

A Better World in the Making

A More
Sustainable
Future



A More Sustainable Future

“Sustainability is the primary moral and economic imperative of the 21st century.” So declares Lord Mervyn King, influential economist and former governor of the Bank of England.

Here at MIT Sloan, much of our wide-ranging work continues to be focused on the critical goal of a sustainable business future: one where the truly epochal benefits of trade itself are balanced with the needs of the planet and its people. While the expansion of trade has driven the kind of technological innovation and poverty reduction our ancestors could only dream of, we also witness a world in which unchecked growth—and reckless business practice—endangers the fundamental well-being of populations and biospheres alike.

That’s why our work at MIT Sloan is consciously and consistently directed toward actualizing a tomorrow where organizations are healthy and stable; where economies are profitable and

responsible; and where natural resources are harnessed effectively, efficiently, and cleanly. The simple fact is: We have no choice. As a species, we must—consciously, rationally, and with the benefit of rigorous research—evolve the mechanisms that have brought us so much benefit, lest they hasten our undoing. And for better or worse, here in the early 21st century, such a statement is not hyperbolic. A truly sustainable future is not only the most efficient, desirable, and ethical future: It is the only survivable one.

Our latest newsletter contains much cause for hope. From social to economic to environmental sustainability, we at MIT Sloan are developing and uncovering research-based innovations across every aspect of business practice. We’re proud to share some of them here. Because together, we will build the future that we owe not only to our children, and ourselves, but also to those who will arrive long after.



UN (**)**
CAMPAIGN FOR A BETTER WORLD

Economic Sustainability

Economic sustainability requires the balancing of means and ends to create and enable business approaches that can succeed for the long term. Our researchers, faculty, students, and alumni are pursuing methods for achieving profitability through responsible management of our limited resources, both human and natural.

GEORGIA PERAKIS

Setting Competitive Clean Tech Subsidies Based on Externalities

Georgia Perakis (William F. Pounds Professor of Management and Professor, Operations Management and Operations Research and Statistics) and her co-authors have taken a detailed look at clean tech subsidies and concluded that they've often ignored a glaringly large externality: uncertainty of consumer demand. "The government will miss their target by a lot when ignoring demand uncertainty," says Perakis.

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ON THE WRONG ASSUMPTIONS DRIVING POLICY

From electric vehicles to home solar panels, governments often offer consumers subsidies on the kinds of clean tech they want to encourage. But how are they calculating the level of the subsidies? And are they accounting for fluctuations in demand during the period a new technology is being adopted? Perakis and her co-authors' paper, "The Impact of Demand Uncertainty on Consumer Subsidies for Green Technology Adoption" (published both in print and online by *Management Science*), identifies more than one faulty assumption underlying certain government subsidy programs, including the assumption of a steady ratio between the dollar amount of the subsidy and the total number of cars or solar panels that will be sold. Similarly, miscalculating or ignoring demand uncertainty means sales can come in significantly below the desired adoption level, which could defeat the purpose behind the subsidies.

STARTING TOO LOW

From Perakis and her colleagues' modeling of a variety of scenarios using varying demand data matched to varying subsidy levels, they concluded that subsidy levels often start off too low. In the case of the electric Chevy Volt, for instance, they identified an optimal subsidy of a higher dollar amount than the \$7,500 the government offered. They concluded not only that uncertainty regarding demand mattered, but that sales targets were critical as well. Their modeling suggested that the ideal required subsidy increases in a curve that tapers off as the sales volume grows: Getting 2,000 Volts sold faster demanded a much higher subsidy, while selling 10,000 Volts didn't demand as robust an amount. Summing up, Perakis says: "The conclusion that we drew is that, basically, if the government sets subsidies by taking externalities into account, then subsidy programs can be far more effective. Even if," Perakis adds, "there are big externalities."



Sanergy: Social, Environmental, and Economic Sustainability—United in Lifesaving Sanitation



Poor sanitation affects more than quality of life: It's a deadly threat to life itself. In parts of the less developed world—including the “informal settlements” surrounding many of the world’s rapidly growing megacities—billions of people lack access to hygienic sanitation. Beyond the costs in human life and dignity, there’s the financial impact: The government of Kenya estimates losses of \$1 million to their nation’s economy *each day* from lack of sanitation. Enter Sanergy, the brainchild of David Auerbach and his partners Lindsay Stradley and Ani Vallabhaneni (all MBA ’11). Sanergy is a social enterprise whose stated goal is to “build healthy, prosperous communities by making safe sanitation accessible and affordable for everyone, forever.” But theirs is no pipe dream. As a systems-based solution, Sanergy has successfully—and deftly—combined individual-level entrepreneurial incentives with community-scale value creation.

It all starts with a toilet. Sanergy manufactures and distributes high-quality, low-cost toilets—so-called “Fresh Life Toilets” (FLT)s—designed specifically for the dense urban environments of Nairobi, Kenya, where the company has piloted its efforts. These waterless FLT)s are sold to local “franchise partners”

(neighborhood entrepreneurs as well as landowners and schools), who receive training, marketing, and operational support to run an FLT. They in turn charge local customers a small fee for toilet access. Then comes the remarkable part: using a cartridge-based collection system integrated into the latrine’s design, Sanergy regularly collects the waste from individual FLT)s, and transports it to centralized depots where it’s converted into valuable products including organic fertilizer and insect-based animal feed. This creates an end-to-end value chain from the urban poor to rural farmers.

In its totality, the Sanergy model enables local entrepreneurship, promotes social sustainability in communities, and provides an environmentally sustainable solution for agriculture. And, with 1,839 active FLT)s currently providing 70,000 daily users for their communities, Sanergy is delivering. They’ve also created more than 1,400 jobs—and, last year alone, removed and safely treated over 5,000 tons of human waste.



Tackling Climate Change

From Micro-Foundations to Macro-Impact

Since joining the MIT Sloan faculty in 2014, Valerie Karplus, SM '08, PhD '11 (Assistant Professor, Global Economics and Management), has taken her economic research in a new direction: one that she describes as “getting under the hood” to investigate the human rules and behaviors that impact the fate of even the most technically elegant climate change policies.

Today, Karplus is examining how societies can respond to global climate change by studying the organizational activities and complex systems that define them. This work builds on Karplus’s prior success as director of the MIT-Tsinghua China Energy and

Climate Project, in which she led a joint team in evaluating and modeling China’s future energy and climate policy proposals. This, in turn, laid the foundation for a China-U.S. joint announcement of post-2020 climate policy goals and generated new momentum for pledges from other nations ahead of the Paris Agreement.

Karplus’s ultimate goal is significant, but under her expert purview achievable: helping policy stakeholders worldwide overcome their oft-cited “implementation challenges” to lay the institutional foundations for a clean energy transition.

“ENVIRONMENTAL POLICY DOESN'T EXIST IN A VACUUM”

While much of Karplus’s work has been and continues to be conducted in the developing world, its implications extend beyond the surface distinctions of nation, industry, and political system.

In her latest research, Karplus has looked at the impacts of a significant new sulphur dioxide emissions reduction standard for coal plants in China. Her comparison of plant-reported and satellite-measured atmospheric emission levels reveals that while progress is being made on a national level, discrepancies in areas facing heightened policy pressure suggest that plant reporting remains susceptible to localized pressures. Beyond illuminating the need for remote sensing data to validate reported numbers, Karplus noted an equally prevalent need for implementation support for local plants and governments, accompanied by stronger, institutionalized incentives to motivate accurate reporting.

Another promising finding from Karplus’s work done in partnership with Noelle Eckley Selin, an associate professor in MIT’s Institute for Data, Systems, and Society (IDSS), is that climate policy can yield a net economic gain to China in 2030 in the form of the co-benefits from reduced air pollution and related deaths. By advocating for the communication of immediate health (and imminent bottom line) benefits over the cost of policy implementation, Karplus is hoping her



study provides policymakers with the evidence to support stronger climate policy. For, as Karplus has said before and will say again, “Environmental policy doesn’t exist in a vacuum. All environmental policies ultimately succeed or fail at the ground level, largely as a result of the decision dynamics within organizations, which we need to understand better.”

FROM ANALYZING DECISIONS TO HELPING LEADERS MAKE POLICY WORK

Global business is attentive to the fact that climate policy—and environmental policies more broadly—will impact their organizations in the future if they are not already impacting them presently. Karplus cites the example of a recent meeting with corporate executives from Spain: “What was on their minds was exactly what businesses should be preoccupied with right now. That is, how can management prepare and organize more effectively to reap opportunities created by new climate policies? How can organizations be better positioned to respond?” Karplus advocates for the value of proactive strategy, knowledge sharing, and operational excellence to enable businesses to comply with new policies—and thrive.

