develop precisely this technology. Her conformable patch emits ultrasound from various points on the surface, creating a sequence of images in quick succession that are stitched together by software into a full 3-D scan of the soft tissue. The patch currently needs to be tethered to an external device that generates the ultrasound images, but Dagdeviren is working toward a self-contained, wireless version that would let people self-screen their bodies for disease on a daily basis.

Canan Dagdeviren employs a YellowBox clean room, left, to develop advanced electronics, such as distributed sensor networks that can be embedded into textiles, right.

PHOTOS: COURTESY OF CANAN DAGDEVIREN

"I have a history of breast cancer in my family, so I should get checked twice a year. That's two data points—you can't even make a graph of that," she explains. "But with conformable technology, given that you can wear it all the time, you could take data on a regular basis and see the progression of a tumor over time. It makes it easy to gather large data sets that are helpful for understanding how your body is functioning."

Dagdeviren directs the highly collaborative process of developing these devices in a dedicated clean room nicknamed YellowBox. There, even the tiniest dust particles are kept from contacting and damaging sensitive microcircuits while her team prototypes these flexible electronics. Covered in head-to-toe gowns, her students directly experience the entire pipeline of designing, fabricating, and testing conformable electronics, from hand-cleaning delicate silicon wafers all the way to publishing their findings. "Every undergraduate in my group publishes at least one journal article," says Dagdeviren, who received a 2017 Outstanding Mentor Award from MIT's Undergraduate Research Opportunities Program. "They usually publish more than one."

In July, Dagdeviren began testing her ultrasound patches with human patients. She's also very much interested in working with MIT's Future Founders Initiative, which supports female-led biotech startups. "Only about 15% of the female faculty launch a company at MIT, so I am trying to be one of them and include my group members," Dagdeviren says. "I'm trying to educate myself about how we can make this technology real. The applications are limitless." —John Pavlus

An Ambitious Vision for the Virtual World

Transmedia Storytelling researcher seeks to draw people together

At a time when bitter conflict often seems to prevail over civil discourse, might virtual adventures make it easier for people to see eye to eye? That's the hope of Çağrı Hakan Zaman SM '14, PhD '20, who believes that his work designing and disseminating new media technologies could help illuminate tough topics and foster common ground.

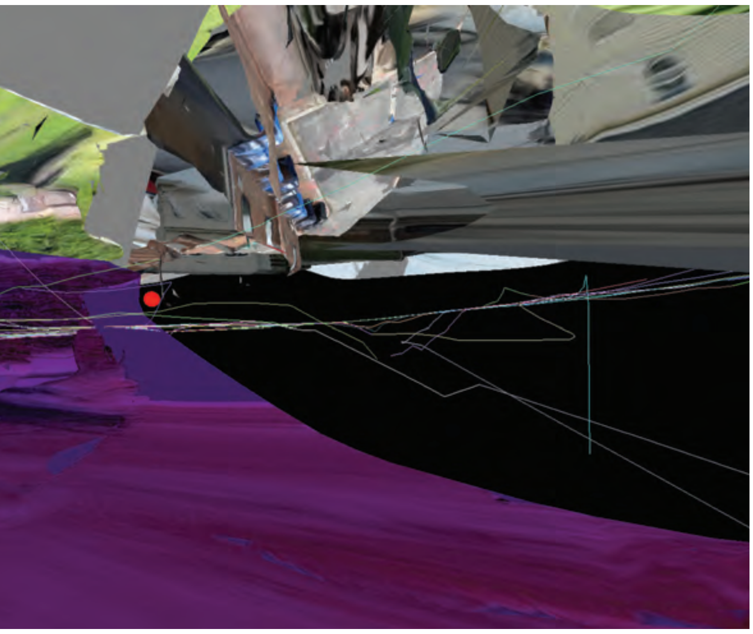
"Bringing people together is very difficult," says Zaman. "By expanding their perceptual, cognitive, and imaginary worlds, we can enable them to experience things from someone else's perspective and forge a mutual point of view."

This is one of the objectives Zaman is pursuing in the Department of Architecture, where he conducts crucial research with MIT's multi-department Transmedia Storytelling Initiative (TSI). Launched in 2019 by the School of Architecture and Planning (SA+P) working closely with faculty in the MIT School of Humanities, Arts, and Social Sciences (SHASS) and others across the Institute, TSI aims to open up new avenues of research focused on the applications, impacts, and opportunities of emerging interactive media tools. The initiative, under the direction of Caroline A. Jones, professor and associate dean of SA+P, carries forward some of the energies from the school's film program from the '60s through the '80s. "We are makers but also work to theorize and alter the media tools on offer," Jones says.

> "When we create a story in space," Zaman says, "we're not just conveying the story better but allowing it to stick with people."

Zaman, an MIT lecturer in architecture and director of the MIT Virtual Experience Design Lab, collaborates with students and faculty partners from across MIT, investigating the use of immersive media to enlighten, unsettle, and open minds. With interactive, 3-D digital experiences that interweave audio, video, and still photography, his lab takes up such issues as ethnic conflict and racial violence.

Zaman puts his digital media tools to use in a wider range of applications as well. He analyzes and improves architectural spaces in the built world, creates spatial simulations to assist visually impaired people, and produces scientific visualizations of processes normally invisible to the human eye. But for Zaman, these diverse ventures share a common theme: "The tools we are innovating can potentially have a huge impact on how people access information and on how they comprehend what's going on in the world," he says. "Eventually they could promote a more humane society."



The Transmedia Storytelling Initiative engages viewers in exhibits such as *September 1955*, far left, an interactive installation created by Çağrı Hakan Zaman SM '14, PhD '20, and *A Fictional Landscape of Togetherness*, near left, a web experience built by Zaman's students.

IMAGES: COURTESY OF ÇAĞRI HAKAN ZAMAN

Spatial storytelling

Fundamental to TSI's mission, and Zaman's research, is a commitment to the narrative form. "My mentor Patrick Winston [an alumnus, professor, and former director of the MIT Computer Science and Artificial Intelligence Laboratory, who died in 2019] believed human intelligence is all about storytelling," says Zaman. "When stories tap into our perceptual selves, we can become much more engaged, even where difficult issues are involved."

In 2017, while still a graduate student, Zaman created *September 1955*, an interactive installation about a pogrom waged against Greeks and other minorities in Istanbul, Turkey. Integrating a library of archival photos of the episode and first-person audio accounts, Zaman reconstructed a spatially accurate photography studio from the period. Users wearing virtual reality headsets could walk around a room to explore and activate different scenes, gaining the feeling that they were bearing witness to events as they unfolded.

"When data becomes tangible, it speaks to you," says Zaman. "Being in a place similar to an everyday lived experience is a more powerful way of conveying information than simply telling things."

This is because human memory is spatially wired, says Zaman, an architect by training. "When we create a story in space, we're not just conveying the story better but allowing it to stick with people much longer."

Zaman continues to plumb the potential of storytelling to alter perceptions, shift perspectives, and perhaps change beliefs through his teaching—work that supports the TSI's main goals: to create new partnerships among faculty across schools and offer pioneering pedagogy to students.

Jones, who directs TSI with help from steering committee members from across the Institute, says, "Çağrı Zaman is truly breaking new ground in innovating tools and approaches, such as opening digital documentary media for archival scrutiny, using machine learning to reconstruct locations for fiction films, and helping our team fundraise for student support. His research, teaching, and mentoring give MIT students new ways of engaging with urgent social issues through spatialized storytelling. That's what TSI is all about."

For example, a fall 2020 class, co-taught by Zaman and D. Fox Harrell, a professor in both the Computer Science and Artificial Intelligence Laboratory and Comparative Media Studies/Writing in SHASS, yielded an interactive app to tell the nonfiction story of Occupy City Hall, a 2020 Black Lives Matter protest in New York City triggered by George Floyd's murder.

A quartet of graduate students (Megan Prakash '18, Wonki Kang, Wuyahuang Li SM '21, and Kwan Queenie Li) developed a cellphone-based, augmented reality interface that could be projected onto the surfaces of a virtual reality living room, where strings of different colors connected to audiovisual objects on walls and furniture. By following these strings and activating the objects (to play video interviews, for instance), users could identify themes from the Occupy tent city: police brutality, media coverage, racial inequity, and artistic expression. The team's intent was to create a digital bridge between a real-world experience comprising a multiplicity of perspectives and physically distanced observers seeking intimate access to that experience.

"This could be a new form of journalism, where you move beyond the mainstream discussion that looks at a place and what happened there," says Zaman. The students have published a paper based on this interactive method and are presenting their work at conferences. "We want to get students interested in telling stories using these media and get them as skilled as we can so they can move out into different venues."

Discipline-spanning applications

Zaman sees a growing role for immersive media in liberal arts curricula and notes that the TSI is spearheading MIT efforts to expand this work worldwide. One recent project he supported, "Digital Archaeology, Virtual Narratives: The Case of Lifta," brought together biblical archaeologists from Ben Gurion University and MIT architecture faculty and students to create a digital tapestry of a Palestinian village notable for its ancient archaeological and architectural remains. By representing the richly varied history of a now politically contested village, the exhibition aimed to offer a more complex view of the site.

In a new venture, "The Latent Archive," Zaman will exploit artificial intelligence to repair rare and delicate historical moving images. Zaman's media tools are also proving useful in science and engineering. He collaborated with Admir Masic, assistant professor in the Department of Civil and Environmental Engineering, on an exhibition that used augmented reality tools to show the properties of the first artificial pigment, Egyptian blue.

As he continues to widen the scope of his research and the range of TSI's collaborations, Zaman envisions immersive media techniques evolving into a fundamental platform for teaching and scholarship in virtually all fields, with a new generation of digital storytelling tools providing a pathway for addressing humankind's most complex challenges, whether racism or climate change. "We can tackle these issues because our technology can squeeze larger periods of time into seconds, and great distances into small spaces," he says. "These experiences can expose more people to different angles of a problem and allow us to engage in constructive conversation with each other."

—Leda Zimmerman

"Many new avenues are emerging for AI technologies, and almost all of them will require new materials and new system architectures," del Alamo says.

Bird Model Tapped for AI

Energy-efficient neural network is based on finch thinking

One month after being hatched, male zebra finches start learning to sing by imitating the songs of their fathers. Practicing thousands of times a day, young finches master these songs in a few months so they can eventually pass on the classics—sometimes used in courting rituals—to the next generation.

For decades, scientists have recognized that the songbird learning process could shed light on how humans acquire languages and other skills. Now, a team of MIT researchers is going a step further: in a novel collaboration supported by the MIT Quest for Intelligence, they are trying to revolutionize artificial intelligence (AI) technology by reproducing, in the form of computational hardware, a vital component of the zebra finch's neural circuitry.

The lead investigators—Jesús del Alamo, the Donner Professor and professor of electrical engineering and computer science; Michale Fee, head of the Department of Brain and Cognitive Sciences and the Glen V. and Phyllis F. Dorflinger Professor; Ju Li PhD '00, the Battelle Energy Alliance Professor of Nuclear Science and Engineering and Professor of Materials Science and Engineering; and Bilge Yildiz PhD '03, the Breene M. Kerr Professor of Nuclear Science and Engineering and of Materials Science and Engineering—bring to this project a broad range of expertise.

Fee, who is also affiliated with the McGovern Institute for Brain Research, has studied songbird learning from a basic science perspective since 1996, though he hadn't focused on applications of his research until joining forces with the others this year. In a 2020 paper for *Nature Communications*, del Alamo, Li, and Yildiz reported on their artificial synapse device, which incorporated new materials and a new electrochemistry-based approach to emulate biological synapses, or connections between neurons. This approach yields low-energy consumption that is approximately one million-fold lower than conventional silicon-based technology and close to those of biological synapses.

