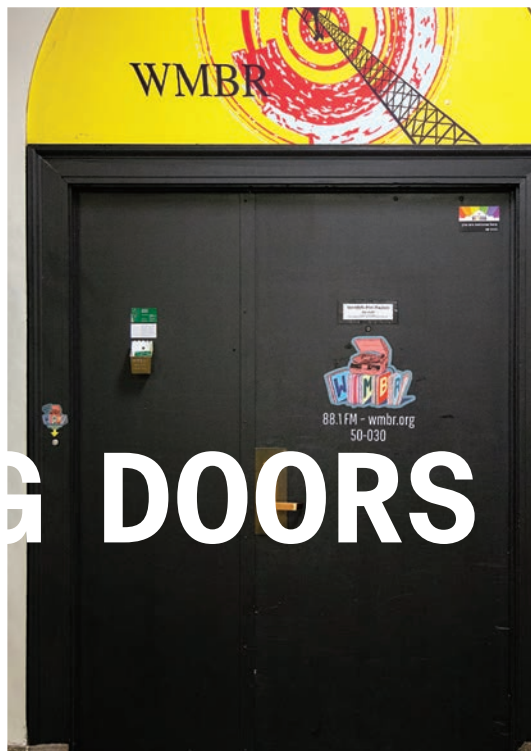


Spectrum



OPENING DOORS





Left: the entrance to Lobby 10 from Killian Court.

PHOTO: BRYCE VICKMARK

FRONT COVER

Doors of MIT (numbered across rows, starting top left): (1) main entrance at 77 Massachusetts Avenue; (2) Building 6; (3) faculty member Stefani Spranger at the Koch Institute; (4) Kalyn Bowen '19 at Next House; (5) Lobby 10 exit to Killian Court; (6) campus radio station WMBR in Walker Memorial; (7) Office of Admissions as seen from the Infinite Corridor; (8) graduate student Ari Bronsoler at the MIT Sloan School of Management; (9) Stata Center classroom 32-124.

PHOTOS: NIKI HINKLE (1, 2, 6, 9); KEN RICHARDSON (3); SARAH BASTILLE (4, 8); BRYCE VICKMARK (5, 7)

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BACK COVER

Sarah Womble, Omar Ebrahim, and Jesse Darden in *Schoenberg in Hollywood*, in November 2018 at Boston Lyric Opera, composed by Tod Machover with a libretto by Simon Robson, and featuring sound design by Ben Bloomberg '11, SM '14 and video projections by Peter Torpey SM '09, PhD '13. Machover is Muriel R. Cooper Professor of Music and Media at the MIT Media Lab. An exhibit about the production is on display through April 30 in the lobby of MIT Building E14.

PHOTO: LIZA VOLL PHOTOGRAPHY/COURTESY OF BLO



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

Contact Us

617.253.2066
spectrum@mit.edu

spectrum.mit.edu
betterworld.mit.edu
giving.mit.edu/spectrum

Vice President for Resource Development

Julie A. Lucas

Executive Director of Communications and Events

Carrie Johnson

Director of Marketing and Communications

Aimée Jack

Editor

Nicole Estvanik Taylor

Creative Director

Barbara Malec

Associate Creative Director

Elizabeth Connolly

Design

Stoltze Design

Contributing Designer

Niki Hinkle

Copy Editor

Evanthia Malliris

Spectrum Online

Stephanie Eich

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

Supporting Smartness

A first-year undergraduate once told me that what impressed her most about MIT was learning that “smartness comes in so many different ways.” I had never heard it put quite like that, but I knew exactly what she meant. For nearly 40 years, I’ve watched smartness arrive on campus in the form of passionate, curious, and inventive students and faculty who enrich our community and advance our mission.

But bringing that smartness to campus is hard work.

MIT is one of only five US colleges and universities that can make all of these three claims: We admit all undergraduate students without regard for their financial circumstances; we award all undergraduate financial aid based on need; and we meet the full demonstrated need of all of our admitted undergraduates. If you’ve shown you have the talent, creativity, and drive to succeed at MIT, we want you on our campus, regardless of your ability to pay.

To keep these commitments, we make a serious investment in financial aid. For the current academic year, MIT increased its financial aid commitment by 9.6%, about 2.5 times the increase in tuition and fees. For graduate students, we continue to enhance our support for merit-based fellowships to help defray the costs associated with tuition and health insurance.

And of course, investment in our community extends to our brilliant faculty. We compete for faculty talent in every field, and an endowed professorship can be the decisive factor in convincing prospective colleagues that MIT is the best place to invest their talent.

Support for scholarships, fellowships, and professorships doesn’t often make headlines, but the truth is that no other form of support is more essential to maintaining the excellence of MIT.

To me, higher education is a little like space exploration. It’s a thrill to build the rocket, and you can’t beat the feeling of discovering a new planet. But if you don’t have a world-class launching pad—in our case, talented students and faculty—you’re not getting off the ground.

Thanks to the extraordinary generosity of nearly 100,000 alumni and friends, we’ve made tremendous progress toward our goal for the MIT Campaign for a Better World. To truly make a better world, however, we must never ease up on our commitment to lowering the barriers for talent—and for every variety of “smartness”—from across the country and around the world.

L. RAFAEL REIF



LEARN MORE
betterworld.mit.edu



Clean Start

This fall marked the grand opening of MIT.nano, an ambitious six-year project to build a state-of-the-art facility for nanoscience and nanotechnology at the heart of the campus. Construction now complete, the journey begins to fill MIT.nano over the next three to five years with the tools and instrumentation thousands of researchers will use to design matter and materials like nature does—atom by atom and molecule by molecule. It is delicate, precise work that will transform fields as far-ranging as energy, health, computing, and manufacturing.

MIT.nano houses a remarkably quiet imaging/metrology facility, an immersion lab for digital visualization, prototyping labs, chemistry teaching labs (see page 4), and art galleries. Many of the building's instruments have yet to be purchased; others have yet to be invented. The first to be installed—a pair of multimillion-dollar cryogenic electron microscopes housed in the basement—can image organic structures in 3-D near-atomic detail, a technology that only recently became commercially available.

In the meantime, one of the greatest resources MIT.nano has to offer is already in place: space. And exceptionally pristine space, at that. A major portion of the facility's square footage is devoted to two capacious clean rooms (such as the one at right) in which the air is scrubbed of dust and other contaminants that could disrupt research at the nanoscale.

PHOTO: ANTON GRASSL/COURTESY OF WILSON ARCHITECTS



Pipes for

- Ultraclean deionized water
- Cooling process water
- Ultrapure nitrogen gas
- Processing gasses
- Compressed air
- Clean air
- Exhaust (carried to heat-reclaiming units)

CLASS 1000 CHASES: areas through which air is drawn back up to scrubber level.

↑ **"Bunny suits"** prevent contamination (humans shed millions of skin cells per day).

1°C

Climate kept consistent within 1°C and one percentage point of humidity.

15 sec.

Air in entire room can be completely scrubbed every 15 seconds.

Matching level above each clean room dedicated to equipment that scrubs and circulates air.

50k

Nearly 50,000 square feet of clean room space.

CLASS 100 BAYS:

10,000× cleaner than typical human environment;
<100 particles larger than half a micron per cubic foot of air.

Bamboo

in courtyard provides a glimpse of nature to workers in the lab.

Amber light

prevents stray UV rays from interfering with nanolithography.

10^{-9} m

= 1 nanometer

Do It Yourself

By recreating a chemistry professor's research, students build the foundations for future discoveries

TITLE

5.372 **URIECA** Module 8: Chemistry of Renewable Energy

INSTRUCTORS

- **Yogesh Surendranath** PhD '11, Paul M. Cook (1947) Career Development Assistant Professor in Chemistry
- **An Chu**, first-year graduate student, chemistry

FROM THE CATALOG

Based on the research of Professor Yogesh Surendranath: Students are exposed to the **electrochemical processes** that underlie renewable energy storage and recovery. They will investigate charge transfer reactions at electrode surfaces that are critical to the operation of advanced batteries, fuel cells, and electrolyzers. The basic theory behind inner- and outer-sphere charge transfer reactions at interfaces will be developed and applied to construct mechanistic models for important energy conversion reactions including the reduction of oxygen to water and the reduction of protons to hydrogen gas. Students will also synthesize new catalytic materials for these reactions and investigate their relative performance.

John Dolhun PhD '73, director of the undergraduate laboratory: "Undergraduate Research Inspired Experimental Chemistry Alternatives: I think the key words there are 'research inspired.'"

Surendranath: "Electrochemistry is a broad field that relates to a myriad array of emerging energy storage technologies, so this laboratory gives students a great deal of exposure to the underlying principles of that field."

THE MODULE

DAY 1: Introductory Experiments and Basic Diagnostics

DAYS 2–3: Molecular Oxygen Reduction via Iron Porphyrin

DAYS 3–4: Heterogeneous Oxygen Reduction via Nickel Sulfide

DAYS 5–7: Metal Deposition and Hydrogen Evolution

THE LAB SESSIONS

Undergraduate Research Inspired Experimental Chemistry Alternatives (URIECA) modules last for only a few weeks, allowing students to fit three or four into each semester. In Module 8, **small groups of students** meet twice a week for up to four hours per session. Each lab session starts with a pre-lab lecture covering a foundational aspect of electrochemistry lab work relevant to that day's experiment—for example, reading and interpreting a cyclic voltammogram,

which researchers use to understand a molecule's electrochemical properties. The teaching assistant encourages students to move beyond rote memorization to a deeper understanding of how these fundamentals apply to **broader lab work**.

Above: classes began in the new Chemistry Undergraduate Teaching Laboratories in the MIT.nano building this past fall.

PHOTO: KEN RICHARDSON



Audrey Pillsbury '19: "That small group setting is useful for learning the material really well—not just reading a manual and doing the steps, but actually learning the methodology behind it."

Valentina De La Rosa '19: "These modules show more of the practical side of things instead of just theory."



THE LAB WORK

By conducting experiments based on work pioneered in [Surendranath's lab](#), students prepare different electrochemical reactions that are the basis for modern batteries and other energy storage and recovery devices. They work in the new Chemistry Undergraduate Teaching Laboratories located in the new MIT.nano building (see sidebar). The advanced facilities in MIT.nano enable faculty to introduce a new level of exploration to the lab work so that students can consider the **nanoscale properties** of the materials they synthesize. The work students do in URIECA labs can inspire an **Undergraduate Research Opportunities Program (UROP) project**, either through a new relationship with a professor or by catalyzing an idea for a line of research. The **techniques** the students learn and employ will give them an edge both in internships and the workforce.

—Stephanie M. McPherson SM '11

Chu: "While the module itself is not necessarily designed to make a new discovery, we gear it towards preparing students to be able to engage in the frontier of research."

Surendranath: "The types of things that allow energy conversion to be possible occur at the nanometer- and molecular-length scales. We are teaching them about modern and very important applications of nanoscience."

Miller Tan '20: "My UROP, utilizing flow chemistry with photo breakdown, is based on Module 7."

Pillsbury: "Every time I go to an internship, I have a pretty good sense of what I'm supposed to do because I've done it before. Learning these kinds of lab techniques is really important."

Why New Undergraduate Chemistry Labs?

The URIECA modules began in 2007 as a new way to teach chemistry majors the ins and outs of lab work with the types of experiments they might encounter in industry or a research lab. But for 10 years, this cutting-edge education took place in a decades-old building that lacked the infrastructure and support for advanced instrumentation.

