FROM IDEAS TO INVENTIONS

103 WAYS MIT IS MAKING A BETTER WORLD

CAMPAIGN FOR A BETTER WORLD

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Dear Friends:

I am delighted to share with you the third in a wonderful series of books illustrating the pioneering spirit of MIT.

In 2013, we chronicled “101 Gifts from MIT to the World,” looking back at groundbreaking discoveries and inventions from MIT’s history that helped shape the society we live in today. In 2016, the second book revealed “102 Paths from MIT to the Future.” With this volume, “From Ideas to Inventions: 103 Ways MIT Is Making a Better World,” we focus on how MIT’s extraordinary people are responding to the enormous challenges of our time.

The ingenuity of our students, faculty, and researchers gives me immense hope—and so does the dedication of our alumni and friends. Your support of MIT’s Campaign for a Better World is inspiring our community to explore new lines of inquiry and new possibilities for impact that will benefit humankind. We are deeply grateful for your partnership as we strive for a brighter future.

Sincerely,

L. Rafael Reif
MIT President

Dear Friends:

I am thrilled to share 103 stories of people and organizations at MIT who work every day to make a better world.

The people of MIT are motivated by hands-on problem solving and by seeking answers to big questions. They have demonstrated time and again that they have the vision, the talent, and the courage to tackle some of the world's most urgent challenges.

The MIT Campaign for a Better World, completed in 2021, brought new resources to the Institute, accelerating discovery and driving innovation. Every gift fuels the engine of MIT's impact on the world, making a difference now and for centuries to come.

Philanthropy helps us to attract the best minds and hands to MIT, and assures that our dynamic campus is equipped for modern teaching, learning, and living. Your generous support has enabled the Institute to remain a shining light in higher education for the benefit of our extraordinary students and faculty, empowering them with deep knowledge, exciting career pathways, and opportunities to better the world.

I hope that as you read these remarkable stories, you will be as proud to be a member of the MIT community as I am.

With sincere thanks,

Julie A. Lucas

Julie A. Lucas
Vice President for Resource Development

IN PURSUIT OF A BETTER WORLD

$6.24B

The Campaign for a Better World raised **$6.24B** to help the people of MIT tackle humanity's urgent global challenges.

112K

Strength in numbers: **112,703** donors contributed to the Campaign

56K

Nearly **56,000** donors made their first gift to MIT during the Campaign

83%

83% of alumni engaged with MIT during the Campaign

WITH THE PARTNERSHIP OF

School of Architecture and Planning
School of Engineering
School of Humanities, Arts, and Social Sciences
School of Science
MIT Sloan School of Management
MIT Stephen A. Schwarzman College of Computing

Guiding Successful Social Policy

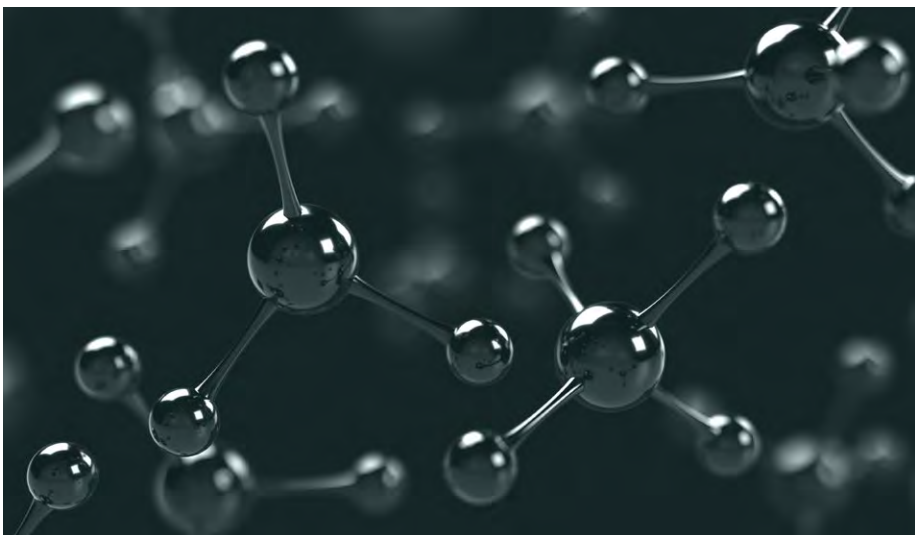
JOSHUA ANGRIST, Ford International Professor of Economics

Guided by the Nobel Prize-winning economic methodology of Joshua Angrist, MIT's Blueprint Labs produces rigorous evidence aimed at helping decision makers design and implement policy solutions to difficult challenges in education, health care, and the workforce. Angrist, who has long advocated applying empirical research tools to vital social issues, sees his 2021 Nobel win as a validation of this approach: "I think this is further evidence that economics has matured greatly as an empirical discipline. Blueprint is a leader in shaping this trend. Our work is more convincing and more relevant than ever."

Reducing Methane for a Greener Future

DESIRÉE PLATA PhD ’09, Gilbert W. Winslow Career Development Professor in Civil Engineering

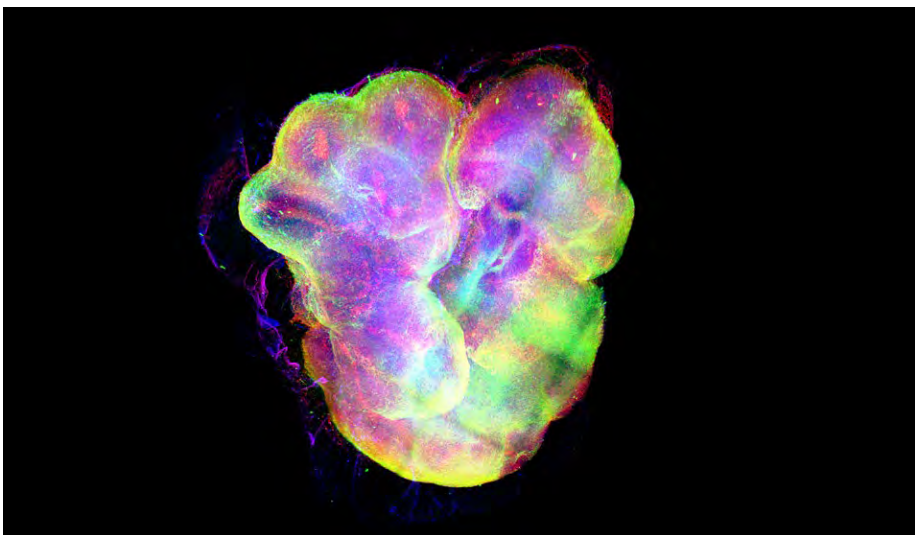
Environmental chemist Desirée Plata seeks to make industrial processes more environmentally sustainable. An ongoing focus of her research is methane, a greenhouse gas up to 120 times more potent than CO_2. Plata and her team aim to lower primary methane emissions dramatically by building an economical system that uses catalysts to capture low-level-to-ambient methane from the atmosphere and convert it into CO_2. “If you could convert just over half of the atmosphere’s methane into carbon dioxide, you could save about 16% of near-term warming—and that buys us more time to respond and adapt to the changing climate,” Plata says.



‘Minibrains’ for Biomedical Progress

KWANGHUN CHUNG, Associate Professor of Chemical Engineering and Neuroscience

Culturing cerebral organoids, or “minibrains,” has given scientists the ability to experimentally manipulate models of human neurological development and disease—but no two organoids are alike, and none resemble actual brains. Kwanghun Chung and his lab members at The Picower Institute of Learning and Memory have developed a new pipeline for rigorously analyzing organoids so they can be useful to researchers. One study yielded new insights into why babies born to mothers infected with the Zika virus have severe neurological issues. By sharing many of his lab’s innovations on GitHub, Chung hopes to speed up biomedical progress.



Words for Climate Change

ANNAUK DENISE OLIN SM ’21

Sea ice several feet thick used to protect the Native Village of Shishmaref in Alaska from winter storm surges. In recent years, the ice formed either late in the season or not at all, while flooding, erosion, and land collapse forced many inhabitants further from the ocean. Tribal member Annauk Denise Olin, who worked to build a curriculum for teaching her Native language of Iñupiaq during her graduate study at the MIT Indigenous Languages Initative, observes that her ancestors had no words for today’s climate. “What’s important in the future is for us to adapt the language to be able to describe these changing conditions exactly,” she says.

Housing Stress Spikes Health Woes

MARIANA ARCAYA MCP '08
Associate Professor of Urban Planning and Public Health

When Covid-19 struck, it was no surprise to Mariana Arcaya that the highest case rates were in gentrifying urban neighborhoods. Skyrocketing housing costs had forced financially insecure people into overcrowded or unstable housing situations, making social distancing an unavailable luxury. Arcaya leads the Healthy Neighborhoods Study, a project examining the link between neighborhood change and health. Collaborating with community-based organizations on participatory action research in communities such as Chelsea, Massachusetts, Arcaya and her students have demonstrated the clear impact of housing insecurity on public health. "We need to listen to communities when they say the pressures they are under are unhealthy and unsafe," she says.

Infinitesimal Answers to Big Questions

LINDLEY WINSLOW, Associate Professor of Physics

Interested in how the physics of fundamental particles shaped our universe, Lindley Winslow and her team in the Laboratory for Nuclear Science study neutrinos—tiny, nearly massless particles that travel at near light speeds—and axion dark matter—particles so small they act like waves. “I like the challenge of measuring things that are very, very hard to measure,” she says. “The motivation comes from trying to discover the smallest building blocks and how they affect the universe we live in.” Winslow, who won the 2010 L’Oréal USA for Women in Science Fellowship, is a strong advocate for young female physicists.

Tech for the Greater Good

NAGELA NUKUNA MBA ’22

A trained engineer, Nagela Nukuna has always believed that technological development is a powerful force in social policy. “Technology expands access and opportunity and helps us scale different policies efficiently,” she says. At the MIT Sloan School of Management, Nukuna has applied an engineer’s analytical rigor to social impact research. Passionate about politics, mis- and disinformation, and voting rights, she envisions a career focused on improving national policies through working at the intersection of tech and politics. One question is constantly on her mind: “How do you use tech to scale social good?”

Climate

MIT is mobilizing Institute-wide to help drive solutions to the climate crisis—the defining challenge of our time. Fast Forward: MIT's Climate Action Plan for the Decade, issued in spring 2021, spans MIT's five schools and the MIT Stephen A. Schwarzman College of Computing. It intensifies and integrates the Institute's efforts to accelerate innovation in climate technology and policy. The Climate Grand Challenges coalesces the MIT research community around some of the most challenging and strategically important problems in climate adaptation, carbon removal, climate science, climate policy, human impacts, and emissions mitigation. The MIT Climate and Sustainability Consortium is creating an alliance of leaders from a broad range of industries to accelerate large-scale, real-world solutions to address the threat of climate change. The Future Energy Systems Center will place the ongoing techno-economic and systems-oriented research from MIT Energy Initiative's Low-Carbon Energy Centers under a common umbrella. The Abdul Latif Jameel Poverty Action Lab's King Climate Action Initiative advances high-impact policy solutions at the nexus of climate change and poverty alleviation.

climate.mit.edu

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Boxing the Sun

ASEGUN HENRY SM ’06, PhD ’09
Associate Professor of Mechanical Engineering

Much of the renewable energy captured from the wind and sun is delivered in a use-it-or-lose-it capacity, but Asegun Henry imagines a sustainable, zero-carbon grid to store it. To get there, he envisions a heavily insulated, warehouse-sized container filled with white-hot graphite. Excess electricity captured during low-use times would be converted into heat and diverted into this container. When energy demand goes up, liquid metal could be pumped through the container to retrieve the heat, and then routed to a converter to turn the heat back into electricity. For Henry, the ambitious “sun-in-a-box” system has the potential to supply our electrical needs even on overcast and windless days.

Putting Ethics on Par with Technology

MARION BOULICAULT PhD '21, Distinguished Postdoctoral Fellow in Ethics and Technology

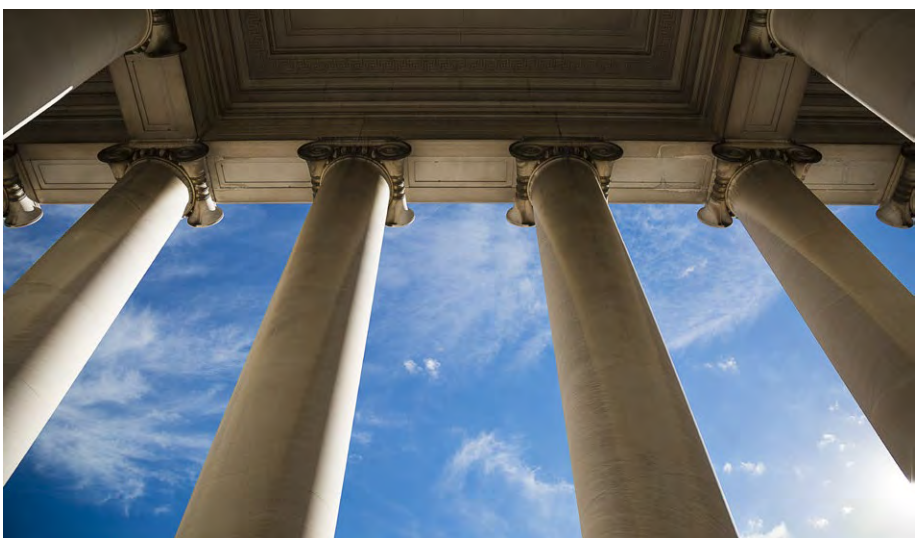
KEVIN MILLS, Postdoctoral Associate in Philosophy

At the MIT Stephen A. Schwarzman College of Computing, Marion Boulicault and Kevin Mills work to help transform technology ethics education and research at MIT. Mills investigates the ethics of computing and artificial intelligence and works primarily on issues surrounding privacy, data collection, and online manipulation. Boulicault takes a feminist approach to questions in the ethics of technology, and codirects the Experiential Ethics program, an innovative MIT course designed to teach ethics by connecting theory to students' own experiences in technology research and internships.

Nonpartisan Analysis for Financial Policy Makers

GOLUB CENTER FOR FINANCE AND POLICY

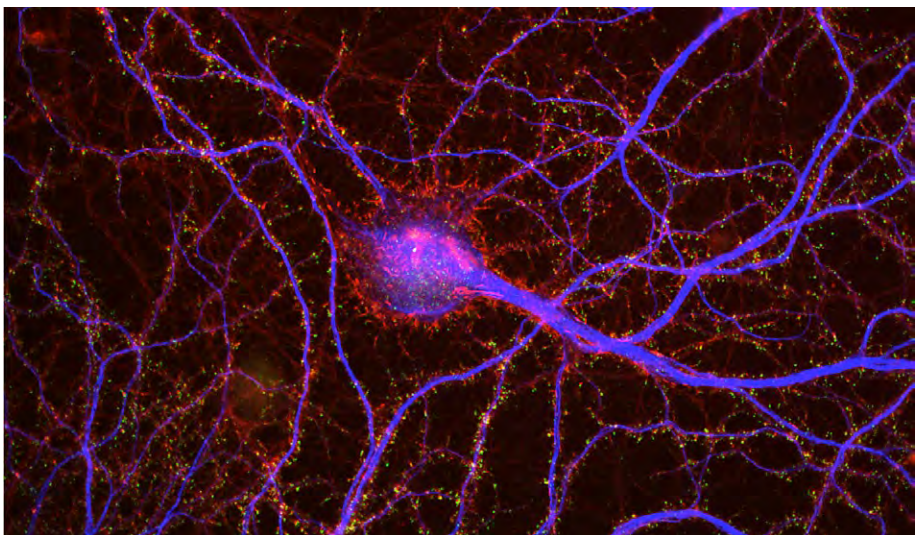
Recognizing a need for creative initiatives to address the unique challenges relating to financial policy and regulation, MIT Sloan established the Golub Center for Finance and Policy (GCFP). Director Deborah Lucas, the Sloan Distinguished Professor of Finance, calls the center "the go-to source for nonpartisan analyses of financial policies." GCFP's cross-disciplinary research focuses on three areas: government financial institutions, financial regulatory policies, and public risk management, seeking to provide greater transparency and elevate the quality of public policy debate through research, education, and outreach. The center also provides educational outreach through course offerings and by hosting speakers and conferences.