The latter research had nothing to do with zebra finches, but Yildiz remembered an intriguing talk given by Fee in 2019 and approached him about collaborating. "We found that there was indeed a good opportunity here," she says—one that Fee was eager to pursue.

"When a bird learns its song, it tries out different things," he explains. "Sometimes that makes the song better; other times it makes it worse." He identified a crucial bit of circuitry in the finch brain, showing that synapses are strengthened when three elements are aligned: the context (where the bird is in a given song), action (a change introduced at that juncture), and reward (the benefit of an improved outcome).

In a real biological neural network, synaptic strength is controlled locally rather than centrally, Fee adds. "Each synapse learns to adjust itself."

Electrochemical control

Now del Alamo, Li, and Yildiz are building a new kind of neural network based on Fee's learning model. Rather than relying on the energy-intensive transistors used in standard neural networks, they are controlling synaptic strength the way the brain does it: electrochemically shuffling ions. This means regulating the flow of electrons and positively charged ions into and out of the artificial synapses. Li and Yildiz are still working out the precise blend of materials and electrochemistry of their reconfigured network, while del Alamo is shrinking down the size of the electrochemical synapses to nanoscale dimensions.

The implications of this work extend far beyond a single device built around principles of songbird learning, del Alamo asserts. "Many new avenues are emerging for AI technologies, and almost all of them will require new materials and new system architectures that are much more energy-efficient than present approaches."

The current effort is already providing clues as to what future computer architectures might look like, but it may also help illuminate key questions in neuroscience, Yildiz says. "The brain is a closed box, but the system we're developing could be an open box to illustrate and test how learning works." –Steve Nadis

Steve Nadis is a 1997–98 MIT Knight Science Journalism Fellow.

PHOTO: WANG LIQIANG

Student, Alum Team Up to Fight Covid-19

Pandemic challenge and scholarship connect Darren Lim ’23 and George Hu ’89

“One of the reasons I like to interview for MIT is to be inspired—and maybe inspire a little bit back,” says George Hu ’89, a former Microsoft developer and creator of the language used for macros in Microsoft Excel. Hu says interviewing MIT applicants in his native Seattle is one way he stays connected to the alma mater that has had so much impact on his life and on the lives of students like computation and cognition major Darren Lim ’23, whom he interviewed in January 2019.

Since that conversation, George and Darren’s friendship has grown. Darren was named the recipient of the Carrie and George T. Hu Scholarship, and then, in early 2020, the two teamed up to fight the Covid-19 pandemic, helping to cofound CovidWA.com, a web-based project run by volunteers that enabled millions of people in Washington state to schedule vaccinations. CovidWA.com was adopted by the state’s department of health as its official data source for vaccination appointments, and the project team received personal thanks from Governor Jay Inslee.

Perhaps the most surprising thing about Darren’s MIT interview, George recalls, is that it didn’t go very well at first. Darren was clearly bright, but he was so reserved that George wasn’t sure he would be a good fit for MIT. “And then, as an aside, Darren said, ‘Well, there was this app that I wrote…’ and I immediately said ‘*What app?*’” Darren proceeded to describe the app he’d created to collect and organize data from his high school’s online grade portal and pull that information into his phone.

George was fascinated but skeptical. “I kept drilling to make sure this was real, and he really knew what he was doing.” As they talked, George realized that Darren was exceptionally talented and a perfect candidate for MIT. “He’s one of the best people I’ve interviewed.”

While proud and grateful to receive the MIT scholarship, Darren emphasizes that he greatly appreciates George’s personal investment too. “He believes in me and my skills,” Darren says, “and I really admire him. We grew up in similar circumstances.” Both men were raised in close-knit, immigrant families where resources were tight, and both discovered as teenagers that computer programming could be, in Darren’s words, an “instrument of creativity.”

It can also be an instrument for good, as the two discovered soon after the rollout of Covid-19 vaccines. George started CovidWA.com hoping to channel the chaos of disparate vaccine information into one central, clear website. He immediately thought of tapping Darren, who was quickly able to build the basic structure.

Over the next several months, CovidWA.com went from an aspiration to a core component of Washington’s pandemic response, collecting disparate data on vaccine appointment availability and making it publicly available. Though still a college junior, Darren was one of the technical leads on the massive project. George says the experience opened his eyes to the incredible things that can be accomplished by ordinary citizens working toward a common goal.

Giving back to MIT, and to students like Darren, was always a cherished goal for George. “I was the fourth member of my family to go to MIT, and scholarships were essential to us.” MIT professors such as Shafi Goldwasser, professor of electrical engineering and computer science; Silvio Micali, the Ford Professor of Engineering; and Barbara Liskov, Institute Professor (all A.M. Turing Award winners) gave him the foundation for an incredible career. Since retiring from Microsoft decades ago, George has remained busy with many projects, including teaching computer science at South Seattle College. “MIT was transformational in my life,” he says, and supporting the next generation by teaching, mentoring, and giving brings him joy. —Kris Willcox

PHOTO: DANIEL BERMAN

Two Views into Particle Research

Chemist, materials scientist share insights relevant to manufacturing

It all started with a lecture and a realization. Materials scientist Christopher Schuh went to a talk given by Keith Nelson in the chemistry department and immediately saw a connection between Nelson's research on polymers and his own work on metals. Soon afterward, the duo, along with their postdoctoral researchers, met to share what they were working on, and from there everything clicked into place. "It was like chocolate and peanut butter—it was pretty obvious to put these things together," Schuh recalls.

Now, the teams are collaborating on research that is not only revealing the fundamental science of high-speed particle impacts but could have important applications in industry.

Nelson, the Haslam and Dewey Professor of Chemistry, is a physical chemist who studies what happens when soft materials like polymers and gels are suddenly driven very far out of their quiescent, equilibrium states. To do this, he has developed an approach that involves launching tiny particles at extremely high speeds toward the soft materials. The particles are sprinkled across a polymer film that lies on a thin gold layer supported by a piece of glass to create a "launching pad." When an intense laser pulse shines through the glass and vaporizes the gold, the gas that forms inflates the polymer layer, much like an airbag inflating during a car crash, and launches a single particle into the air. The particle, around 10 microns in diameter (seven times smaller than the width of a human hair), then hits a polymer or gel substrate and plunges in.

To capture every step of the action, Nelson acquired a device composed of 16 separate cameras that rapidly turn on and off in sequence as the particles impact their targets.

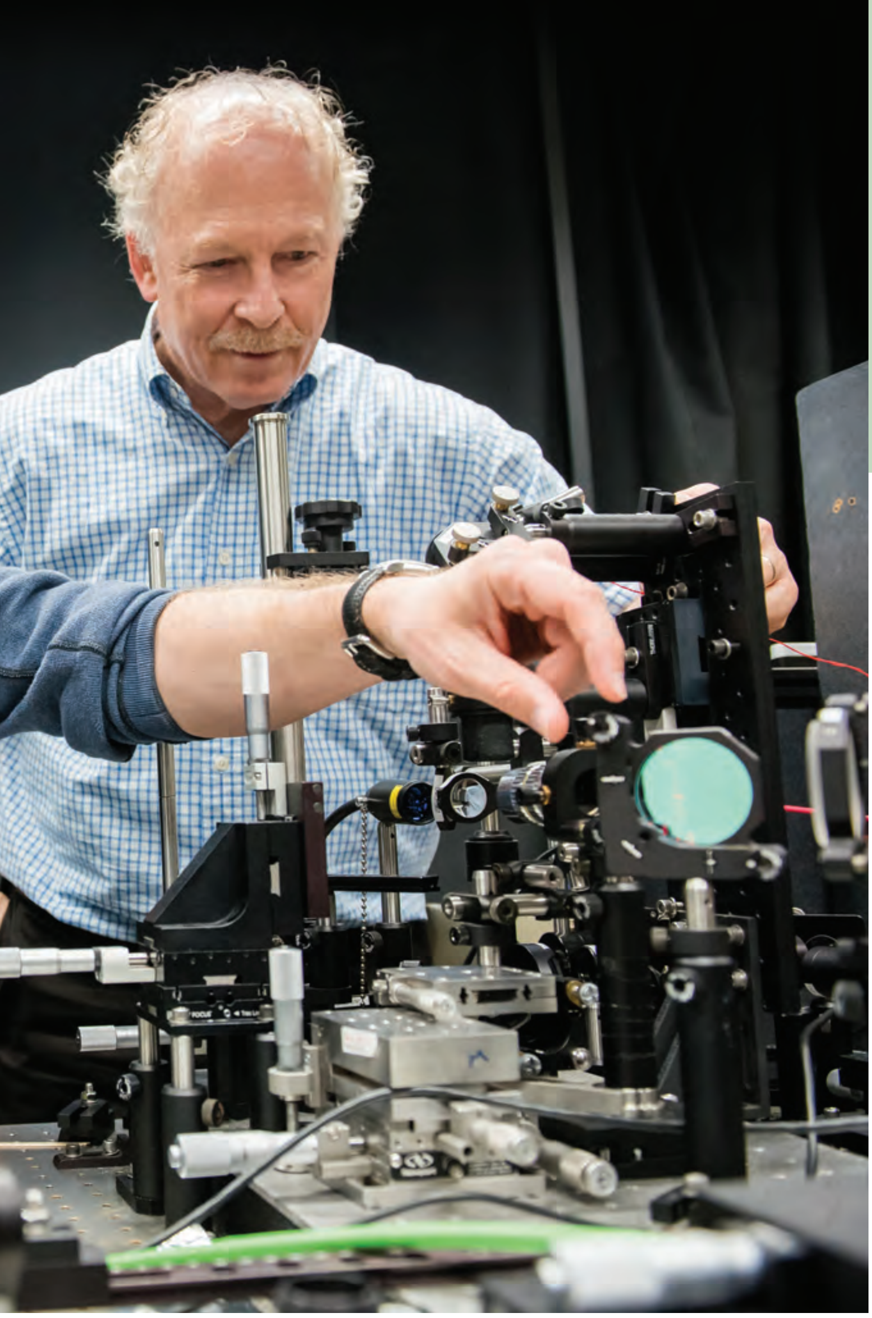
> Collaboration is "in the DNA" of MIT, Schuh says. "There are all kinds of settings where we run into each other and interact."

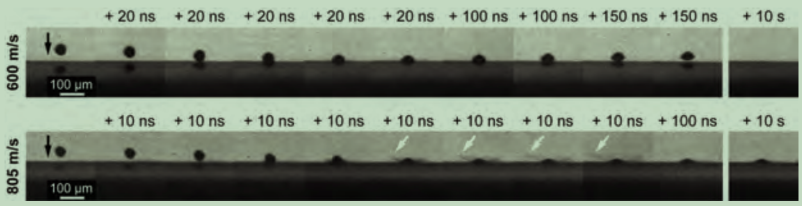
The work revealed that using different particles, substrates, and speeds leads to very different outcomes. "In some cases, the impact will look a little bit like a kid jumping into a swimming pool, and in other cases it will look more like a kid jumping on a trampoline," Nelson says.

Meanwhile, in the Department of Materials Science and Engineering, Schuh—the Danae and Vasilis Salapatas Professor of Metallurgy—conducts research on rigid, strong materials such as metals. In particular, he is interested in a new additive manufacturing process called cold spray. "The idea is that you can make metals by spraying powders of metal really fast, at supersonic speeds," Schuh explains. At these high speeds, the metal particles hit the metal substrate and stick instead of bouncing off, enabling metals to layer on top of each other to create coatings or even rebuild a damaged area.