PREPARING FOR POLICY CHANGE: THREE RECOMMENDATIONS FOR ALL ORGANIZATIONAL LEADERS

Karplus singles out three “robust observations” for business leaders to keep front-of-mind when preparing for the new realities of climate change:

1. **Being proactive is a must**—It does not cost much to start thinking ahead and identifying existing competencies that become more relevant and valuable with climate policy. Starting early and making strategic decisions that incorporate climate realities can allow companies to be industry and policy pacesetters.
2. **Addressing climate change**—like any other “external shock”—is itself an opportunity for leadership: a chance to develop better information flow between management and employees, and improve orchestrated action across a company.
3. **Operational excellence**—how a company saves energy, manages its carbon footprint, and more generally connects and optimizes activities—is a more important competitive asset than ever before.

How can management prepare and organize more effectively to reap opportunities created by new climate policies? How can organizations be better positioned to respond?

For all the challenges climate change brings, Karplus believes that it also provides nothing less than a unique opportunity for companies the world over to reinvent themselves as more resilient organizations. Much of her emerging insight is covered—and its future evolution prepared for—in her new course offering on global energy politics, markets, and policy. With students drawn from every school and department within MIT, the course encourages participants to explore how well academic frameworks explain real-world behavior and phenomena in response to energy policy, and imagine (or reimagine) the corresponding models and behaviors that can support their success.

PICTURING A BETTER, CLEANER, FAIRER WORLD

From the field to the classroom, Karplus’s work is organized around the bigger picture of a better world—and the future she believes is possible, informed by the frontier knowledge and the collaborative culture that define MIT.

As she says, “It’s about finding out what’s really driving outcomes on the ground, and the implications for transitioning to more sustainable pathways. It’s about longer-term thinking, rather than quick wins and short-term solutions that can undermine progress. This is something that we at MIT are well suited to do—I believe it’s in our power to see a better world, and to do so together.”

A charge perfect for mission-driven leaders, and—as Karplus emphatically adds—“our alumni are an indispensable part of this mission.”



An Infinitely Cool Invention to Save Water and Dollars

Derek Warnick, MBA '09, is the chief operating officer in charge of a very cool idea: reducing the massive amount of freshwater used in power generation plants, and other heavy industry, by up to 20 percent. Along with co-founders Maher Damak, PhD '18, and Karim Khalil, PhD '18, their company Infinite Cooling boasts winning not only the Robert P. Goldberg \$100,000 grand prize of the MIT \$100K Entrepreneurship Competition, but also the MIT Clean Energy Prize, the U.S. Department of Energy's Cleantech Grand Prize, and the Rice Business Plan Competition Grand Prize. The real prize for Warnick is the impact their enterprise can have worldwide, in terms of both positive environmental benefits and massive cost reductions for heavy industry globally. As an example, power plants are one of the largest consumers of water in the United States, demanding upwards of 161 billion gallons of freshwater per day, and totaling 39 percent of all U.S. freshwater demand. Infinite Cooling's patent-pending technology uses electrical fields to recapture over 80 percent of the water droplets that would ordinarily escape in vapor plumes, potentially reducing power plant water consumption by 20 percent, translating into savings of millions of gallons—and millions of dollars—each year.

161B

POWER PLANTS' DEMAND
IN GALLONS OF
FRESHWATER PER DAY

“Research is revealing that when companies take a systematic approach to managing sustainability issues, they actually do very well from a business perspective.”

**Jason Jay, PhD '10, Senior Lecturer and Director,
Sustainability Initiative at MIT Sloan**

JASON JAY

Innovation in the Classroom...and Beyond

Jason Jay, PhD '10 (Senior Lecturer and Director, Sustainability Initiative at MIT Sloan), has found a timely focus for his work: sustainability-oriented innovation, or “SOI.” The ultimate goal of SOI is nothing less than addressing technically, managerially, and socially complex sustainability issues to enable societies to thrive in an era of increasingly finite planetary resources. Given the scope of present challenges and the spectrum for impact, Jay has been intent on inculcating the process for creating effective sustainability-oriented organizations.

Working with support from Lockheed Martin, received via the MIT Energy Initiative, Jay has taken his study into the classroom through his “Innovating for Impact” course (15.385). Designed to help students understand the process of SOI through the eyes of entrepreneurs, corporations, and investors looking for both financial and social returns, Jay employs a combination of case discussions, lectures, and hands-on projects to develop students’ skills (and confidence) to bring sustainable models to market scale. As an ever-evolving test bed for innovation best practices, Jay has recently introduced social impact measures pioneered by postdoctoral researcher Ingo Michelfelder, including Lean Impact

Measurement methodology, as well as a blended finance model (combining philanthropic and market-rate capital) from MIT alumna and researcher Sarah Kearney’s PRIME Coalition (MS, Engineering Systems Division '12, visiting researcher at MIT Sloan, 2012–2016) into course 15.385.

Unlike teaching and supporting the process of conventional innovation, one of the critical aspects of SOI is sharing information, work, and goals across a disparate range of stakeholders. As Jay notes, “All of this means a very practical challenge for our entrepreneurial students: how to map stakeholders, and distinguish customers from beneficiaries from other stakeholders, so you can really give paying customers their due attention.”

It’s a challenge that—once reconciled—creates significant opportunities. For his students in 15.385, Jay cites the examples of Spoiler Alert and Sanergy (both profiled elsewhere in this issue) as exemplar businesses built on sustainability-oriented innovation principles—businesses that are reaping the benefits of products that create social and environmental good.

Perhaps most significantly, Jay emphasizes, 15.385 has come to serve as the feeder to—and key element of—

MIT’s entrepreneurial ecosystem. As an “incubator for impact-oriented startups,” 15.385 aims to support students in developing their business concepts to pitch in competitions like the IDEAS Global Challenge, Clean Energy Prize, Water Innovation Prize, the Rabobank prize, and more. “This research and knowledge exists to be used, and used now,” asserts Jay. With funding support through the MIT Campaign for a Better World, the class (and Jay’s ongoing research through the Sustainability Initiative) provides a way for alumni funding to support emerging enterprises in driving a more sustainable world.



The Dematerialized Path to Growth

Andrew McAfee, '88, '89, LGO '90 (Co-Director, MIT Initiative on the Digital Economy) musters a straightforward example to illustrate the environmentally encouraging trend he calls “dematerialization”: a 1991 Radio Shack ad, in which 11 of the 13 devices advertised are today contained within a single smartphone. “We have finally figured out how to give ourselves more and more while taking less and less from the planet,” McAfee declares.

The fears of the early 1970s were understandable, explains McAfee. After all, the trend lines of that moment—from population and economic growth to resource use and pollution—gave many people cause for alarm. We had built an economy that, in McAfee’s words, “did exactly what it was designed to do: *grow*.” Growth that apparently was taking place at the expense of the health of our planet.

Yet, the actual future held a surprise: events and outcomes utterly unlike what the popular imagination, and our worst fears, had envisioned. Economic and population growth continued in the decades that followed. But the world-ending catastrophes? They never arrived.

However counterintuitively, in the years following the 1970s’ fever pitch of concern, continued GDP expansions were accompanied by marked *reductions* in the use of multiple resources: water, trees, cropland,

metals like iron and steel, and minerals like phosphate and potash. “For the first time in human history,” affirms McAfee in retrospect, “we have decoupled output growth from resource consumption.” Part of this decoupling can clearly be credited to examples akin to the Radio Shack instance: consolidation of multiple functions within fewer physical devices, with an accompanying decline in the need to produce resource-consuming “gizmos” which accomplish a single, isolated task. But additionally, the evidence was undeniable that mankind had collectively begun to find countless other ways to accomplish more with less. We hadn’t *stopped* consuming: We had simply found more efficient—and increasingly sustainable—ways of doing so. As McAfee waggishly puts it, “This isn’t because we’re noble. It’s because we’re *cheap*.”

Our growing ability to take less, and use less, of the resources offered by the planet is “the best environmental news in the world.” This “dematerialization”—as McAfee follows the pioneering researcher Jesse Ausubel in labeling it—is nothing less than “the ability to consume the things we *want*...while using fewer resources, fewer *molecules* from the world.”

While more is needed to undergird the trend of dematerialization, McAfee offers three specific recommendations: (1) reducing of pollution through increased regulation, accompanied by tough enforcement; (2) further reducing greenhouse gas emissions by using a variety of novel and crucial technologies—including renewable energy, better batteries, climate engineering, lab-grown meat, and nuclear energy; and (3) finally, increasing our efforts to reduce global poverty, planet-wide. Such steps will not only bring us closer to a world in which the dystopian terrors of the 1970s seem more distant. It consciously moves us in the direction of a global economy that reaches for true sustainability on *all* levels: economic, social, and environmental. Our growing ability to create greater prosperity out of fewer resources means that we have the means, if we choose, to create a world in which the benefits of wealth and technology are truly shared, for the benefit of all. It is a chance, as McAfee concludes, to “take ‘yes’ for an answer”—and acknowledge that true sustainability presents the opportunity to leave behind, once and for all, the notion of a zero-sum economic system.