Harnessing Brain Plasticity for Recovery

ELLY NEDIVI, William R. and Linda R. Young Professor of Neuroscience

Elly Nedivi explores the brain's ability to adapt to its environment and learn new things, focusing on remodeling the synapses that connect nerve cells into circuits. This plasticity can aid recovery from brain injury, and is also known to be deficient in brain disorders such as bipolar disorder—an area where her lab at The Picower Institute for Learning and Memory has recently made significant discoveries. "It's a rare situation where people have been able to link mutations genetically associated with increased risk of a mental health disorder to the underlying cellular dysfunction," she says. "For bipolar disorder, this might be the one and only."



On the Move in Africa

METRO AFRICA XPRESS (MAX)

Adetayo Bamiduro MBA ’15 and Legatum Foundry Fellow Chinedu Azodoh MFin ’15 benefited from MIT’s entrepreneurial ecosystem while founding MAX, a technology-enabled vehicle subscription platform for low-to-zero emission vehicles in Africa. As they continue to scale their business, the cofounders advocate for small business growth and a more welcoming economy for innovation and entrepreneurship in Africa. “Our work involves delivering an integrated, affordable, and collateral-free vehicle subscription package that includes low-to-zero emission vehicles, health care, insurance, and original equipment manufacturing services,” says Bamiduro. “MIT Sloan helped me realize I could contribute significantly to the world through leadership.”

Recipes for Sustainable Materials

ELSA OLIVETTI PhD ’07
Esther and Harold E. Edgerton Associate Professor of Materials Science and Engineering

STEFANIE JEGELKA
Associate Professor of Electrical Engineering and Computer Science

Leveraging a neural network that can pore through scientific papers, Elsa Olivetti and Stefanie Jegelka have developed a way to extract “recipes” for producing particular types of materials through pattern recognition. They have used this mechanism to suggest alternative recipes for known materials and applied it to examples ranging from solid-state batteries to cement. In the future, this method could also help to identify practical ways to create new materials with desirable properties. Olivetti’s primary research focuses on improving the environmental and economic sustainability of materials, while Jegelka’s interests span the theory and practice of algorithmic machine learning.

Rebuilding Cultures through Art

AZRA AKŠAMIJA PhD '11, Associate Professor of Architecture;
Director, Program in Art, Culture and Technology

A Bosnian Muslim whose family escaped war in the early 1990s, Azra Akšamija is a versatile artist and architectural historian who creates works of cultural resilience in the face of conflict and crisis. Her work frequently explores encounters between Islam and the West. She was given the Aga Khan Award for Architecture for her design of a prayer space at Austria's first-ever Muslim cemetery. Some of Akšamija's best-known designs are wearable art, including her "Frontier Vest," a garment that works as a jacket for refugees and can be transformed into a Jewish prayer shawl or an Islamic prayer rug.

AI That Truly Empowers Us

ALEKSANDER MĄDRY SM ’09, PhD ’11, Cadence Design Systems Professor of Electrical Engineering and Computer Science

AI is everywhere, but is it user friendly? Is it safe? Does it truly empower its users as well as the other stakeholders? Aleksander Mądry, director of MIT’s Center for Deployable Machine Learning, thinks more about such questions—whether deep-learning systems malfunction when presented with something unfamiliar, for example—than just AI’s performance. Mądry investigates what makes our current AI tick, and how we can deploy it in a way that is responsible and leads to positive outcomes for both its users and our society.

The Power of Truth

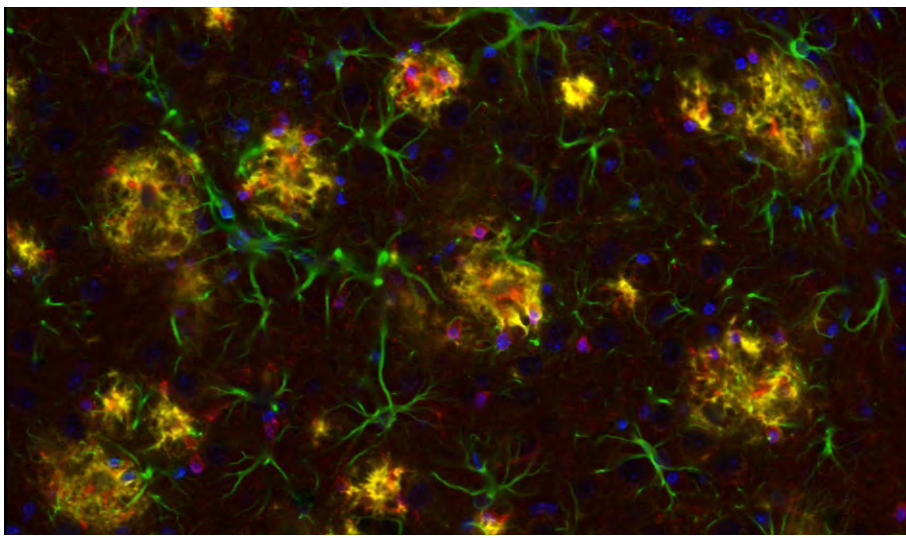
SINAN ARAL PhD '07, David Austin Professor of Management; Director, MIT Initiative on the Digital Economy

"Social media disrupts our elections, our economy, and our health," says Sinan Aral, author of the book *The Hype Machine*, which examines the costs and benefits of online life in modern society. When vaccine misinformation was disseminated via social media during the pandemic, Aral coauthored a paper that analyzed data from a massive international survey. Responses showed that public health officials should not begin communications with stern warnings to unvaccinated people; emphasizing the growing number of people getting vaccinated yields better results. "Simply providing people the truth, the accurate information, is very effective."

Fighting Alzheimer's with Light and Sound

LI-HUEI TSAI, Picower Professor of Neuroscience

Alzheimer's disease is the sixth-leading cause of death in the United States. Li-Huei Tsai, director of The Picower Institute for Learning and Memory, is studying a potential Alzheimer's therapy, GENUS, which involves stimulating 40 Hz brain rhythms with light and sound. Clinical studies of GENUS to test its safety and efficacy are underway. Data indicate that exposure to 40 Hz light and sound is safe and might contribute to improved cognition, sleep quality, brain connectivity, and preservation of brain volume in patients with mild Alzheimer's disease.



Computing and AI

In 2019, the launch of the MIT Stephen A. Schwarzman College of Computing heralded a new era of computer science and AI education and research at MIT. The college's educational aspirations are anchored in the creation of a generation of "bilinguals"—people who are fluent both in technology and in another specialty such as business, biology, urban planning, or even music, and who can apply their dual expertise to humanity's great challenges. Marzyeh Ghassemi PhD '17, the Herman L. F. von Helmholtz Career Development Professor, joined MIT in 2020 in the Department of Electrical Engineering and Computer Science (EECS) and the Institute for Medical Engineering and Science. Ghassemi's Healthy ML lab applies machine learning to improve health in ways that are robust and fair. Manish Raghavan will join as an assistant professor in a shared position between the college—in EECS's Faculty of Computer Science—and the MIT Sloan School of Management in September 2022. Raghavan's research seeks to uncover bias in job-hiring algorithms. To continue to grow this highly interdisciplinary community, the college has been filling 25 new faculty positions that are shared with other academic departments.

computing.mit.edu

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Making Urban Spaces Work for Residents

ANGELES MARTINEZ CUBA MCP ’21

Angeles Martinez Cuba shifted her focus from architecture to urban planning to work on providing people with equal access to basic services. “Urban inequalities are frequently institutionalized through planning tools and policies,” she says, “while urban planning for social equity should build equal access opportunities in which people can reach their full potential.” At MIT, Martinez Cuba investigated the relationship between public schools and their neighborhoods, which vary depending on spatial interdependence among their amenities. She found that schools can become anchor spaces for neighbors to assemble, develop a sense of community, and carry out civic life through the shared use of school-neighborhood spaces.

The Future of Music

SEBASTIAN FRANJOU ’21

Louis Sudler Prize winner Sebastian Franjou ’21 studied classical guitar and music theory in his native France but chose MIT for his university education so he could pair music with electrical engineering and computer science. “Even though you can study some aspects of sound or music in other disciplines, there’s really nothing else where it’s this easy to make music with it,” he says. Students who follow in Franjou’s footsteps can look forward to new music production spaces and music technology research labs, in addition to enhanced performance and rehearsal spaces, in MIT’s first dedicated music facility when the new building is completed in 2024.

Pollution Crosses State Lines

STEVEN BARRETT, Professor of Aeronautics and Astronautics

More than half of all air quality-related early deaths in the United States result from emissions originating in a different state, according to an MIT study led by Steven Barrett, whose research focuses on reducing environmental impacts from aviation. While regulations such as the Environmental Protection Agency's Clean Air Act have helped to significantly curb emissions from electric power plants, the study found that many additional sources of pollutants including road transportation, aviation, and heating systems for homes and businesses are also significant. "To make further progress," Barrett says, "we should start focusing on road transportation and commercial and residential emissions."

Designing a More Equitable World

MITDesignX

To help transform the innovative ideas of students and alumni into action, the MIT School of Architecture and Planning launched MITdesignX, a venture accelerator for design and the built environment. The program provides entrepreneurs with curriculum, funding, workspace, mentors, and networks. “Housing, infrastructure, and education affect us all, and they are often underserved by innovation,” says MITdesignX Executive Director Gilad Rosenzweig MCP ’13. “We are not only serving the demand of our community of aspiring entrepreneurs, but also addressing critical needs of cities, society, and industry by helping launch new companies focused on these pressing issues.”

Scrutinizing Cryptocurrency

ANTOINETTE SCHOAR
Stewart C. Myers-Horn Family Professor of Finance

Investors are interested in cryptocurrencies, but confused about their risks and benefits. Antoinette Schoar worked with a team of researchers to analyze Bitcoin transactions from 2015 to 2021, building a novel database and unique algorithms to extract information about market participants. Bitcoin ownership was found to be concentrated among a small set of very wealthy addresses, presenting risk to market stability and unequal benefits. “Somebody who can easily spend a few hundred million dollars’ worth of Bitcoin and sell it or buy it can have a massive price impact in the market,” says Schoar, who is now researching other crypto platforms.

The Fusion Solution

ANNE WHITE, School of Engineering Distinguished Professor of Engineering

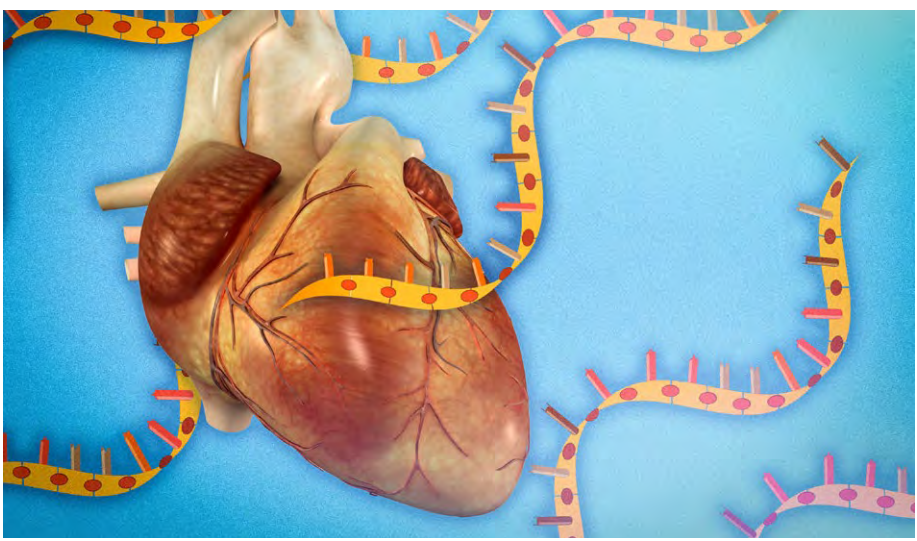
PABLO RODRIGUEZ-FERNANDEZ PhD '19, Research Scientist, Plasma Science and Fusion Center

The climate crisis, says Anne White, head of the Department of Nuclear Science and Engineering, "demands that we use every tool in our toolbox—and develop new ones." Fusion represents a potentially clean and almost limitless energy source, yet many obstacles remain. While a graduate student under White's supervision, Pablo Rodriguez-Fernandez became intrigued by one fusion mystery: Why, under certain conditions, does cooling the edge of a fusion plasma result in the core becoming hotter? His novel observations and simulation techniques offer new insights on the complex physics of plasma heat transport and point toward more robust models of fusion plasma behavior.

The Heart of the Matter

LAURIE BOYER, Professor of Biology and Biological Engineering

Laurie Boyer investigates the gene regulatory mechanisms involved in heart development and how faulty control of these processes leads to disease. While certain animals regenerate and heal their hearts after an injury, human adults who have experienced cardiac trauma are unable to repair the damage leading to heart failure. Boyer and her team work to uncover key pathways that could be used to stimulate human heart cells to replenish themselves, which, she says, "would be transformative for the many patients that suffer from cardiac disease." A deep understanding of how the heart is formed during early development and how this organ maintains its vital functions throughout life is needed to fill in the missing pieces of the puzzle. The lab's work is enabling the design of new therapeutic approaches for a variety of heart conditions that may also inform how we treat other diseases.



Retrofitting Urban Environments for the 21st Century

NORMAN B. LEVENTHAL CENTER FOR ADVANCED URBANISM

Directed by Sarah Williams MCP ’05, the Norman B. and Muriel Leventhal Professor of Architecture and Planning, the Leventhal Center integrates research on urban design with processes of urbanization to meet the challenges facing the world’s cities. Drawing on MIT’s deep engagement with design and planning, architecture, technology, and transportation, the center advances the understanding of cities and proposes new forms and systems for urban communities. Center researchers have explored projects ranging from equitable resilience, which prototypes design solutions for climate change with a commitment to equity, to digital urbanism, which considers the role of technology in the design of cities.

Wastewater Provides Key Health Data

BIOBOT ANALYTICS

In 2014, Mariana Matus PhD ’18 and urban studies research fellow Newsha Ghaeli teamed up for an interdisciplinary research project conceived by Professor Eric Alm in the Department of Biological Engineering and Associate Professor Carlo Ratti in the Department of Urban Studies and Planning. The team’s demonstration that wastewater epidemiology could generate key public health information led to the founding of Biobot Analytics, which now works with communities in all 50 states. Biobot’s Covid-19 testing detected the virus in wastewater 7 to 10 days before clinical cases appeared, guiding community responses during the pandemic. “No other data set has been shown to have this predictive value,” says Matus.

Wellbeing

At its heart, the MIT student experience is about expanding horizons, making lifelong friendships, and participating in learning and leadership opportunities. Given the tools to take care of their physical and mental health, develop healthy relationships, and clarify their sense of purpose, our students will be better equipped to thrive at MIT and beyond, empowered to work wisely, creatively, and effectively for the betterment of humankind. Existing and future elements of the student experience include a planned Wellbeing Lab in the Stratton Student Center and the bolstering of support resources such as DoingWell, the CARE Team, GradSupport, Student Mental Health and Counseling Services, and Student Support Services, as well as key programs offered by Community Wellness, the Department of Athletics, Physical Education and Recreation, and Student Support and Wellbeing. The singular living and learning environments of MIT's residential communities, including a new graduate tower in Kendall Square and a new Vassar Street undergraduate residence, will continue to enrich students' lives. Together, these threads of experience will strengthen the fabric of an MIT education.

studentlife.mit.edu/wellbeing

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Diversity, Development, and Dignity

EVAN LIEBERMAN, Total Professor of Political Science and Contemporary Africa

ASYA MAGAZINNIK, Assistant Professor of Political Science

In the MIT Global Diversity Lab (GDL), director Evan Lieberman leads an interdisciplinary team's efforts to inform scholarship, policy, and practice around human diversity and to train future leaders and scholars. Their ultimate goal is to answer the question, "Who is us?" in shaping global responses to the world's most pressing problems, and do so on a macro- and microscale. GDL associate Asya Magazinnik's research centers on the impact of local politics in the United States. "State and local governments are stepping onto the national political stage, becoming key players in things like immigration enforcement and criminal justice," she says.