Schuh wanted to study the fundamental mechanics of this "incredibly complicated, rapid process," which have largely remained unknown even as the cold-spray manufacturing industry has grown. When he learned Nelson had a system for launching and imaging individual particles at high speeds, he was immediately intrigued.

"We figured out that we really should think about applying my method to Chris's ongoing study of cold-spray manufacturing, three words that I had never heard in sequence before,"





Christopher Schuh, left, and Keith Nelson together captured images of particles hitting a substrate (inset), and causing a spray of tiny particles. The spray is marked with white arrows at a point where the frames are just 10 nanoseconds apart.

PHOTO: SARAH BASTILLE PHOTOGRAPHY

Nelson says with a laugh. "I don't know how much time elapsed between that first meeting and when the first data were acquired, but it was surprisingly short."

"The beauty of being able to work with Keith on this project is we can take one particle and really understand the unit process. If you can understand one, it teaches you better how to spray millions," Schuh says.

Particle "splash"

Schuh and Nelson began investigating why metal particles sometimes adhere to the metal they hit and sometimes bounce off. One of the first images they captured is also one of their most striking, showing the solid metal "splash" that forms when a metal particle traveling at supersonic speed hits and sticks to a metal substrate. "One of our key directions is understanding, wow, what is this splash? Where did it come from? And how do you get it to happen?" Schuh explains.

To learn more, the researchers are systematically manipulating the variables involved—including the size of the particles, what they're made of, and how fast they're traveling—and recording the outcomes. They are working with pure metals such as aluminum, titanium, and iron that are the building blocks of the structural alloys used in industry, and they are also testing conditions that will be relevant to applications in industry. "These are, in the end, very practical as well as very fundamental results," Schuh says. As the research continues, the pair plan to explore how to use this process to build high-quality metal that is structurally sound.

Schuh and Nelson are also studying what happens in extreme conditions, when metal particles are launched at a metal substrate even faster—roughly four million miles per hour. At these speeds, the impact generates heat, which can cause the particle and substrate to soften or melt, creating a different kind of splash that sends liquid metal in every direction. "It's a really important threshold to be able to cross. The temperature rise has a significant effect on the kind of behavior we're looking at," Nelson says. "No one has been able to measure it; there's no thermometer you can put in there that can react fast enough," Schuh adds. "So, we're pushing on that frontier."

Industrial applications

Beyond filling in a gap in basic knowledge, the research is relevant in cold-spray manufacturing, where melting and liquid splashing "is disastrously bad," Schuh says, eroding a metal surface instead of building it up. The work could also be more broadly applied to any field where particles are hitting a surface at extremely high speeds, such as aeronautics or space travel.

Nelson considers their collaboration to be "an even split" between fundamental and applied research. "I don't think either of us would be that excited about it if there weren't a pretty large fundamental gap in understanding, but it is also pretty interesting that there are also direct applications," he says. "Where MIT shines is at connecting basic science to applications, and keeping one foot in each of those is very important to us," Schuh adds. "Our sweet spot is where new fundamentals inform an application."

Both Schuh and Nelson credit MIT with providing the fertile ground that enabled their collaboration to take shape in the first place. "MIT is the gift that keeps on giving in terms of the kinds of people that are here," Nelson says.

"There are all kinds of settings where we run into each other and interact," Schuh says, reflecting on how collaboration is fostered at MIT. "It's just a churning, roiling, exciting atmosphere; it's in the DNA, it's in the architecture, it's in the campus, and it's in the people." —Catherine Caruso SM '16

Policy Student Aims to Use Tech for Good

Nagela Nukuna MBA '22 hopes to ensure fair elections

Nagela Nukuna MBA '22 has always felt the pull of two different disciplines—tech and policy. In her view, they merge more practically than one might think. "Implementation is so important in policy. Technology expands access and opportunity and helps us scale different policies efficiently," she explains. An engineer by training, she's currently adding a dual degree to her toolbox: an MBA from the MIT Sloan School of Management and a master's of public policy from the Harvard Kennedy School.

One deceptively simple research question drives her work: How do you use tech to scale social good?

Nukuna has always considered tech to be the more "stable" of her two possible career paths. She watched her Cameroonian parents work their way up from jobs at McDonald's to careers in the sciences: her mom is a chemist, her dad is a doctor. She was inspired to excel, too, in some area of technology, which she loved, and the drive to give back was there from the very beginning. Nukuna's parents always modeled gratitude, and she has watched them help other families in West Africa. "'Do what you can, help where you can'—that was my parents' motto, so I've tried to take it on," she says.

The allure of tech led Nukuna to an undergraduate degree in industrial engineering at Georgia Tech, where she learned how to solve problems in a systems-focused way with analytical rigor and data. Meanwhile, her passion for politics led her to become student body president and to promote election turnout in a state with a history of voter suppression. In college, she met a role model, former President Jimmy Carter, one of only two presidents with an engineering degree. His trajectory made her feel she could also do both things she loved.

Nukuna went on to jobs at Google and Netflix, but she also gained essential policy experience, including taking on early education policy as an intern for Delaware Governor John Carney in 2020. At MIT, she participated in an MIT Sloan Action Learning lab focused on rural America, completing a class project for the Office of Economic Vitality (OEV) in Tallahassee, Florida. She learned the social context in class and then helped collect data from town halls, surveys, and economic studies. She analyzed these data using a qualitative coding process and used the results to develop recommendations for the OEV on how to more effectively promote minority- and women-owned businesses.

"Money isn't everything"

The Action Learning lab and other experiences at MIT have helped her see policy problems with fresh eyes, learn about the evolving tech-based economy, and apply research findings to real-world issues. She appreciates that MIT Sloan focuses on developing principled, innovative leaders: "They'll bring in speakers who remind us that money isn't everything, that giving back is important. I'm grateful people keep instilling that in me so that it'll stick when I have to remember it in important situations later." Her path at MIT has been made possible through the Beatrice Ballini (1986) Fellowship, and Nukuna says she doesn't take that investment lightly.

All of this preparation, she hopes, will help her achieve her goal of working to improve national policies, like voting rights, in part by understanding the impact of technology on social systems. She might one day make policy recommendations to combat misinformation on social media, she says, or assess bias in immigration databases. No matter where she lands, she intends to employ technology to forge a path to public good. –Katherine J. Igoe

PHOTO: SARAH BASTILLE PHOTOGRAPHY

TPP Initiative Links Research, Policy

Broad-based goal is informed decision making


Maji


Atkinson

As an undergrad at the University of Delhi in India, Poushali Maji remembers that for a few weeks at the beginning of every winter, a thick blanket of smog would descend upon the city. "You could maybe see a few feet ahead of you," she recalls. Much of that seasonal air pollution comes from the burning of crop stubble left behind after harvest in more rural areas to the north. It gets trapped and concentrated in a thin layer of air near the ground, blows southward, and chokes the communities in its wake.

However, Maji says the impacts of agricultural practices extend far beyond waste burning and air pollution; many practices are inherently water- and energy-intensive, too. So, through her work today as a postdoctoral researcher with MIT's Institute for Data, Systems, and Society (IDSS) and as the coordinator of the Research to Policy Engagement Initiative in MIT's Technology and Policy Program (TPP), Maji takes a wider view. She's examining how policies that incentivize a shift toward different types of farming might benefit air and water quality, energy consumption, resource scarcity, and the climate.

TPP's Research to Policy Engagement Initiative was launched in 2019 to address exactly this kind of multifaceted problem. Maji says its aim is to forge "connections between the work that we do in our lab and on our laptops with the challenges on the ground to create real and lasting impact." The group achieves this by meeting with researchers and policy makers, working collectively to solve problems within and across labs, and organizing cross-disciplinary seminars. Topics for these gatherings, which may involve community partners, government, and industry, range broadly from the trade-offs of deploying Covid-19 testing in the workplace to the prospects for using policy, research, and advocacy to close the racial digital divide.

Measuring sustainability

In her environmental work, one of Maji's steady collaborators is TPP master's student and Biogen Fellow Will Atkinson, whose research examines how climate and health data can be used to make policy decisions more equitable, immediate, and cost-effective. (Atkinson has long been something of a data junkie. As a kid, he'd tear open *The Providence Journal*, locate the sports section, and pore over the Red Sox box scores—each one a statistical summary of the game.) This past year, Atkinson has spent much of his time updating projections of air pollutant emissions so he can compare the efficacy of possible interventions, such as fuel efficiency improvements or the wholesale adoption of electric vehicles.

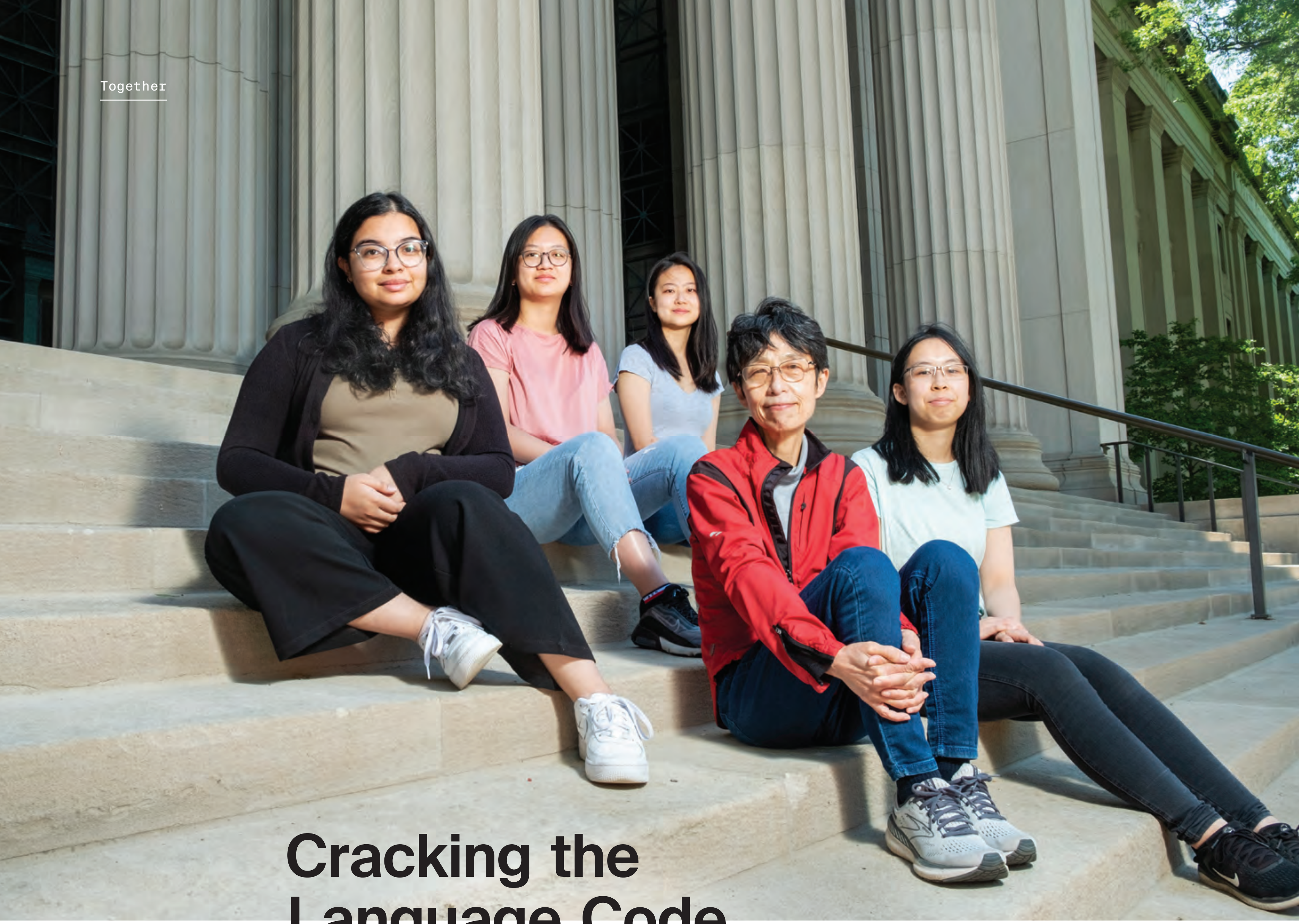
Since both Maji and Atkinson are working out ways to measure sustainability, they share their results, give each other feedback, and compare notes on the literature. Together, they hope to move critical research insights into relevant action in the policy world.