DAVID KEITH

The Industry Implications of Self-Driving Vehicles

David Keith, PhD '91 (Mitsui Career Development Professor and Assistant Professor, System Dynamics), has an eye on the future of driving: namely, the ways that self-driving cars can revolutionize aspects of vehicle use, ownership, and safety, for individuals and industry alike.



ON EVOLVING THE CONCEPT OF "OWNING" A VEHICLE

"Self-driving cars have the potential to facilitate vehicle sharing in ways that are not currently possible," Keith suggests. "They have the potential to change the whole paradigm of vehicle ownership." Since statistics show that the majority of cars remain parked for up to 95 percent of the day, utilizing shared, self-driving, on-demand cars could transform the mobility value chain, with possible benefits including cost savings, an overall decrease in fuel use, and relief of traffic congestion.

ON IMPLICATIONS FOR FREIGHT AND PUBLIC TRANSPORTATION

Trucking presents one obvious opportunity to apply autonomous self-driving technology, for, as Keith notes,

"a lot of the time spent driving is along freeways in relatively straight lines...[and] we already have the technologies to do a good job of that." Similarly, road-based mass transit could benefit from the cost savings of autonomous technology. While some job losses would be an inevitability (there are, after all, 3.5 million truck drivers currently working in the United States), Keith believes that humans will remain indispensable to the transportation industry, especially for enhanced operational and customer service roles.

ON THE FUTURE OF AUTOMOTIVE SAFETY

Motor vehicle accidents claimed 40,000 lives in the United States in 2017 alone, and autonomous

vehicles might well prevent many of these deaths if human errors can be reduced. As Keith notes, this will require more autonomous cars in service, with many more hours spent learning on the road, for the technology to reach its full safety potential. "To get AVs [autonomous vehicles] from making good decisions 90 percent of the time to 99 percent of the time is easy enough. To get to 99.9 percent of the time is harder; but to get rid of that smaller margin of error, you're talking millions and millions of miles of driving experience."

95%

THE AMOUNT OF THE DAY MOST CARS SPEND PARKED

A Clear-as-H₂O Approach to Resource Pricing

In the resource-conscious world of 2018, “too much water” isn’t a conundrum you hear about very often. But when Sourcewater CEO and founder Josh Adler, SF ’13, heard a presentation about “unconventional energy production”—also known as fracking—while a Sloan Fellow in the MIT Energy Ventures program, overflow was part of what intrigued him. So was the explosive growth of the industry. Adler soon realized that a business opportunity existed in the fact that 10 times more water than oil was produced from the average U.S. well—the same water that was the primary cost of operations, due to its hauling and disposal. Upon discovering that there was no existing marketplace for operators to obtain quick, transparent pricing and supply of water services, Adler’s Sourcewater was born as the platform for water sourcing, recycling, treatment, and disposal in the energy industry...and beyond. “The best thing [fracking companies] can do, both



environmentally and economically, is *reuse* produced water instead of freshwater. We try to facilitate those non-freshwater trades among energy companies, industry, and agriculture. It’s a sustainable way to cut the cost of hauling and disposal and ensure a reliable, mission-critical supply chain.”

The Past—and Future—of a Sustainable Economy

In his role as managing director at sustainability consulting firm Pure Strategies, Tim Greiner, SM ’94, MCP ’94, advises industry-leading companies on building sustainability into strategy, products, and supply chains. As Pure Strategies celebrates its 20th year with over 400 clients served, Greiner’s news from out front is promising, though it comes with an urgent call-to-action. He explains, “Today, companies have moved from a compliance mentality to a value-generating mentality when it comes to environmental and social issues.

Twenty years ago, we would have been delighted to be on the C-suite radar like we are now, and have investors see

sustainability as a board-level priority. But with resource scarcity, climate change, and social problems on the rise, we need to exponentially accelerate sustainability in capital flows, innovation, and governance over the next 20 years.”

To assist business leaders in working toward this outcome at scale, Pure Strategies has recently developed a suite of tools and expertise that leaders can use to transform their products, supply chains, and models for greater social and environmental performance. The tools include the company’s first-of-its-kind Chemical Footprint Project (CFP) scorecard for leaders looking to evaluate and improve the health and safety of products and supply chains, and an array of market research papers and reports that represent the business value of

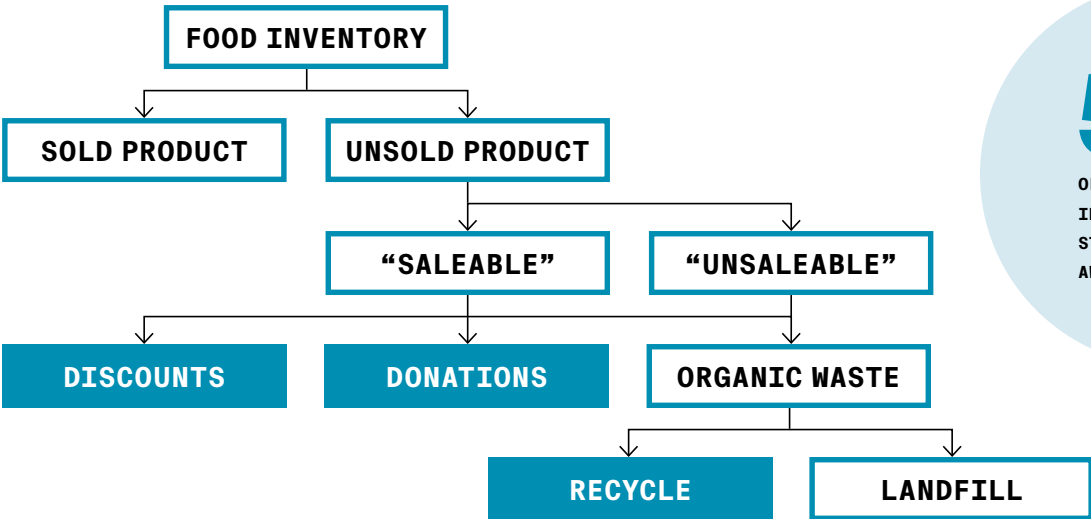
sustainability and best practices from sustainability-driven companies, including Apple, IKEA, Walmart, Seventh Generation, and others. Greiner has also advised market leaders in setting aggressive greenhouse gas emission targets, plastic waste reduction, and circular economy strategies. According to Greiner, the business case is clear: “Sustainability-focused companies can increase productivity, reduce risks, and uncover new growth opportunities.”

Greiner notes that we face formidable social and environmental challenges ahead, but he is optimistic. “We’ve proven companies can be a powerful force for good in the world. Now we need to double down on these strategies. Future generations are counting on us to get it right.”



Waste Not, Want Not: Spoiler Alert’s Double Bottom Line Model

Spoiler: Nearly half of the food we produce in the United States is thrown away, uneaten. Enter the remarkable food-meet-consumer donation platform created by Emily Malina and Ricky Ashenfelter (both MBA '15). With a shared mission to solve America’s food waste problem, Malina and Ashenfelter’s Spoiler Alert connects local non-profits with food that’s otherwise destined for the dump. By enabling manufacturers, restaurants, and producers to post about (perfectly good) food that’s about to be thrown away, non-profits get notifications from which they can accept and arrange an instant transaction. Having seen the successes of companies like Airbnb and Zipcar, Ashenfelter and Malina brought the efficiencies and optimizations of the platform economy to their design. “The beauty of our model is that we as a company never take possession of any of the food,” says Ashenfelter. “We don’t own trucks; we don’t hold inventory.” After all, as Ashenfelter notes, “One of the easiest ways to address climate change and hunger is [to use technology] to do more with the food we’re already producing.”



50%
OF FOOD PRODUCED
IN THE UNITED
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AWAY, UNEATEN



Social Sustainability

Our work around social sustainability is directed at creating practices that sustain and encourage the health and well-being of employees, communities, and customers locally and globally. Here is some of the groundbreaking work that our faculty, students, and alumni are conducting to make business work for stakeholders up and down the value chain.

OTTO SCHARMER

From Ego-System to Eco-System Thinking

Otto Scharmer (MIT Senior Lecturer; Founding Chair of the Presencing Institute; Co-Founder, MITx u.lab) proposes an approach to current resource challenges spanning finance, food, fuel, water, and labor that is as radical as it is straightforward. As Scharmer asserts, “Two words summarize the shortcomings of mainstream economics—externalities and consciousness. The solution to global crises begins between our ears.”

Scharmer frames his solution in this way: The “externalities” that currently threaten humanity’s future include that our economy uses one and a half times the regeneration capacity of planet Earth. Furthermore, this is enabled by a current capitalist economy in which eight people own as much as the bottom half of mankind combined. Cosmetic “consciousness” solutions such as “corporate social responsibility”—of which Scharmer is deeply skeptical—must give way to a fundamental evolution from an “ego-based system to an eco-based system.”

Such change will require new methods and tools, as well as a new approach to systems change. According to Scharmer, the essence

of Awareness-Based Systems Change can be summed up as follows: “You cannot change a system unless you transform the consciousness of people in the system at personal, societal, and global levels.” To facilitate an ego-to-eco shift, the most important leverage point is “to make the system sense and see itself,” says Scharmer.