The Politics of Public Health Data

CRYSTAL LEE, PhD Student, Program on Science, Technology, and Society

Crystal Lee studies the social and political dimensions of data visualization, which was used effectively to convince millions of people to mask and social distance during the pandemic. Monitoring pandemic misinformation on social media, however, Lee and a team of undergraduate researchers found that science skeptics convincingly created "counter-visualizations," contesting mainstream scientific conclusions by focusing on different metrics or interpreting them in a misleading way. "I still think data analysis is important," she says, "but it's certainly not the salve that I thought it was in terms of convincing people who believe that the scientific establishment is not trustworthy."

What Can Ice Tell Us?

MEGHANA RANGANATHAN, PhD Student in Climate Science

"Ice is humanity's record book," says Meghana Ranganathan, who seeks to improve scientists' ability to forecast climate change by looking at the movement and shape shifting of ice sheets over time. Using computational methods to analyze vast amounts of satellite data from glaciers in Antarctica and fundamental physical principles of materials, she hopes to build models that will yield more accurate estimates of the contribution of ice sheets to sea-level rise, which should guide climate action. Ranganathan is keenly aware of the urgency: "This is not a problem for the future. It's happening now."

Keeping Watch Over Democracy

CHARLES STEWART III, Kenan Sahin Distinguished Professor of Political Science

Voters were concerned about the safety of going to the polls during a pandemic, but Charles Stewart III, who heads the MIT Election Data and Science Lab, believes the aftermath of the 2020 vote poses far greater danger, as misinformation about ballot tabulation has resulted in harassment of election officials. “Democracy depends on people doing meticulous, boring things right all the time,” he says. “To have this cacophony of death threats thrown on you is wearing on the people who are stewards of democracy.” Stewart advocates for applying new scientific research to the practice of democracy in the United States.

Sustainability Through a Business Lens

ROBERTO RIGOBON PhD ’97
Society of Sloan Fellows Professor of Management

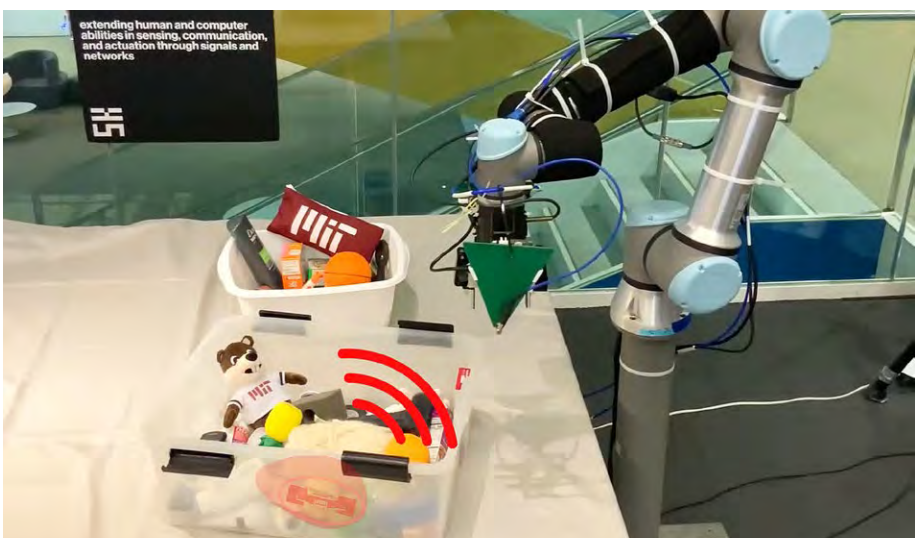
Environmental, social, and governance (ESG) data are intended to help investors put money toward more ethical companies, but research from different ratings agencies diverges broadly. In response, Roberto Rigobon founded the Aggregate Confusion Project, which explores the divergence of ESG ratings and applies a business lens to the field of sustainability. Using these ratings to guide the behaviors of just a small number of the nation’s biggest polluters would make a huge difference to addressing time-sensitive climate crises, he says: “The only way to solve these problems is to create an army of able individuals who are willing to tackle important questions.”

Finder of Lost Things

FADEL ADIB SM ’13, PhD ’17, Henry L. Doherty Career Development Professor in Ocean Utilization

ALBERTO RODRIGUEZ, Class of 1957 Career Development Professor in Mechanical Engineering

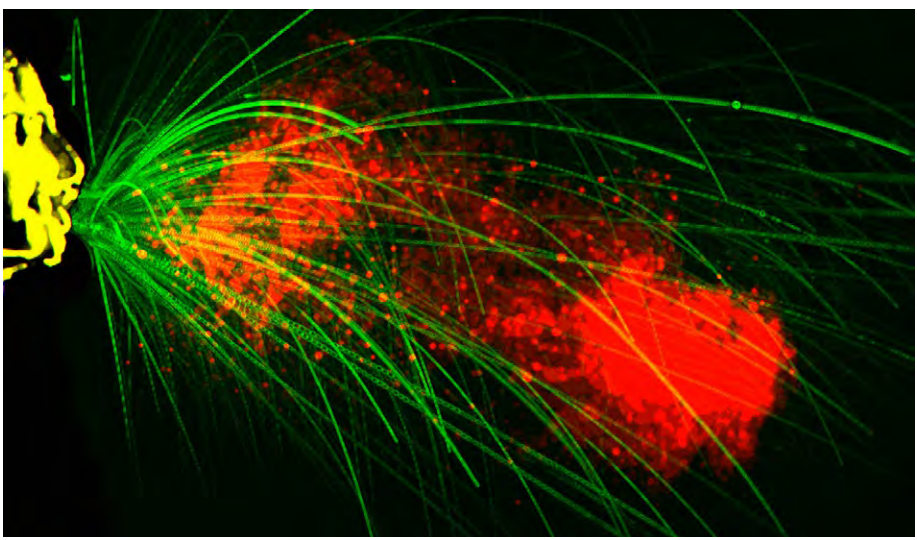
A robotic arm developed by researchers including Fadel Adib and Alberto Rodriguez can find objects—even if they are hidden. Equipped with a radio frequency antenna and camera, RFusion uses machine learning to locate and grasp its target. The device could have broad applications in the future: fulfilling orders in a warehouse, identifying and installing components in a factory, or even helping a disabled person with daily home tasks. “This idea of being able to find items in a chaotic world is an open problem that we’ve been working on for a few years,” says Adib.



Slowing the Spread of Covid-19

LYDIA BOUROUIBA, Associate Professor of Civil and Environmental Engineering and Mechanical Engineering

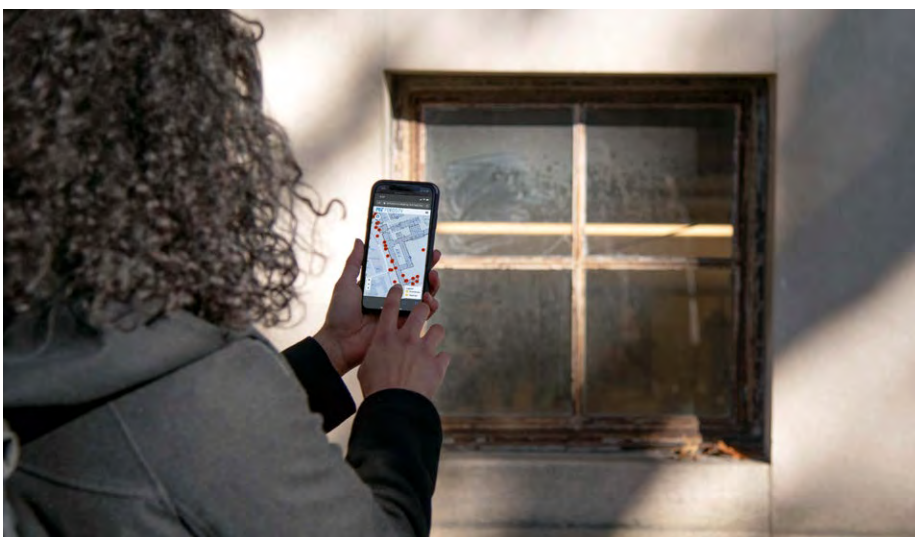
Lydia Bourouiba's fundamental research into fluid dynamics and pathogen transmission demonstrated that particles expelled through exhalations, such as coughing, travel farther than previously thought. She sounded the alarm on Covid-19 early: "By the end of January 2020 it was very clear, based on the situation in China, that this was going to be a pandemic." Her work led to a better understanding of respiratory emission dynamics and informed public health interventions. Now also researching indoor airflow and pathogen adaptation, Bourouiba hopes her findings will enable new mitigation strategies (both pharmacological and non-pharmacological) that increase safety indoors, including in health and educational settings.



A More Resilient Campus

MIHO MAZEREEUW, Associate Professor of Architecture and Urbanism

As director of the Urban Risk Lab, Miho Mazereeuw has embedded disaster preparedness into communities all over the world. Today, she is also applying this expertise to MIT. Mazereeuw's lab enlists students, faculty, and staff to fan out and measure porosity in buildings throughout campus. The valuable data collected will be used for flood mapping as the MIT Climate Resiliency Committee, managed by the Office of Sustainability, seeks to equip MIT for increasingly severe weather systems. "The goal is to understand various heights of flood waters and which spaces are likely to be inundated," says Mazereeuw.

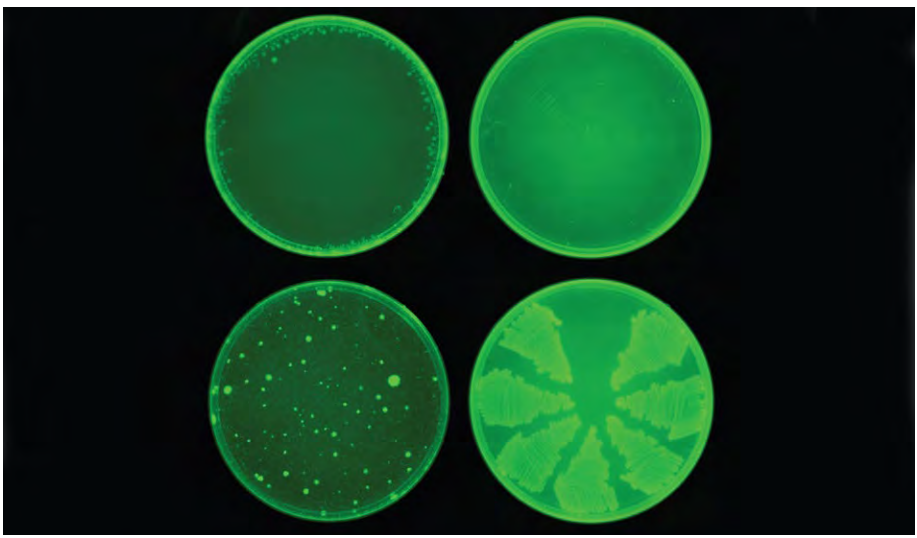


AI Points the Way to New Antibiotic

REGINA BARZILAY, School of Engineering Distinguished Professor for AI and Health; AI Faculty Lead, Jameel Clinic

JIM COLLINS, Termeer Professor of Medical Engineering and Science, Life Sciences Faculty Lead; Jameel Clinic

In a pioneering use of machine learning, Regina Barzilay and Jim Collins created an AI algorithm that helped identify a powerful new type of antibiotic. This approach enabled the researchers to draw from a pool of more than 100 million molecules using no human presumptions. “The model can learn new patterns unknown to human experts,” explains Barzilay. With bacterial resistance to existing antibiotics on the rise, there is an urgent need for new drug treatments. “People keep finding the same molecules over and over,” says Collins. “We need novel chemistries with novel mechanisms of action.”



Economics

MIT economists at the intersection of science, technology, and human behavior are using economic science to address our most pressing challenges, provide pragmatic policy advice, and explore the world in profound ways. Across a wide range of disciplines and research areas, they are deeply invested in finding solutions that work and are providing important new insights on the economic implications of climate change, health care, and globalization. For example, economics professor David Atkin's studies of trade and development have helped experts better understand trade's effects both in the United States and abroad, while David Autor, the Ford Professor of Economics, examines the global effects of China's emergence as a great economic power. Autor seeks understanding of "how we minimize adverse consequences of a changing economy and create a world we all want to live in." Environmental economists, including Clare Balboni, the 3M Professor in Environmental Economics, are studying the consequences of climate change for trade, migration, and infrastructure, examining, for example, how sea-level rise should affect infrastructure investments and potential policies to contain tropical forest fires.

economics.mit.edu

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New Tools for Urban Planning

SIQI ZHENG, Samuel Tak Lee Champion Professor of Urban and Real Estate Sustainability

Siqi Zheng, faculty director of the MIT Center for Real Estate, says, "My overarching goal as a scholar is to build our understanding of the behavioral foundations for urban real estate and environmental actions aimed at sustainable urbanization." Zheng's team finds social media data to be a useful research tool. For example, they analyzed millions of posts to assess the impacts of environmental and health hazards, such as air pollution, climate risks, and Covid-19 on the emotional state and behavior of social media users in China, the United States, and other countries.

Simulations Lead to Sustainable Results

CLIMATE PATHWAYS PROJECT

Using interactive simulations to advance the adoption of evidence-based climate policy, the Climate Pathways Project reaches top policy makers with messages of sustainability. Created by the MIT Sloan Sustainability Initiative and nonprofit Climate Interactive, the simulations—C-ROADS (Climate Rapid Overview and Decision Support) and En-ROADS (Energy Rapid Overview and Decision Support)—are used by elected officials, business leaders, educators, and laypeople worldwide. Research shows the simulations enable people to learn for themselves about climate change, what they can do about it, and the need for urgent action—and build their desire to take action.

Hacking Biology

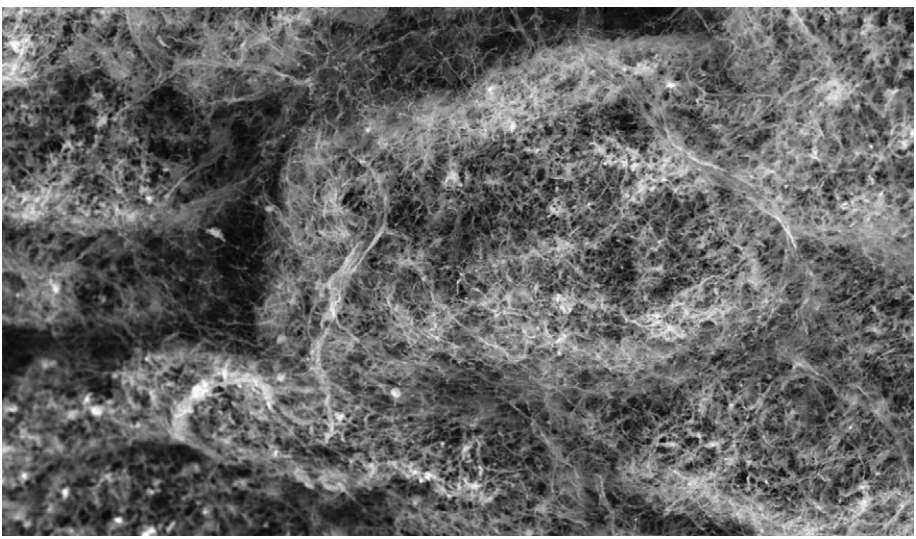
GINKGO BIOWORKS

In 2008, four PhD students and their faculty advisor at MIT, Tom Knight ’69, SM ’79, PhD ’83, turned their shared fascination with synthetic biology into a small spin-off, Ginkgo Bioworks. Together they genetically engineered organisms for applications ranging from building sustainable agriculture to manufacturing perfume. Bootstrapped in the Cambridge apartment of CEO Jason Kelly ’03, PhD ’08, the company now has more than 600 employees and 350,000 square feet of Boston lab space. For the initial public offering in September 2021, Ginkgo Bioworks’ founders chose “DNA” as their stock ticker symbol.