Such collaborations are just what Professor Noelle Selin envisioned when she took over as director of TPP in 2018, hoping to grow the program's footprint and impact. With the Research to Policy Engagement Initiative, she says she wants "to create a community to advance best practices, engage with stakeholders, and learn from one another." It's working: Selin, a professor in IDSS and the Department of Earth, Atmospheric and Planetary Sciences, now sees people within and outside MIT connecting across a range of disciplines spanning architecture, engineering, business, computing, and the humanities. In the long run, she hopes the initiative's work will help those who make decisions do so based on an understanding of the world that is informed by science and technology.

Maji agrees. Her dream is to be a part of scaling up the research insights developed at MIT to inform policy at a regional, national, or even international level. It's the sort of effort, Maji says, that might just allow enough people to locate one another to find a way out of the smog, together. —Ari Daniel PhD '08


India Gate, Delhi.

PHOTO: AMIT KG / SHUTTERSTOCK.COM



Cracking the Language Code

Computation, humanities pairing leads to apps for learning English

If a picture tells a thousand words, can it help someone learn a language?

Consider a student of English trying out a new app for language learning. As the student begins to a type a story—say about a duck swimming in a river—images pop up on her screen, illustrating her original composition in real time. "The app picks up a duck image from the web, then a river image, so you can basically create your own picture book," says Takako Aikawa, senior lecturer in Japanese at MIT Global Languages in the School of Humanities, Arts, and Social Sciences (SHASS). "As you type, it can help you visualize what you just wrote."

That app, dubbed Story Maker, is just one of a number of innovative new learning applications Aikawa has helped students create as part of an interdisciplinary collaboration fostered by the Programs in Digital Humanities, informally known as the Digital Humanities Lab (DH Lab). Launched in 2019 with a $1.3 million grant from the Andrew W. Mellon Foundation and based in SHASS, the DH Lab integrates digital and humanities education, teaching, and research.

Since its creation, the DH Lab has launched 23 diverse projects in collaboration with 10 disciplines in SHASS and the School of Architecture and Planning, exploring efforts such as analyzing the formal content of historical photographs through machine learning to creating tools for teaching and learning about the spread of democracy in Africa through game elements. With approximately 30 participating students each semester, the lab is now the largest Undergraduate Research Opportunities Program (UROP) host on campus.

Students working with Aikawa through UROP experimented with technologies such as visual recognition, text-to-speech, and natural language processing to push the bounds of language learning software far beyond point-and-click flash cards. "The beauty of this project is it was really the students' creativity that led the way in utilizing existing technologies to design new tools," Aikawa says.

Aikawa led the project as a digital humanities faculty fellow embedded in the DH Lab for a semester. "Our fellows reap the rewards of the amazing work that MIT undergrads

Takako Aikawa, in red, poses with Digital Humanities Lab students, from left: Shara Bhuiyan '24, Jackie Lin '24, Yifan Wang '24, and Peihua Huang '24.

PHOTO: M. SCOTT BRAUER

can do developing computational methods and tools," says Stephanie Ann Frampton, faculty director of the DH Lab and associate professor of literature. "In turn, work in the lab provides a unique opportunity for students to have a crash course in a humanities or social sciences field."

Sharing knowledge

Before coming to MIT to teach Japanese in 2013, Aikawa worked at Microsoft Research as a computational linguist. At MIT, she has worked to create language-learning apps using natural language processing and other computational tools. For this project, she started by teaching students about linguistics and language pedagogy, helping them think like language instructors about how best to engage students. "I hope that they get at least a little taste of the complexity of human languages," she says.

Meanwhile, DH Lab faculty and staff provided the scaffolding to help students design and program the apps using a variety of popular technologies. "It was really about creating a space in which both the humanities and computing sides were able to communicate with each other and speak each other's language—no pun intended," says Ryaan Ahmed, the lab's technical director, who also develops music software for the Cambridge-based company Artusi. Before even starting to code, students consulted with Aikawa, Ahmed, and lead developer Michael Jean to design interfaces that would be both easy to use and aesthetically pleasing, wireframing apps with design software.

"It's different than what students are usually doing in computer science classes, in which they are trying to solve problems by writing code," Ahmed says. "This may be their first time really thinking about the end-user experience." Among the apps they created was one that automatically generates crossword puzzles and hangman games from a list of vocabulary and definitions. Another creates flash cards from images. "It uses object detection to find all of the objects in a scene and then constructs these rich flash cards where students have to identify the objects," says Ahmed. The app helps instructors generate content quickly while teaching students words in context.

Another application allows an instructor to upload text in the form of a dialogue, then prompts students to complete half the conversation using multiple choice. Students had to come up with techniques for the app to automatically generate wrong answers. "Instead of an instructor creating a multiple-choice quiz with one right answer and three wrong answers, the system created the dialogue," says Ahmed. "Students had to think about what it means to create a plausible wrong answer."

Creating so many different kinds of modules for language learning allowed students to learn in a variety of ways, using speech, text, and visual prompts. "I learned a lot more about full-stack development and how computer science is used outside of the school setting," says Peihua Huang '24, herself a non-native English speaker who joined the project out of a desire to help others learn English in a fun and meaningful way. Another student, Shara Bhuiyan '24, appreciated the freedom students had to bring their visions to fruition. "We were given creative control over the projects," she says. "Senior lecturer Aikawa and Ryaan were both very supportive in the process, providing us with guidance in whatever direction we decided to take the project."

Future collaboration

The apps were designed as asynchronous tools that could supplement the remote learning environment of the Covid-19 pandemic. However, the DH Lab and Global Languages—which share space on the sixth floor of Building 16—are now discussing ways they can further collaborate, including by expanding to support languages beyond English. Frampton, who also teaches Latin in MIT's Ancient and Medieval Studies program, says, "I'm already looking forward to using the hangman and quiz-generator tools."

The DH Lab, Frampton says, fulfilled students' interest in learning about new coding software, such as NLTK—the Natural Language Tool Kit used for processing human languages in Python. But it also sparked their interest in the more human side of language learning. "We saw that they were equally motivated by the pedagogical mission of Takako's project—how do we make teaching and learning easier, more fun, and more natural for faculty and students at MIT and beyond?"

In that regard, says Aikawa, the student projects exceeded her expectations, creating applications that are both technically complex and addictively enjoyable to use. "The bottom line is that these applications are fun," she says. "Learners love to keep using them, and that enables them to learn a foreign language much more quickly."

—Michael Blanding

"[The project] was really about creating a space in which both the humanities and computing sides were able to communicate with each other," Ahmed says.

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9.12.16
Samuel Tak Lee Building
Building 9, home to the Department of Urban Studies and Planning and the Center for Real Estate, reopens after renovations.

10.7.16
The Simons Building
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2.9.17
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5.2.17
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5.17.17
A Global Strategy for MIT
MIT releases a report for global engagement, outlining a framework for the Institute's international activities in education, research, innovation, and service.

9.5.17
MIT's First Facility Dedicated to the Performing Arts
A new purpose-built home opens on Vassar Street for MIT's Theater Arts program, which draws the fifth-largest enrollment of any course at MIT.

9.7.17
MIT-IBM Watson AI Lab
IBM and MIT join forces to carry out fundamental AI research and propel scientific breakthroughs that unlock AI's potential.

9.24.17
Building 31
A significant renovation transforms a 90-year-old space into a home for research in autonomous vehicles, turbomachinery, energy storage, and transportation.

2.1.18

MIT Quest for Intelligence

MIT launches an initiative to discover the foundations of human intelligence and drive the development of technological tools that can positively influence society.

2.27.18

Task Force on the Work of the Future

MIT launches an Institute-wide initiative to understand how emerging technologies are changing the nature of human work and the skills required.

9.17.18

Abdul Latif Jameel Clinic for Machine Learning in Health

MIT announces an endeavor to develop machine-learning technologies that will revolutionize disease prevention, detection, and treatment.

10.4.18

MIT.nano

MIT.nano, a 200,000-square-foot center to make, measure, and image materials at the nanoscale, opens its doors at the center of campus.

10.15.18

MIT Stephen A. Schwarzman College of Computing

A major commitment to address the global opportunities and challenges presented by the prevalence of computing and the rise of AI ushers in a new era for the Institute.

10.23.18

New MIT Museum

The MIT Museum breaks ground in preparation to take up residence in the eye of Kendall Square's innovation district, where it will occupy more than 58,000 square feet of galleries, classrooms, and state-of-the-art program and performance space.

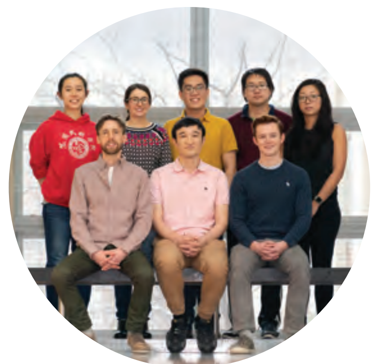
1.2.19

MIT Raises Goal for Campaign for a Better World to $6B

1.15.19

Teaching at the Right Level Africa

Teaching program led jointly by MIT's Abdul Latif Jameel Poverty Action Lab and the Indian nongovernmental organization Pratham significantly scales up its efforts.



2.27.19

MathWorks Fellowships

Mathematical computing software company MathWorks, cofounded by Jack Little '78, creates 100 graduate fellowships in the School of Engineering and the School of Science.

3.20.19

Alana Down Syndrome Center

MIT establishes a center to engage scientists and engineers in an effort to increase understanding of the biology and neuroscience of Down syndrome.

11.14.19

UROP Turns 50

The Undergraduate Research Opportunities Program (UROP), which supports thousands of projects each year—with 91% of MIT graduating seniors participating in at least one UROP during their undergraduate years—celebrates a major milestone.

6.18.20

MIT-Takeda program

MIT and Takeda Pharmaceuticals announce a joint effort to fuel the development and application of AI capabilities to benefit human health and drug development.

7.23.20
Climate Grand Challenges
The Institute calls on its community to tackle the most challenging and highest-impact research problems associated with climate change.

7.29.20
King Climate Action Initiative
The Abdul Latif Jameel Poverty Action Lab launches an initiative to solve problems at the nexus of climate change and global poverty alleviation.

7.29.20
K. Lisa Yang and Hock E. Tan Center for Molecular Therapeutics in Neuroscience
The McGovern Institute for Brain Research launches a major new research effort to change how we treat brain disorders by developing innovative molecular tools that target dysfunctional genetic, molecular, and circuit pathways.

10.26.20
MIT and Accenture Convergence Initiative for Industry and Technology
MIT and Accenture team up to further advance learning and research through new business convergence insights in technology and innovation.