When MIT.nano, the campus's striking new addition dedicated to nanoscience, celebrated its grand opening this fall, among the first occupants to do science under its roof were chemistry students utilizing the new undergraduate chemistry lab facilities on the top floor. Being in this building allows URIECA module students to use state-of-the-art equipment such as an ICPMS (inductively coupled plasma mass spectrometer), an instrument that detects singly charged atoms of elements at concentrations at or below one part per trillion.

Department of Chemistry head Tim Jamison, who is the Robert R. Taylor (1892) Professor of Chemistry, and Jennifer Weisman, head of the Chemistry Education Office, explain how the new space has answered a pressing need.

How are these new chemistry labs providing a better educational opportunity for MIT's chemistry students?

TJ: Our previous Chemistry Undergraduate Teaching Laboratories (UGTL) were well past their prime, with instrumentation that was several generations behind the times. The new UGTL in MIT.nano is state of the art. With the goal of combining a fantastic new space and innovative laboratory education, we have also undertaken an ambitious modernization of the instrumentation. We've made great progress, but we're not at our goal yet. We welcome any and all support for this modernization initiative!

How many students take advantage of the department's classes in a given year?

JW: The department currently has 67 undergraduate majors, including students majoring in Course 5 (chemistry) and 5-7, the joint chemistry and biology major. But during the 2017-18 academic year, we taught 1,249 undergraduate students from 21 different majors, as well as first-years who haven't yet declared. With few exceptions, all MIT undergraduates must take one term of chemistry as part of the General Institute Requirements (GIRs).

Are URIECA modules for majors only? What chemistry lab opportunities are offered to non-majors?

TJ: Our chemistry majors complete all 12 modules in our URIECA curriculum, and we welcome all other students to take them too. For example, Module 1: Fundamentals of Spectroscopy and Module 2: Synthesis of Coordination Compounds and Kinetics require only the chemistry GIR as a prerequisite. We also offer Chemistry 5.310 for non-majors. All of our laboratory subjects are held in these new state-of-the-art laboratories—and by virtue of being located in MIT.nano, we hope that students' awareness of nanoscience and the opportunities in that field will also be raised.



Opening Doors

How remarkable can it be to open a door for another person?

So often, our passages from one place to the next are everyday, ordinary. But sometimes stepping through changes everything.

For undergraduates, graduate students, and faculty members, the financial support that provides entrance to MIT, or to a new avenue in their work, can be life-changing. The generosity of those who support scholarships, fellowships, and professorships unlocks one door to reveal many more. Behind each one: new ideas that may shape a career; opportunities to make a true dent in problems once thought intractable; rooms packed with strangers who will become friends, colleagues, mentors, collaborators.

The people at MIT are what make it an exceptional place. When someone who belongs here pauses at the door, holding it open can make all the difference.

One of five beaver sculptures created by Tara Fadenrecht, a lecturer in the Department of Materials Science and Engineering, and cast in silicon bronze by the team of instructors at the Merton C. Flemings Materials Processing Laboratory (aka "the Foundry"). The sculptures were finished and fabricated into door handles (in use at that facility and the MIT Glass Lab) by Fadenrecht and Christopher Di Perna.

To Be Continued

Each MIT story is different—but those who give and receive scholarships share a sense of the possibilities

Less than 15 minutes after fellow MIT math majors Stephen Berenson '82 and Matisse Peppet '20 first met, the conversation turned to time travel.

To be fair, “almost like time travel” were Berenson’s exact words, describing a potential mechanism for rewinding cells to their pre-malignant state. He’d been sketching his career for Peppet: three decades at J.P. Morgan, then a new direction with Flagship Pioneering. Working with biotech entrepreneurs, he explained, he’s been able to roam broadly through frontiers of scientific research that have always fascinated him.

The point of Berenson’s story was to assure Peppet that, her own path as yet unmapped, the future holds any number of possibilities. Reflecting on their encounter afterward, she says it also affected how she thinks about the present. When the two discovered they’d studied with the same professor, “it made me realize that, years after I graduate, I might remember some of the classes I’m taking now with the same

fondness he showed for that algebra class,” says Peppet, a junior from Ohio who is double majoring in math and philosophy. “I’ve kept returning to that glimpse of perspective through the busy mid-semester haze, a reminder that this time is treasure.”

The meeting came about because Berenson has endowed a scholarship of which Peppet is a beneficiary. She is one of thousands of undergraduates whose time at MIT is, in a very real sense, a gift made possible by donors who trust students will use this opportunity to transform their lives and the world around them. Time and again, they’ve been proven right.



Berenson (left) and Peppet

“Now my future looks very different”

James Li '19 remembers Pi Day 2015—the March 14 release of MIT admissions decisions. Steeling himself for disappointment, he shut himself into his bedroom to log on and learn his fate. The moment remains vivid in his mind. “I read the words. I couldn’t believe it. Read them over again. I walked across the room to my bed and just lay there face down for a bit. I didn’t think that would happen. And now my future looks very different than I thought it would.”

Born in China and raised in California, Li says he nearly didn’t apply to MIT, which “seemed like a whole other world, something kind of mythical.” There was another consideration: “I don’t think I would have applied had MIT not had need-based financial aid. Even if I got in, I wouldn’t have been able to go. Knowing it would be financially possible was definitely a factor in applying, and in accepting.”

“I don’t think I would have applied had MIT not had need-based financial aid. Even if I got in, I wouldn’t have been able to go,” says Li.



Li

For Li’s fellow senior, Kalyn Bowen ’19, MIT was a goal she was determined to pursue. “All of my friends ended up at the University of Hawaii, but if I had stayed in Hawaii, I feel like I would never have left. MIT was where I really wanted to be.” She adds: “If I didn’t get a scholarship and had to take out loans, I think I still would have come, but I would have been so stressed.” A first-generation college student who emigrated from Japan as a teen, she says p-sets provided ample stress as she struggled to catch up with classmates who’d had access to more AP classes and other advanced academic opportunities in high school. During a tough first year, she was “relieved that financial burden wasn’t a factor.”

Neither Bowen nor Li have a single person to thank for their scholarships. Instead, each has a whole group of supporters. They are supported by funds established, respectively, by the Classes of 1979 and 1989. Hundreds of alumni have donated to funds like these, often to mark their reunion years, giving a collective boost to undergraduates for whom need-blind admissions paired with guaranteed need-based financial aid puts MIT in reach.

Bowen still has academic stress in her life, she says—but now she also has what she calls a happiness journal. “Every day for two years now, right before going to sleep, I write at least one happy thing that happened to me that day. There hasn’t been a day at MIT when I couldn’t think of a happy thing. It’s usually more than one thing. It’s usually like a five-bullet list.”

The richness of the MIT experience has led Li and Bowen, both set to graduate this spring, in unanticipated directions. Li’s major is mechanical

engineering, but sampling classes across disciplines has shaped his aspirations as have hands-on research experiences at the MIT Media Lab’s City Science group, a robotics startup, and an R&D division at Ford. “My hope is to do something at the intersection of transportation, mechanical engineering, and urban planning,” he says. After discovering the Department of Anthropology, he has also gained an interest in how culture and technology interact. “I’d like to end up in a role where I can use my engineering skills to build something meaningful, but also think about how people use it and react to it, how it will affect communities.”

Bowen’s own arc has shifted since her first year. A computer science major with a love for learning languages, by junior year she found herself looking for ways to incorporate her growing passion for education. She interned at companies building apps for tutoring and for teaching children with no English language background how to code; assisted with intro classes in her department; and worked at a nonprofit supporting students from low-income backgrounds. “Teachers are some of the people I admire and appreciate the most. They’re the reason I’m here at MIT today,” she says. “I feel like they should be paid more and get more recognition. I started thinking about how I can change that. Majoring in computer science taught me math and logic I would need in any career, but after I graduate I’m planning on getting a master’s in political science and then going to law school so that I can become an educational lawyer.”

“It’s the giving of themselves”

It was raining on the day Gloria Wong drove with Shivani Chauhan ’18 and her roommate to the beach near Wong’s home. Even so, Wong recalls, the two young women grabbed an umbrella and strolled along the ocean’s edge.

Love of the water is something Chauhan has in common with Backman Wong '48, Gloria Wong's late husband, in whose name she established the scholarship that supported Chauhan throughout her undergraduate education. Backman earned his degree in mechanical engineering in three years, learning to sail in the process. He commuted to campus, remaining a helpful presence for the three of his nine siblings still at home in Boston. "The times were so different," Gloria Wong comments, noting that while his career as a director of research and development involved plentiful travel, in college her husband did not have the far-flung internship opportunities MIT students now enjoy through the MIT International Science and Technology Initiatives program. Wong was struck by Chauhan's enthusiasm and confidence as she described learning experiences in locations such as Israel and California. Last year, Chauhan also completed a yearlong SuperUROP project for her computer science major, doing intensive research on communications networks. "She had a very clear sense of how she was going to approach her plans for the future," Wong remembers of their conversations.



Wong (left) and Chauhan

Getting to know her scholarship donor, says Chauhan, "is a connection I cherish to this day."

"It was the generosity of strangers investing money in a nobody that made me realize I could be a somebody," says Freitas.

Now a master's of engineering candidate at MIT, Chauhan is designing machine learning technology to improve diabetes screening in India. She says getting to know Wong during her undergraduate years—through campus events, correspondence, and that seaside visit—has created "a connection I cherish to this day."

Attending MIT first captured Chauhan's imagination when, as a Colorado high schooler, she participated in a competition using the Institute's App Inventor platform. "I'd like to think I would have found a way to make my dream of going to MIT possible no matter what, but the financial aid package was so generous, it helped me be fully happy with my decision, knowing it wasn't putting a huge burden on my family." She found a way to pay the opportunity forward through outreach with the Society of Women Engineers, encouraging girls in local schools to consider a future in STEM.

Wong has met several of the students that the Backman (1948) and Gloria Wong Fund has supported since 2008. The decision to honor her husband's memory with such a gift followed his quiet lead: "He was always eager to help out in MIT's fundraising events. I know that he treasured the education that was given to him. It came through not so much in what he said as what he did."

She was pleased to recognize that quintessentially MIT quality

in Chauhan when hosting her and her friend in her town. The students joined Wong at a church event, "and I didn't expect them to help in the kitchen or to serve, but they did. It's not so much asking or telling, it's the giving of themselves."

"Nothing would have made them prouder"

Among Backman Wong's fellow 1948 graduates in mechanical engineering was another Massachusetts native named Bill Russell. The Institute played "a leading role" in Russell's story, including a career at the MIT Instrumentation Laboratory and its successor, the Draper Lab, according to Jeffrey Rosensweig PhD '85.

Both Russell and Rosensweig met their wives through MIT. Russell married his classmate's sister. And Rosensweig married Russell's daughter, Rita Lenore Russell Rosensweig '78. Rita was working at MIT as an architect when Jeff arrived to study economics under such influential faculty members as Rüdiger Dornbusch and Stanley Fischer PhD '69. With so many family links to the Institute, it was a natural fit in 2007 for the Rosensweigs to establish the William Arthur Russell Jr. (1948) Fund. "We wanted him to know that he would have a legacy that would live on forever at this Institute he loved so much," says Jeff, who is now a professor of international business and finance at Emory University. Through his final years, he says, his father-in-law enjoyed reading letters from his scholars: "He always was proud that MIT would accept the best regardless of their background."