Mysteries of Mucus

KATHARINA RIBBECK, Andrew and Erna Viterbi Professor of Biological Engineering

The human body produces many fascinating materials, but one intrigues Katharina Ribbeck above all others—mucus. “It allows us to integrate nutrients, it protects us from pathogens, and it allows us to communicate with the outside world,” she says. Ribbeck’s lab investigates how mucus barriers exclude or allow the passage of different molecules and pathogens and the mechanisms pathogens use to penetrate mucus barriers. “Mucus is the battleground for our interactions with the microbial world,” Ribbeck continues. Her team has published studies showing how mucus keeps problematic pathogenic microbes in check, preventing them from causing damage. Mucus doesn’t kill the microbes; it tames them.



Tracking Literature's Impact

SANDY ALEXANDRE
Associate Professor of Literature

Sandy Alexandre studies and champions literature as an ever-dependable source for meaning making (mens) and technological innovation (manus). Fiction is chock full of creative ideas and opportunities for eureka moments for avid readers, thinkers, tinkerers, and makers alike. In a project for MIT's Digital Humanities, "The Reading Redux," Alexandre gathered data from participants about the important experience of rereading a text. In another project, she looks particularly to science fiction for the variety of unique and urgent ways these writers imagine that social problems—from climate change to elder care—could be solved.

Building Bridges Between Architects and Engineers

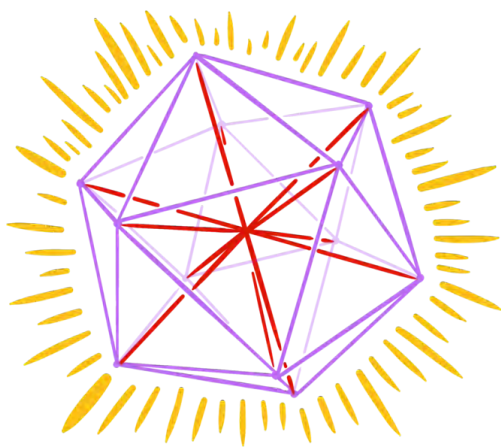
CAITLIN MUELLER ’07, PhD ’14, Associate Professor of Building Technology and Civil and Environmental Engineering

In the conventional building process, architects and engineers rarely collaborate at the beginning of a project. For Caitlin Mueller, this disconnect revealed many missed opportunities—for one, buildings that look great can often prove expensive to build and operate. By creating software that generates design alternatives and simulates their performance, she hopes to qualitatively change how buildings are conceived and made. Bringing architecture and engineering together and considering engineering problems during the design process will ultimately lead to structures that are more cost-effective, more environmentally sustainable, and cheaper to build and operate, Mueller says.

Teaching Students to Solve ‘Unsolvable’ Geometry

YUFEI ZHAO ’10, PhD ’15, Assistant Professor of Mathematics

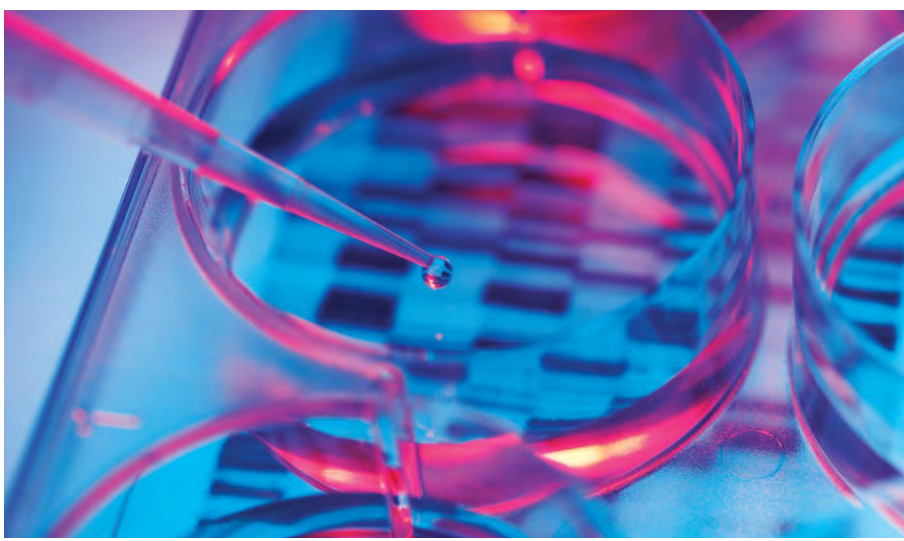
Yufei Zhao, the 2018 winner of the Future of Science Award in the School of Science, prioritizes creativity when it comes to teaching and research. He shared a well-known, unsolved geometry problem on equiangular lines with his team of undergraduate and graduate student researchers and together, they found a solution. Their findings include new insights into spectral graph theory, which provides mathematical tools for studying networks and algorithms in computer science. “It’s not every day that a long-standing open problem gets solved,” says Zhao.



Powering Gene Discovery

CAROLINE UHLER, Associate Professor of Electrical Engineering and Computer Science

In the Department of Electrical Engineering and Computer Science, Caroline Uhler develops methods in machine learning and statistics to power discovery in the life sciences. She and her students study genomics to better understand how disease impacts the human body on a cellular and tissue level, seeking information that will help point to targeted treatments. Early in her academic career, Uhler says, “I got really interested in causality and gene regulation.” Changes in one gene, she explains, can have cascading effects on the expression of other genes in a cell, on cell-cell communication, and on tissue architecture.



Speeding Drug Innovation by Staying Local

SNAPDRAGON CHEMISTRY

Snapdragon Chemistry, cofounded by Associate Provost Tim Jamison, the Robert R. Taylor Professor of Chemistry, helps pharmaceutical companies manufacture drugs locally to shorten the time it takes for new drugs to get to patients. Snapdragon acts as a chemistry lab, running experiments on behalf of pharmaceutical customers to create molecules of interest, then automates production processes to speed the molecules' creation. Snapdragon has worked with more than 100 companies, ranging from small biotechs to large multinationals like Amgen, for which it has helped develop potential cancer treatments.

Design

Design advances innovation and serves society. It breaks boundaries, combining resourceful problem-framing and problem-solving with ongoing critical reflection and dialogue. As a long-time global leader in design education and research, MIT has developed a vision to elevate and strengthen design with the aim of amplifying the human and creative dimensions of technology. The new Morningside Academy for Design is being led by John Ochsendorf, the Class of 1942 Professor in the Department of Architecture and Department of Civil and Environmental Engineering, and Maria Yang '91, the Gail E. Kendall Professor in the Department of Mechanical Engineering and associate dean of the School of Engineering. They, along with an Institute-wide faculty committee, are exploring new research frontiers in design, as well as collaborations to enhance design education, including potential joint degree programs. Much of this work will take place in the renovated Metropolitan Storage Warehouse, which is envisioned as a new hub for design on the MIT campus.

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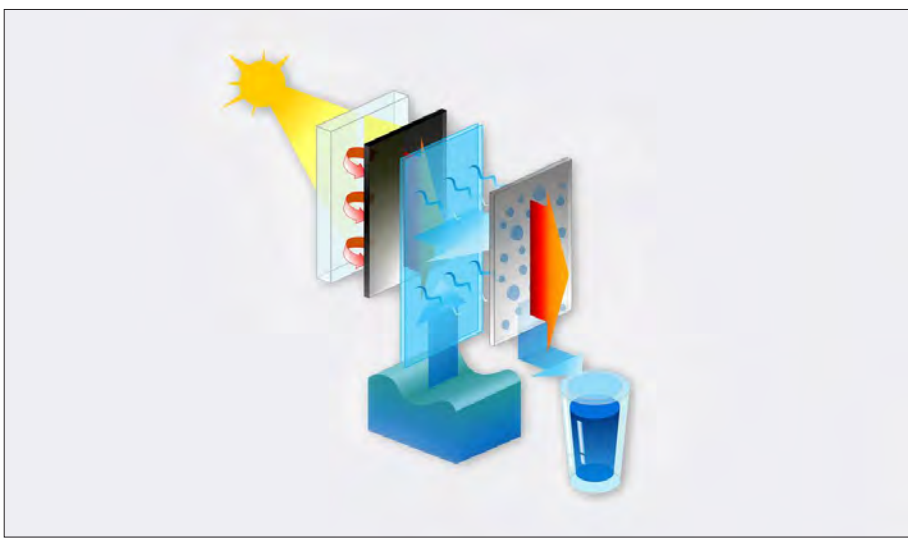
Drinkable Water out of Thin Air

EVELYN WANG '00, Ford Professor of Engineering

ALINA LAPOTIN SM '19, PhD Student in Mechanical Engineering

Even the world's most arid climates may soon have a new source of drinking water at their fingertips, thanks to the work of MIT researchers. Evelyn Wang, head of the Department of Mechanical Engineering, worked with PhD student Alina LaPotin on a system that can extract drinkable water from the air. Working at humidity levels as low as 20% and relying only on sunlight or any other source of low-grade heat as an energy source, this atmospheric water-harvesting system could present unprecedented access to water in the world's driest regions. Wang's team continues to work on improving the device's scalability.



Innovating to Transform Today's Health System

JOSEPH DOYLE, Erwin H. Schell Professor of Management and Applied Economics

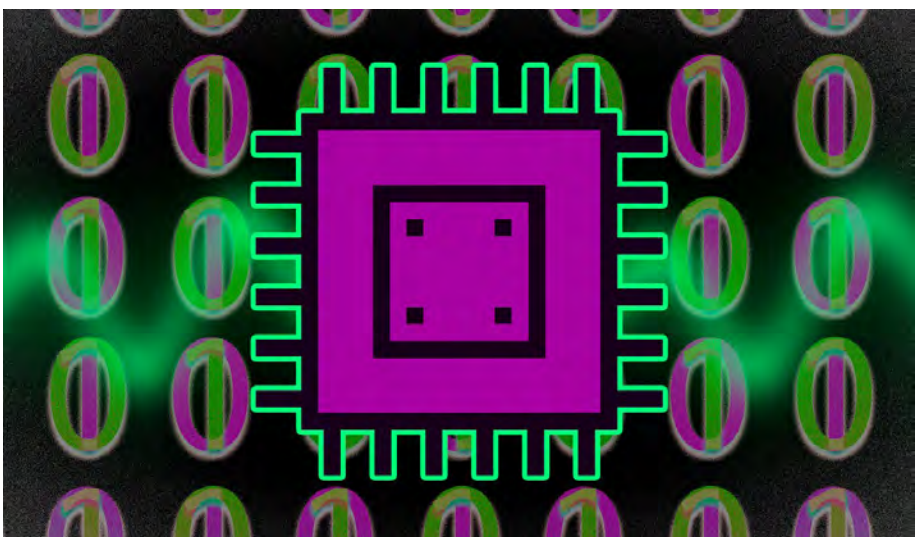
JÓNAS ODDUR JÓNASSON, Assistant Professor of Operations Management

The MIT Sloan Health Systems Initiative (HSI) brings industry leaders together with world-class researchers and students on projects to both improve health and lower health care costs. For example, HSI codirector Joseph Doyle's research investigates sources of value and waste to inform policies aimed at improving the quality and cost-effectiveness of the US health care system. Meanwhile, Jónas Jónasson focuses on understanding and improving the operational effectiveness and efficiency of decentralized health care delivery systems.

Computing's Quantum Leap

WILLIAM D. OLIVER SM '97, Professor of Electrical Engineering and Computer Science and Physics

MIT Center for Quantum Engineering Director William D. Oliver is building a new class of computer—a quantum computer—with the potential to radically improve how we process information and simulate complex systems. Quantum computers can process information far faster than classical computers for certain problems, in some cases completing tasks in minutes where a classical computer would in theory take millennia. "Quantum computing is transitioning from scientific curiosity to technical reality," says Oliver. "We know it works on a small scale. Now we're trying to increase the size of the systems so we can do problems that are actually meaningful."



Exploring Plastic-Eating Enzymes

LINDA ZHONG-JOHNSON, PhD Student in Microbiology

More than 60% of all plastic produced since the 1950s has ended up in landfills and the environment. Inspired by the pristine, plastic-free landscape of Alaska, Linda Zhong-Johnson became determined to find a way to eliminate plastic waste entirely. Her research around polyethylene terephthalate, or PET—which most water bottles are made of—brought her attention to an enzyme that digests plastic: PETase. She soon realized that there was a huge gap in the field's understanding of how PETase works. "Getting that fundamental picture of the enzyme and establishing good methods to study it are my priority," Zhong-Johnson says.


WHY NATIONS FAIL

Transformative Economics for the 21st Century

DARON ACEMOGLU
Institute Professor

Economist Daron Acemoglu's research has produced influential studies about government, innovation, labor, and globalization. He credits the intellectual environment created by his MIT colleagues as beneficial to that research, especially "in an age when economics is more relevant than ever but also in the midst of a deep transformation." Acemoglu has written extensively about the labor-market implications of automation, robotics, and AI, arguing that technology's use should be thoughtfully planned. "There isn't an ironclad rule of what it is that humans can do and technologies cannot do," he says. "It depends on what we value and how we use technology."

MIT and the Legacy of Slavery

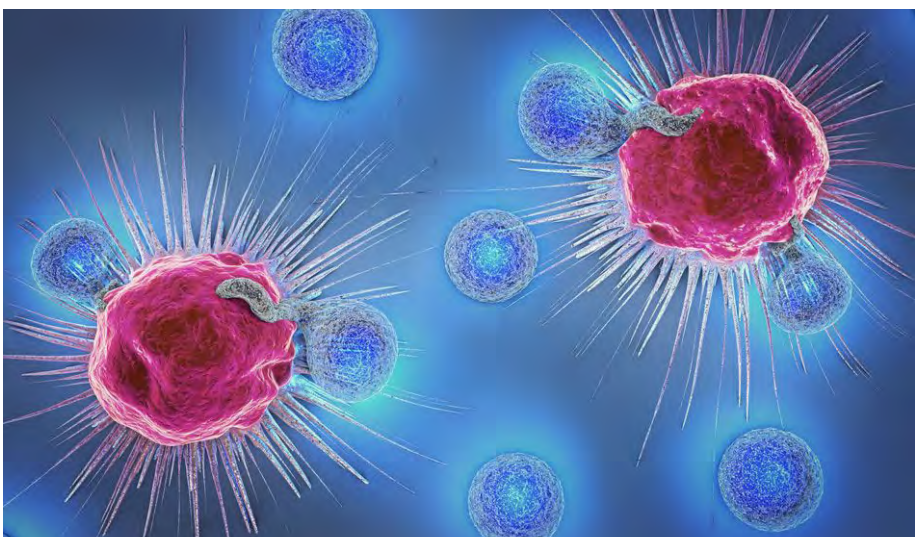
CRAIG STEVEN WILDER, Barton L. Weller Professor of History

In the course MIT and Slavery, created in 2017 by Craig Wilder, undergraduates conduct archival research about the role of both slavery and racism in MIT's history. New lines of research that emerge and an ongoing curricular project will enable MIT to contribute to a larger national conversation about still hidden legacies of slavery, especially the relationship between the Atlantic slave economies, the fields of science and engineering, and US technical institutions. "We are not only participating in a larger exploration of the ties between American universities and slavery," says Wilder. "We are leading a part of it."

Simple Tests for Complex Medical Issues

HADLEY SIKES, Associate Professor of Chemical Engineering

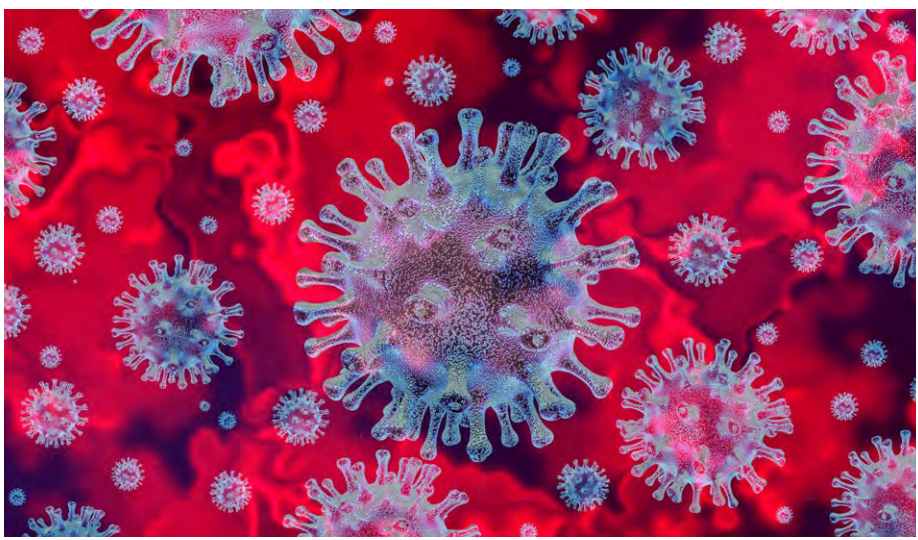
In the lab of Hadley Sikes, researchers engineer biomolecular systems to detect and treat disease in new ways. From early tumor detection to rapid Covid-19 tests—which her lab was able to develop quickly in response to the pandemic in 2020—the principles of engineering design support and extend the practice of evidence-based diagnosis and treatment. “In the products that we want to widely disseminate, our idea is that if things are as simple as they can be, that might give them a better chance of being more widely used,” she says.