11.1.20
Graduate Residence in Kendall Square
New graduate residence opens in Kendall Square, providing 454 housing units for single graduate students and families with children.

11.2.20
MIT InnovationHQ
MIT InnovationHQ opens in Kendall Square, encompassing more than 25,000 square feet of space for innovation and entrepreneurship activities.

1.28.21
MIT Climate and Sustainability Consortium
An alliance of leaders from a broad range of industries joins MIT to vastly accelerate large-scale, real-world implementation of solutions to address the threat of climate change.

2.13.21
New Vassar Residence Hall
A new 450-bed undergraduate community, developed through a collaborative process that identified student priorities and sought new ways to improve the living experience, opens on campus.

3.21.21
Strategic Action Plan for Diversity, Equity, and Inclusion
MIT shares a first draft of its strategic plan to deliver an explicit, directional, and aspirational set of actions to address issues of diversity, equity, and inclusion.

5.21.21
Fast Forward: MIT's Climate Action Plan for the Decade
A new action plan is unveiled to tackle the climate crisis, committing to net-zero emissions by 2026 and charting a course to marshal MIT's capabilities toward decarbonization.

6.1.21
Music Building
MIT breaks ground on a new state-of-the-art music facility adjacent to Kresge Auditorium.

6.29.21
Schimmel Family Program for Life Sciences
MIT announces a life sciences program that will support the Department of Biology's Graduate Training Initiative and graduate students across MIT.

Scholarships: Investing in Potential

Scholarships—the foundation of MIT's commitment to need-blind undergraduate admission—are a vital component of the Institute's ability to provide the full range of support needed for students who have earned their place at MIT. Each financial commitment to an outstanding undergraduate made during the Campaign introduces a new voice into the MIT community of problem solvers and change makers, simultaneously enriching the life of the recipient and the campus.

DONOR SPOTLIGHT

ARASH SALEMI '93

"The critical thinking skills I developed at MIT have had a significant impact on my career at each level—from student to surgeon to researcher," says Arash Salemi '93, MD, FACS, a cardiac surgeon and chair of cardiothoracic surgery at RWJ/Barnabas Health in New Jersey. "Whether it's during surgery, where the stakes are high, or while we are researching ways to innovate and improve our medical procedures, our teams are routinely solving complex medical problems."

Salemi says he feels "extremely fortunate" to have gotten an MIT education, where the dynamic and diverse learning environment provided both outstanding professional preparation and lifelong friends. He also shares MIT's steadfast commitment to inclusion and to educating students "of every background, from all over the world."

"I've been humbled and inspired to see the diverse, talented applicants who have been drawn to MIT over the years," Salemi notes. "We must do everything possible to make sure that these impressive thinkers and future leaders get the opportunities they deserve."

Today, Salemi remains active in the MIT community; his gifts to the Institute include two scholarship funds established since 2018. "Building a better world includes leveling the playing field across all spheres," says Salemi. "Many young people share the curiosity and thirst for learning that drew me to MIT. I hope this scholarship can play a small part in helping them realize their aspirations." —Kris Willcox

Sarah Aaronson '23

Course 14-2 Mathematical Economics

A member of MIT's sailing team, Sarah Aaronson '23 says she's awed by the power of the wind that speeds boats on the Charles River. "It's quite incredible to be harnessing a natural element to move as fast as we do," she says.

Off the river, the mathematical economics major from Ashland, Oregon, likewise moves at full sail as president of Burton-Conner and an active member of MIT Hillel and Alpha Chi Omega.

Aaronson is busy studying too, hoping to pursue a research career in economics and public finance. For an undergraduate research project with the Abdul Latif Jameel Poverty Action Lab, she investigated the impact of infrastructure investments on business growth in Indonesia and found the work inspiring. "Economics speaks to the basic resources people need to survive and thrive," she says. "The work I hope to do can make tangible improvements in people's lives."

The Elliot K. Wolk Scholarship has been the wind beneath her sails. Aaronson says, "I simply would not have been able to attend MIT without it." —Mark Sullivan

DONOR PHOTOS: CHRIS TAGGART (SALEMI), KELSEY EDWARDS (KENNARD/REEVES)

DONOR SPOTLIGHT

LYDIA KENNARD MCP ’79 AND MARLYSE REEVES ’17, SM ’20

“If you have an excellent education and you work really hard, you can achieve great things,” says Lydia Kennard MCP ’79, founder and CEO of KDG Construction Consulting in Glendale, California. Her belief in the power of education, passed on to her by multiple generations of her family, inspired her to create the Kennard Reeves Scholarship Fund, which supports African American undergraduate students at MIT.

Lydia, who holds a master’s degree in urban planning from MIT, is proud to steward the fund with her daughter, Marlyse Reeves ’17, SM ’20, a doctoral candidate in the Department of Electrical Engineering and Computer Science.

Earlier this year, Lydia and Marlyse were pleased to meet the current scholarship recipients. “The cool thing for me,” says Marlyse, “is to see the different paths these students are taking and how they are finding what it is they’re really passionate about.”

Lydia adds, “My desire is for the students to be successful, to fully leverage their MIT experience, and to take the investment they’re making in *themselves* really seriously.” Lydia and Marlyse both hope that recipients will find unique ways to give back, creating opportunities for others. “That’s an obligation we all have to uplift future generations,” says Lydia.

—Kris Willcox

Hung Huynh ’24

Course 2-A Engineering

“MIT isn’t just about the smarts,” says Hung Huynh ’24. “It’s about passion, collaboration, and support.” A first-generation college student, Huynh is thrilled that the Drs. Francesco and Marybeth Pompei Scholarship has made it possible for him to attend MIT. “It’s better than a perfect match,” he says.

Growing up in the Midwest after his family left Vietnam, Huynh loved working with his hands. “I knew that when I grew up, I wanted to make things,” he recalls. Interviewing a mechanical engineer for a ninth-grade career planning assignment prompted him to research engineering schools, and MIT quickly moved to the top of his list.

Huynh is already working on two startup ideas, one of which focuses on social entrepreneurship and digital inclusion. “More than a billion and a half children were out of school because of Covid-19 and a third of them didn’t have access to online education,” he notes.

His other startup idea arose from personal experience with health care: “As a poor family, we always dreaded trips to the hospital because of the cost,” Huynh says bluntly. He hopes to use nanomedicine to create affordable, scalable methods of preventing the atherosclerosis that causes ischemic heart disease, which is the leading cause of death worldwide, according to the World Health Organization.

Huynh says, “Because of MIT, I’ve been empowered with the resources and perspective to start small but think big.” —Christine Thielman

About 60% of MIT’s undergraduates receive need-based financial aid from the Institute.

DONOR SPOTLIGHT

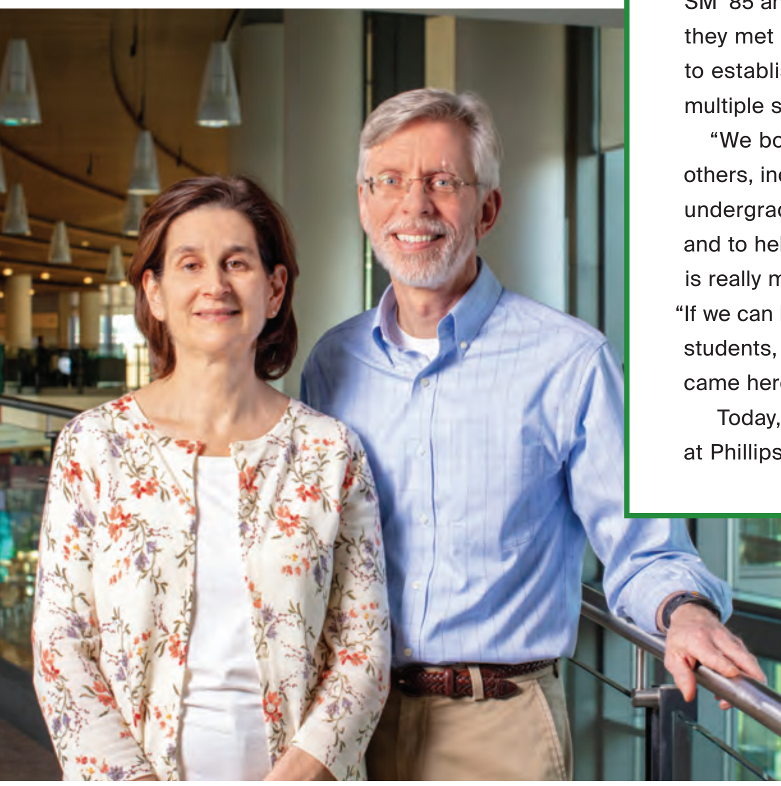
TOM DAVIS ’84, SM ’85 AND BETSY DAVIS ’84, MARCH ’88

The shared undergraduate experience of Tom ’84, SM ’85 and Betsy (Beliveau) Davis ’84, MArch ’88—they met in a fencing class at MIT—led them to establish a scholarship fund that has helped multiple students attend the Institute.

“We both benefited from the generosity of others, including scholarships,” says Betsy. “The undergraduate years are incredibly formative, and to help somebody else have that experience is really meaningful to us.” Tom agrees, adding, “If we can knock down the financial burden for students, they’ll be more focused on what they came here to do.”

Today, Betsy is associate director of facilities at Phillips Academy Andover and Tom works (remotely) in supply chain management for a Palo Alto, California, consulting firm. Both have happy memories of MIT. “There were moments in class where the waters parted and you could see truth in its purest form,” says Tom. “But some of the best moments for me happened outside of the classroom.”

Tom and Betsy, who also established a bequest plan that ensures their fund will support more students in the future, hope others will consider establishing scholarships. “Funding a scholarship feels like an investment in the future for everyone,” says Betsy, “because the impact students can make with a little bit of assistance from us is incredible.” —Christine Thielman



Sheila Baber ’21

Course 12 Earth, Atmospheric and Planetary Sciences; Course 8 Physics

Sheila Baber ’21 spent her early childhood on her grandparents’ farm in South Korea helping grow cabbage, lettuce, and sesame. Now she hopes to combine a love of agriculture with training in the latest satellite technology to feed people on Earth and, maybe someday, on Mars.

As a sophomore, Baber was part of a team that placed second in NASA’s Breakthrough, Innovative, and Game-changing Idea Challenge to devise a working greenhouse on Mars. The experience helped inspire her career path in Earth observation: “I started out trying to grow plants in space,” she says. “Now I’m looking at plants from space to help farmers grow more food using less water, fertilizer, and ultimately fossil fuels.”

A recipient of a scholarship established by Natalie Lorenz-Anderson ’84, the recent graduate traveled to South Korea through the MIT International Science and Technology Initiatives this past summer to work for a satellite company. She plans to begin PhD studies at the University of Maryland, where she will focus on satellite applications in agriculture.

Baber hopes to advance the use of tiny cube satellites to produce images that can help predict crop yields or warn of potential famines. She doesn’t lose sight of the purpose behind capturing images of the Earth from space. “Behind the pixels are the people,” she says. “And the people are those I want to help.” —Mark Sullivan

82%

In 2021, 82% of MIT seniors graduated with no debt.

$54,601

The estimated average need-based scholarship for undergraduates in 2021–2022 is $54,601.

DONOR PHOTO: M. SCOTT BRAUER (DAVIS)

Liam Ackerman ’21

Course 6-2 Electrical Engineering and Computer Science

“I always knew I wanted to be an engineer,” says Liam Ackerman ’21. “I never stopped talking about how technical solutions could solve problems.”