When Jeff faced tragedy last year, losing Rita to breast cancer, he was moved to honor her in the same way they'd chosen for her father. He has established a charitable remainder unitrust that will fund scholarships in her name. "One of the things that inspired Rita was reading about students making practical inventions that are enhancing people's lives," he says. "I think

nothing would have made Bill or Rita prouder than to support students who will go out to do the great works so needed in the world.”

Jeff adds that during the era when they met, his wife volunteered as an advisor to first-year students, many of whom were the first from their families to attend college. That’s an experience with which current Russell Scholar Maxwell Freitas ’19 can identify. At a recent gathering with scholarship donors, Freitas spoke frankly about his background as the son of Brazilian immigrants seeking a better life for their kids.

“I grew up seeing them work harder than absolutely anyone I know,” Freitas declared. “They were unable to go to college. They were just trying to make ends meet for my brother and me. My dad was a painter, and my mom was a housecleaner. Most people would probably see these as lesser occupations, but I have learned to see my parents for the way they truly are: for the heroes that society needs. It’s not because of what they do but how they do it. We didn’t live a luxurious lifestyle, but there was so much my parents offered my brother and me.... We’ve learned to value life and use our skills to serve the world. Through all of high school I internalized this and worked my butt off. Clearly, I don’t come from a background where my family could help me with my advanced homework. I didn’t get much talk about scientific or academic topics at the dinner table. And I came from a pretty urban public school. But I had a dream to give back to my parents and make everything worth it.”

Since arriving at MIT, Freitas has fallen in love with biological engineering: “I came to realize that life science has so much beauty in it and so much untapped potential in making our biology work for us in better ways than it has for thousands of years.” He has worked in labs focused on leukemia research and the regeneration of heart cells. Having never left the US before college, Freitas will graduate this spring with 17 countries in his passport, including Brazil, where he visited hospitals to learn more about public health, and India, where he helped to develop prosthetic devices for amputees. “All of this is just a testament to how much MIT has done for me. I’m confident I can redefine the boundaries of what the world knows as the status quo, and I’m confident I can make my parents proud.

“It was the generosity of strangers investing money in a nobody that made me realize I could be a somebody,” he told those assembled. “My life would be radically different if I didn’t have the means to come to MIT.” Exactly where he’ll go from here, no one in the room could know—but it’s not hard to see the promise in a story with such a strong beginning.

—Nicole Estvanik Taylor



PHOTO (ABOVE): JOHN ROSENSWEIG

PHOTO (LEFT): ROSE LINCOLN

Scholarships at MIT

MIT has a longstanding commitment to need-blind admissions, of which scholarships are the foundation. To stand by this commitment year after year is a formidable financial undertaking—but it is a promise backed by the strength of MIT’s broader community, enabled by numerous gifts of all sizes to scholarships and unrestricted funds. Thanks to this collective generosity, thousands of undergraduates have seized the opportunity of an MIT education, regardless of their financial circumstances.

8,849 **29%**

undergraduates have received scholarships from MIT over the past decade.

of undergraduate financial aid dollars (>\$34M) comes from MIT’s unrestricted funds.

\$51,111

median scholarship awarded by MIT.

\$64,612

tuition and fees, plus estimated room and board.

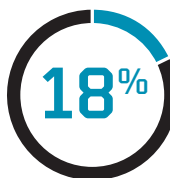
ACROSS THE UNDERGRADUATE STUDENT BODY



receive scholarships from MIT.



come from families earning ≤\$90K and are guaranteed to attend MIT tuition-free.



are first-generation college students.

ALL FIGURES AS OF ACADEMIC YEAR 2017-18.

Leading to Green

More efficient or more sustainable? Janelle Heslop helps businesses achieve both

Janelle Heslop is no shrinking violet. She found a voice for herself and the environment when she was in middle school, volunteering as a junior docent for the Hudson River Museum.

“I was a 12-year-old giving tours, preaching to people: we’ve got to protect our resources,” Heslop says. “At a very early age, I learned to have a perspective, and assert it.”

Today, Heslop is honing her passion into skills in business and engineering through her second and final year of MIT’s Leaders for Global Operations (LGO) program. The program provides two degrees: an MBA from the MIT Sloan School of Management and an SM from the School of Engineering, giving Heslop the foundation to pursue her dream of transforming businesses around their environmental impact. “You can make fun and interesting products that also take good care of our natural resources,” she says.

Before coming to MIT, Heslop had worked successfully in consulting with a focus on

“You can make fun and interesting products that also take good care of our natural resources,” Heslop says.

The Augustus O. Tai (1991) Fellowship

sustainability and investments in clean technology. At GreenOrder, she advised companies like General Electric on sustainability. She then joined Veolia, a global environmental services company, where she reconnected with her passion for water through projects such as a four-year collaboration with New York City's Department of Environmental Protection that helped save the agency \$150 million.

Heslop decided to come back to school to learn the skills that could effectively drive environmental stewardship in business. The LGO program has been a fantastic fit, academically and socially. "The LGOs are a really tight-knit and passionate community," Heslop says. "Everyone is clearly super smart and really will be—or already are—world-changers. But their humility and compassion for others is truly inspiring to me."

An alumnus of the program, Augustus "Gus" O. Tai SM '91, has demonstrated his own admiration for LGO students by endowing the graduate fellowship that currently supports Heslop. "I remember getting the letter from LGO," she says, "which said something like, 'You're receiving this based on your accomplishments thus far—but also the *potential* that you have to be a leader.'"

"It's extremely encouraging to know that I have people who really believe in me from the institutional level, all the way down to my classmates," she says. And of Tai's gift: "To know that someone's investing in me to be here is amazing."

Outside of classes, Heslop continues to pursue that enduring passion for water instilled along the Hudson. She's codirecting the Water Innovation Prize this year, a student startup competition that awards \$30,000 to the top-three teams with innovative solutions to water-related challenges. Past winners have included technologies for detecting water-borne bacteria, harvesting water from the air, and waterless toilets. "I wanted to be with people who care about the same things I care about," Heslop says.

At the same time, Heslop is busy conducting research toward her thesis. She recently wrapped up a six-month stint at the biotech company Amgen, evaluating new technologies for manufacturing drugs to "help usher in the next generation of manufacturing," she says. Advised by Heidi Nepf, the Donald and Martha Harleman Professor of Civil and Environmental Engineering, Heslop aims to identify technologies that "can meet demand, are operationally efficient, and don't ruin the environment."

The culture at Amgen has been eye-opening, Heslop says. Its people are driven and passionate about breakthroughs in health care, and they've embraced Heslop's ideas and methodologies to weigh the environmental impacts of their manufacturing systems. "They've been so open to that," she says. "I think it's because they're thinking about the long-term health and sustainability of communities."

Those are values that Heslop holds dear. And while she doesn't know what industry she'll work in after she graduates in June 2019, she's confident she could be happy in many sectors, whether she is helping a company to make drugs more efficiently, or to design consumer products that aren't toxic to people or ecosystems.

With a laugh, she says: "This might be my over-the-top view of myself, but I think *any* industry can use my skillset and passions."

—Alison F. Takemura PhD '15

Augustus "Gus" Tai is an inveterate, self-described hipster. When he started in the LGO program in 1989, then called Leaders for Manufacturing (LFM), he was looking for a way to be different from his peers. But in LFM, Tai now recalls, he encountered a tribe of people who reflected values so central to him that he found himself *wanting* to share the group traits, instead of to reject them.

"What struck me as unusual was that the students I was with took the name—*Leaders for Manufacturing*—seriously," he says. He saw deep integrity, thought, and humility in what his classmates would do and say: for instance, their questions and work ethic, the lunch sessions they would create to further their learning, and their ability to hear opinions without being swayed by them. From then on, Tai says, he has loved the community of LFM/LGO alumni. "All these folks are really thoughtful and sincere," he says. "They're really committed to service."

And they're everywhere, in "any company that's well known for making things that are hard to make," Tai adds. The alumni roster includes the worldwide consumer CEO of Amazon, the former vice president of worldwide operations at Google, a vice president at Apple, and an acting US secretary of defense.

"It's very clear to me that the alumni group is the most competent, capable, and inspiring group I've ever been affiliated with," says Tai, who has worked for more than 20 years as a partner at the venture capital firm Trinity Ventures.

To aid the continued development of such gifted leaders, Tai created the fellowship that currently supports Janelle Heslop. She embodies many of the values that MIT and the LGO hold, Tai says, adding that he hopes to meet her in the near future and find out "if I can be helpful in her journey."

Tai's interest in supporting LGO students is a natural extension of his work mentoring

CEOs of startups and his values as a mindfulness practitioner. He attends to the growth of individuals and, in particular, cultivates the oft-underappreciated, but crucial, leadership skill of kindness. Being kind, especially to yourself, he says, lets you serve others best. —Takemura



Urgent Care

Ari Bronsoler's economic analysis helps to identify best practices in a struggling health system

With diabetes, “Mexico has three main problems: prevention culture, diagnosis capabilities, and early treatment,” Bronsoler explains.

PhD candidate Ari Bronsoler wants to transform health care delivery in his native Mexico. The economist's work addresses pressing issues in his home country, including diabetes, sugary beverage consumption, and communication efficiency.

Bronsoler works at MIT with economics professor Jonathan Gruber '87. Gruber was intrigued by Bronsoler's prior work in diabetes analysis, studying pay-for-performance contracts and concocting algorithms to improve diagnostic efficiency—as well as, in Gruber's words, by “his incredible work ethic and general devotion to attacking really important questions.”

It is urgent work: Diabetes is a health care crisis in Mexico. Bronsoler notes that 18% of Mexico's medical resources are spent on diabetes treatment. Stunningly, the number of diabetes patients in Mexico is predicted to nearly double by 2045, passing the 21 million mark.

The Mexico Fund for Graduate Students largely enables Bronsoler's research in this critical area. The fellowship was funded by Pedro Aspe PhD '78, Mexico's former minister of finance, to support promising economics students from Mexico.

With diabetes, “Mexico has three main problems: prevention culture, diagnosis capabilities, and early treatment,”

Bronsoler explains. “Many people end up not getting tested or confirmed with a diabetes diagnosis when they should, and around half of the diabetics in Mexico are undiagnosed. Further, many patients who are diagnosed don't comply with the recommended treatment or don't have access to it, leading to an increase in complications, hospitalizations, disabilities, and deaths later on.”

This is largely the result of a fragmented health sector, lack of prevention culture, and overburdened public institutions that cannot keep up with the increasing demand, he says.

Bronsoler's groundbreaking undergraduate research provided IMSS—the country's largest health care provider, with more than 58 million beneficiaries—with data to enable it to detect high-risk patients using a predictive algorithm. In fact, IMSS now uses the risk calculator he developed and has made it publicly available online.

Now, he is working on diabetes treatment research in Monterrey, Mexico, where he has partnered with Eli Lilly and Clinicas del Azucar,



The Mexico Fund for Graduate Students

a low-cost suite of clinics created by Javier Lozano MBA '10. These private clinics have introduced evidence-based algorithms to diagnostics and care, offering unlimited consultations for an annual fixed fee. When they visit, patients receive comprehensive evaluations by multiple specialists in less than two hours.