Managing in the Eye of the Storm

MELANIE IVARSSON EMBA ’19

Melanie Ivarsson believes the Executive MBA program at MIT Sloan was ideal preparation for the role she began in January 2020 as senior vice president and chief development officer of Moderna. Leading a team working under enormous pressure to develop a Covid-19 vaccine, Ivarsson was inspired by their adaptability to difficult circumstances. “It’s all down to teamwork,” she points out. “Nobody has ever developed a drug on their own.” Looking ahead to potential vaccines and therapies for diseases other than Covid-19, Ivarsson told the MIT Sloan community in 2021, “Moderna is pushing forth with what mRNA can do for the world.”



Morality and Climate Change

KIERAN SETIYA, Professor of Philosophy

Climate action is about more than science. The moral issues at stake, according to Kieran Setiya, include how much people living today care about future generations and how our society responds to vulnerable populations already displaced by climate change. Setiya, whose research explores questions of ethics, human agency, and human knowledge, co-teaches a course on the ethics of climate change. “Do we make progress toward a more just and egalitarian future?” he asks. “The answer depends very much on whether we respond to crises like this with grace and compassion and justice, or not.”

Life Sciences

The long arc of scientific research that led to lifesaving mRNA vaccines to combat Covid-19 began in the 1970s, with Institute Professor Phillip A. Sharp's discovery of split genes and spliced RNA, which would earn him the 1993 Nobel Prize in Physiology or Medicine. Researchers working in the MIT Center for Cancer Research—later to become the Koch Institute for Integrative Cancer Research at MIT—investigated basic cellular mechanisms to understand the causes of cancer. The fundamental scientific research conducted in these labs and the collaborative environment that brought scientists and technicians together is part of MIT's unique formula for groundbreaking—and Nobel Prize-winning—discoveries. MIT's life sciences enterprise has expanded significantly with an unparalleled cadre of researchers across many different departments, centers, and industry partnerships. In 2021 the family of Paul Schimmel PhD '66, the John D. and Catherine T. MacArthur Professor of Biochemistry and Biophysics Emeritus, established the Schimmel Family Program for Life Sciences, which supports scientists and engineers from multiple disciplines who are part of the vibrant Kendall Square biotechnology ecosystem working to accelerate tangible outcomes for human health and our planet.

betterworld.mit.edu/life-sciences

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Maximizing the Impact of Clinical Trials

ANDREW LO, Charles E. and Susan T. Harris Professor of Finance

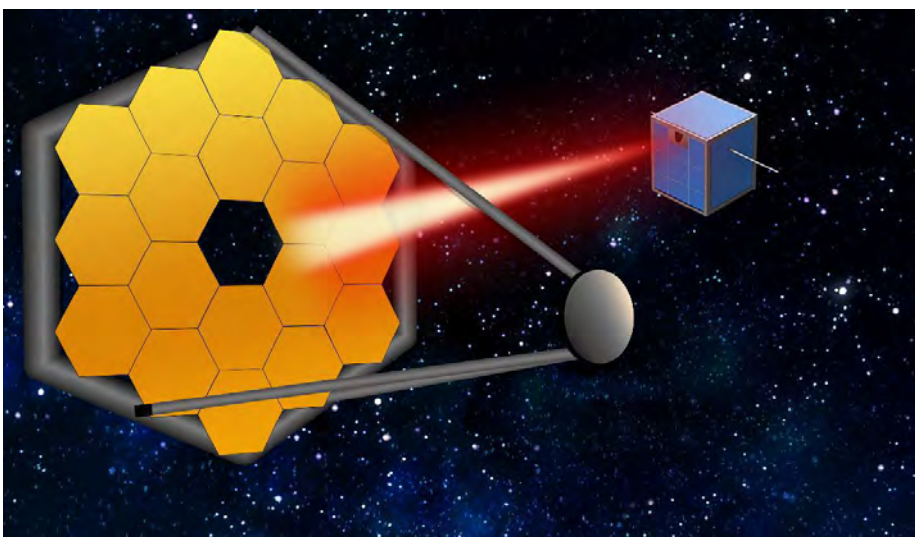
The road between an exciting medical discovery and the approval of its corresponding life-saving therapy can be long and risky. Andrew Lo wants to improve that process with Project ALPHA (Analytics for Life-sciences Professionals and Healthcare Advocates), which provides more timely and accurate estimates of the risks of clinical trials and related metrics. “More accurate risk metrics will eventually lead to fewer big failures, faster approval times, cost savings to the entire health care system, and more investment capital for developing breakthrough therapies,” he says, “all of which means more, and better, therapies to patients sooner.”

Small Satellites in Space

KERRI CAHOY, Associate Professor of Aeronautics and Astronautics

PAULO LOZANO SM ’98, PhD ’03, Miguel Alemán Velasco Professor of Aeronautics and Astronautics

At MIT, professors are advancing the next generation of satellites. Paulo Lozano is designing tiny solar-powered ion thrusters that can efficiently propel shoebox-sized satellites, known as CubeSats, through space, while Kerri Cahoy is developing a small fleet of optical and laser technology demonstration nanosatellites, one of which was launched in 2020. They seek to reduce the cost and risk of space exploration and improve communication systems and weather monitoring. “The goal is to make [CubeSats] do most of the things we already do with big satellites, except in a less expensive way,” says Lozano.

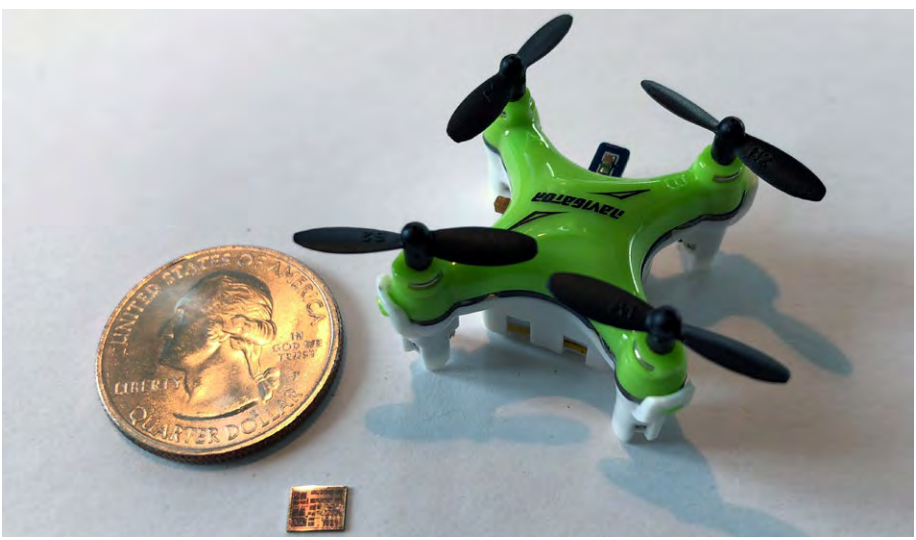


Tiny Robots, Huge Possibilities

VIVIENNE SZE SM ’06, PhD ’10, Associate Professor of Electrical Engineering and Computer Science

SERTAC KARAMAN SM ’09, PhD ’12, Associate Professor of Aeronautics and Astronautics

Vivienne Sze’s efficient hardware brings AI applications to smartphones and tiny robots. Paired with Sertac Karaman’s research in embedded systems and mobile robotics, the applications for their low-energy, high-output technologies are endless. They’ve already designed a computer chip, Navion, that is just 20 square millimeters and consumes just 24 milliwatts of power, or about 1 one-thousandth the energy required to power a lightbulb. Now their interdisciplinary research group, Low-Energy Autonomy and Navigation, is focused on the co-design of algorithms and hardware for low-energy autonomous vehicles ranging from miniature robots to high-endurance vehicles.



A Safer Food Supply Chain

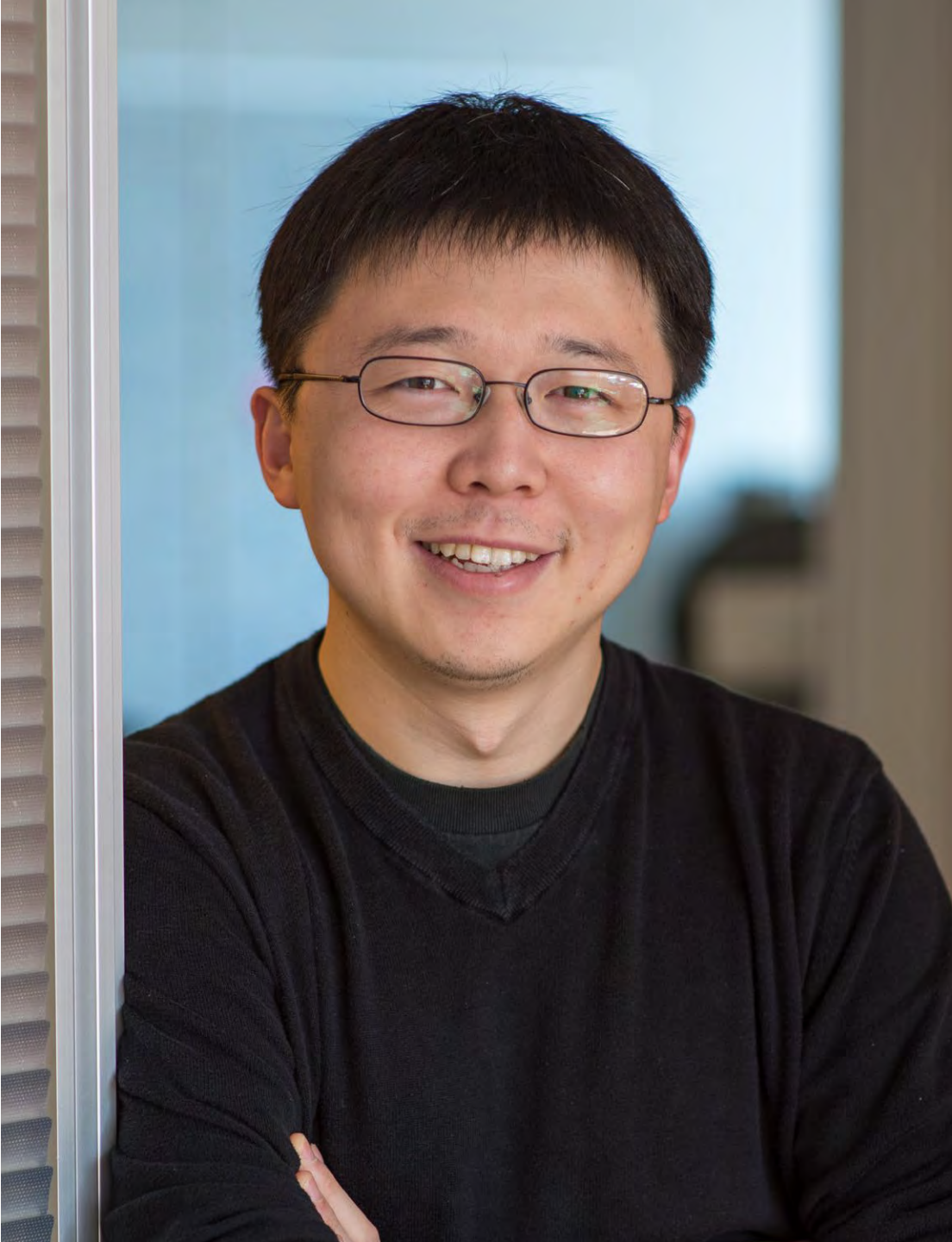
FOOD SUPPLY CHAIN ANALYTICS AND SENSING INITIATIVE

MIT Sloan launched the Food Supply Chain Analytics and Sensing Initiative (FSAS) in 2020 to develop and deploy predictive analytical tools and technologies to improve the design and management of safe and reliable food supply chains. “This is a global challenge with relevance to every country on the planet,” says FSAS faculty director Retsef Levi, the J. Spencer Standish Professor of Operations Management. “We hope that our multidisciplinary work can help inform policies and industry practices and build better global food systems.” Joined by students and faculty from the schools of science and engineering, FSAS is working in three areas: management of food safety; design and optimization of agricultural supply chains and markets; and issues of food access and food waste.

CRISPR Speeds Discovery in Brain Research

FENG ZHANG
James W. and Patricia T. Poitras Professor of Neuroscience
Professor of Biological Engineering

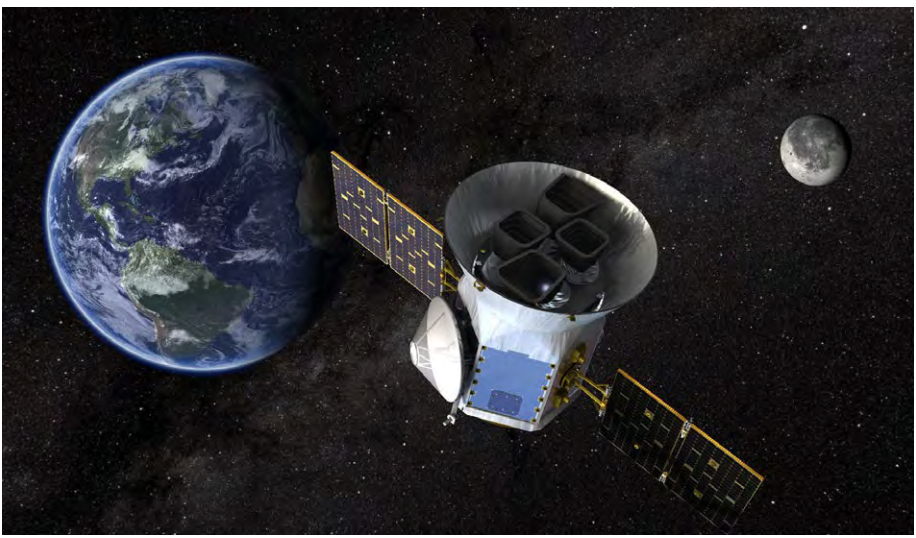
Feng Zhang pioneered the development of CRISPR-based genome editing tools, which are accelerating biomedical research around the world. At the MIT McGovern Institute for Brain Research, Zhang leverages natural diversity to engineer programmable molecular therapeutics that can be tailored to treat a wide range of human diseases, including complex brain disorders. “Nature is an incredible inventor,” Zhang says, “and we hope to use natural systems as the starting point to develop powerful new molecular technologies that can advance human health and wellbeing.”