After his father suffered an injury that significantly reduced the family’s financial resources, the Ashar Aziz Mens et Manus Scholarship made it possible for Ackerman to pursue his dreams at MIT. “As a low-income student, I’ve been uniquely lucky,” he says.

A varsity pole vaulter, Ackerman honed his leadership skills as captain of MIT’s track team. His time as an athlete and inspiration from his father’s impressive recovery from two hip replacements led him to research human mobility, and he joined the MIT Media Lab’s Biomechatronics group through the Undergraduate Research Opportunities Program. Passionate about health care equity, Ackerman used his technological expertise to build a predictive model that uses socioeconomic data to identify areas most in need of mobile health clinics.

Ackerman says he is grateful to have completed his undergraduate years without student loans, and he will return to MIT to pursue his master’s degree in the Department of Electrical Engineering and Computer Science. His goal? “I can use what I learned at MIT to make the world a better place.”

—Christine Thielman

Unrestricted Gifts, Unlimited Impact

Approximately 40% of MIT’s FY21 operating budget relied on unrestricted dollars.

In FY21, the unrestricted budget covered 32% of MIT’s undergraduate financial aid.

Over the life of the Campaign for a Better World, MIT alumni and friends contributed $881M in unrestricted funds or commitments to the Institute, representing a 67% increase in unrestricted giving compared to the previous decade. Gifts such as these are MIT’s “essential fuel,” says President L. Rafael Reif, “enabling us to meet the core needs of a thriving institution, seize unexpected opportunities, and cultivate an environment of academic excellence and bold innovation for our students.”

Flexible funding has long helped MIT stand firm in its commitment to undergraduate support, ensuring that every undergraduate who has earned admission can enroll, regardless of family financial circumstances. In 2021, the unrestricted budget covered almost a third of MIT’s undergraduate financial aid.

“MIT’s strength derives from its students, and our undergraduates depend on MIT’s ability to help meet their financial needs,” says Stuart Schmill ’86, dean of admissions and student financial services. “Our scholarship support is so robust because of the generosity of our alumni and friends who make gifts in a variety of ways.”

In contributing to MIT’s strong financial foundation, unrestricted giving during the Campaign also helped the Institute realize opportunities such as the development in Kendall Square of a new innovation and entrepreneurship hub known as MIT InnovationHQ; a new graduate residence and childcare facility; and a new home for MIT admissions. Unrestricted gifts are also contributing to the acceleration of MIT’s commitment to action on climate change.

When Covid-19 struck in early 2020, flexible funding empowered the Institute to rapidly respond: safely operating the campus; investing in the capacity to perform Covid-19 tests; accelerating the implementation of tools and practices for online teaching and remote work; and providing access to equipment and technology to support largely uninterrupted teaching, research, and innovation. The availability of flexible unrestricted reserves, as well as recurring unrestricted resources, which in 2021 comprised 40% of MIT’s general operating budget, were central to MIT’s efforts to protect its community in the early days of the pandemic and continue to play a vital role.

For the donor community, a commitment of unrestricted funds is a show of faith in the Institute’s ability to direct the resources where they are most needed. “There are so many great areas to support at MIT, we couldn’t pick just one,” says Brad Billetdeaux ’72, who with his wife, Susan, made two unrestricted planned gifts in 2017 and continues to provide support. “We trust that MIT knows best what areas need funding.” Similarly, Lawrence Linden SM ’70, PhD ’76 calls his 2018 unrestricted gift a reflection of “my deep affection for MIT as an institution and confidence in its future.”

MIT’s unrestricted donors, says President Reif, “give us the great gift of their confidence—confidence in the mission, power, and people of MIT to do good for the nation and the world.”

Fellowships: Fueling MIT's Research Engine

Brilliant graduate students are a major force in the Institute's research enterprise. Fellowship support raised during the Campaign gives MIT the capacity to retain its competitive edge in attracting the most talented, inventive, and diverse graduate students from around the world, offering remarkable young minds the confidence and freedom to chase big ideas in pursuit of a better world.

DONOR SPOTLIGHT

LESLYE MILLER FRASER '78, SM '80 AND DARRYL FRASER '80

"The beauty of MIT is in the faculty and the students," says Leslye Miller Fraser '78, SM '80, a member of the MIT Corporation and a retired environmental appeals judge for the US Environmental Protection Agency. "I am always in awe of these young people and their accomplishments."

MIT education was a life-changing opportunity for Leslye and her husband, Darryl Fraser '80, both of whom majored in chemical engineering. That's why today, the couple work to open doors for others, particularly students from underrepresented groups. Together, they co-chair MIT's Annual Giving Leadership Circle, and they have interviewed MIT applicants for more than 30 years. They recently created a fund at the School of Engineering to support historically underrepresented graduate students.

Darryl, a retired corporate vice president of communications for Northrop Grumman Corporation, hopes their fellowship will provide more opportunities for talented underrepresented students to attend MIT and to enter the workforce as skilled engineers. "The talent is there; our intent in creating the fellowship is to help MIT tap into it."

"MIT is phenomenal at solving complex problems that we put our minds to," says Leslye, noting that increasing diversity in STEM education is one of the key challenges of our time. "I believe MIT can be a role model for other institutions." —Kris Willcox

DONOR PHOTO: MELISSA LYTTLE (FRASER)

Elba Alonso-Monsalve

PhD Student in Theoretical Physics

Elba Alonso-Monsalve is fascinated by black holes. “We don’t know the laws of physics inside black holes,” she explains. “We can’t know what it’s like to jump into one until we find new, improved laws.”

In particular, Alonso-Monsalve is intrigued by a famous conundrum known as the “black hole information paradox,” which pits what is known about quantum mechanics against the theory of general relativity. The problem, she explains, is that while quantum information must last forever, it seems to vanish without a trace when black holes shrink and disappear by emitting radiation.

MIT’s Center for Theoretical Physics is the ideal place to investigate such mystifying behavior, says Alonso-Monsalve, recipient of the Frances and Arthur Peskoff Physics Fellowship. “Having a fellowship is very helpful because I’m not restricted to the funding of a specific professor,” she says. “I’m really interested in interdisciplinary research, in how people can learn from each other.”

Alonso-Monsalve is enthusiastic about the possibilities for future discoveries at MIT, long regarded as a worldwide leader in physics research. “Because of MIT, I am able to study regions of the universe that are supposed to be out of reach for humans,” she says.

—Christine Thielman

Shivang Tayal MBA ’22

MBA Student, MIT Sloan School of Management

Shivang Tayal MBA ’22 started a grassroots campaign called Rakshak ki Raksha—Protecting Our Warriors—to assist frontline health care workers in rural India during the Covid-19 pandemic.

The MBA student, whose studies at MIT Sloan are supported by the Ivy Head Family Fellowship, credits MIT for encouraging him to focus his campaign where it would have the most impact. “Helping marginalized women in rural India figure out basic needs such as protective gear was something no one was focusing on,” says Tayal, who is from Hisar, India, 100 miles west of New Delhi.

After the first lockdown was declared in India in 2020, Tayal says Rakshak ki Raksha distributed kits containing sanitizers, gloves, masks, and face shields to as many as 13,000 health care workers across 900 towns and villages. During a second wave of Covid-19 earlier this year, he adds, the project delivered oximeters to 2,400 villages across India.

Most of the frontline workers protected were rural women, the auxiliary nurses and midwives who typically oversee public health and child welfare in Indian villages, and who led containment efforts there when the pandemic hit.

“We wanted to protect them,” Tayal says. “These health care workers put their lives at stake in a system that was not prepared for a deadly pandemic like this.” —Mark Sullivan

Alvin Harvey SM ’20

PhD Student, Department of Aeronautics and Astronautics

On the Navajo Nation reservation between Tse Bonito, New Mexico, and Fort Defiance, Arizona, where Alvin Harvey SM ’20 grew up, his grandmother didn’t have running water. “In a way it was almost like living on Mars,” Harvey recalls.

Today, Harvey’s understanding of the challenges of living with limited resources informs his main research interest: safeguarding the health of astronauts on space flights. Harvey, a licensed pilot who would like to become an astronaut himself someday, says he hopes the work he’s doing, which includes designing reduced gravity harnesses, will also have useful applications on Earth—in patient rehabilitation, for example.

He credits the MIT Summer Research Program and support from the Garriott Space Fund and other fellowship funding for making his graduate studies possible.

At MIT, he says, he has been given the opportunity to pursue space research while at the same time reflecting on his Indigenous cultural roots. Advocating for First Nation values and respect for the Earth to be extended to the moon and stars, he asks, “How can we make space sustainable?”

—Mark Sullivan

DONOR SPOTLIGHT

STEVE MA MBA '09 AND FRANCES CHIA WEI TSUNG MBA '10

Steve Ma MBA '09, and his wife, Frances Chia Wei Tsung MBA '10, have established the Steve Ma and Frances Chia Wei Tsung Fellowship Fund to support graduate students at MIT's School of Architecture and Planning (SA+P).

While attending American schools in his home country, Taiwan, Ma enjoyed drawing comics and considered going to art school. Instead, he says, "I decided to keep my options open," and studied architecture and computer science as an undergraduate at the University of California, Berkeley. "Architecture is a practical art," says Ma. "You see the tangible results of design."

Ma says he found the hands-on approach to solving problems at the MIT Sloan School of Management "eye-opening." "We'd build from the fundamentals, not by analyzing case histories."

Since graduating, Ma has led the company his mother founded in 1983, NutritecEnjoy Corporation. The company is now the largest clinical nutrition products and consulting company in Taiwan.

"We are grateful to MIT and want to give back," says Ma. "Our fellowship encourages design thinking in the next generation. SA+P teaches design skills that the world needs more than ever, to solve problems and think outside of the box." —Susan Saccoccia

Kartik Vira

PhD Student, Department of Economics

Kartik Vira became interested in economics during high school, when the financial crisis of 2008 illustrated to him just how much the discipline affects society.

"I think economics is an extremely powerful framework for understanding lots of different aspects of the way we organize society, whether that's decisions on an individual level, political institutions, or businesses and markets," he says. "I'm interested in behavioral economics in particular—introducing models with a more psychologically realistic approach to economics. I think that's exciting because these models can help governments to design policies based on a better understanding of how we really make decisions."

As Vira begins his doctoral studies, he is grateful that the Carl Shapiro Fellowship Fund brought him to MIT, where he has the chance to work with renowned faculty members such as Institute Professor and John Bates Clark medalist Daron Acemoğlu. "The faculty have really impactful research designed to improve outcomes for people around the world," he says.

While starting at MIT during the pandemic was challenging, Vira says he found a welcoming community within the Department of Economics. "In my cohort, we have a really good sense of community and camaraderie," he says. "I can see that MIT values that sense of community." —Joelle Carson

R'mani Haulcy SM '19

PhD Student, Department of Electrical Engineering and Computer Science

Since childhood, R'mani Haulcy SM '19 has been interested in Alzheimer's, the neurodegenerative disease that begins with memory loss and progresses to dementia. "I don't know that it is living life if you can't remember anything," she says, recalling the struggles of afflicted family members.

In the Spoken Language Systems Group within MIT's Computer Science and Artificial Intelligence Laboratory, Haulcy uses machine learning to identify speech differences in people with cognitive impairments. Originally planning to work on self-driving cars, she shifted focus after taking a class on speech recognition from senior research scientist Jim Glass SM '85, PhD '88, now her advisor.

"There are themes in speech that we're not able to hear, but models can pick up on them," she explains, noting that machine learning can be used to distinguish one cognitive impairment from another, useful information for both clinicians and drug developers. Spotting Alzheimer's at earlier stages may help researchers find methods to slow the disease's progression—or someday prevent it.