Bronsoler is conducting a three-year randomized control trial to estimate the effect that this one-stop shop model of diabetes care could have on health outcomes and to understand what drives patient adherence and how it could be improved by varying different aspects of incentives. Such a system could reduce the IMSS burden. "It may be reasonable to have entities like this treat a large portion of the Mexican diabetic population that is currently being treated in the public system. It could induce savings and help free up constrained resources to treat other diseases," he says.

If it works, the government might choose to institute a public policy to incentivize people to visit the clinics and adhere to treatment, Bronsoler adds. "If there is an improvement, it will lead to better control of the disease. Then there will be fewer hospitalizations and probably less overall spending," he says.

Meanwhile, Bronsoler is also studying the impact of Mexico's sugary beverages tax on health outcomes, analyzing consumption and health care data throughout the country.

"Taxing high-calorie foods has become a common strategy to fight obesity and non-communicable diseases around the globe," he says. "However, the literature has mainly focused on estimating what the effect of the tax is

on consumption—there is no reliable estimate about a high-calorie tax effect on health." Regardless of its outcome, his research aims to provide evidence that allows policy-makers to make more informed decisions about a tax that has inspired heated debate.

Finally, Bronsoler is studying the use of information and communication technologies (ICT) in Mexico City IMSS hospitals, focusing on how technology can speed the transfer of cardiac patients from lower-capability hospitals to specialized ones. Bronsoler's research focuses on Código Infarto (CI), a program that has improved the treatment of cardiac patients and implemented better ICT to facilitate hospital transfers. He is utilizing case-level data from Mexico City emergency rooms to track overall improvement in the survival rate from hospitals that use CI versus those that don't.

"I hope to prove that efficient reallocation of existing resources and improved organization in developing countries may help dramatically improve quality of service provided at the countries' institutions. Attention to heart attacks is the first example of this," he says.

Bronsoler hopes his work as a Mexico Fund Fellow can have long-range effects on health care delivery in his home country and potentially the whole world.

"The Mexico Fund changed my life. It's been an amazing opportunity for me to learn as much as I've been learning and to be able to explore different ideas around improving the health of my own country. I'm grateful, I'm enjoying it—and I hope I can contribute in return," he says.

—Kara Baskin

PHOTO: SARAH BASTILLE



Pedro Aspe PhD '78 has maintained a distinguished career at the pinnacle of finance and economics. Mexico's former minister of finance is now president of real estate investment company Insignia Capital.

He has held other high-level teaching and government positions in Mexico, including chairman of the economics department at Instituto Tecnológico Autónomo de México (ITAM) and secretary of budget and secretary of the treasury.

That professional trajectory started at MIT, Aspe says, and he was driven to give back to an institution that gave him so much.

"The economics department was just outstanding, with teachers who were just brilliant. It was the best I could find in the world," he says, noting that he studied under legendary Nobel Prize-winner Franco Modigliani. Future Nobel laureate Paul Krugman PhD '77 was also a classmate.

"The interaction among faculty and students was superb. And because I've been so lucky, I wanted to set aside assets to return to the institutions that have helped me," Aspe says.

Fellowships fully cover a recipient's tuition and health insurance and include a stipend for living expenses. The Mexico Fund is devoted to supporting Mexican citizens pursuing a PhD at MIT, with a preference for students in the Department of Economics. Ari Bronsoler is the first beneficiary.

Aspe praises Bronsoler's work ethic and devotion to Mexico. He hopes that Bronsoler makes the most of the funds—but, most of all, that he savors his MIT years.

"This is the opportunity of your lifetime. Enjoy it! Grab hold of all the things you can," Aspe says. "Those were the best years of my life: I learned from teachers, I learned alone in the library, and I learned from my fellow students. It was just magnificent."

—Baskin

PHOTO: JAVIER PALACIOS/CUARTOSCURO.COM

Transforming Traditions

Erin Genia infuses new technologies into the techniques of indigenous art

For Erin Genia, a graduate student in the MIT Program in Art, Culture and Technology (ACT), exposure to digital technologies at the Institute has opened new pathways for telling the stories that comprise her remarkably diverse body of work. A native Dakota from Olympia, Washington, Genia uses her mastery of technique and materials to explore Dakota philosophies and how they might address contemporary challenges such as climate change and indigenous cultural preservation.

Genia entered MIT in 2017 as an award-winning conceptual artist whose work has been exhibited nationally and internationally; she received her first public art commission in 2017 for *Anpa O Wicahnpi, Morning Star*, a Dakota pride banner displayed at the Seattle Center. She has also held positions as a community organizer, educator, and cultural worker.

Her most recent major work is the sound sculpture *Acoustic Tipi*, which she exhibited at the 2018 Venice Architecture Biennale. Created in the shape of the traditional Dakota dwelling but stylized to promote sound-transmitting capabilities, the piece features four drums and evokes two supernatural beings from Dakota legend who bring environmental catastrophe.

“The sound of the drum is communication, and I wanted to create a structure that would house that energy,” says Genia.



Genia created *Acoustic Tipi* as a public interface to explore climate change, bringing people together to play the drums and create resonance that reverberates into the Earth. “The sound of the drum is communication, and I wanted to create a structure that would house that energy,” says Genia. “It’s a prayer with the cosmos.”

The various elements of *Acoustic Tipi*—the deerskin drums, painted deities, and precisely crafted wood panels—demonstrate Genia’s deep fluency in materials and devotion to continually adding to her mastery of media which include photography, drawing, painting, sculpture, jewelry, and casting.

At MIT, Genia is adding new technologies such as CNC (computer numerical control) cutting and 3-D imaging to her toolbox to further expand her creative reach and “adequately respond to ideas in whatever medium I think would be best. Digital fabrication has helped me get to the heart of what I want to focus on.”

No matter what the medium, the morning star symbol is a constant across Genia’s body of work. She describes the morning star as a living symbol that embodies the “Dakota philosophy and cosmology and lays out how to exist in the world.” If she’s unsure about how to approach a new medium, she “can always fall back on this image and explore it using the different techniques that I’ve been learning.”

In her wearable piece *InVisible*, the morning star manifests in shimmering, pieced gossamer fabric. In *Eclipse*, which Genia created in Neil Gershenfeld’s How to Make (Almost) Anything class at the MIT Media Lab, the symbol is boldly expressed through the precise angles of a CNC cutting machine.

Genia grew up immersed in a culture of creation as part of a family of artists and craftspeople. After starting her studies in ethnobotany, Genia transferred to the Institute of American Indian Arts in Santa Fe and ultimately got her degree in fine arts and Native American studies at Evergreen State College in Olympia. She also earned a master’s of public administration in tribal governance from Evergreen. It’s been a circuitous educational path for Genia, who describes herself as a non-traditional student. “I’ve gone to a number of different schools and have three kids. I’ve always had to navigate having a family, a job, going to school, and being an artist.”



Above: a glazed clay vessel made by Genia in 2016, inspired by Standing Rock’s Sacred Stone Camp, depicts the spirit of a water protector.

PHOTO: COURTESY OF THE ARTIST

Left: Genia with *Acoustic Tipi* (2018).

PHOTO: NICOLÁS KISIC AGUIRRE

From Many Sources, Full Support

Erin Genia is able to focus fully on her art education without financial and time limitations thanks to full fellowship support from the Program in Art, Culture and Technology (ACT) under the larger umbrella of the School of Architecture and Planning (SA+P). With such funding, artists can focus completely on their vision and amplify their voices in response to critical challenges around the world.

“In my experience, fully funded fellowships allow graduate students to put 100 percent of their effort toward their studies,” says ACT director Judith Barry, “whereas teaching and research assistantships often require a substantial time commitment—sometimes as much as 20 hours per week.”

ACT promotes opportunities for its students to find meaning in some of the most important issues of our time—such as the environment, cultural empathy, migration, and human rights—and to reveal opportunities to create a better world. The result is a program that combines the Institute’s focus on real-world problems with the power of artistic expression.

In addition to her fellowship, Genia has received support from a number of other sources, such as travel funding from ACT and the Office of the Dean, and additional project funding from ACT and the Council for the Arts at MIT. In 2018, Genia organized a panel of indigenous artists as part of the MIT Zoetics+ symposium. That work was funded by Cambridge artist and philanthropist Juliet Kepes Stone, daughter of late MIT professor and renowned artist György Kepes, and SA+P, along with MIT’s Office of Graduate Education, and Committee on Race and Diversity. Genia is also supported by other institutions, including by the First Peoples Fund, and by the Higher Education Program of her tribe, the Sisseton Wahpeton Oyate.

One of SA+P’s highest priorities is encouraging philanthropy for graduate fellowships. Promising young artists may not be able to rely on high-paying jobs right out of school and cannot ignore financial considerations when choosing where to study. With full support, top candidates can join the SA+P community and pursue their careers free from worry about costs.

In the absence of ACT fellowships, Genia was able to benefit from general Institute funds. Donors who make unrestricted gifts to MIT give the Institute the flexibility to apply the funds where they will have the greatest impact; often this means supporting students. “We must enable those students who are accepted by MIT to come to MIT,” says Hashim Sarkis, dean of SA+P. “This is our most critical priority at SA+P, to raise the necessary funds to offer all students the benefit of full tuition support, whether through endowed fellowships, expendable gifts of tuition support, or unrestricted gifts to SA+P and MIT.” —Downey



Above: *Eclipse* (2017), Genia’s expression of the morning star created with a CNC cutting machine for the class *How to Make (Almost) Anything*.

PHOTO: COURTESY OF THE ARTIST

After spending time on the periphery of the art world—working in art supply stores, framing, and doing community-based art outreach—“it was time to take everything I had learned and apply it to my practice,” she says. “And that’s how I decided to get my terminal degree in art here at MIT.”

Genia receives full fellowship support to study at ACT, which is part of the MIT School of Architecture and Planning. She says the support makes it possible to focus solely on her work and education. “Access to the incredible people, resources, and spaces at MIT has given me the confidence to explore, push, and even make mistakes, in service of ultimately producing excellent work.”

Looking forward, Genia wants to contribute to the reemergence of indigenous traditions for future generations. “Much of our cultural knowledge and artistic practices have been decimated. But there’s a great movement that’s happening now to bring those techniques back.”

—Katy Downey

Looking Forward to Fusion

Technical policy scholar Patrick White joins the SPARC project to ask: what comes after success?

Controlled fusion power has been a tantalizing prospect for decades, promising a source of endless carbon-free energy for the world. Unfortunately, persistent technical challenges have kept that achievement on an ever-receding horizon. But recent developments in materials science and superconductivity have changed the landscape. The proposed SPARC experiment of MIT's Plasma Science and Fusion Center (PSFC), in collaboration with the private, MIT alumni-led company Commonwealth Fusion Systems, is poised to use those breakthroughs to build the first fusion device that generates more energy than it consumes, bringing commercial

fusion energy within practical reach in the near future.

Patrick White, a PhD candidate in the Department of Nuclear Science and Engineering (NSE), is looking ahead to that long-awaited day. His PhD project, funded by the Samuel W. Ing (1953) Memorial Fellowship in the NSE department and PSFC, anticipates the many questions that will follow a successful SPARC project and the development of fusion power. "How do you commercialize this technology that no one's ever built before?" he asks. "It's an opportunity to start from scratch." White is focusing on the regulatory structures and safety analysis tools that will be necessary to bring fusion power plants out of the laboratory and onto the national power grid.