Discovering New Planets and More

TRANSITING EXOPLANET SURVEY SATELLITE

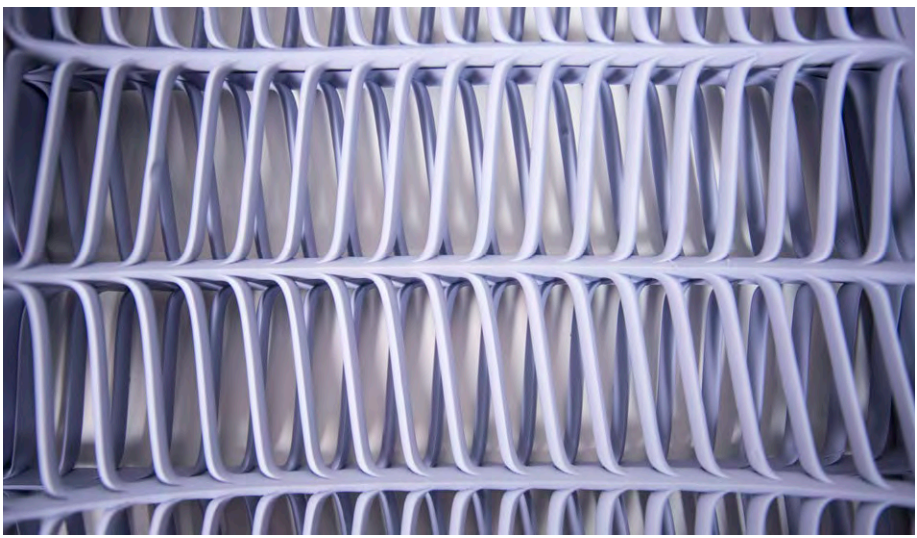
In 2020, the MIT-led NASA mission Transiting Exoplanet Survey Satellite (TESS) completed its two-year primary task, having imaged three-quarters of the sky and enabled the identification of more than 2,100 exoplanet candidates, including the discovery of the first Jupiter-size planet orbiting a white dwarf star. TESS is now collecting data at fine time resolution to identify transient astrophysical events. Surprising TESS discoveries include: measurements of “star quakes” in thousands of stars; detection of stars being ripped apart when they have ventured too close to supermassive black holes in several galaxies; and prompt observations for more than 200 bright supernovae.



Smart Materials for Better Design

SKYLAR TIBBITS SM ’10, Associate Professor of Design Research

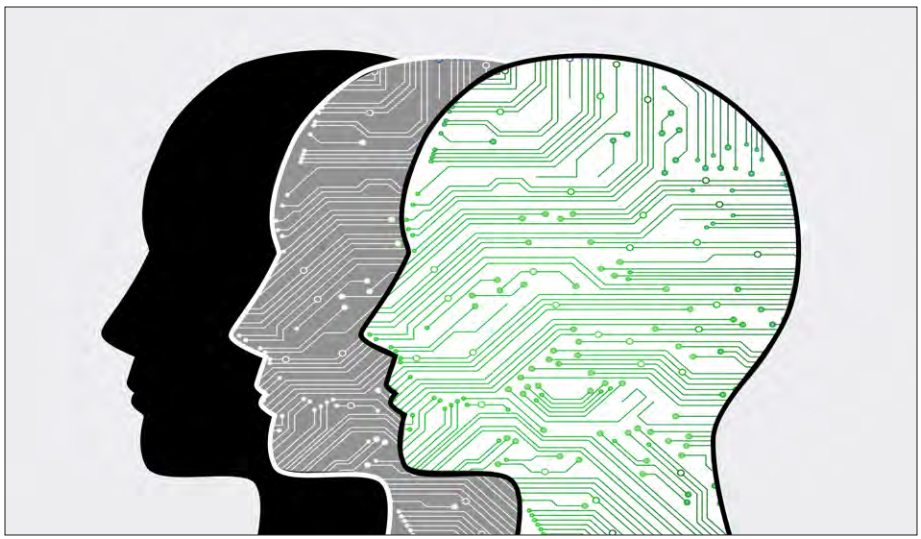
Skylar Tibbits, founder and codirector of the Self-Assembly Lab, is pioneering the field of 4-D printing. His team has developed cutting-edge concepts such as smart textiles, transformable architecture, and self-assembling mobile phones. The Self-Assembly Lab works on a variety of applications, translating their technology into solutions like architectural facades that adapt to the weather and shoes that respond to foot activity to provide appropriate support. In one project, the team is working to battle erosion and sea-level rise in the Maldives by growing islands through the self-organization of sand.



An Interdisciplinary Approach to Combating Systemic Racism

FOTINI CHRISTIA, Ford International Professor in the Social Sciences

As the lead organizer for the Initiative on Combating Systemic Racism at MIT, Fotini Christia, director of the Sociotechnical Systems Research Center, facilitates efforts to seed and coordinate cross-disciplinary research on how to overcome racially discriminatory processes and outcomes in American institutions. “Our intent is not only to identify but to also propose fixes on racially inequitable outcomes that result from implicit or explicit biases,” she explains. The initiative is working to create a visible presence at MIT for cutting-edge computational research across societal domains, including but not limited to policing, health care, and housing.



The Cost of Progress

KATE BROWN, Thomas M. Siebel Distinguished Professor in the History of Science

Award-winning historian Kate Brown confronts the human and environmental effects of technological progress. She explored communities living amidst public health disasters caused by radioactive fallout from Chernobyl and radioactive waste from production of nuclear weapons. “Technologies that have made it possible for more and more of us to inhabit the Earth have also made it less hospitable to human life,” she notes. Now researching food security through the lens of human-plant alliances, Brown makes the case that biological isolation from other species is impossible: “The history of civilization has hinged on the building and demolition of boundaries between species.”

Open Learning

Open Learning is bringing MIT teaching and research to the world, reinventing how education is delivered. MIT Open Learning is driven by scientists and engineers who tap the science of learning—neuroscience, cognitive science, and rigorous education research—to improve the practice of education in person, digitally, and virtually through such programs as the MIT Integrated Learning Initiative and the Center for Advanced Virtuality. In its workforce and professional education programs, MIT Open Learning expands learners' knowledge and skills to prepare them to engage in real-world challenges and opportunities in their lives. Through OpenCourseWare, the MIT Refugee Action Hub, and the MITx MicroMasters, MIT is opening up equitable access to new education pathways for diverse communities of learners around the world. The Responsible AI for Social Empowerment and Education program is rethinking how to holistically and equitably prepare diverse K–12 students, an inclusive workforce, and lifelong learners to be successful, responsible, and engaged in an increasingly AI-powered society. Further, through initiatives such as the Abdul Latif Jameel World Education Lab, MIT is working to shift minds and build capacities of individuals and organizations over the long term to address large-scale challenges in US and global education.

openlearning.mit.edu

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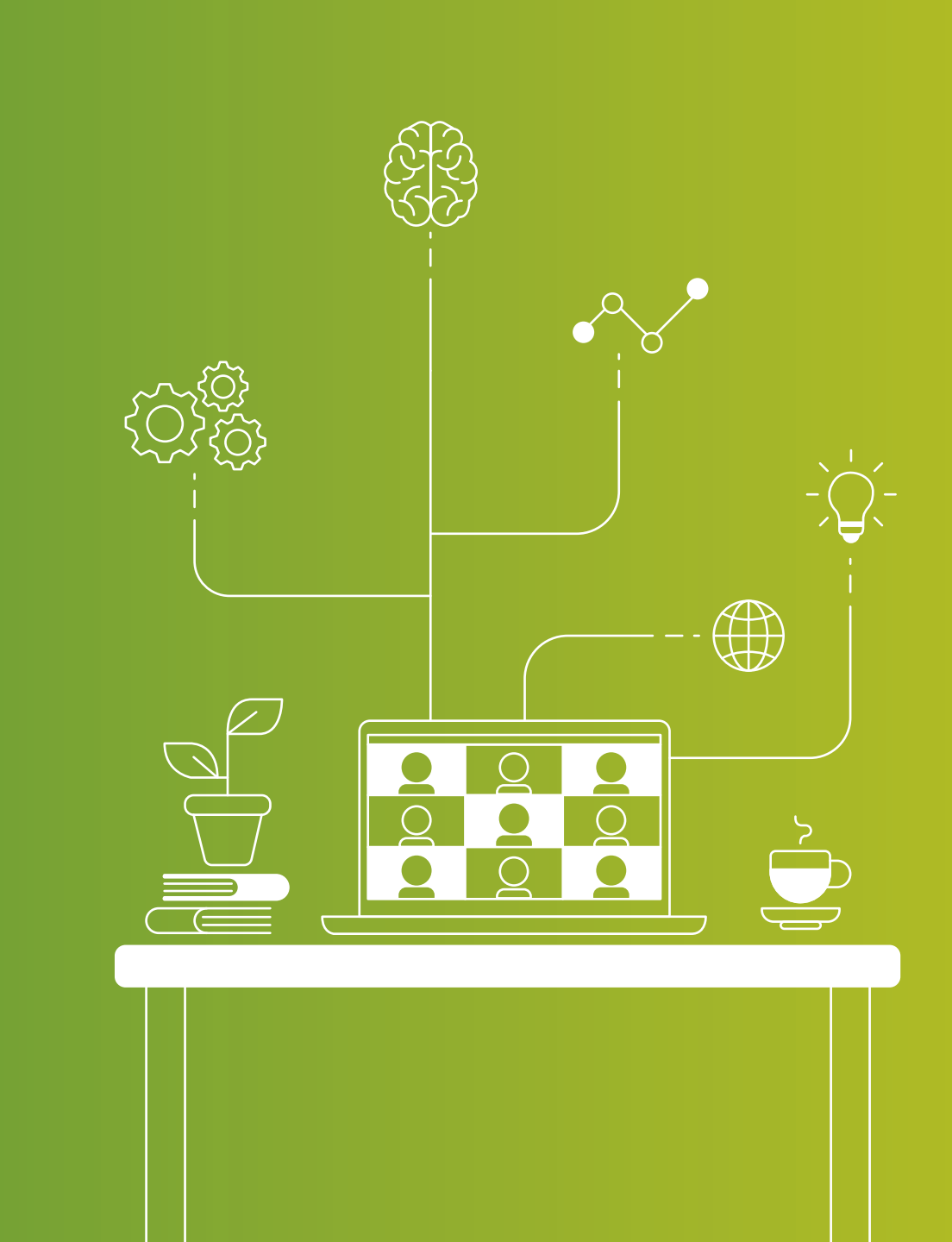
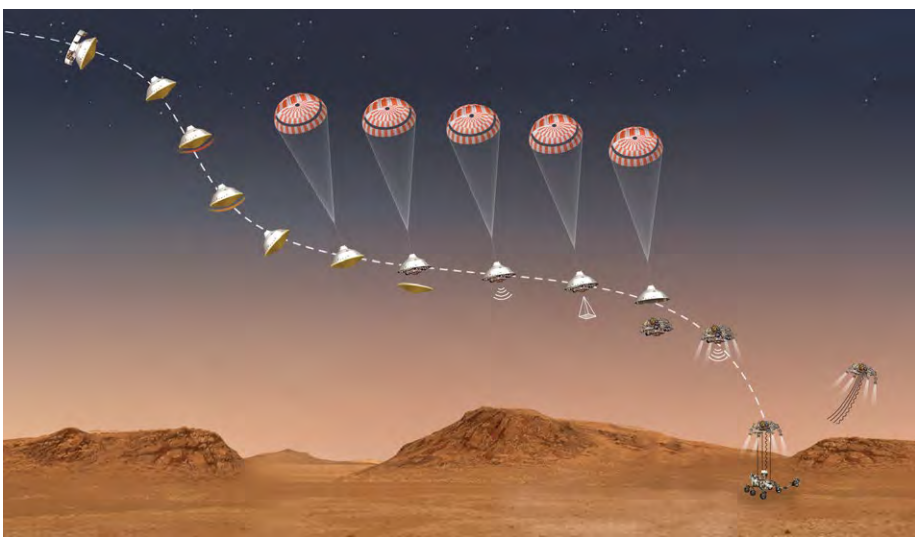


Integrating Computing Across Disciplines

LAURENT DEMANET, Professor of Applied Mathematics

DAVID DARMOFAL SM '91, PhD '94, Jerome C. Hunsaker Professor of Aeronautics and Astronautics

How do different greenhouse gases affect the climate? How does Covid-19 transmission change with lockdown measures? Will a Martian lander survive its descent through the Mars atmosphere? These questions and others are explored in Introduction to Computational Science and Engineering (CSE), a pilot class taught by Laurent Demanet and David Darmofal and created by the Center for CSE as part of the Common Ground for Computing Education. The class is intended to show students how computational algorithms apply across a variety of majors while they gain proficiency in computer programming.



The Real Cost of Living

AMY GLASMEIER, Class of 1922 Professor of Economic Geography and Regional Planning

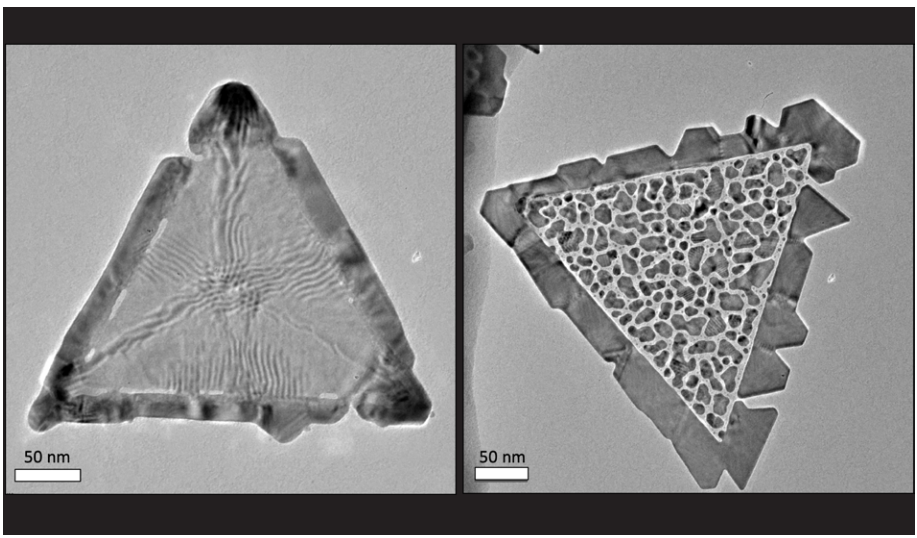
Long before the pandemic and its economic ripple effects, Amy Glasmeier identified a problem facing US workers: in many places in the United States, it would take working two-and-a-half to three minimum-wage jobs to make ends meet. In 2003, Glasmeier created a living wage calculator showing the income needed for costs of living in various regions. “The quickest way to make all Americans sleep easier at night,” she wrote in 2020, “is by providing a living wage to get by in the era of Covid-19.” The calculator is used daily by corporations, individuals, local and state governments, and members of Congress.

Nanoscale Imaging Science

JAMES LEBEAU, John Chipman Associate Professor of Materials Science and Engineering

FRANCES ROSS, Ellen Swallow Richards Professor of Materials Science and Engineering

Frances Ross and James LeBeau strive to make MIT a leader in characterization science, which involves probing and measuring the structure and properties of materials. They joined the MIT faculty to oversee the state-of-the-art electron microscope systems being installed in the newly opened nanotechnology fabrication and analysis facility MIT.nano. Ross studies nanoscale materials, which grow and react in both gases and liquid media, by filming the reactions as they take place under an electron microscope. LeBeau develops electron microscopy techniques to quantify the atomic structure of material defects in ceramics, metals, and electronic materials.



Decoding Political Networks

IN SONG KIM, Associate Professor of Political Science

In Song Kim works to demystify the financial relationships that affect legislative policy. He built a database, LobbyView.org, which includes massive amounts of public records about Congressional lobbying and allows users to search and easily connect the activities of lobbyists, companies, and politicians. “Researchers can examine how private interests are reflected in actual policy making and which political networks dominate legislative politics in certain issue domains,” he says. Of the more than 12,000 bills introduced each year in Congress, according to Kim, “the majority of those bills are lobbied . . . by one or two groups.” LobbyView is also a powerful teaching tool; Kim’s students learn about politics through big data analysis, applying algorithms to identify meaningful patterns.

A Smarter Home for Human Health

DINA KATABI SM ’99, PhD ’03
Thuan and Nicole Pham Professor

Wearable devices track our movements and habits, but are merely reactive—and can be invasive. Dina Katabi works in the Department of Electrical Engineering and Computer Science on wireless systems that can track human movement even through walls without cameras or wearable sensors, simply by using machine learning to analyze changes in the surrounding radio waves. These invisible trackers have myriad uses, from helping homeowners save energy to alerting a caregiver about changes in a patient’s vital signs or a missed medication. “They will enable truly ‘smart’ homes in which the environment senses and responds to human actions,” Katabi says.