A MathWorks Fellow, Haulcy is grateful that her fellowship allows her to concentrate exclusively on research. "Because of MIT, I've become aware of potential solutions that I never knew existed, and I believe in my ability to solve problems," she says. —Christine Thielman

Angeles Martinez Cuba

Master's Student, Department of Urban Studies and Planning

A native of Lima, Peru, who studied traditional architecture, Angeles Martinez Cuba shifted her focus to urban planning to work on providing people with equal access to basic services.

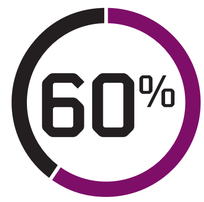
Having worked on education infrastructure for the government of Peru, Martinez Cuba is now investigating the relationship between public schools and their surrounding communities for her MIT thesis. "My hope is that in the future, schools become anchor spaces in which neighbors can assemble, develop a sense of community, hold social interactions, and carry out civic life through the shared use of school-community spaces," she says.

The José Miguel Bejos Fellowship Fund helped bring her to MIT to pursue this work. "I feel beyond grateful for this funding," she says. "The fellowship helped me have a clear mind from other economic concerns and take full advantage of MIT's resources."

One key MIT resource for Martinez Cuba is its diverse community. "I am thrilled by the Department of Urban Studies and Planning's vastly actionable vision and multi-angle approach to address social and urban challenges," she says. "Because of my time at MIT, I have become even more passionate about social and sustainable development." —Joelle Carson

$531M

The MIT Campaign for a Better World raised $531M in support of graduate student aid.



Roughly 60% of students at MIT are at the graduate level.

DONOR SPOTLIGHT

ERAN BROSHY '79 AND FEIGUE BERMAN-BROSHY, PHD

"Improving health care while lowering its cost has been a driving factor in my professional life," says Eran Broshy '79, who for more than three decades has worked as a health care executive building high-growth businesses that inject efficiencies into the sector. "The United States spends twice as much on health care as a share of its GDP than other developed countries do, yet we don't have better outcomes."

Broshy and his wife, Feigue Berman-Broshy, PhD, see MIT as a potent force in transforming health care, which is why they created two fellowships.

One currently supports graduate students in MIT's Department of Brain and Cognitive Sciences (BCS). "By reverse-engineering the brain, BCS aims to discover how the brain gives rise to the mind," explains Broshy. "Such understanding will open new frontiers in science and medicine."

A previous fellowship helped advance research at MIT's Institute for Medical Engineering and Science (IMES). "At IMES, I was interested in supporting graduate students with promising ideas they want to bring forward and move from the lab to the market," he says.

Since 2013, Broshy has served on both the IMES and BCS Visiting Committees, and he chairs the latter. "One-third of what MIT is doing relates to moving health care into new frontiers," says Broshy, who is also a member of the MIT Corporation. "Being able to support and observe its developments from a front-row seat is incredibly satisfying. It's a privilege to be part of it. MIT gave me a great start. I'm glad to give back." —Susan Saccoccia

DONOR PHOTOS: IMAGE COURTESY OF THE DONORS (MA/TSUNG), CHRIS TAGGART (BROSHY/BERMAN-BROSHY)

Professorships: Empowering Brilliant Educator Innovators

The MIT faculty is a thousand-strong community of researchers, inventors, and doers from every field of inquiry. They are relentlessly expanding the limits of human knowledge and bringing their expertise to bear on the global challenges of today and tomorrow. Professorship support in the Campaign helps MIT empower distinguished faculty and tap the full potential of rising stars.

Antoinette Schoar

Stewart C. Myers-Horn Family Professor of Finance; MIT Sloan School of Management

Antoinette Schoar aims to give consumers and regulators a clearer understanding of finance to help them make better decisions.

"Finance is a fantastic tool for helping people improve their lives," she says. "Unfortunately, it can become a hindrance, and it shouldn't."

Schoar's current research projects include investigating the impact of new technologies on consumer finance, how credit card companies are using ever-expanding big data to tailor consumer targeting, how consumers manage their retirement savings, and new payment systems such as cryptocurrencies.

"We're working to help redesign financial products such as credit cards so they serve people when they need it rather than getting people into trouble when they don't even notice they're getting into trouble," she says.

Schoar co-chairs the National Bureau of Economic Research's Corporate Finance Program and is a cofounder of ideas42, a nonprofit that uses insights from behavioral economics and psychology to solve social problems.

In 2019, she was named the Stewart C. Myers-Horn Family Professor of Finance at MIT Sloan. "I am very honored and proud to hold that professorship," she said. "Having the resources that help me do the work I'm doing is extremely helpful.

"MIT has given academia a template for doing good in the world while at the same time doing fundamental science," Schoar said. "Since its inception, MIT has been a model for both." —Mark Sullivan

DONOR SPOTLIGHT

LIP-BU TAN SM '80

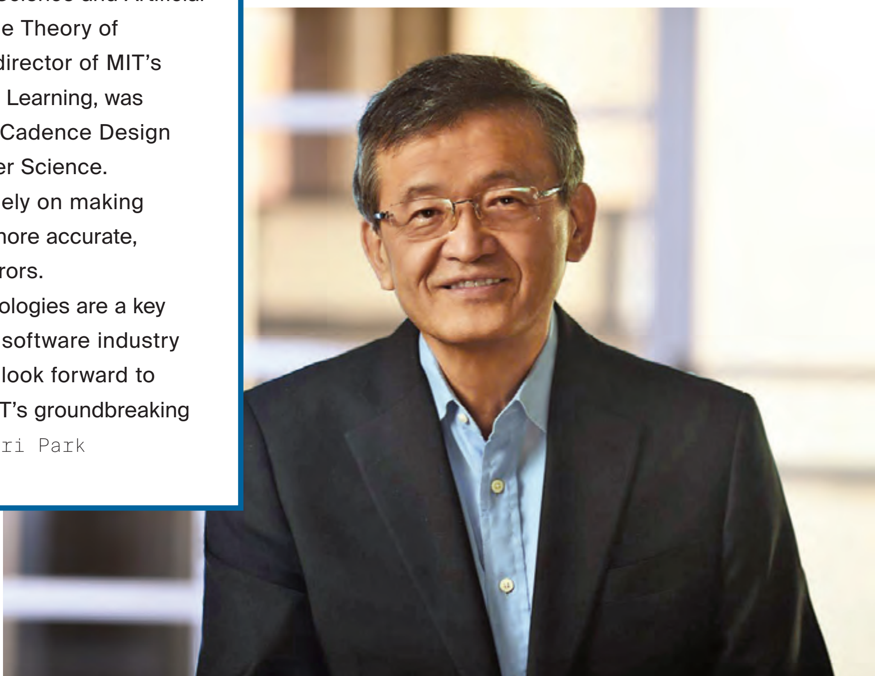
For Lip-Bu Tan SM '80, establishing a professorship in the MIT Stephen A. Schwarzman College of Computing signals a "very personal" commitment to the Institute.

"I was fortunate to have obtained my master's of science in nuclear engineering from MIT, where I focused my studies on system simulation analysis," says Tan, the chief executive of Cadence Design Systems, a leader in global electronic design innovation.

Creating the new fund in the Schwarzman College reflects Cadence's overall commitment to supporting education and fostering innovation at the vanguard of computing, says Tan. "We're delighted to support MIT's efforts to advance innovation in the exciting fields of artificial intelligence, machine learning, and data analytics," he says.

Aleksander Mądry SM '09, PhD '11, a member of the MIT Computer Science and Artificial Intelligence Laboratory and the Theory of Computation Group, and the director of MIT's Center for Deployable Machine Learning, was recently named the inaugural Cadence Design Systems Professor in Computer Science. Mądry's research centers largely on making machine-learning techniques more accurate, efficient, and robust against errors.

"These transformative technologies are a key element of the computational software industry and Cadence," says Tan. "We look forward to enabling the acceleration of MIT's groundbreaking research in these areas." —Terri Park



DONOR PHOTO: IMAGE COURTESY OF CADENCE (TAN)

Stephen Morris

Peter A. Diamond Professor in Economics; School of Humanities, Arts, and Social Sciences

"The PhD program at the MIT economics department is perhaps the best in the world," says Stephen Morris, inaugural recipient of the Peter A. Diamond Professorship in Economics, created by a gift from economics alumnus C.C. Chen '63, SM '65, PhD '67.

An economic theorist, Morris notes that the department has "a huge focus on and investment in our students." He enjoys supporting graduate students in their research while pursuing his own. His research centers on strategic aspects of economics: anticipating how market participants such as investors and traders will respond to policy changes and other economic events.

Morris views the economics department as a shining example of MIT's interdisciplinary, collaborative approach to discovery. "It's an intellectually integrated department—everyone is engaged with what's happening in all the groups."

He is particularly proud of a course for second-year PhD students, 14.192 Advanced Research and Communication, which he created and teaches jointly with Esther Duflo PhD '99, the Abdul Latif Jameel Professor in Poverty Alleviation and Development Economics at MIT and co-winner of the 2019 Nobel Prize in Economic Sciences. Because students are encouraged to begin their own research early in the program, the new course helps equip them to write research papers and publish important findings earlier in their academic careers.

Morris says, "Because of MIT, I've rethought graduate education and how it works." —Christine Thielman

GENEROSITY
EDUCATION
RESEARCH
INNOVATION
GLOBAL
PEOPLE
CHALLENGES
ASPIRATIONS
ENGAGEMENT
BETTER
WORLD

Elly Nedivi

William R. and Linda R. Young Professor of Neuroscience; School of Science

Elly Nedivi explores the brain's ability to respond to its environment and learn new things, focusing on remodeling the synapses that connect nerve cells into circuits. "Understanding the basis for this plasticity is highly relevant to our ability to repair or ameliorate brain damage," explains Nedivi, the William R. and Linda R. Young Professor of Neuroscience, who is also affiliated with the Picower Institute for Learning and Memory.

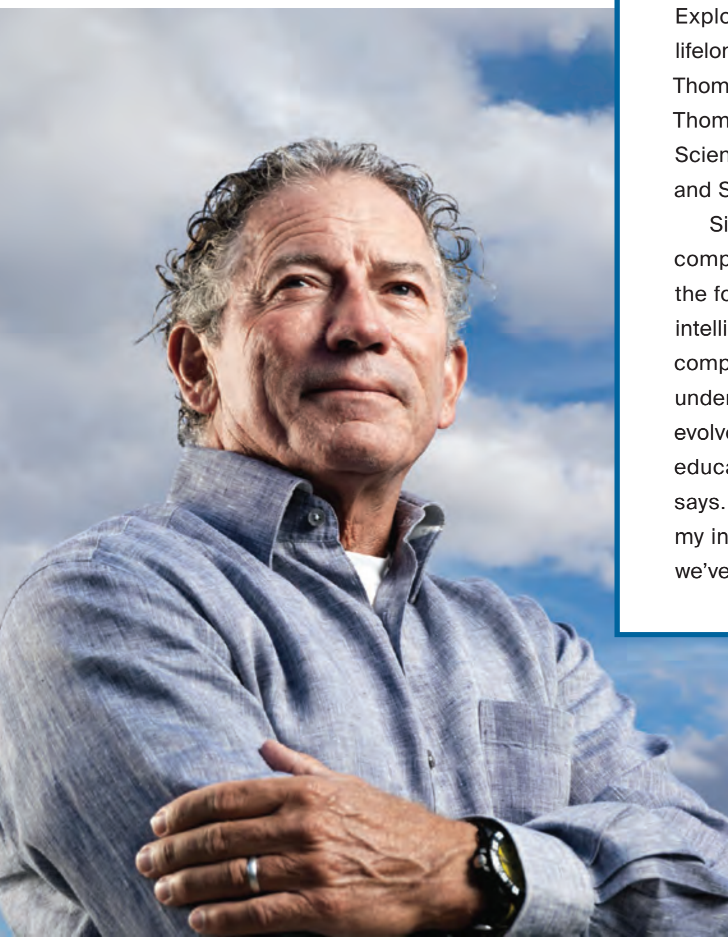
To watch plasticity happen, Nedivi works with Peter So, MIT professor of mechanical and biological engineering, to create new microscopy tools. She says their longtime collaboration is a benefit of working at MIT. "Scientists working so closely with such talented and creative engineers is quite unique to MIT. For me, it has enriched my research in many ways, making experiments that might seem impossible, possible," she says.