He first became fascinated with nuclear science and technology while studying mechanical engineering at Carnegie Mellon University. "I think it was the fact that you can take a gram of uranium and release the same energy as several tons worth of coal, or that a single nuclear reactor can power a million homes for 60 years," he remembers. "That absolutely blew me away." He saw commercial reactor technology up close during an undergraduate summer internship with Westinghouse, and followed that with two summers in Washington, DC, working with the Defense Nuclear Facilities Safety Board.

When White came to MIT for graduate work, he joined the MIT Energy Initiative's major interdisciplinary study, *The Future of Nuclear Energy in a Carbon-Constrained World*, authoring the regulation and licensing section of the final report (which was subsequently released this past September). He began casting about for a PhD topic around the time the SPARC project was announced.

The goal of SPARC is to demonstrate net energy from a fusion device in seven years—a key technical milestone that could lead to the construction of a commercially viable power plant scaled up to roughly twice SPARC's diameter. Because the fusion process produces net

energy at extreme temperatures no solid material can withstand, fusion researchers use magnetic fields to keep the hot plasma from coming into contact with the device's chamber.

"How do you commercialize this technology that no one's ever built before?" White asks. "It's an opportunity to start from scratch."



Patrick White (photographed in the Plasma Science and Fusion Center) is focused on the policy questions that will arise from the new SPARC technology.

PHOTO: BRYCE VICKMARK

The Samuel W. Ing (1953) Memorial Fellowship

Currently, the team building SPARC is refining the superconducting magnet technology that will be central to its operation.

Already familiar with the regulatory and safety framework that's been developed over decades of commercial fission reactor operation, White immediately began considering the challenges of regulating an entirely new potential technology that hasn't yet been invented. One concern in the fusion community, he notes, is that "before we even have a final plant design, the regulatory system could make the ultimate device too expensive or too cumbersome to actually operate. So we'll be looking at existing nuclear and non-nuclear industries, how they think about safety and regulation, and trying to come up with a pathway that makes the most sense for this new technology."

His PhD project proposal on the regulation of commercial fusion plants was selected by the PSFC for funding, and he got down to work in fall 2018 under three advisors: Zach Hartwig PhD '14, the John C. Hardwick Assistant Professor of Nuclear Science and Engineering; assistant professor Koroush Shirvan SM '10, PhD '13; and Dennis Whyte, director of PSFC and the Hitachi America Professor of Engineering.

White's career plans beyond the fellowship remain flexible: he notes that whether he ends up working with the licensing of advanced fission reactors or in the new world of commercial fusion power will depend on the technology itself, and how SPARC and other experimental projects evolve. Another possibility is bridging the communications gap between the nuclear industry and a public that's often apprehensive about nuclear technology: "At the end of the day, if people refuse to have it built in their backyard, you've got a great device that can't actually do any good."

For now, White's fellowship is not only laying the groundwork for his own future, but also perhaps the future of what would be one of the greatest technological advances of humankind. He points out that the stakes are higher than simply developing a new energy technology. "If we're really concerned about climate change and decarbonizing, we need to have every single tool on the table," he says. "The more tools, the better." —Mark Wolverton

Mark Wolverton is a 2016–17 MIT Knight Science Journalism Fellow.



In memory of Samuel Ing '53, SM '54, ScD '59, his family has established a fund to support graduate students at MIT's Plasma Science and Fusion Center (PSFC) who are taking part in SPARC, the center's push to create a smaller, faster, and less expensive path to fusion energy.

Born in Shanghai, China, Ing (1932–2018) was mentored by Professor Thomas Sherwood at MIT. Joining the Xerox Corporation after graduation, he rose from senior scientist to principal scientist to senior vice president of the Xerographic Technology Laboratory at the Webster Research Center in Webster, New York. He spent most of his career in western New York with his wife Mabel, who he met at an MIT dance. They raised four daughters: Julie, Bonnie, Mimi, and Polly.

An innovator and advocate for new technologies, including desktop publishing, Ing became intrigued with MIT's approach to creating fusion energy after attending a talk by PSFC director Dennis Whyte at the MIT Club in Palo Alto in early 2016. His daughter Emilie "Mimi" Slaughter '87, SM '88, who majored in electrical engineering, later expressed her own enthusiasm to her father when, as a member of the School of Engineering Dean's Advisory Council, she heard Whyte speak in the fall of 2017.

Mimi Slaughter remembers her father's passion for innovation and entrepreneurship.

"It's the MIT culture," she says. "I see that in the fusion lab—the idea of just doing it; figuring out a way to try to make it happen, not necessarily through the traditional channels. I know my Dad would agree. He did that at Xerox. He had his own lab, creating his own desktop copiers. That grew out of what he experienced at MIT."

The Ing family is celebrating that creative spirit with the Samuel W. Ing Memorial Fund for MIT graduate students who will be driving the research and discovery forward on SPARC. It was a class of PSFC graduate students that proposed the original concept for this experiment, and it will be the young minds with new ideas that, with the support of the fund, will advance fusion research at MIT.

Or as Ing said of the ideas behind SPARC: "Very interesting technology. It has a tremendous future, and if anyone can do it, it's MIT." —Paul Rivenberg

Above: three generations of MIT alumni in 2017. From left, Melissa Slaughter '17 with her grandfather Samuel Ing '53, SM '54, ScD '59 and her parents Mimi Slaughter '87, SM '88 and Frank Slaughter '84.

PHOTO: COURTESY OF MIMI SLAUGHTER



Tuning the Model

Meghana Ranganathan uses math and machine learning to improve how climate predictions are made

A siren wailed, prompting Meghana Ranganathan, age 6, to run to the closet in the guest room. She was armed with a stack of *Calvin and Hobbes* books and a glass of water. She closed the door behind her and waited out the tornado. “That would be my setup until I fell asleep in there, and then my mom would move me,” she says.

Ranganathan grew up in Dallas, where tornado watches and warnings happen a couple of times each year. Which means she took to that closet a lot. Once, in high school, she crammed into an office with 20 other students and a teacher for four hours, waiting out three tornadoes circling the area.

Ranganathan has started to apply her theoretical work to a real-world problem: the movement and shape-shifting of ice sheets.

It was later, in college, that her fear of storms transformed into something else. Ranganathan came to understand that “you can use math to represent the world around you.” In particular, she was taken with mathematical models that predict weather and climate—the very predictions that give the people of Dallas, say, a heads up that a tornado is brewing.

Today, as a graduate student in the Department of Earth, Atmospheric and Planetary Sciences (EAPS) at MIT, Ranganathan is focused on improving how models work. One approach is to meld an imperfect model (built primarily out of equations and assumptions) with an actual dataset (sparse and uncertain as it may be) to bring the model output into stronger alignment with reality. The technique can be “used to better recreate the past,” says Ranganathan, so that the future can be better anticipated. The goal is to apply what she’s learning to models of weather and extreme climate. “The big hurdle is being able to understand what’s going to happen with climate change,” she says. “If we run a climate model for 100 years, what is actually going to happen in 2100?”

Ranganathan has started to apply her theoretical work to a real-world problem: the movement and shape-shifting of ice sheets. Traditionally, researchers run a model of ice flow and compare it to observations of the position and velocity of a glacier over time. Inevitably, discrepancies arise, causing the model to be tuned and

The Callahan Dee Fellowship

tweaked until it more closely mimics reality. But Ranganathan is attempting to enhance and perfect the model by also including the actual satellite data from glaciers in Antarctica.

Should all go well with her work, Ranganathan hopes to improve the certainty around what the future holds. But weather and climate are chaotic systems, making them difficult to predict by definition. One way that Ranganathan is tackling the chaos is through machine learning, where a computer teaches itself with little or no human input. Advised by Sai Ravela, an EAPS principal research scientist with a computer science background, she is using neural networks—a machine learning model roughly based on the connections in the human brain—to help tackle the vast amounts of data she’s dealing with. The hope is to speed up the effort and make it more accurate.

Ranganathan’s graduate work at MIT is possible because of financial support, including from the Callahan Dee Fellowship Fund.

“The people who dedicate their resources to fellowships are enabling all of this amazing work that we do,” she says. “It’s what makes it possible for me to be here. I mean, the fellowship has been everything.”

Despite the imminent danger facing this planet, Ranganathan no longer runs to the closet to seek cover. Instead, she surrounds herself with people who help her make sense of it. There are the researchers in her department dedicating their lives to weather and climate “to help make the world a better place.” They give her hope. And there are the residents of polar regions themselves—people Ranganathan is already speaking with (in Greenland, for instance) to understand the full range of a community’s experience with climate change. They give her a reality check.

Last fall, the Intergovernmental Panel on Climate Change released a report stating that without action, the worst effects of a changing climate will occur within the next one to three decades. Which means: the siren is wailing. And Meghana Ranganathan and her colleagues are doing all they can to respond. —Ari Daniel PhD '08

Above: Ranganathan spent a week in Kangerlussuaq, Greenland, in 2016 as an undergraduate studying environmental science.

PHOTO: COURTESY OF MEGHANA RANGANATHAN

Pat Callahan '75, SM '77 and David Dee spent much of their adult lives in California, face-to-face with droughts and forest fires—local manifestations of a changing climate. But even before that, as an undergraduate majoring in mechanical engineering at MIT and a master’s student in the MIT Sloan School of Management, Callahan recalls experiencing the oil crisis of the 1970s. The environment “has been on my mind for forever,” she says. “It’s the worry about what we’re doing to the planet that’s so hard to bear, frankly.” Today, with a global climate crisis imminent, Callahan says, “it seems more pressing than ever that if you can do something, howsoever small, you try to do it.”

This thinking is what motivated the couple to create the Callahan Dee Fellowship Fund, which provides graduate fellowships to students in the Department of Earth, Atmospheric and Planetary Sciences. Recipients like Meghana Ranganathan and the other current Callahan Dee Fellow, Donald Martocello, are focusing their research efforts in the arenas of climate science and sustainability. Callahan, who recently retired as the chief administrative officer at Wells Fargo, hopes that the students receiving this funding “will do something important” that she and her husband couldn’t achieve otherwise. As she puts it, “the collective knowledge that a place like MIT can deliver to the world has to be part of the solution.” It’s why Callahan is donating to her alma mater, offering philanthropic funds to graduate students to work in fields that, in her view, are underfunded by the federal government at the moment.

MIT means a great deal to Callahan. “I loved going to school there, I had a good career when I left there, and I have very good feelings about the university,” she says. “There are really smart, motivated, hardworking people at MIT, and it feels like a good place to invest.” Funding these fellowships has allowed Callahan to take all the environmental issues she cares about—from plastics to warming seas—that she’s “pondered and thought about and read about to no avail over many, many years” and do something concrete about them. —Daniel

PHOTO: CINDY CHARLES



Life in the Field

Juanjuan Zhang pushes marketing science forward, inspired by its original MIT pioneer

In 1983, an academic journal called *Marketing Science* published an article about ground coffee. Co-authored by eminent MIT researcher John D.C. Little '48, PhD '55, it contained a statistical model showing how shoppers adjusted their coffee-buying preferences based on predictable factors such as brand loyalty, sale pricing, and in-store discounts. Little had been able to achieve this level of mathematical precision thanks to the emergence of the big-data revolution of that

era, laser-scannable Universal Product Code (UPC) markings on food packaging, which for the first time made it practical to capture consumer behavior in enough detail to model it using scientific methods.