Engineering Food Safety

A. JOHN HART SM ’02, PhD ’06, Professor of Mechanical Engineering

BENEDETTO MARELLI, Associate Professor of Civil and Environmental Engineering

Benedetto Marelli, A. John Hart, and a team of researchers applied a technological approach to the problem of food waste, designing a sensor to detect spoilage and bacterial contamination. Equipped with silk microneedles that can pierce plastic packaging, the sensor changes color when it identifies contaminating bacteria such as pathogenic *E. coli*. Made widely available, smart food sensors could be used to head off outbreaks of food-borne illnesses at various stages along the food supply chain. “A technology like this would give confidence to the end user to not waste food,” says Marelli.

Fine-Tuning Search and Rescue

PIERRE LERMUSIAUX, Nam Pyo Suh Professor of Mechanical and Ocean Science Engineering

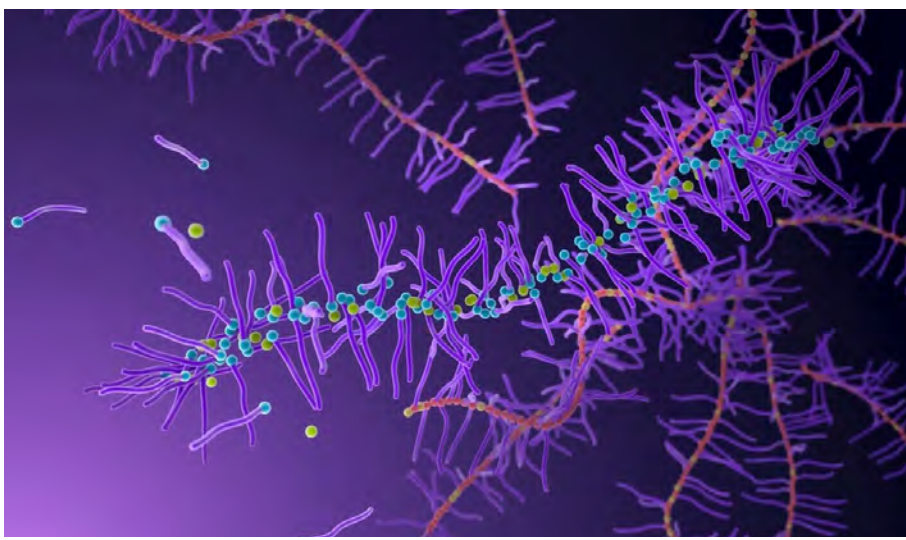
THOMAS PEACOCK, Professor of Mechanical Engineering

In a search-and-rescue operation at sea, every moment counts. Thomas Peacock and Pierre Lermusiaux helped develop a method with colleagues from other institutions that identifies hidden “traps” where missing objects or people might be steered by ocean conditions such as currents, surface winds, and waves. The novel Eulerian approach uses the most reliable velocity forecast snapshots to quickly uncover the most attracting regions of the ocean at a given time. Results were demonstrated in real-time using MIT ocean forecasts. “This method uses data in a way that it hasn’t been used before, so it provides first responders with a new perspective,” says Peacock.

Making Robust Plastics Recyclable

JEREMIAH JOHNSON, Professor of Chemistry

Thermosets, which include epoxies, polyurethanes, and rubber, are useful in cars, electrical appliances, and other products that must be durable and heat-resistant. The downside? They can't be easily recycled and don't decompose because of the strength of the chemical bonds holding them together. Jeremiah Johnson's research group aims to solve this problem: they produced a deconstructable version of one thermoset called pDCPD, broke it down into a powder, and used the powder to create more pDCPD. Johnson's group has gone on to make degradable versions of other thermoset materials using this general approach.



Big Push on Fusion

ZACHARY HARTWIG PhD ’14, Robert N. Noyce Career Development Professor of Nuclear Science and Engineering

Zachary Hartwig helps lead the Institute’s fusion energy research activities, including collaborations with startup Commonwealth Fusion Systems (CFS) to commercialize fusion as a source of unlimited, safe, carbon-free energy. In September 2021, he led a joint MIT-CFS team that demonstrated a new type of large-scale superconducting electromagnet, the most powerful of its kind ever created, capable of producing magnetic fields over 20 tesla. This breakthrough technology is the foundation of an accelerated approach to demonstrate net energy production from fusion for the first time in a device called SPARC.

Mobility

The MIT Mobility Initiative is an Institute-wide effort designed to decarbonize global mobility and accelerate the transformation to a transportation system that is safe, clean, and inclusive. The initiative conducts research, directly engages with industry leaders across the mobility ecosystem, hosts the Institute's transportation education program, and cultivates transportation-related entrepreneurship at MIT. "We are in the midst of large-scale disruption in transportation as new technologies and capabilities, ranging from electrification to AI, meet new objectives, such as decarbonization, public health, and social justice," says Director Jinhua Zhao MCP '04, SM '04, PhD '09, associate professor of city and transportation planning. "At the Mobility Initiative, we are working to shape those trends and to help drive innovation forward." The initiative has expanded scholarship opportunities and updated the Institute's transportation curriculum, adding mobility-focused courses on decarbonization, entrepreneurship, and equity, and more than doubling the program's applicant pool.

mobilityinitiative.mit.edu

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Toward Faster Drug Development

J. CHRISTOPHER LOVE, Raymond A. and Helen E. St. Laurent Professor of Chemical Engineering

NEIL DALVIE, PhD Student in Chemical Engineering

J. Christopher Love's team seeks to transform biopharmaceutical development from discovery to manufacturing to make new drugs accessible as quickly as possible across the globe. Pursuing a Covid-19 vaccine provided a perfect test: Under pressure from the pandemic, Love and his team, including PhD student Neil Dalvie, worked to design and build potentially life-saving vaccine candidates and to get treatments to patients faster. They were able to model ideas for sharing cell strains and providing access to advanced tools that, moving forward, will speed development of life-saving drugs, Love says.

Protecting Rural India's Frontline Health Care Workers

SHIVANG TAYAL MBA '22, Ivy Head Family Fellow

Fellowship recipient Shivang Tayal helped launch a grassroots campaign to assist frontline health care workers in rural India during the Covid-19 pandemic. The campaign distributed kits containing sanitizers, gloves, masks, and face shields to as many as 13,000 health care workers across 900 towns and villages. Most of the frontline workers protected were rural women, the auxiliary nurses and midwives who typically oversee public health and child welfare in Indian villages. The MBA student credits MIT for encouraging him to focus his campaign where it would have a meaningful impact.

Innovating Food Waste

BRITTNY CHONG MBA ’22

“I’ve always been focused on innovation, even when working for others in the public and private sectors,” says second-year MBA student Brittny Chong. While pursuing her degree at MIT Sloan, Chong founded WiRa Lab, which aims to apply machine-learning analytics and interactive design to managing food waste. The startup has designed a “smart bin” to identify commonly discarded food products, providing clients with data to inform food supply and demand forecasting. Another goal is the conversion of food waste into biofuel, which Chong views as a potential economic driver for communities disproportionately impacted by climate change.

Gauging Pollution's Effect

ARLENE FIORE, Peter H. Stone and Paola Malanotte Stone Professor in Earth, Atmospheric and Planetary Sciences

Arlene Fiore specializes in understanding how polluting emissions from anthropogenic and natural sources influence atmospheric chemistry, the climate system, and air pollution. Her research has linked atmospheric chemistry with climate-change phenomena such as record-breaking rainfall and heat waves. Fiore says she studies interactions across realms that in the past have been considered separately, such as the climate system and air quality, and urban air pollution and global atmospheric chemistry. A developing focus of her research involves detecting and attributing the influence of human activities on atmospheric composition and climate.

Making Encryption Harder to Crack

VINOD VAIKUNTANATHAN SM ’05, PhD ’09
Professor of Electrical Engineering and Computer Science

Vinod Vaikuntanathan’s work involves future-proofing cryptography for a world that may soon see the rise of ultrafast quantum computers. Still in their infancy, quantum computers, because of their incredible speeds, could be used to break through most of today’s toughest cryptographic schemes. “All the existing public-key encryption systems you use over the internet are insecure if you can build scalable quantum computers,” says Vaikuntanathan who uses algebra, geometry, and number theory to fortify encryption to stand up to the toughest adversaries.

Building for the Climate

ALPHA YACOB ARSANO SM '17, PhD Student in Architecture and Building Technology

In her home city of Addis Ababa, Ethiopia, Alpha Arsano saw centuries-old building techniques such as earthen walls, natural airflow, and insulation abandoned in favor of massive, glass-walled skyscrapers that rely on mechanical systems for climate control. She was moved to investigate how buildings might be made more environmentally sustainable by orienting them to take advantage of light and natural air flow rather than using air conditioning. "Integrating such strategies with active heating and air conditioning can dramatically reduce energy consumption and fossil fuel emissions," Arsano says.

Common Ground in Computing

JEFFREY GROSSMAN, Morton and Claire Goulder and Family Professor in Environmental Systems

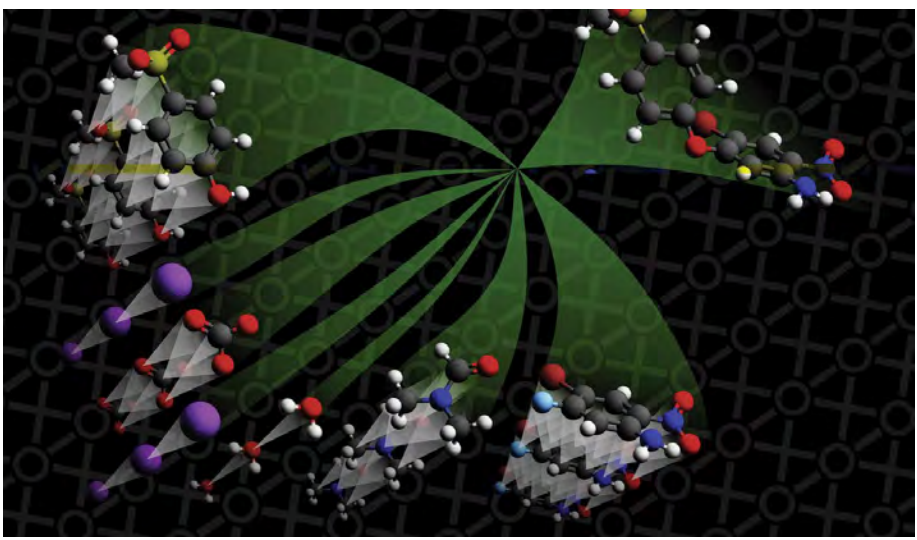
ASU OZDAGLAR SM ’98, PhD ’03, MathWorks Professor of Electrical Engineering and Computer Science and Deputy Dean of Academics, Schwarzman College of Computing

The Common Ground for Computing Education focuses on educating “computing bilinguals”—students fluent in both computing methodology and the fundamentals of their discipline. Common Ground brings together faculty from different MIT departments to co-develop and co-teach broadly applicable classes that synthesize substantive computing content with discipline-specific materials. Asu Ozdaglar and Jeffrey Grossman co-chair the program’s standing committee, comprised of faculty from all five MIT schools and Digital Learning. Four new courses have been piloted since January 2020.

Learning to Engineer New Molecules

CONNOR COLEY SM ’16, PhD ’19, Henri Slezynger Career Development Professor of Chemical Engineering

Connor Coley leads the Open Reaction Database, a community-driven, synthetic chemistry-focused repository that encourages researchers to share experiments that haven’t worked and wouldn’t normally be published. Discovering a new drug requires finding and understanding molecules in a time- and labor-intensive process that does not always guarantee success. Coley, who is developing computational tools that learn from mistakes as well as successes to predict molecular behavior, holds a shared appointment between the Department of Chemical Engineering and the Artificial Intelligence and Decision-Making Faculty of the Department of Electrical Engineering and Computer Science.



Storytelling into the Future

ÇAĞRI HAKAN ZAMAN SM ’14, PhD ’20, Lecturer, Department of Architecture

D. FOX HARRELL, Professor of Digital Media and Artificial Intelligence

The Transmedia Storytelling Initiative brings together MIT’s experts in the arts, virtual reality, and computer science to produce compelling stories and groundbreaking curricula. Researcher Çağrı Hakan Zaman, who leads the MIT Virtual Experience Design Lab, recently helped bring Supersense, an AI-powered application for the visually impaired, to market. Seeking to disseminate virtual and augmented reality technologies in education, Zaman co-taught a course with D. Fox Harrell, director of the MIT Center for Advanced Virtuality. The course, Virtuality and Presence, explored the design, implementation, and analysis of physical, virtual, and augmented reality experiences.

Campus

A major evolution of MIT's physical campus, from the nanoscale to the grandest scale, continues apace. The MIT Museum's new home in Kendall Square set to open in fall 2022 is another piece of Kendall's transformation as a vibrant gateway to the Institute. A dedicated music building, slated for completion by 2024, will include world-class performance and teaching space as well as production labs for music technology students. The iconic Metropolitan Storage Warehouse at the heart of campus is being reconfigured as a modern hub for interdisciplinary design research and education and a new home for the MIT School of Architecture and Planning. The building will house a 17,000 square foot makerspace—the largest on campus—to be overseen by MIT's Project Manus. Alongside the I.M. Pei '40-designed Green Building, the new Earth and Environment Building will be a vital center for environmental and climate research. And the new home for the MIT Stephen A. Schwarzman College of Computing, slated to be completed in summer 2023, will provide state-of-the-art space for computing research and education.

betterworld.mit.edu/campus

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FIRE PROOF.
WAREHOUS

MIT Quest Powers Discovery

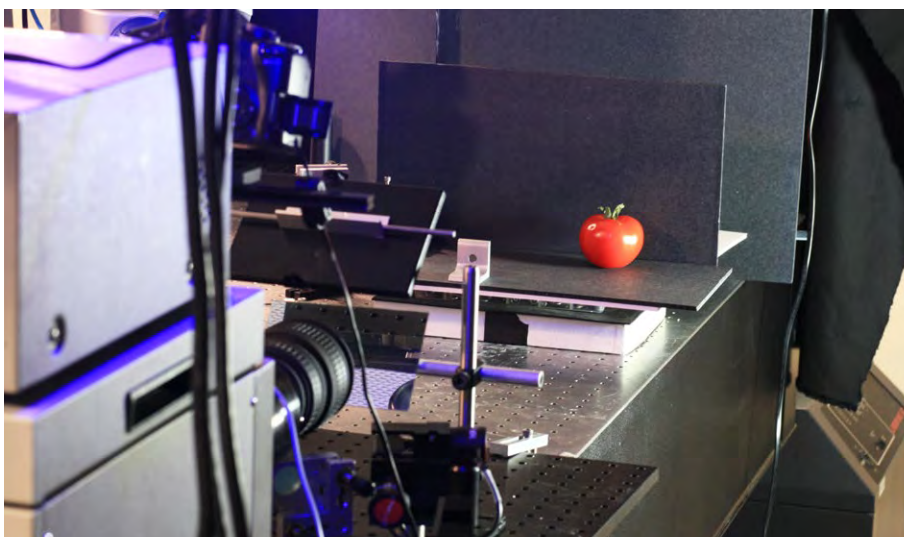
MIT QUEST FOR INTELLIGENCE

The MIT Quest for Intelligence, founded in 2018, brings the interdisciplinary MIT community together to address one of the greatest challenges in human history—understanding how brains produce intelligence and how it can be replicated in artificial systems. “As MIT Quest progresses on this challenge, it will advance the development of novel, human-like intelligent systems and associated tools and technologies that will have a wide spectrum of societal benefits and applications,” says MIT Quest Director James DiCarlo, the Peter de Florez Professor of Neuroscience. Research teams supported by MIT Quest are working at the intersection of computer science, artificial intelligence, neuroscience, and cognitive science.

Making the Invisible Visible

RAMESH RASKAR, Associate Professor of Media Arts and Sciences

Ramesh Raskar wants to make the invisible visible—inside our bodies and beyond—for health, work, and connection. “The goal,” he says, “is to create an entirely new class of computational and sensory platforms with an understanding of the world that far exceeds human ability.” His research group, the MIT Media Lab’s Camera Culture, has worked on cameras that see around corners, envisioning cars that can avoid collision and endoscopes that can see beyond the line of sight. His EyeNetra eye health diagnostics devices are used in 90+ countries. The group is also proud of inspiring several large research initiatives to tackle the UN’s sustainable development goals.