The discretionary funding her lab has received over the years is critically important to her research, Nedivi says, because it can drive forward projects that are not ripe for funding through traditional means. "The first microscope Peter built in my lab was funded this way."

As important as brain research is, however, Nedivi cites education as MIT's greatest contribution. Education is "the strongest force for good in the world," she says. "That's what we do at MIT—and we do it really well." —Joelle Carson

DONOR SPOTLIGHT

THOMAS M. SIEBEL



Exploring the history of science has been a lifelong passion for veteran software entrepreneur Thomas M. Siebel, who recently established the Thomas M. Siebel Professorship in the History of Science at the MIT School of Humanities, Arts, and Social Sciences.

Siebel, who founded the pioneering software company Siebel Systems and is currently the founder, chair, and CEO of C3.ai, an artificial intelligence software platform and applications company, attributes his success in part to a deep understanding of how information technology evolves, including "making a reasonably well-educated guess about where we'd go next," he says. "All of my decisions were informed by my interest in the history of science, and so far, we've been in the right place at the right time."

The inaugural recipient of the professorship, Kate Brown, is an internationally recognized historian of science and the environment. "It's a great privilege to be able to support great scholars like [Brown] who can help graduates gain a deeper understanding of liberal arts and history," says Siebel.

Siebel's philanthropy also includes a professorship in the Institute for Data, Systems, and Society—held by Tommi Jaakkola PhD '97, a professor in the Department of Electrical Engineering and Computer Science and a leader in machine learning—and the Siebel Scholars, which supports MIT graduate students. Siebel says, "It's just a great privilege to make some contribution at the edge of that remarkable achievement that is MIT." —Katy Downey

90

During the Campaign, 90 funds were established in support of professorships.

1,064

The MIT faculty comprises 1,064 professors.

11

Of the current MIT faculty, 11 have been awarded a Nobel Prize.

Samuel Madden '99, MNG '99

College of Computing Distinguished Professor of Computing; MIT Stephen A. Schwarzman College of Computing

"It's an honor to be named the inaugural College of Computing Distinguished Professor of Computing," says Samuel Madden '99, MNG '99. For him, the best part is that the professorship provides "resources to help support my students and the research that we do. It also gives me inspiration to keep doing the work."

"My research involves doing interesting things with data of all types," he says. At MIT's Computer Science and Artificial Intelligence Laboratory, Madden and Hari Balakrishnan, the Fujitsu Professor of Computer Science, have used mobile sensing and data analytics to measure the impact of human behavior on road safety.

Excited by the potential of their findings to reduce accidents, the pair cofounded Cambridge Mobile Telematics, a company that provides safe driving technology to insurance carriers, telecommunications and auto companies, and other mobility providers. Drivers can use the company's app to monitor their driving, and good drivers can get insurance discounts, Madden explains. The app monitors several behaviors, he notes: "Do you slam on the brakes? Do you look at your phone a lot?" Awareness and feedback help drivers improve over time, and Madden is proud that MIT research is making driving safer.

"MIT offers an amazing set of resources to us to get work done," says Madden. "And of course, we have the best students and colleagues in the world."
—Christine Thielman

DONOR PHOTOS: ETHAN PINES/THE FORBES COLLECTION (SIEBEL), SARAH BASTILLE PHOTOGRAPHY (STONE/MALANOTTE-RIZZOLI)

Christopher Voigt

Daniel I.C. Wang Professor of Advanced Biotechnology; School of Engineering

"As synthetic biologists, we're trying to massively advance the scale of genetic engineering projects," says Christopher Voigt, the Daniel I.C. Wang Professor of Advanced Biotechnology. "We're focused on how to build better cells and on what that means for agriculture, medicine, industry, and beyond."

To Voigt, potential applications of biological engineering seem infinite: synthetic biology has been used to identify alternatives to harmful chemical fertilizers in agriculture and to design more targeted and effective drug therapies by reengineering the bacteria that live within us. MIT researchers have even developed enzymes that break down polystyrene, a positive step toward reducing the environmental impact of discarded plastic.

Funds from the professorship have enabled Voigt and his students to attend conferences outside of their particular field, helping them to identify potential interdisciplinary collaborators. "MIT is unique in its ability to cross boundaries," he remarks.

Also exceptional, according to Voigt, is the Institute's deep commitment to entrepreneurship as well as innovation. "Everyone here has the mindset of getting new technology out into the world," says Voigt. "Because of MIT, I know that the results we generate in the lab will be translated to have a real impact." —Christine Thielman

Siqi Zheng

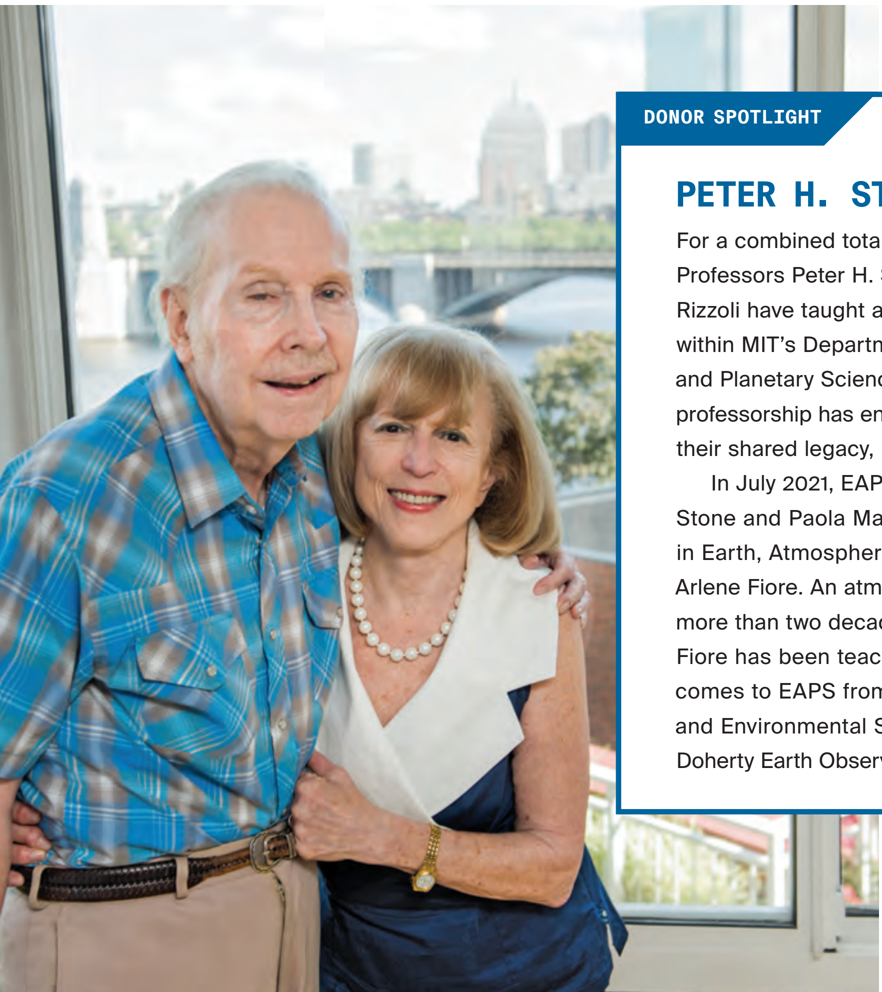
Samuel Tak Lee Champion Professor of Urban and Real Estate Sustainability; School of Architecture and Planning

"The world is 55% urbanized right now, but it will be about 68% urbanized in 2050. That means another 2.5 billion people living in our cities," says Professor Siqi Zheng. Her research centers around building environmental sustainability into these changing cities while maintaining positive economic and social development.

"I appreciate that the MIT approach is to make a real-world impact," she says. "We work together to tackle technical policies and societal issues around the world, not just in the lab, but within the cities with local stakeholders."

One way Zheng makes an impact is by leading the MIT Sustainable Urbanization Lab. It engages with fast-urbanizing cities that serve as "living labs" where MIT researchers can test and deploy their urban-focused innovations, from improved transportation to air quality policy interventions. Similarly, since becoming faculty director of the MIT Center for Real Estate, she envisions a more global, interdisciplinary approach to urban sustainability for the center.

Zheng credits the Samuel Tak Lee Champion Professorship of Urban and Real Estate Sustainability for bringing her to MIT and says the Institute's interdisciplinary environment is helping her research to bloom in new ways. She explains, "At MIT, it's easy to collaborate with other disciplines—there are no boundaries." —Joelle Carson



DONOR SPOTLIGHT

PETER H. STONE AND PAOLA MALANOTTE-RIZZOLI

For a combined total of more than 80 years, Professors Peter H. Stone and Paola Malanotte-Rizzoli have taught and conducted research within MIT's Department of Earth, Atmospheric and Planetary Sciences (EAPS). Endowing a professorship has enabled the couple to continue their shared legacy, Malanotte-Rizzoli says.

In July 2021, EAPS welcomed its first Peter H. Stone and Paola Malanotte Stone Professor in Earth, Atmospheric and Planetary Sciences: Arlene Fiore. An atmospheric chemist with more than two decades of research experience, Fiore has been teaching since 2011 and comes to EAPS from the Department of Earth and Environmental Sciences and Lamont-Doherty Earth Observatory of Columbia University.

Fiore's work in climate science reflects a central focus for both donors. Stone, who is now emeritus, wrote and coauthored seminal papers on global warming. Malanotte-Rizzoli, a professor of physical oceanography, has developed climate, ocean circulation, and ecosystem models that chart the world's oceans.

"Professor Fiore is a superb teacher, mentor, atmospheric chemist, climate specialist, and researcher," says Malanotte-Rizzoli. "Climate science is the science of the future, bringing together all of the earth sciences. She brings to MIT the breadth and depth of expertise to move the earth sciences forward and meet the greatest challenge of the 21st century: climate change." —Susan Saccoccia

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ROCKING OUR WORLD

"How Will We Live Together?" is the organizing principle behind the 17th International Architecture Exhibition of La Biennale di Venezia 2021. Curated by Hashim Sarkis, dean of MIT's School of Architecture and Planning (SA+P), and running through November 21, 2021, the exhibition features several exhibits by MIT faculty, including *Igneous Tectonics*. This installation imagines a new design strategy for the age of climate change—sequestering and embedding CO_2 into a resilient, sustainable, renewable building material: rock. The installation was developed by Cristina Parreño Alonso, lecturer in SA+P, and Sergio Araya Goldberg SM '06, PhD '11 in collaboration with Assistant Professor Matěj Peč of the Department of Earth, Atmospheric and Planetary Sciences.

IMAGE: ANDREA AVEZZÙ, COURTESY OF LA BIENNALE DI VENEZIA

MIT ( )
CAMPAIGN FOR A BETTER WORLD