BUILDING BETTER

“If you have a country where the environment is taken care of, policies are working, the markets are thriving, but people are unhappy, that country’s approach is not sustainable. In constructing a better world, we have to pay attention to all the dimensions of sustainability.”

**Roberto Rigobon, PhD '97,
Society of Sloan Fellows
Professor of Management**

Designing and Sustaining a Mission-Driven Enterprise

As a leader within a purpose-driven company like Farmer’s Fridge, priorities, mission, and culture are never far from the mind of Shayna Harris, MBA ’11: specifically, the commitment to fresh, healthy, and accessible food, and how it translates into explicit rules that inform how the company makes its collective decisions. With a long-held interest in “breaking models in the food system,” Harris’s 2016 appointment as chief operating officer at Farmer’s Fridge was a role for which she was prepared to establish goals and priorities. “But the real work,” Harris says, “was to figure out how we aligned ourselves with [our company’s] mission.” Farmer’s Fridge is a network of automated, self-serve “micro-restaurants” (each fridge measures 12 square feet) offering wholesome dishes prepared daily for locations around Chicago and Milwaukee.

But beyond the current product offering and delivery system, the company’s mission encompasses key issues: improving people’s health, addressing food waste, and building broader access to fresh and healthy food throughout the country. In living out that mission through their daily business activities, Harris explains that guidelines based on their core mission—such as so-called “nutritional guardrails” to assure the products they offer are both delicious and nutritious—were designed to guarantee that, even as the company expands its menu offerings, they remain true to their healthy founding principles. In sum: the mission comes first. “These guardrails are critical to how we grow,” she says. “The mission of the company is actually driving all of our research and development.”



JOANN DE ZEGHER

The Impact of a Cleaner Supply Chain

In the first large-scale global analysis of its kind, Joann de Zegher (Maurice F. Strong Career Development Professor and Assistant Professor, Operations Management) and her co-authors have analyzed corporate practices for sourcing sustainable materials. She and her colleagues have determined

that while many companies make some attempts to address sustainability, most deal with only small portions of their supply chains.

According to de Zegher, “Current efforts have limited reach.”

While global supply chains impact 80 percent of global trade (and employ more than one in five workers), de Zegher found that more than 70 percent of attempts at

1 in 5

WORKERS ARE EMPLOYED IN GLOBAL SUPPLY CHAINS

sustainable sourcing practices cover only one (or a few) input material for a given product, leaving the rest of a product’s upstream impact unaddressed. In addition, more than 60 percent of such instances of sustainable sourcing apply to only first-tier suppliers, leaving the rest of the supply chain untouched.

On a positive note, however, the researchers found that companies headquartered in countries with many active NGOs, engaged customers, and/or heightened social and environmental awareness are more likely to use sustainable sourcing practices. While much remains to be done to see fully sustainable supply chains, public awareness and pressure are poised to make a greater difference going forward.



Creating the “Learning Organizations” of the Future

Peter Senge, PhD '78 (Senior Lecturer, Leadership and Sustainability), has made a career out of examining what makes systems work, and—in particular—how organizations learn in systemic contexts. After first captivating global attention with his seminal book *The Fifth Discipline: The Art and Practice of the Learning Organization*, Senge has gone on to spend the last few decades working at the forefront of enabling, nurturing, and helping others foster lasting changes in complex settings. Senge's diverse work has been singularly focused on optimizing the learning processes he believes will lead to true sustainability, from teaching classes at MIT Sloan to steering collaborative innovation by working with multinational companies and NGOs to going upstream from the business world to a global education study with MIT's Abdul Latif Jameel World Education Lab (J-WEL).

So far, Senge's research has led him to one inescapable conclusion: “Going forward, organizations will have to be much more in tune with—and ultimately responsible for—their impact on social and environmental well-being. They will *need* to learn, and keep on learning.”

After all, as he emphasizes, “a system works the way it works because of how we work. Human systems are always based on assumptions, habits, and established ways of doing things. We only learn, and learn how to change at a deep level, when we start to understand that.”

THE END OF ONE ERA...AND THE BEGINNING OF ANOTHER

For more than a century, Senge explains, the formula for management could be expressed simply: exploiting

natural and social capital to create financial capital. “That's coming to an end: Business today has realized that we only have one planet, and its resources—human and environmental—are both finite and necessary for success. We've got a long way to go to fix the past...and unfortunately, we don't have forever to do it.”

But that's where the encouraging news starts, beginning in the 1990s with Senge's explorations of organizational learning, and further refined in his present-day study of the mechanisms that support cross-organizational collaboration. Through each evolutionary phase of Senge's work, he says, companies small and large alike have shown a remarkable willingness to learn, an ability to collaborate, and a surprising openness to act compassionately to address current crises—crises which they are clearly taking more and more seriously.

FROM A COLLABORATIVE LAB TO COLLABORATION IN THE WORLD

One of Senge's recent studies has been conducted in one of the world's most important and threatened industries: that of global food production. According to the Organic Farming Research Foundation, a full 50 percent of the world's topsoil has been lost over the last 150 years, and farmers worldwide have faced margins that have shrunk to the point where, in many regions, production literally costs more than it earns.

For the last 20 years, the Sustainable Food Lab has supported 70 partner companies and NGOs working to identify and implement sustainable approaches to food supply chain issues. As many companies involved

are in fact direct competitors in the marketplace—like Unilever and Kellogg—the Food Lab has designed and helped participants follow a “pre-competitive collaboration” model reliant on setting shared goals, co-creating and piloting solutions, and fostering relational space: what Senge has defined in a recent research paper as a “consciously created atmosphere of radical respect, careful listening, and peer interaction, where learning and trust can flourish.” The dynamic created by “relational space” has both the power to drive cross-organizational innovation as well as increase emotional investment in shared goals. As quoted in *Relational Space: The Heart of Sustainability Collaborations*, one participant explained: “These people are committed, I mean really committed, beyond what I would have believed if I weren’t involved.”

MOVING UPSTREAM TO A DIFFERENT KIND OF “LEARNING ORGANIZATION”

Currently, Senge has extended his work with “learning organizations”—much as his mentor, Jay W. Forrester, SM ’45, founder of the field of system dynamics and longtime MIT Sloan professor, did later in his career—by working on a PreK-12 education innovation project supported by the J-WEL.

Although education is one of the systems most responsible for the future of humanity, it remains one of the most fragmented in the world. So with the support of the International Baccalaureate (IB) schools network, Senge and his J-WEL colleagues are today piloting a Compassionate Systems Initiative prototype in classrooms across 10 countries worldwide. The framework, developed with J-WEL research scientist Mette Boell, is designed to help educators cultivate their students’ social-emotional learning, systems thinking, and compassion to ultimately enable them

to apply their skills to prototyping solutions for interconnected global challenges.

As Senge notes, “This is about pragmatism, really. We won’t solve the issues of sustainability in our generation. They are centuries in the making. They are a product of ways of thinking and acting which have been nurtured consistently in the way young people are raised and educated, and the extent to which their capacities as human beings are cultivated. We need to build a future—and future leaders—biased toward being able to steer the social and cultural changes we need, compassionately, collaboratively, and mindfully.”

A BROADER LOOK AT THE BIGGER GOAL: HOW TO BUILD A BETTER FUTURE

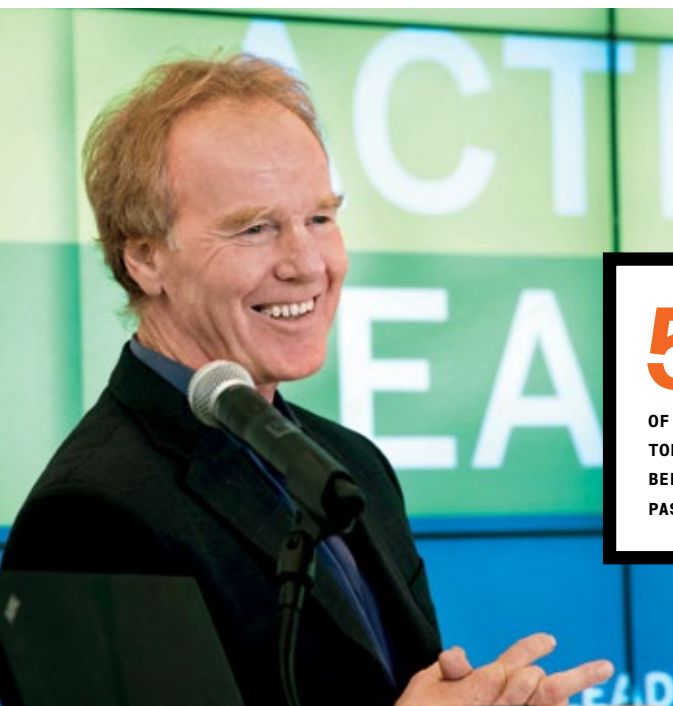
Ultimately, Senge reminds us that building a better tomorrow for future generations doesn’t start with just discarding the past, but rather with looking critically at what worked to adapt it. He explains that companies once were routinely founded with charters that specified their broader purposes, going beyond profit to identify how they would serve the community. “This is actually an old idea, embedded in society for thousands of years, and lost only relatively recently—that it is a privilege and not a right to make a profit, and with that privilege comes a responsibility to contribute to larger society.” This sense of responsibility was lost, he asserts, in part through the “financial theory of the firm” pushed by many business schools in recent generations—but never, to his note, lost nor forgotten at MIT Sloan.