Thirty-five years later, MIT Sloan School of Management faculty member Juanjuan Zhang—recipient of a new MIT professorship created by Little's family in his honor—remembers the ground-coffee paper vividly. “It was the first paper I ever read about marketing,” she says. Zhang, who studied game theory and econometrics at the University of California, Berkeley, cites Little as her inspiration for entering the field of marketing science—a field that Little, now an Institute Professor Emeritus and her longtime MIT colleague, is often credited with inventing.

An expanded concept of “marketing”

To Zhang, marketing is “a way of communicating—of bridging the gap between production and adoption, between intention and acceptance.” Her research shows how that gap can affect almost anything. For instance, in 2010 Zhang studied how kidney-transplant patients tend to reject viable organs when they are farther down on the waiting list. The reasons for someone higher on the list “passing” on a vital organ transplant may have nothing to do with the organ's medical quality, but the rational tendency of subsequent patients toward rejecting what others have rejected leads to 10% of donated kidneys going unused.

To Zhang, this is a marketing problem: patients are making sense of incomplete information in a way that harms their health. But trying to close this “information

To Zhang, marketing is “a way of communicating—of bridging the gap between production and adoption, between intention and acceptance.”



“they’re based on theories that we refine using data.” And just as technological advances have allowed scientists to gather higher-fidelity information about the natural world, marketing science, too, has been driven forward by the availability of more and better data. The super-

**Institute Professor
Emeritus John D.C.
Little '48, PhD '55,
in his office in 2005.**

PHOTO: ED QUINN

market UPC codes of the 1980s, which inspired Little’s coffee paper, led to the e-commerce boom of the late 1990s and early 2000s, which then seeded the current marketing landscape of smartphones and social media that Zhang inhabits. In 2017, for example, Zhang and colleagues from Tsinghua University conducted

a randomized study on Weibo, China’s largest microblogging site (similar to Twitter). They found that just 42 social media influencers could increase a TV show’s viewings by up to 57% simply by retweeting promotional content about the show to their millions of followers.

People, not particles

But just as Little changed the paradigm of marketing by incorporating scientific methods, Zhang’s research is now questioning the fundamental assumptions behind some of those methods. Her own study on the effect of tweeting, for example, assumes that a randomized field experiment provides a gold standard framework for establishing cause and effect. “The field experiment methodology is analogous to what has been broadly used in natural sciences. We measure the effect of a treatment in a ‘lab’ that we create in the field, where human subjects behave without knowing they are in an experiment,” she says. “But my current work tries to rethink if that’s actually the right method.”

Why wouldn’t it be? Zhang’s answer is simple: “People are not particles. Particles react—they don’t think. But humans do. Humans make inferences from every marketing message, every policy change, every natural stimulus they experience.” To Zhang, this basic fact complicates the supposedly “clean” data from field experiments—a problem Zhang refers to in her research as “belief endogeneity.”

If, for example, a smartphone company wants to see how demand for a new phone varies with price, the company could conduct a field experiment offering the same phone to different groups of buyers at \$99 and \$999. That buyers don’t know they’re being observed is the whole point: by comparing the two groups’ buying behaviors in this field lab, the marketers can “know” that one factor—price—is influencing demand.

Or can they? Buyers who don’t know they’re in an experiment may draw their own conclusions about the circumstances—assuming that price reflects quality, for example. “That layer of thinking contaminates the experiment,” says Zhang. “Our next step is to find out if there’s a systematic way to debias the data. We’re trying to provide a marketing scientific angle to this whole problem of big data, by saying that every data point is alive.”

Zhang’s work on that front is still in progress, but she says its paradigm-questioning purpose is inspired by Little’s example. “He’s only interested in the boldest ideas,” she says. “That’s my goal and the goal of many of the faculty here, to say: ‘let’s innovate, not just refine.’”

Zhang acknowledges that being named the John D.C. Little Professor was “a very personal and tearful moment, and an honor of a lifetime.” But even at age 90, Little is still combining big ideas with a practical bent, and he gave a parting gift in the latter spirit to Zhang. “When he retired last year, he traded offices with me—so I’m now sitting in his office, in his chair,” Zhang says. “These are some giant shoes to fill. But this is absolutely invigorating.” —John Pavlus

gap between experts and laypeople,” Zhang says, can also have unintended consequences—as she discovered while studying the effects of mandatory labeling policies for genetically modified organisms (GMOs) in foods. In an ongoing project, Zhang combined field data with a game-theoretical model to show that transparency about GMOs actually led people to avoid the labeled food more often, even though the current scientific consensus holds that genetically modified foods are safe.

“It shows that governments can use marketing too,” Zhang says. “The popular view is that a transparency-motivated policy of GMO labeling can’t go wrong: ‘We tell consumers what is in the food, so that they can make better informed decisions for themselves.’ But, as marketing researchers, we know that consumers are not scientists—they read news, they try to guess what science has to say, and that’s when even government policies of the best intention can backfire.”

Marketers aren’t traditionally seen as scientists, either. But in the current age of hyper-targeted advertising and data-driven product management, being scientific has become part of every marketer’s toolkit. This systematic reliance on data largely began with John D.C. Little.

Little earned an undergraduate degree in physics from MIT in 1948 before shifting his graduate studies to operations research. Also referred to as “management science” or “decision science,” operations research focuses on methods for optimizing solutions to complex problems using rigorous mathematical techniques. Little rose to eminence within the field with his proof of what would become known as “Little’s Law”: $L = \lambda W$.

That compact equation might as well be the $E = mc^2$ of operations research. It describes so-called queueing behavior: how long it takes for items to arrive at and pass through any system, whether it’s cars through a traffic stop or patients entering a hospital ER. Little’s successful application of generalizable mathematical rigor to an entire category of seemingly unrelated practical problems revolutionized his field—and fired his curiosity about bringing that same rigor to another practical domain: marketing.

“One of the things people have been reluctant to do was to call [this field] a science,” Little told an interviewer in 2012. “But everything has fundamentals. And they remain to be discovered and utilized.”

It’s a perspective Zhang shares. “Our ‘laws’ may not be as clean-cut as Newton’s First Law of Motion,” she says. Still,

A Wide Net to Trap Cancer

Stefani Spranger is exploring multiple avenues for the next immunotherapy breakthrough

A young lab at the forefront of immunotherapy discoveries is an exciting yet challenging place to be. MIT faculty member Stefani Spranger, an expert in cancer biology and immunology, understands that better than most people.

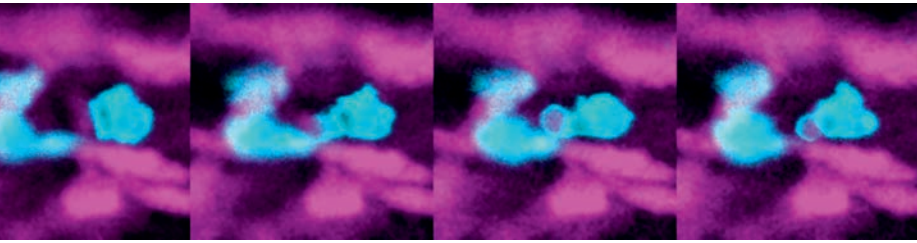
Spranger knows that new labs such as hers, which opened in July 2017 at the Koch Institute for Integrative Cancer Research at MIT, face distinct advantages and disadvantages when it comes to making their mark. While younger labs typically have startup grants, they lack the long-term funding, track record, and name recognition of established researchers; on the other hand, new labs tend to have smaller, close-knit teams open to tackling a wider array of investigative avenues to see what works, what doesn't work, and where promise lies.

That's when the funds and recognition of an endowed professorship can make a big difference, says Spranger, an assistant professor of biology who last year was named the Howard S. (1953) and Linda B. Stern Career Development Professor. "Not everything will work, so being able to test multiple approaches accelerates discovery and success," she says.

Spranger is working to understand the mechanisms underlying interactions between cancer and the immune system—and ultimately, to find ways to activate immune cells to recognize and fight the disease. Cancer immunotherapies (the field in which this past year's Nobel Prize in Physiology or Medicine was awarded) have revolutionized cancer treatment, leading to a new class of drugs called checkpoint inhibitors and resulting in lasting remissions, albeit for a very limited number of cancer patients. According to Spranger, there won't be a single therapy,



Spranger



“Not everything will work, so being able to test multiple approaches accelerates discovery and success,” Spranger says.

one-size-fits-all solution, but targeted treatments for cancers depending on their characteristics.

To discover new treatments, Spranger’s lab casts a wide net, asking big-picture questions about what influences anti-tumor immune response and disease outcome while also zooming in to investigate, for instance, specifically how cancer-killing T cells are excluded from tumors. In 2015, as a University of Chicago postdoc, Spranger made the novel discovery that malignant melanoma tumors with high beta-catenin protein lack T cells and fail to respond to treatment while tumors with normal beta-catenin do.

Her lab focuses on understanding lung and pancreatic cancers, employing a multi-disciplinary research team with expertise ranging from immunology and biology to math and computation. One of her graduate students is using linear algebra to develop a mathematical model for translating mouse data into more accurate predictions about key signaling pathways in humans.

Another project involves exploring the relationship between homogeneous tumors and immune response. Not every cancer cell is identical, nor does it have the same molecules on its surface that can be recognized by an immune cell; cancer patients with a more homogenous expression of those cells do better with immunotherapy. To investigate whether that homogeneity is due to the tumor or to the immune response to the tumor, Spranger is seeking to build a model system. The research involves a lot of costly sequencing—up to \$3,000 per attempt, which is fairly expensive for a young lab—and each try has an element of what Spranger half-jokingly describes as “close your eyes and hope it worked.”

“Being able to generate preliminary proof of concept data for high-risk projects is of outstanding importance for any principal investigator,” she says. “However, it is particularly important to have freedom and flexibility early on.”

Boosting potential

Advancing cancer research and supporting the careers of promising faculty were the intentions of Linda Stern and her late husband Howard Stern ’53, SM ’54, whose gift has supported a series of biology professors since 1993. The first appointee to the chair was Tyler Jacks, now director of the Koch Institute.

Linda Stern says her husband, the cofounder and chairman of E-Z-EM, Inc., and a pioneer in the field of medical imaging, gave thoughtfully to many charitable causes. Yet MIT, where he earned undergraduate and graduate degrees in chemical engineering, had a special place in his heart.

“He was very involved and loved MIT,” says Stern, whose own career path included working as a private detective for 28 years. “He made wonderful contacts and got a wonderful education. He was a real heavy hitter when it came to defending the university.”

MIT’s continued excellence in a competitive environment depends on its ability to recognize and retain faculty, nurture careers, support

A montage showing how, over time, dendritic cells (blue) pick up tumor fragments (magenta) in order to activate T cells to combat cancer.

IMAGE: TIMOTHY FESSENDEN / SPRANGER LAB

students, and allow for the pursuit of novel ideas. Like the full professorships awarded to tenured faculty members, career development professorships such as the one endowed by the Sterns fund salary, benefits, and a scholarly allowance. These shorter-term (typically three-year) appointments, however, are specifically meant to accelerate the research and career progression of junior professors with exceptional potential.