New Tech, New Ethical Questions

DAVID KAISER, Germeshausen Professor of the History of Science

JULIE SHAH '04, SM '06, PhD '11, Professor of Aeronautics and Astronautics

Rapid advances in computing have raised new social and ethical questions. Consumers and corporations alike worry about the confidentiality of health and financial data, and the use of machine learning and facial recognition software for job applicant screening can reinforce biases. In their capacity as associate deans of Social and Ethical Responsibilities of Computing in the MIT Stephen A. Schwarzman College of Computing, David Kaiser and Julie Shah are determined to "incorporate humanist, social science, social considerations, and policy/civic perspectives into the teaching, research, and implementation of computing at MIT, and to freely share our methods and learnings more broadly."

Creating Spaces that Shape Action

SARA BROWN, Class of 1957 Career Development Professor of Music and Theater Arts

Sara Brown, whose set designs have been featured in theater, dance, and opera performances around the United States and internationally, encourages her MIT students to view stage environments as a means to shape action, mentoring them as they develop designs for departmental and independent projects. In 2019, Brown led MIT students in a collaboration with incarcerated women at the South Bay House of Correction in which the group painted a two-story mural at the prison that was replicated on campus through an augmented reality experience. Brown followed up in 2021 with a remote course for MIT and incarcerated students: Exploring the Dramatic Imagination.

The Spatial Dimensions of Inequality

JUSTIN STEIL
Associate Professor of Law and Urban Planning

Institutional power is often wielded by controlling physical spaces, whether a city block or a jail cell. Justin Steil conducts research on racial justice through the lens of the spatial dimensions of inequality and the intersection of urban policy with property, land use, and civil rights law. His widely cited research and innovative teaching style resulted in a 2020–2021 Harold E. Edgerton Faculty Achievement Award for excellence in service, mentorship, and research that impacts critical societal challenges in environmental sustainability and social justice.

Practical Decisions for AI Policy

AI POLICY FORUM

With AI now influencing every aspect of culture and government, MIT has established the AI Policy Forum, a global effort convened by the MIT Stephen A. Schwarzman College of Computing with the aim of moving AI principles to practice. MIT researchers and AI experts from all over the world have convened task forces working to develop policy recommendations that will allow governments to benefit from AI's innovations while also taking society's greatest needs into account. "Our goal is to help policy makers with practical decisions about AI policy," says Daniel P. Huttenlocher SM '84, PhD '88, dean of the MIT Schwarzman College of Computing and Henry Ellis Warren (1894) Professor of Electrical Engineering and Computer Science.

Soft Materials for Hard Challenges

XUANHE ZHAO, Professor of Mechanical Engineering

What do a lobster underbelly, inflatable prosthetic hand, and flexible 3-D-printed brain implant have in common? In Xuanhe Zhao's lab, it's their soft-but-strong properties. Zhao's fundamental research has led to the design of extremely tough, cost-effective adhesive and biocompatible hydrogels and hydrogel-solid hybrids with multiple applications, such as double-sided surgical tape that rapidly seals bleeding tissues together or thread-like robots that navigate the brain's blood vessels to mitigate stroke damage within the golden hour. In the future, the materials might be used for addressing sustainability challenges such as "harnessing fresh water from dry air and inspiring the design of durable yet fully recyclable plastics," Zhao says.

A New Kind of Magic Carpet

WOJCIECH MATUSIK SM ’01, PhD ’03 and TOMÁS PALACIOS, Professors of Electrical Engineering and Computer Science

ANTONIO TORRALBA, Delta Electronics Professor of Electrical Engineering and Computer Science

The sentient magic carpet from Aladdin has a competitor. A new tactile sensing carpet from MIT’s Computer Science and Artificial Intelligence Laboratory (CSAIL) can estimate human poses without using cameras, in a step toward improving health monitoring, smart homes, and gaming. Faculty members Wojciech Matusik, Tomás Palacios, and Antonio Torralba are among the CSAIL team members that crafted the smart fabric embedded with sensors that can sense pressure from the person on top of it, leading to a better understanding of human movements.

Launching Student Entrepreneurs

MIT DELTA V ACCELERATOR

The MIT delta v accelerator helps student entrepreneurs turn business ideas into viable and sustainable ventures. Working in teams each summer from dedicated space in the Martin Trust Center for MIT Entrepreneurship, students receive financial support from fellowships and mentoring from entrepreneurs-in-residence, while also benefiting from the substantial delta v alumni network. Startups launched from delta v include Bloomer Tech, which is integrating fabrics technology and machine learning to equip women's clothing to collect health care data, and Solstice, which uses shared solar farms to expand consumer access to affordable renewable energy.

Work

The remarkable progression of innovations that imbue machines with human and superhuman capabilities is generating significant uncertainty and deep anxiety about the future of work and a collective concern about how to harness these technological innovations for social benefit. The MIT Task Force on the Work of the Future, led by Elisabeth Reynolds PhD '10, who now serves on the National Economic Council as special assistant to the president for manufacturing and economic development, and codirectors David Autor, the Ford Professor of Economics, and David Mindell PhD '96, the Frances and David Dibner Professor of the History of Engineering and Manufacturing and professor of aeronautics and astronautics, explored how emerging technologies are changing the nature of human work and the skills required. MIT Sloan's Thomas Kochan, the George M. Bunker Professor of Management, says a new social contract is required for improved worker-employer relationships. In her book *Overload: How Good Jobs Went Bad and What We Can Do About It*, Erin Kelly, the MIT Sloan Distinguished Professor of Work and Organization Studies and codirector of the MIT Institute for Work and Employment, shows how organizational change and work redesign strategies can address burnout, overload, and turnover.

workofthefuture.mit.edu

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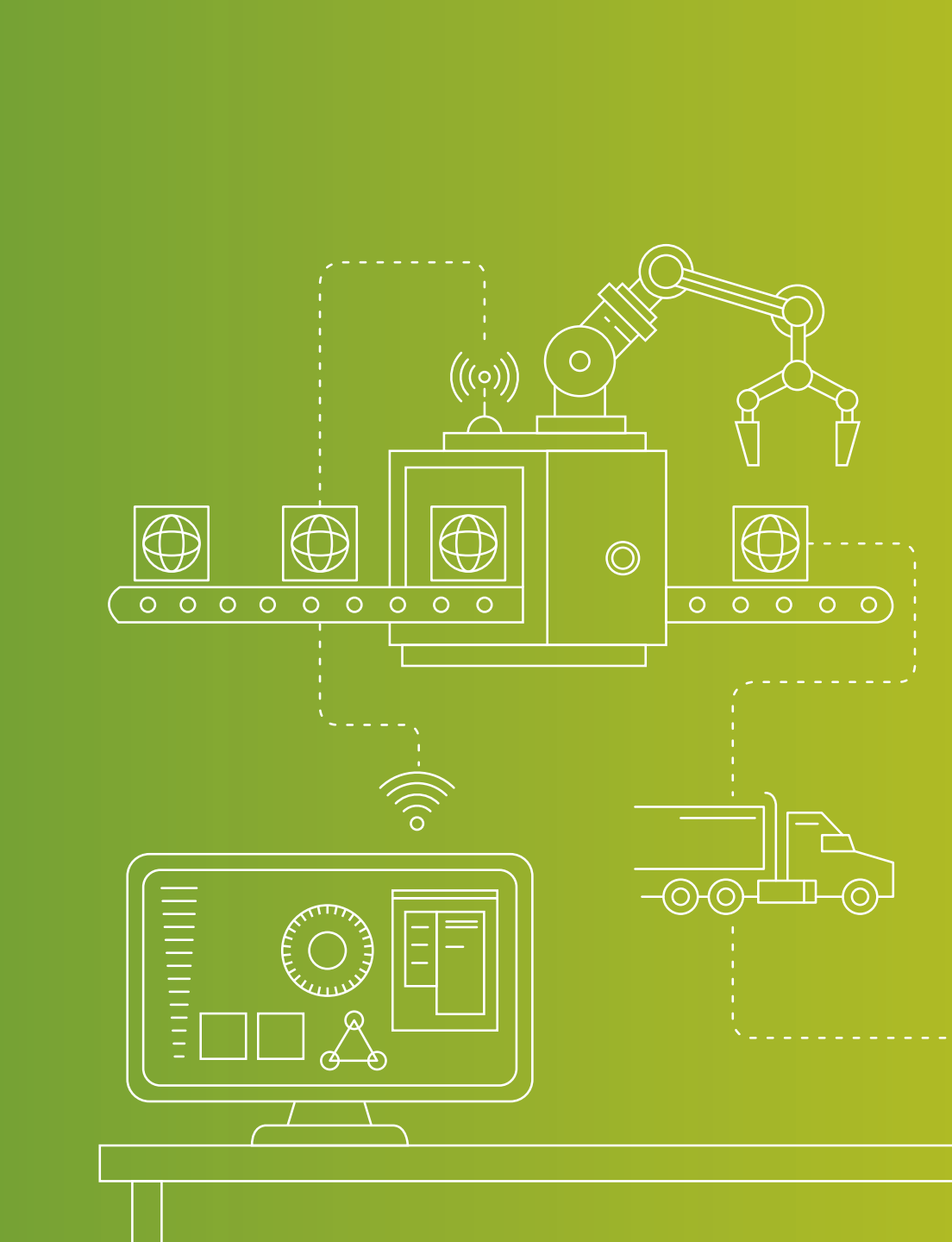
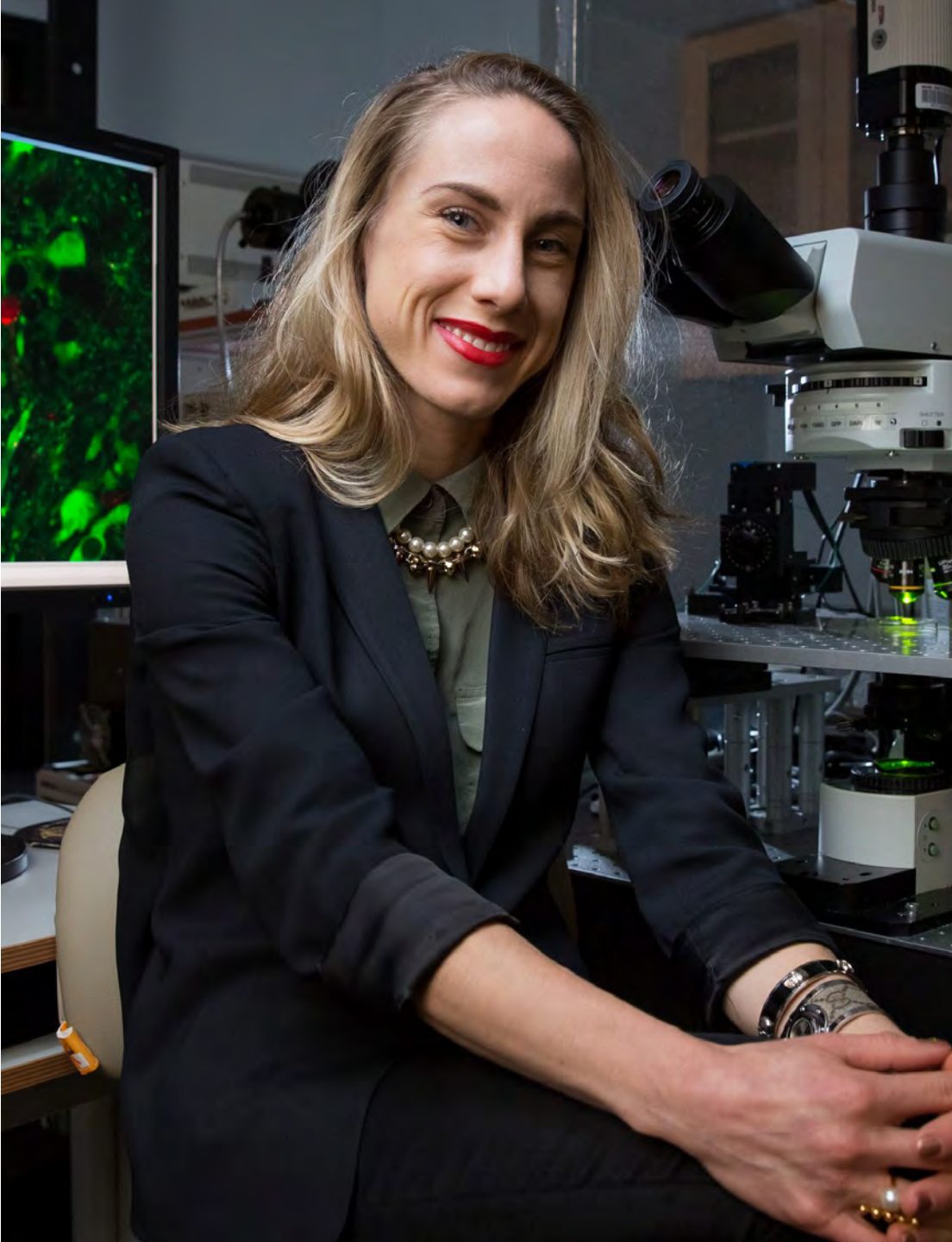


Mysteries of the Nervous System

POLINA ANIKEEVA PhD ’09
Professor of Materials Science and Engineering and
Brain and Cognitive Sciences

Investigators at the K. Lisa Yang and Hock E. Tan Center for Molecular Therapeutics in Neuroscience, established within MIT’s McGovern Institute for Brain Research, seek minimally invasive treatments for neurological and neuromuscular disorders. Polina Anikeeva works at the intersection of materials science, electronics, and neurobiology, designing probes that are compatible with delicate neural tissue but that match the signaling complexity of neural circuits. “The communication between the nervous system and the rest of the body is enormously mysterious,” she says. “Developing tools to understand it I think will be a task sufficient for a lifetime.”



Electrifying and Decarbonizing Industry

YET-MING CHIANG ’80, ScD ’85, Kyocera Professor of Ceramics

There are huge parts of the global energy system, such as energy storage, fertilizer production, and steel and cement manufacturing, where there simply aren’t affordable ways to decrease greenhouse-gas emissions. Yet-Ming Chiang and his lab are working to change that from multiple angles, including through development of an “air-breathing” battery that can cost effectively store electricity for long durations with minimal location restraints and zero emissions. Chiang and a former postdoc in his lab, Leah Ellis, have launched Sublime Systems, a startup that has developed a low-cost way to manufacture zero-carbon cement using renewable electricity.

Reinventing Workflow to Meet Pandemic Challenge

SHEILA DODGE EMBA ’12

NELSON REPENNING PhD ’96, Sloan School of Management Distinguished Professor

When the pandemic struck, Sheila Dodge, the general manager of Broad Genomics and an institute scientist at the Broad Institute of MIT and Harvard, helped convert a Broad clinical processing lab into a large-scale Covid-19 testing facility in a matter of days. Dodge had worked with Nelson Repenning at MIT Sloan researching dynamic work design, a method of managing workflow in which knowledge workers find issues and make improvements in real time. She applied the principles of dynamic work design to her lab, scaling it to process more than 150,000 Covid-19 tests daily by late mid-2020.

Fighting Climate Change and Poverty

ESTHER DUFLO PhD '99, Abdul Latif Jameel Professor of Poverty Alleviation and Development Economics

ABHIJIT BANERJEE, Ford Foundation International Professor of Economics

Over the next decade, the King Climate Action Initiative (K-CAI) intends to help improve the lives of at least 25 million people hard hit by poverty and climate change. With a founding gift from King Philanthropies, MIT's Abdul Latif Jameel Poverty Action Lab (J-PAL) launched K-CAI to solve problems at the intersection of climate change and global poverty alleviation. "To protect our wellbeing and improve the lives of people living in poverty, we must be better stewards of our climate and our planet," says J-PAL Director Esther Duflo, who was awarded the Nobel Prize in economic sciences along with J-PAL cofounder Abhijit Banerjee.

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CAMPAIGN FOR A BETTER WORLD

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