“Principled, innovative leaders who improve the world’ ... that has been the essence of Sloan’s mission for decades. We’ve always understood that businesses must have larger purposes, which always relate to the wider world. And making a better, more sustainable world is what we in this community can do best.”

When it comes to that end, Senge’s advice is clear: “Start where you are—with your company, with your work, with supporting the issues you know in your heart are the right ones to support. Always align your organization’s purpose and focus with larger issues and shared values. It’s about what you can do today

to help, rather than hinder, a shared and sustainable future.”

Ever the educator, Senge leaves off with a few leading questions. “How do you manage your supply chain? How can your company learn to do a better job of impacting the communities it serves, as well as its own employees? Right now, start there.”



50%
**OF THE WORLD’S
 TOPSOIL HAS
 BEEN LOST OVER THE
 PAST 150 YEARS**

A Triple Bottom-Line Business That Goes the Distance

If there's a term that could be said to describe Adetayo Bamiduro, MBA '15, and former Legatum Fellow, it's "serial social entrepreneur." After co-founding NovaGen Power Solutions with Adeyemi Adepetu, SDM '14, in 2014 as a waste-to-energy business powering clean energy production and job creation in Nigeria, Bamiduro's present venture (co-founded with Chinedu Azodoh, MFin '15) has brought him back home to his native country. This time, Bamiduro is out to tackle Lagos's issues with urban mobility, last-mile delivery, traffic congestion, and expansive unemployment, one moto-taxi trip at a time. His company, MAX, utilizes a proprietary web and mobile platform to make motorcycle transportation and delivery safe, efficient,



and affordable for city dwellers—while effectively providing “up-escalators” to drivers. Unlike other Nigerian enterprises (and even other platform-based mobility companies), MAX puts drivers (called “champions”) at the heart of the business. Drivers are offered competitive earnings, safety training, health insurance, installment plans to finance electric moto-taxi purchases, accessible charging stations, and even workshops on financial literacy. In addition to the 500+ jobs that Bamiduro's MAX has created and the 300,000+ cleaner, safer trips that have been completed since August 2015, Bamiduro has a vision to expand from Lagos to Ghana, the Ivory Coast, and Senegal, creating many more jobs and sustainable opportunities. As he says best, “[With this business] we fundamentally want to change the mindset for Africans and have them think about the future—not just living day by day.”

The Good Companies, Good Jobs Revolution

The three largest occupations in the United States—retail salespeople, cashiers, and food prep and service workers—employ upwards of 11.5 million people. But these jobs are anything but “good jobs.” Workers contend with unpredictable schedules, few opportunities for advancement, and poverty-level wages. Even more significantly, these jobs often provide little dignity for those who do them, relying on repetitive, mindless, or grueling tasks (the kind that may soon be automated).

But rather than representing a grim prospect, this situation presents a unique opportunity to begin creating tomorrow's good jobs right now, according to Zeynep Ton (Adjunct Associate Professor, Operations Management), author of the seminal *The Good Jobs Strategy* and president of the Good Jobs Institute, and researcher Sarah Kalloch, MBA '16 (executive director of the Good Jobs Institute), in their recent paper “Transforming Today's Bad Jobs into Tomorrow's Good Jobs.”

Ton and Kalloch observe that many of these present-day jobs demand creative and problem-solving skills, non-routine manual labor, physical dexterity, and social interaction: all qualities that don't lend themselves to automation. In fact these skills—by which humans enjoy a unique aptitude and advantage—are precisely those that the often-promised “jobs of the future” will require.



Thus, the good jobs revolution, according to Kalloch, isn't something we need to wait for. By working to transform today's “bad jobs” into good jobs, we prepare both businesses and employees for the future. She cites the example of good jobs companies that involve employees directly in decision-making and in improving the customer experience, both areas requiring uniquely human skills. “Good jobs companies are less likely to focus on machines replacing workers,” she explains, “and more likely to focus on machines as a valuable complement to their valuable people.”

By positioning themselves ahead of the curve, such good jobs companies will be better prepared for future technology advances than their competitors. After all, Kalloch reminds us, technology rollouts require an engaged and prepared workforce on the frontlines—ready to help both the business and its customers adapt. As Home Depot discovered during a costly and mismanaged attempt to implement new automation procedures, failure to involve store associates can make the difference between a technology rollout that improves customer (and employee) experiences and one that falls far short. In contrast, Spanish retailer Mercadona's worker-centric upgrades to their logistics and in-store technologies led directly to improvements in productivity—all without downsizing.

When—and How—Companies Benefit from Supply Chain Transparency

Increasingly, consumers purport to care deeply about the ways in which companies they patronize treat labor—and other social and environmental aspects of their supply chains. But what kinds of visibility and disclosure regarding a company’s supply chain actually impact consumer perceptions and purchase behaviors? When do consumers choose to patronize a

company based on a perception of virtue? And to what degree does purchasing behavior vary with the extent to which an individual consumer is willing to sacrifice his or her own benefit to improve the payoff for others?

Yanchong (Karen) Zheng (Sloan School Career Development Professor and Associate Professor, Operations Management) and her research colleagues have drawn a series of insightful conclusions from their experimental studies:



1. With a higher level of supply chain transparency, consumers’ valuation of a company’s social responsibility efforts *increase*, pointing to a potential revenue benefit from greater transparency.
2. The motive to reward a company’s responsible practices has a significant and positive impact on the price premium that consumers are willing to pay for associated products *only* when the company is highly transparent about its supply chain practices.
3. Greater supply chain transparency has a *stronger* effect on consumers who are *less* predisposed to paying a premium for more responsible practices than for consumers already predisposed to doing so.

Going Against the Grain for Widespread Welfare

How much can a supply chain change lives for the better? In the hands of the founders of Wild For, the hope is that it can help Ethiopian farmers double their output and triple their profits. Co-founded by Aleem Ahmed and Caroline Mauldin (both MBA ’15) with support from the Legatum Center for Development and Entrepreneurship at MIT and the Mastercard Foundation, Wild For’s business is centered around teff: a tiny East African grain high in protein and fiber, renowned as a longtime staple of the Ethiopian diet. While working in East Africa, Ahmed learned that 6 million teff farmers lacked a market for their grain. By connecting the dots between existing supply and skyrocketing U.S. demand for healthy gluten-free products, he and Mauldin realized their opportunity. Today, Wild For has launched a line of air-popped teff chips in the San Francisco market, and is planning to expand to the East Coast in 2019 through a Whole Foods partnership. As Ahmed explains, “At Wild For, we’re trying to generate consumer demand for a product that’s healthier, and uses teff so we can devote more attention to the teff

value chain in Africa and drive better prices for local farmers.”

6M TEFF FARMERS
LACK A MARKET
FOR THEIR GRAIN

A Platform for Distributed Manufacturing in Emerging Economies

“Ethical Fast Fashion.” If it sounds like a contradiction in terms, you haven’t yet heard of Soko. Headquartered between San Francisco and Nairobi, Soko utilizes a proprietary, mobile-to-web “virtual factory” technology to enable a distributed network of over 2,500 global jewelry artisans to sell their wares (over 40,000 units each month) to conscious consumers. Co-founded by serial venture-backed entrepreneur and MIT alumna Ella Peinovich, MArch ’12, with the help of the Martin Trust Center for MIT Entrepreneurship’s Global Founders’ Skills Accelerator (GFSA, the predecessor to the current delta summer accelerator) and the Legatum Center at MIT, Soko’s goal is nothing less than transforming global supply chains, one product, one fairly paid artisan, and one satisfied customer at a time. “Ethics are part of the DNA of our business,” explains Peinovich. “We believe that for things to be beautiful, the systems that create them must also be beautiful.”

In her latest business, Powered By People, Peinovich is leveraging the privacy advantages of blockchain technology to build reputational trust across a network of distributed buyers and producers into a fully transparent supply chain of home-based workers—once more, promoting economic prosperity for global producers. As she explains: “We are passionate about advancing the productive contribution of others through innovative business processes and inclusive technology.”

A World Beyond Sweatshops

There's a term that sums up the kind of labor practice Greg Distelhorst, PhD '13 (Mitsubishi Career Development Professor in International Management; Assistant Professor, Global Economics and Management) has spent his career studying: that of the sweatshop. "I use that word because we all have a basic idea of what it means: long hours, unsafe conditions, getting cheated out of wages through theft... or cheated out of human dignity through verbal and physical abuse."