“The professorship showed me that MIT as a community is invested and interested in fostering my career,” says Spranger. The discretionary funds she receives from the chair can cover, without need for an approval process, expenses that are not paid for by grants or that suddenly arise from a new idea or opportunity. They can keep projects running in tough times, fund travel to conferences, and purchase equipment. “It gives you a little more traction,” Spranger says. “It’s probably the best invested money because you have a lot of ideas you want to test, and at the same time, you are still checking the pulse of where the field might go and where you want to build your niche.” —Pamela Ferdinand

Pamela Ferdinand is a 2003–04 MIT Knight Science Journalism Fellow.



STONES AND BEAMS

Ensamble Studio's
Antón García-Abril
challenges basic
notions about how
(and where) buildings
can be made



When architect Antón García-Abril joined the MIT faculty from Madrid four years ago, he resolved that he wouldn't leave behind any part of his professional self. "In Spain, it doesn't exist, 'Anton the researcher,' or 'Anton the professor,' or 'Anton the man in practice,'" he says. "Our practice and our research exist as an imbricated, holistic activity."

Taking over an abandoned parking lot on the northern edge of the MIT campus, he enlisted students to test materials such as ultralight steel beams, foam, and concrete for something he called the Prototypes of Prefabrication Laboratory—POPLab. The aim was to design a building as a series of prefabricated panels that could be constructed off-site and then quickly assembled in place.

To put that idea into practice, he focused on the ultimate case study: building his own house. Along with his partner in work and life, Débora Mesa, then an MIT researcher, García-Abril bought an ugly brick garage in nearby Brookline, Massachusetts, and then designed a spare, modern structure to sit above it—calling it the Cyclopean House after its single large rectangular window.

García-Abril and his partner, Débora Mesa (pictured far left), live with their children in Brookline, Massachusetts, in a prefabricated home of their own design.

PHOTO: ARTEMIO FOCHS NAVARRO

“We built it in Spain, imported it, and assembled it here,” he explains. Divided into seven large pieces, the entire house fit into a half-dozen shipping containers. It took only six days to assemble, creating a chic, minimalist home where García-Abril and Mesa now live with their four children. “It was the proof of concept of how things could be done using the practice and research platform of MIT,” he says.

García-Abril sees such prefabricated construction techniques as the future of architecture in the United States, where he believes a lack of affordable housing “is going to create a grand crisis very, very soon in this country. We have to make buildings better in quality and cheaper in cost.” The prefab concept has already caught on in Europe, with its tradition of a “master builder” who oversees architecture, engineering, and construction. In North America, by contrast, these roles are specialized and, in his view, far too fractured:

“Architects do design, engineers do engineering, and general contractors do the contract, and all these are totally in miscommunication and conflict,” he says.

The son of a composer, García-Abril grew up in Spain, where he studied architecture at the Superior Technical School of Architecture in Madrid and won the prestigious Spanish Royal Academy Prize for research in 1996. In 2000, he began experimenting with increasingly stripped-down materials, founding Ensamble Studio with Mesa. Together, they began constructing buildings in unconventional ways, frequently by recombining cast-off industrial components.

In Spain, their Musical Studies Centre in Santiago de Compostela uses rough-hewn stone blocks piled into a cube that looks both accidental and solid. By contrast, their Berklee Tower of Music in Valencia is a delicately balanced matrix of beams with rectangular cutouts; it seems to defy gravity like a giant game of Jenga.

One of Ensamble’s first experiments in prefabricated design was the couple’s home in Madrid, a massive structure of concrete beams in tension with one another, with a swimming pool on the upper level cascading in a waterfall into a ground-level pool. The building took a year to design, but only seven days to build.

Where nature meets technology

Even while Ensamble Studio has pioneered new techniques for prefab design, it hasn’t limited itself to one genre, but rather has designed educational, institutional, and residential buildings, each taking its formal cues from use and environment.

In fact, some of the residential projects have been the opposite of prefab, rather remarkably site-specific and build organically into the landscape. For a 2006 small

vacation home in Spain they call the Truffle, García-Abril and Mesa poured concrete over a large pile of hay bales to create a mushroom-like structure overlooking the ocean. To remove the hay from inside the structure, they employed a cow, which ate it slowly over the course of the year, to gradually reveal a cozy, naturalistic space inside. For another project on Menorca called Ca’n Terra, they transformed an abandoned stone quarry into a minimalistic subterranean atelier.

At the same time García-Abril and Mesa were making their prefabricated home in Brookline, they were also working on a series of massive sculptures at the Tippet Rise Art Center in Montana. The rough-hewn concrete shapes stand in harmony with the sweeping natural vistas around them. “It’s an arts project that uses architecture and civil engineering for expression,” he says. “I would say that it’s a humanistic approach to nature.”

Creating the painstakingly balanced sculptures was a technological challenge, with 3-D scanning and computer-assisted modeling used to produce the exact specifications that would keep them upright. “We used all of these hybrid intersections between architecture, landscape, civil engineering, and art to create that communication.”

García-Abril sees that intersection between nature and technology as the center of his work. “I’ve been giving the same lecture for 10 years,” he says. “I named it ‘Stones and Beams’—the two archetypal material units. The stone is the given solid part of nature that we organize, and a beam is a synthesized mechanical artifact designed to make the efficient transfer of load.”

Throughout history, he says, the majority of construction in the world has been with “stones”—reorganizing the materials found on-site to create a structure specifically designed for a particular place. While more recent construction has increasingly utilized manmade

(7)

VIEW GALLERY

Assembly of the prefab
Cyclopean House
spectrum.mit.edu/ensamble

García-Abril and Mesa’s sculpture series “Structures of Landscape” at the Tippet Rise Art Center in Montana includes *Inverted Portal* (2015).

PHOTO: IWAN BAAN





materials manufactured off-site, today's sophisticated technology can enable architects to go even further and to create an entire building off-site with prefabricated "beams."

"Everything that you do in a factory can be automated with contemporary tools, algorithms, and systems," he says. "You can do as much more as possible in the safe, controlled environment of a factory versus the wild, uncontrollable space that is a construction site."

Off-site vision

Taken to its logical conclusion, that concept means making houses and buildings just like any other factory-assembled consumer good. "A Tesla car is manufactured in Nevada and sold in Moscow or Madrid, but it's the same car," he offers as an example. "The supply chain of manufacturing is detached from the place where the car is going to be sold and operated."

For their Cyclopean House, the architects created solid foam cores composed of 98% air and reinforced with steel and a thin layer of concrete for structural strength and to protect from fire. Each of the seven "beams" was dedicated to a single purpose: cooking, bathing, dining, sleeping, etc. Assembled, they created a two-story, 2,500-square-foot home with a bedroom, office, kitchen, and roof deck.

The entire home was light enough to sit atop the concrete garage without the need for any additional foundation support. The project, including transportation from Europe aboard a container ship, was completed at only a fraction of the local cost. "I think this is the future of architecture—to be ready to engineer and produce a building anywhere in the world and then assemble it in North America," García-Abril says. Currently on sabbatical, he is forming a company that could help put into practice the fruits of his ongoing research at Ensamble Fabrica, the Madrid-based counterpart of POPLab, and at the same time exposing students to a bold new vision for architectural construction.

"I want to share my vision with those students who want to accompany me," he says. "To do this, we will have

to work with those around the world who have that same vision, and to communicate with the instruments, robots, machines, and all the tools that will conduct and transfer our orders from data into matter."

—Michael Blanding

Above: Ensamble Studio's Musical Studies Centre in Santiago de Compostela, Spain (2002).

PHOTO: ROLAND HALBE

Turning Points: 150 Years of Architecture at MIT

Fall 2018 marked the 150th anniversary of MIT's first architecture class, making what is now the School of Architecture and Planning (SA+P) home to the oldest architectural course of study in the United States.

To mark the occasion, the department is celebrating with a diverse array of educational and social programming on campus throughout the academic year. The events will culminate in a symposium and alumni open house on campus April 12–13. The symposium, which will be open to the public, uses the theme of "turning points" to bring faculty together to discuss futures for design research.

"One can think of turning points as historical—a significant occurrence that shifted one's focus—or as setting a new trajectory to head towards, where we need to reflect on our direction, and adjust our course accordingly," explains Andrew Scott, interim head of the Department of Architecture. "The symposium is an examination

of the criticality in our faculty's disciplinary work, whether that's scholarly inquiry, design practice, or other forms of innovative research. We're aiming to have an exposé and an open discourse about what we are doing and where we want to go."

This forward-thinking approach is hardly new for the department, as MIT Museum visitors can see in a new exhibit through August 2019. *Drawing, Designing, Thinking: 150 Years of Architecture at MIT* chronicles the innovative turns that the department has taken to address the demands of a rapidly changing world. This



exhibit highlights the evolution of the curriculum and the design studio, the development of a culture of architectural research, and an examination of how the department continues the production and advancement of knowledge through design, research, and scholarship.

Beyond special events and exhibitions, the fall 2018 semester focused on the department's pedagogical creativity. The "Practice PLUS" lecture series brought esteemed speakers to campus to discuss key challenges of practicing architecture today, and for the first time, an open call for "Experiments in Pedagogy" resulted in 14 new workshops and classes proposed by students and faculty. These courses broached such interdisciplinary topics as climate change, material upcycling, robotics, creative writing, and contemporary politics, with multiple formats ranging from a weekend field trip to half-semester seminars. "Students and faculty have enjoyed

the ability to hit a topic quickly and have fun with it—to test new ideas, formats, subjects, and collaborations," says Scott. "The experiments have been a breath of fresh air, and have underlined the need to continually reflect upon and change our teaching to address new questions and challenges." —Joelle Carson

A 1948 illustration by György Kepes of the Department of Architecture's curriculum.

IMAGE: COURTESY OF MIT INSTITUTE ARCHIVES AND SPECIAL COLLECTIONS



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This Was Paris

An excerpt from Catherine E. Clark's book on the changing conventions of photography

Catherine E. Clark is a connoisseur of the photo archive. An associate professor of French studies and Class of 1947 Career Development Professor at MIT, she reviewed scores of snapshots—including thousands submitted to the amateur photo contest “C'était Paris en 1970”—while researching her book, *Paris and the Cliché of History: The City and Photographs, 1860–1970*.

The book presents a study of photographic history in Paris and a new methodology for using photographs as historical documents. How we think about them, Clark suggests in this excerpt adapted from the introduction, can be informed by the surprising roots of the word “cliché.”



In one of the most visited and thus most photographed cities in the world, history has come down through the generations as the history of photography. Looking through these pictures reveals a familiar narrative of urban renovations—the World’s Fairs, revolution, war, and street life—in short, the myriad aspects of urban life for over a century. But photographs are not just representations of the city’s past: their production, collection, and circulation are part and parcel of Paris’s history. Looking *at* and *around* photographs helps us to write a social history of photography.

This approach investigates three levels of meaning held within the photo. Photographs, first, offer us access to the historical events they depict. Second, and inseparable from the first, they capture “the history of photography” or the history of the making of the images. The photo always records the act of photography itself, the social interaction between the photographer and the subject. Photographers are just as much players on the scene as those they capture. Historians of photography and historians who use photos often focus on these two levels of meaning, reading them as images that tell us about the events that occurred in front of the lens and about how they were captured. Their

focus on the immediacy of the photograph, however, can cause them to overlook its history as a material object that acts in the world. Because they are objects, rather than mere disembodied images, photos are traces of the history of their preservation and use. We must accordingly account for a third level of historicity rooted in their materiality: “the history of photographs.” By virtue of their existence in an archive, on a printed page, or on the wall of an exhibition, photos bear witness to the actions that brought them there and reveal histories of acting in the world.