For all the benefits that have accompanied the

globalization of supply chains and the dropping of trade barriers—benefits like a massive reduction in worldwide poverty—there have been accompanying abuses that have become all too familiar, evoked by the image of preteens “making clothes and soccer balls for people in the West,” as Distelhorst sums up. While exploitative working conditions don't conform to the historic capitalist definition of “unsustainable,” research like Distelhorst's is beginning to show there are alternatives to a race to the bottom.



**EXPANDING THE TOOLKIT FOR
IMPROVING GLOBAL LABOR CONDITIONS**

Today, Distelhorst is examining the ways that companies can play a constructive role in changing sweatshop labor conditions. From his recent work with Nike to his mentorship of MIT Sloan Action Learning's Sustainable Business Lab (S-Lab) teams to his research with big industry all over the world, Distelhorst has found evidence for a variety of approaches that corporations can adopt to ensure fair pay and conditions for workers across their supply chains—approaches like applying lean manufacturing principles or exploring fair trade certifications.

“We have to augment the old toolkit for improving labor conditions, government regulation, and freedom to unionize. In places like China or Vietnam—or even some segments of the U.S. economy—workers simply lack the power to use those mechanisms.”

**LOWERING COSTS WITHOUT LOWERING STANDARDS:
THE LEAN ADVANTAGE**

When it comes to monitoring and improving labor practices, a majority of forward-looking corporations find themselves in a peculiar position: as customers, rather than stakeholders. In most instances, multinationals do not directly employ the workers involved in parts and supply manufacturing, so novel approaches are necessary.

Distelhorst's recent research with Nike originated with looking at how lean management could have an impact on jobs in the developing world. The last 30 years have seen lean manufacturing methods revolutionize countless industries, starting with Japanese automakers. By Distelhorst's explanation, Nike began employing lean management to be more competitive.

“But the most compelling—and encouraging—conclusion that's come out of our research with Nike is that going lean can make your company more competitive, more cost efficient, more productive, and, even more important, more socially sustainable and better for workers. Not less.”

**CERTIFICATIONS AND MONITORING FOR SOCIALLY
SUSTAINABLE LABOR PRACTICES**

Another method Distelhorst has been examining stems from mentoring continuing S-Lab work with Patagonia. Given S-Lab recommendations, Patagonia is testing a fair trade premium to direct a portion of its supply chain expenditures directly to accounts controlled by factory workers. And through other S-Lab projects, Distelhorst is working with MBA and EMBA students to explore the best mechanisms to set a fair living wage.

Though identifying a wage that works across

It's our job to improve conditions based on real solutions, and reduce the harm caused by global trade without trading away the incredible ways it has lifted entire populations out of poverty.

industries and borders is ambitious, Distelhorst's new study in Florida with the Fair Food Program points to the value of combining a fair trade premium with grassroots farm monitoring to enable companies to better understand the work being done, better adhere to labor policies, and better determine a living wage. Distelhorst believes that the Fair Food Program represents a promising approach—putting, as it does, workers at its center. And Distelhorst and his colleagues are currently pursuing new research to fully document the impacts of this program on workers.

SUSTAINABLE SOLUTIONS START HERE

Recalling his start in the field, Distelhorst mentions his discovery of research on labor violations while studying political science with mentor (and then the Alvin J. Siteman [1948] Professor of Entrepreneurship) Richard Locke, PhD '89. “I saw an opportunity to get involved in research that was intellectually rigorous, that had opportunities all over the globe, and that could actually have a direct impact on vulnerable workers. After that, I was hooked.”

He is quick to remind us that trade itself is not the enemy. “It's our job to improve conditions based on real solutions, and reduce the harm caused by global trade without trading away the incredible ways it has lifted entire populations out of poverty.”

By Distelhorst's own description, MIT Sloan is a place where people demand solutions—an institution where researchers are “pleasantly pressured” to ensure their studies translate into change in the real world.

“I chose this place to pursue my work because the importance of sustainability will only grow in the years to come. Our shared drive at MIT Sloan for real-world impact is, I hope, poised to deliver more successes.”

And as he proudly notes, “No one else is doing it quite the way we are.”

Environmental Sustainability

Environmental sustainability might seem the most self-evident in its definition: requiring as it does the sustainable use—and preservation—of the resources within the landscapes and biospheres in which we live, work, and create. But as the longest-established, most familiar dimension of what we call “sustainability,” its implementation requires perhaps more finesse, experimentation, and innovation than in any other arena. The following are just some examples of the remarkable work our faculty, students, and alumni are conducting in this realm.

JOHN REILLY

Carbon Taxation: A Win-Win for the Climate and Consumers Alike

For those who work on the problem, putting a price on carbon has been a clear imperative for some time. But how should it be done? A new joint study from the National Renewable Energy Laboratory (NREL) and researchers at MIT—including John Reilly (Senior Lecturer and Co-Director of the MIT Joint Program on the Science and Policy of Global Change)—has analyzed a wide range of proposals and suggests an equitable policy “sweet spot”: attempting to better equalize burden-sharing between the poor on whom the burden of increased energy costs will fall the hardest and those economically equipped to better absorb the impact of making carbon costlier. “It’s sort of an obvious solution,” Reilly says, “to take some chunk of the money and use it to focus on the poorest households, and use the rest to cut taxes. It doesn’t seem like a hard thing.” The researchers’ analysis ultimately demonstrated that, in a model starting with a \$50 per ton carbon tax and increasing it 5 percent year over year, the numbers should lead to a 63 percent reduction in total U.S. greenhouse gas emissions by 2050. This figure is in line with the 50 percent carbon reduction estimated to be needed by 2050 to mitigate the worst impacts of climate change; and ideally—as Reilly concludes—to “get to net zero beyond that.”



WILLIAM "BILL" AULET

The MIT Clean Energy Prize: Then and Now



William "Bill" Aulet, SF '94 (Professor of the Practice, Technological Innovation, Entrepreneurship, and Strategic Management; and Managing Director, Martin Trust Center for MIT Entrepreneurship), an active voice involved with the MIT Clean Energy Prize, would be the first to tell you that there is seldom success without bold innovation. In fact, as he puts it in his seminal book, *Disciplined Entrepreneurship: 24 Steps to a Successful Startup*: "If there is already a market research report out there with all the information you need, it is probably too late for your new venture."

First held in 2007—and distinguished as the nation's largest energy-innovation competition for students—Aulet explains that the Clean Energy Prize (CEP) has a twofold mission: "to inspire, and prepare, the next generation of leaders to take on the world's most pressing energy challenges."

Fast-forward to 2018: Now in its 11th year, the CEP has awarded more than \$2.6 million to the launch of clean energy startups; teams have collectively raised more than \$430 million in additional funding after participating in the competition, and have employed more than 700 people around the globe. At MIT's Samberg Conference Center this year, 17 CEP semifinalist teams showcased their innovations in four categories: generating energy, improving energy usage, delivering energy, and providing energy for developing economies.

When it came to the final pitches—following an all-day event including keynotes from clean tech industry executives—the participants did not disappoint: Fiat Flux from MIT was awarded \$10,000 for their development of a light-based technology that continuously cleans organic contaminants off seawater reverse-osmosis filters. Safi Analytics was awarded \$10,000 for a platform that collects the sensor data to provide real-time information for factory managers. Polar Panel won the second-place prize of \$20,000 for modifying a NASA-developed solar refrigeration system to power refrigerated railcars. The grand prize went to Lithio Storage who is developing an electrolyte that helps batteries withstand much broader temperature ranges and be more efficient, safer, and cheaper to operate. Says Aulet: "This is why the CEP and the work of the Martin Trust Center matter more than ever. MIT is the right place to continue providing a launchpad for new companies—and technologies—that will change the world for the better...and solve our toughest challenges." He also reminds alumni that their donations in support of the Clean Energy Prize are critical to the continued success—and existence—of the program.

\$2.6M

THE AMOUNT CEP HAS
AWARDED TO LAUNCH
CLEAN ENERGY STARTUPS

DANIELLE DAHAN

Eliminating Energy Waste with Machine Learning

Why not use the actual MIT campus and facilities as a place to conduct research in sustainable operations, management, and design? The MIT Office of Sustainability (MITOS), with the help of the first-ever Campus Sustainability Incubator Fund, is making that concept a reality with the recent award of a \$200,000 grant. Though the grant is shared among four multidisciplinary projects right on campus, one in particular stands out for its distinctly "MIT" approach: that is, using the power of machine learning to reduce or eliminate wasteful energy use from the HVAC systems that keep campus buildings comfortable. Danielle Dahan, SM '17, a graduate research assistant at the MIT

Center for Energy and Environmental Policy Research (CEEPR), collaborated with MIT Sloan's famed Professor Christopher Knittel, Wade Berner of MIT Facilities, and undergraduate Manuel Mundo, BS Math '18, in testing and analyzing the effectiveness of fault detection and diagnostic (FDD) software in preventing energy waste. "FDD systems have the potential to detect problems in HVAC systems that go unnoticed for years, wasting significant amounts of energy," explains Dahan. "This research allows us to quantify the impact of these systems and help inform policy and code requirements that promote the adoption of energy-saving technologies."

Coordinating Action on Climate Change

Over the years, many have tried to label John Sterman, PhD '82 (Jay W. Forrester Professor of Management; Professor, System Dynamics and Engineering Systems and Co-Director, Sustainability Initiative at MIT Sloan), from half-joking sobriquets like “Dr. Doom” to descriptors like “sober optimist.” While

Sterman may have the air of a provocateur, his story can't so easily be reduced to a description of temperament. It is rather Sterman's enduring bias toward action—toward helping others take action—on “the most wicked problem and important opportunity of our time” that deserves a descriptor: that of a principled, innovative leader relentlessly working to make a better, greener world.



A SERENDIPITOUS PATH TO SYSTEM DYNAMICS—AND SUSTAINABILITY

While Sterman didn't follow a straight path into the field of sustainability, he certainly found himself on that path quite early.

“It was 1971—and I was a nerdy high school kid—when my father, a research chemist, brought home Jay Forrester's groundbreaking article, ‘Counterintuitive Behavior of Social Systems.’ It instantly sparked my interest in how complicated, dynamic systems work...and that's never gone away.”

As a Dartmouth freshman, while spending much of the fall programming Forrester's first World model into BASIC for his own experimentation, he met Forrester's co-researchers Dana and Dennis Meadows, changed his major to system dynamics, and after graduating found himself bound for MIT to do his doctoral work at the institution that invented the discipline.

“You could say I have always been interested in sustainability, from high school on,” he says.

“SUSTAINABILITY IS THE QUINTESSENTIAL SYSTEMS PROBLEM. AND IT'S A WICKED PROBLEM.”

That Sterman is now, decades later, the faculty co-director of the Sustainability Initiative at MIT Sloan should come as no surprise. He explains, “Forrester invented the field of system dynamics right here at MIT Sloan, and sustainability is the quintessential systems problem. It's global in scope, affects every company, every country, every organization, and every person...and it has all the characteristics of a complex, dynamic system, so it's extremely hard to manage well.”

While active research in his field is a crucial part of Sterman's agenda—including new papers exploring how to limit global warming to 1.5 degrees by 2100, a study showing that cutting forests for bioenergy can actually harm the climate, as well as work on the PROMISE framework with Sustainability Initiative at MIT Sloan Director Jason Jay, PhD '10, and Faculty Co-Director Roberto Rigobon, PhD '97, (Society of Sloan Fellows Professor of Management, who was featured in our previous newsletter)—Sterman has found that research alone is not enough to drive meaningful action on a “wicked problem.” He wryly observes that, “research shows that showing people research doesn't work. Whether it's seat belts, smoking, or climate change, telling people how they can improve their health and welfare doesn't change their behavior.”

So how can scientists help people learn for themselves without dictating how they should behave, and while remaining true to the science?

SIMULATION: CHANGING HEARTS AS WELL AS MINDS

People normally learn through experiments and experience, but for climate change—and many critical issues we face—experiments are impossible and experience comes only too late. Simulation is the solution. Simulations have long been used to train people in

aviation, factory operations, medicine, and the military. Sterman and others in system dynamics pioneered “management flight simulators” that give people a chance to learn about even more complex systems like a company, market—or the climate. The field of system dynamics, he points out, has a long history with educational simulations, going back to the famous Beer Game, developed at MIT in the 1950s and still used around the world, an interactive experience that allows participants to play the role of managers in a supply chain, make decisions together to minimize costs, and see the results. This past August marked the 30th year Sterman has run the Beer Game as the capstone event in MBA orientation at MIT Sloan.

So can simulation help with sustainability? Sterman and colleagues developed the World Climate Simulation to find out. Since its release three years ago, World Climate has been used by more than 44,000 people in 78 countries, including senior policymakers, international business leaders, and ordinary citizens to role play climate negotiations and experience in real-time how decisions and carbon-reduction measures play out across the globe. In another new paper, Sterman and colleagues show that participating in World Climate not only enhances participants’ understanding of climate change but also affects them emotionally, boosting feelings of urgency, hope that we can still make a difference, and, most importantly, their desire to take action. “They’re left with the feeling, ‘What I do matters; the problem can be solved.’ That’s the kind of experience—the kind of gut-level motivation—that can drive the action we need.”

INTO THE WORLD...

Sterman has many stories of MIT Sloan colleagues and alumni whose lives have been altered by their experience with the World Climate Simulation. He shares, “After World Climate one former student, Noel Zamot, told me, ‘This was life-changing. How do I get more involved?’ He and his wife learned to facilitate the workshop and led it at their church; eventually, he decided he had to make still more of a difference. He left his previous job, and moved to Puerto Rico where he’s leading the effort to rebuild the electric power system to be renewable and resilient.”

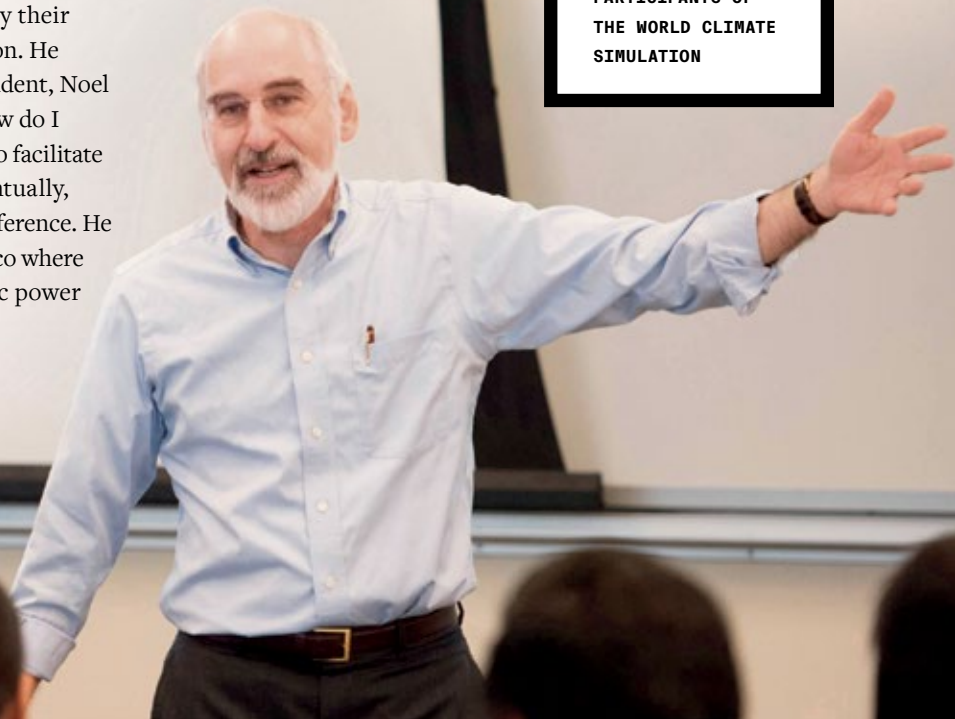
UNIQUELY POSITIONED TO SOLVE THE “WICKED PROBLEM”... AND TAKE ADVANTAGE OF A WICKED OPPORTUNITY

Sterman believes that MIT Sloan has a profound opportunity—and responsibility—when it comes to taking action to make a better world. “Too many people still think the economy and environment are in opposition, that it’s ‘growth vs. green.’ In fact, there’s a fundamental alignment between a healthy economy, a healthy environment, and healthy people. Businesses cannot prosper if we destroy the environment and harm the people, nor can the environment survive when people are poor and hungry. I see more and more MIT Sloan leaders, more and more MIT Sloan alumni, of all ages, seeking to align their professional and personal lives with what they most truly desire—to build a world in which they, and all people, can thrive. More and more find that it’s possible to help make the world a better place, and have a successful, satisfying career at the same time.”

He adds that building a sustainable world is the greatest entrepreneurial opportunity since the Industrial Revolution—one that demands principled, innovative leadership in word and deed. “Within the lives of our children, we will know whether or not we succeed—we can do it, but there’s no time to waste. And if not us...then whom?”