How, though, does one read this context? Such analysis involves the sort of careful detective work borrowed from the methods of the social and material history of ideas: notably histories of printing, publication, and circulation, studies of reception, or the history of narrative structures, footnotes, and timelines. The physical details of the cards—from the age of their paper to whether they are handwritten or typed—in the catalog of photographs at Paris’s historical library, the Bibliothèque historique de la Ville de Paris, tell the history of the archive’s growth, purview, and organization. The photographs themselves, which may be glued to backings, bear stamps,

The use of the past imperfect tense—*c'était, this was, Paris*—in the very name of the 1970 contest suggests that the camera's products were part of history even before the shutter opened.

and closer. In the first decades of the twentieth century, it appeared that photographs of the present would be pictures of the past within two generations. In 1944, it was just a matter of weeks. By 1951, critics described pictures of the present as images of the past in the same breath. The use of the past imperfect tense—*c'était, this was, Paris*—in the very name of the 1970 contest sug-

gests that the camera's products were part of history even before the shutter opened. have notes about loans, or even original and then revised captions, also tell of the archive's uses. In illustrated books, captions and surrounding texts reveal how authors, editors, and designers conceived of the function of their illustrations. At other times close attention to the composition of a photograph uncovers something about the influence of past images of Paris. After all, images dialogue with other images as much as with the world outside the frame.

With so many pictures available, what of the risk that looking at photohistories of the capital or the use of photographs in historical celebrations might just open up onto a history of the tired circulation of clichés? After all, even the most cursory browse through the kiosks that line the quays of the Seine, the tables of half-price books at stores such as the *Mona Lisait*, or the gleaming aisles of today's FNACs turns up generic Paris picture books: ones published, vaunted, and sold ad nauseam at discount. Don't these books and their seemingly endless, identical photos enable the stale recycling of history that epitomizes the "museum-city?" If so, how do we get beyond the idea of such photos and their ubiquitous presence as clichés, and worse, is there any service the photo can provide the city other than to reproduce it as a cliché?

We must start by rethinking the very term "cliché." Since the late nineteenth century, in both English and its original French, "cliché" has denoted an idea or image, repeated so often that it has become tired, unremarkable, and ultimately meaningless. Before that, however, it had two other meanings, each of which

originated in the material culture of mass print and image production. First, cliché meant a metal printing plate cast from set movable type or a combination of type and images on metal plates or wooden blocks. Secondly, after the invention of photography, the term used to denote the sensitized glass plates on which the camera captured images: in other words, the photographic negative. While these two meanings are technical or historical in English, they have endured in French. "Cliché" also later assumed a third French sense, now a bit dated, as a generic umbrella for any sort of photographic image. In both languages, the cliché as a trite idea thus only appeared on the heels of these other denotations, as the product of mass print culture, of reproduced and reproducible ways of thinking about the world.

We need to recuperate those older meanings: to read photographs as clichés, in other words, invokes a methodology that conceives of them as mass-produced objects functioning in close relationships to other types of images and texts. To do so means considering the material conditions of the photograph's production and circulation in the world before understanding it as hackneyed or trite. The multiple meanings of "cliché" also make it essential to explore photography's relationship to other pictures and texts. If photography became a dominant means of preserving the city, this does not mean that Parisians lost interest in the rich visual record of the city's past that survives in paintings and prints. Individuals worked out their ideas about how photographs captured and evoked the past in relationship to these other types of pictures. By employing the word "cliché," this book obliges us to also bear these nonphotographic antecedents and influences in mind when looking at their photographic counterparts.

Because time itself seemed to speed up over the course of the twentieth century, that "one day" when photographs might serve as fragments of the past seemed to grow closer

Reproduced and adapted from *Paris and the Cliché of History (2018)* by Catherine E. Clark. By permission of Oxford University Press.



Submissions to the contest "C'était Paris en 1970" reveal—through their creators' choice of subject, framing, and sometimes pointed captions—how thousands of amateur photographers viewed the capital's history and radical urbanization. From left: "The Elderly in Paris Before the Expulsion (on the rue Payer whose buildings are destined to be demolished soon)" (anonymous); "New and Old Buildings of Paris, Citroën, rue de Ginoux" (anonymous); and "The Big Movie Theaters of the boulevard des Italiens" (André Guillemenot).

MIT Reshapes Itself to Shape the Future

Gift of \$350 million establishes the MIT Stephen A. Schwarzman College of Computing

An extended version of this story appeared on MIT News on October 15, 2018.

MIT has announced a new \$1 billion commitment to address the global opportunities and challenges presented by the prevalence of computing and the rise of artificial intelligence (AI). The initiative marks the single largest investment in computing and AI by an American academic institution and will help position the United States to lead the world in preparing for the rapid evolution of computing and AI.

At the heart of this endeavor will be the new MIT Stephen A. Schwarzman College of Computing, made possible by a \$350 million foundational gift from the chairman, CEO, and cofounder of Blackstone, a leading global asset manager. Schwarzman is an active philanthropist with a history of supporting education, culture, and the arts, among other causes.

The new MIT Schwarzman College of Computing will be an interdisciplinary hub for work in computer science, AI, data science, and related fields.

The college will:

- reorient MIT to bring the power of computing and AI to all fields of study at MIT, allowing the future of computing and AI to be shaped by insights from all other disciplines;
- create 50 new faculty positions located both within the college and jointly with other departments across MIT—nearly doubling MIT’s academic capability in computing and AI;
- give MIT’s five schools a shared structure for collaborative education, research, and innovation in computing and AI;
- educate students in every discipline to responsibly use and develop AI and computing technologies to help make a better world; and
- transform education and research in public policy and ethical considerations relevant to computing and AI.

Through the college, MIT seeks to strengthen its position as a key international player in the responsible and ethical evolution of technologies that are poised to fundamentally transform society. Amid a rapidly evolving geopolitical environment that is constantly being reshaped by technology, the college will have significant impact on our nation’s competitiveness and security.

“As computing reshapes our world, MIT intends to help make sure it does so for the good of all,” says MIT President L. Rafael Reif. “In keeping with the scope of this challenge, we are reshaping MIT. The MIT Schwarzman College of Computing will constitute both a global center for computing research and education, and an intellectual foundry for powerful new AI tools. Just as important, the college will equip students and researchers in any discipline to use computing and AI to advance their disciplines and vice versa, as well as to think critically about the human impact of their work. With uncommon insight and generosity, Mr. Schwarzman is enabling a bold agenda that will lead to a better world. I am deeply grateful for his commitment to our shared vision.”

“There is no more important opportunity or challenge facing our nation than to responsibly harness the power of artificial intelligence so that we remain competitive globally and achieve breakthroughs that will improve our entire society,” Schwarzman says. “We face fundamental questions about how to ensure that technological advancements benefit all—especially those most vulnerable to the radical changes AI will inevitably bring to the nature of the workforce. MIT’s initiative will help America solve these challenges and continue to lead on computing and AI throughout the 21st century and beyond.”

Representing the most significant structural change to MIT since the early 1950s, the college will be celebrated with a major public showcase on February 28, and is slated to

Representing the most significant structural change to MIT since the early 1950s, the college is slated to open in September 2019.

The initiative marks the single largest investment in computing and AI by an American academic institution.

open this September. Construction of a signature new building is scheduled to be completed in 2022, with the current site of Building 44, on Vassar Street, identified as a preferred location. Fifty new faculty positions will be created: 25 to be appointed to advance computing in the college, and 25 to be appointed jointly in the college and departments across MIT. A new deanship will be established.

The college will teach students the foundations of computing broadly and provide integrated curricula designed to satisfy the high level of interest in majors that cross computer science with other disciplines. It will seek to enable advances along the full spectrum of research—from fundamental, curiosity-driven inquiry to research on market-ready applications.

It will be a place for teaching and research on relevant policy and ethics to better ensure that the technologies of the future are responsibly implemented in support of the greater good. To advance these priorities, the college will develop new curricula; host forums to engage leaders from business, government, academia, and journalism to shape policies around the ethics of AI; encourage scientists, engineers, and social scientists to collaborate on analysis and research; and offer research opportunities, fellowships, and grants in ethics and AI.

In its pursuit of ethical questions, the college will bring together researchers in a wide range of MIT departments, labs, centers, and initiatives, such as the Department of Electrical Engineering and Computer Science (EECS); the Computer Science and Artificial Intelligence Lab (CSAIL); the Institute for Data, Systems, and Society; the Operations Research Center; the MIT Quest for Intelligence, of which the Center for Brains, Minds, and Machines is a signature initiative; the Center for Computational Engineering; and beyond.

The MIT Schwarzman College of Computing builds on MIT's legacy of excellence in computation and the study of intelligence. In the 1950s, MIT professor Marvin Minsky and others created the very idea of artificial intelligence.

Today, EECS is by far the largest academic department at MIT. Forty percent of MIT's most recent graduating class chose it, or a combination of it and another discipline, as their major. The largest laboratory at MIT is CSAIL, which has its roots in two storied MIT labs: the Artificial Intelligence Lab, established in 1959 to conduct pioneering research across a range of applications, and the Laboratory for Computer Science, established in 1963 to pursue a Department of Defense project for the development of a computer system accessible to a large number of people.

A search is underway for the college's inaugural dean, conducted by a committee formed by Provost Martin Schmidt SM '83, PhD '88. Schmidt is working closely with the chair of the faculty, Susan Silbey, and the dean of the School of Engineering, Anantha Chandrakasan, to define the path forward.

"I am truly excited by the work ahead," Schmidt says. "The MIT community will give shape and energy to the new college."



LEARN MORE ABOUT THE FEBRUARY CELEBRATION
helloworld.mit.edu

Better World Events Continue in 2019

What is MIT's role in realizing the world-changing possibilities of human and machine intelligence? How is the Institute advancing the science of teaching and learning? These and several other topics have brought together MIT's alumni and friends in cities across the United States and the world, as the MIT Campaign for a Better World continues to build momentum.

After four stops this winter and spring in California, regional events showcasing MIT leadership, faculty, alumni, and students will visit several additional cities this year, with other locations still to be announced.

FEBRUARY 5, 2019

Palo Alto

FEBRUARY 7, 2019

San Francisco

MARCH 19, 2019

San Diego

MARCH 21, 2019

Los Angeles

COMING IN FALL 2019

Atlanta

London



More than 400 members of the MIT community gathered in October 2018 at New York City's PlayStation Theater. Participants in a panel discussion on MIT's approach to education included, from left, moderator and MIT Chancellor Cynthia Barnhart SM '85, PhD '88, Ford Foundation Professor of Engineering; Simmons Hall president Edward Fan '19; and architecture professor and Environmental Solutions Initiative director John E. Fernández '85, faculty head of house at Baker House.


PHOTOS: DANA MAXSON PHOTOGRAPHY



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COMPOSING HISTORY

Widely recognized for designing new technologies for performance and creation, musical visionary Tod Machover directs the MIT Media Lab's Opera of the Future group. In *Schoenberg in Hollywood*, commissioned by Boston Lyric Opera, he turned to the past—and a fellow composer—for inspiration. The titular figure fled Hitler's Europe for Hollywood, where he sought to reconcile art with entertainment, and spiritual identity with political action. Though focused on musical history, the technically complex production and boundary-breaking sounds reveal Machover, as ever, pushing his field forward.