78

THE NUMBER OF
COUNTRIES HOUSING
THE 44,000
PARTICIPANTS OF
THE WORLD CLIMATE
SIMULATION



Accelerating the Transition to a Low-Carbon Economy



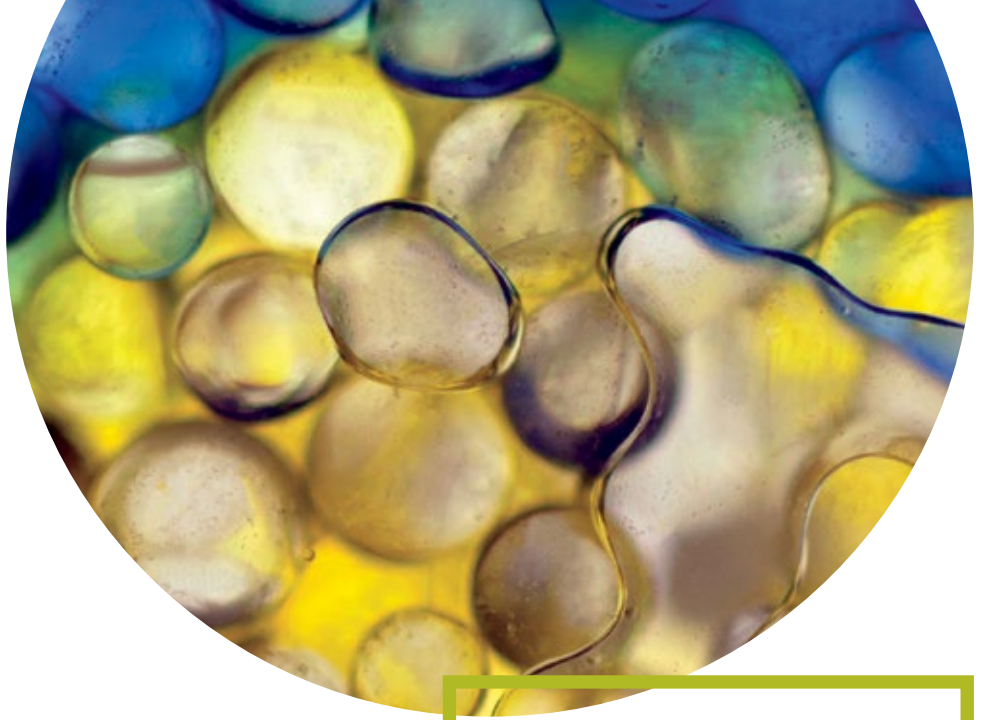
Christopher Knittel (George P. Shultz Professor and Professor of Applied Economics) wants to help move the world toward the sustainable, low-carbon economy we need. So he's spent his career researching the issue through an eminently practical lens: one consumer decision at a time.

“My work focuses on what policies are most likely to be effective and efficient, by studying how consumers and firms make decisions in the marketplace: how they respond to everything from changes in fuel prices to changes in regulations.”

After an initial focus on the telecommunications market, as well as forays into banking and finance, Knittel explains that his focus has changed since his son's birth in 2008. He's moved away from using the combined knowledge from his years of research in the service of changing minds to constructing policy that works for people around what he calls “the most pressing problem for humankind”: the sustainability of the planet.

DRIVING TOWARD A MORE EFFICIENT FUTURE

“There's wide agreement from the economics community that we have to put a price on carbon—whether that's through cap-and-trade or a carbon tax.” Promisingly, Knittel's



research reveals several interesting ways in which either approach can be made to work for consumers, whether through progressive carbon tax or cap-and-trade policy design.

To wit, Knittel's most recent study demonstrates that a carbon tax would launch all the kinds of economic activity needed for a cleaner, more sustainable world. From tracking vehicle use in California, Knittel has evidence that increasing the cost of carbon (through fuel prices or a tax) reduces the number of miles driven; leads to older and "dirtier" cars being retired earlier; and prompts consumer investment in hybrids, EVs (electric vehicles), and other more efficient means of transportation. Combine these factors and we find a virtuous cycle: consumers save, automakers have incentive to innovate, and the environment benefits—illustrating the chain of events that can help inform policymakers to do the right thing.

FROM ENERGY MARKETS TO ENERGIZED POLICY

Beyond transportation, Knittel sees huge untapped opportunities for business in other realms of a decarbonized economy: from the electric markets at large to the wider development of affordable, clean technologies—and a corresponding range of customer adoption incentives that can provide policymakers a menu of options to drive widespread changes in energy use.

"Cooperation when it comes to business innovation and policy design will literally change the world," declares Knittel. And in his role as director at the Center for Energy and Environmental Policy Research (CEEPR) and as co-director of the Electric Power

Systems Low Carbon Energy Center (EPS) at MIT, his work includes fully understanding the tradeoffs, implications, and measures that need to be in place for such a global transformation.

EPS AND CEEPR: WHERE THE INTEGRATED ENERGY FUTURE BEGINS

Though one of eight low-carbon energy centers at MIT, EPS has a unique role to play: that is, examining the technological, social, and economic implications of an integrated energy future. As Knittel explains, "If you imagine a hub-and-spokes model, we're the center that's tasked with understanding how all these energies will work together—this is what MIT does so well." Correspondingly, in his role as director of CEEPR (began in the late 1970s, and the oldest energy economics and policy research center in existence), Knittel is steering the empirical study of the global policy issues related to energy supply, demand, and the environment with a mind to improve them for good.

TAKING ACTION FOR A BETTER FUTURE, AS BUSINESS LEADERS—AND CITIZENS

Though Knittel has dedicated the bulk of his present efforts to

Cooperation when it comes to business innovation and policy design will literally change the world.

providing evidence and direction to policymakers looking to enact triple bottom-line legislation, his directive to citizens and professionals is equally clear: prove conventional wisdom wrong.

"According to conventional wisdom, 'sustainability' is bad for business. The single most effective thing we can do is this: prove that wrong. Continue to prove that wrong." After all, as Knittel notes, "The goal of MIT in general, and MIT Sloan in particular, is to train the future leaders of business: the ones who will demonstrate how to run sustainable businesses, make corporate investments in clean technology, and do the right thing—all behaviors that will influence policymakers. We need that leadership. The world needs that leadership. And we need it now."

“In order to fight climate change, we need to free up more capital. There’s going to be a revolution and if we let the market do its magic, we could accelerate the transition to a clean future.”

Michael Sonnenfeldt, ’77, SM ’78; Entrepreneur, MIT Donor and Philanthropist, and Political Activist

Modeling U.S. Water Resources Under Climate Change

Water’s molecular constitution may be simple, but that’s where the simplicity ends. When it comes to water resources, we find ourselves in a complex, dynamic nexus of systems—climatic, biological, hydrological, agricultural, and economic. In turn, effective modeling for water resources demands a unique level of discipline and systemic understanding. Which is exactly what Henry Jacoby (William F. Pounds Professor of Management [Emeritus]; MIT Joint Program on the Science and Policy of Global Change) and his co-authors have delivered in their article, “Modeling U.S. Water Resources Under Climate Change.” Along with his seven co-authors, Jacoby identifies areas of potential stress on this precious resource to help direct attention to water-planning



needs and illustrates how climate change mitigation policies could impact resources. Dynamic interactivity and interdependence are the keys, as the study explains: “While many studies consider the impact of anthropogenic climate change on water supply using [climate and economic influences], few models, if any, are set up to consider the interdependence of these influences.”

Bringing Innovation to Agriculture

As an MIT Sloan student, Sarah Nolet, SM ’16, ran the Food and Agriculture Club, co-led the 2015 Sustainability Summit, was co-managing director of the 2016 Sustainability Summit, and wrote her thesis on “Accelerating Sustainability-Oriented Innovations in Agribusiness.” Now her energy goes into helping high-potential leaders in agriculture—and high-potential agricultural enterprises, startups, and models—scale. Nolet founded AgThentic to provide strategy consulting services and growth advisory support to investors, businesses, and government outfits, upon recognizing an unmet need for integration between the worlds and players in agriculture and technology. In earning her MIT Sloan Sustainability Certificate, Nolet



got the interdisciplinary education that today enables her to seamlessly bridge the lexicons of farming and tech innovation, bring venture development practices to farmers, and help even seasoned leaders in the industry think more like

entrepreneurs, in service of a sustainable approach. “For example,” Nolet says, “[we’re] running an accelerator program for farmers who have an idea and want to start a technology-based business. We’re halfway through our second cohort.”

The Clean Slate for Investing

As a veteran of the energy industry, Ray Wood, SM '90, currently managing director and head of global power and renewables at Bank of America Merrill Lynch, has spent the bulk of his own professional life thinking about ways to sustain innovation in the renewables sector—and has generously provided significant support for MIT Sloan's sustainability work in tandem. Indeed, Wood's years of experience have evidenced that to really make progress on climate change, renewables must gain traction in developing economies like China, India, and Brazil. As he wryly observes, "You don't have to be a visionary to see that there's going to have to be major changes made in those places to provide citizens with a cleaner environment." But as solar and wind-power costs have declined dramatically, it's

become easier for developing nations to make the transition. And in Wood's view, "It's incumbent on all of us to make these investments." As a frequently featured speaker at the annual MIT Energy Conference and an increasingly prominent presence with the Sustainability Initiative at MIT Sloan, it's clear Wood's relationship with MIT Sloan has never slackened. "I'm really proud of my affiliation with MIT," he states. "It's been instrumental in what I've been able to do with my career." And critically—from his global perspective—he sees MIT Sloan's contributions to the sustainable future as more important than ever. "This research is making a relevant contribution to the clean tech community not just in Boston, but across the world."

CHARLES FINE

Defining a Greener Future for Urban Mobility

Charles Fine (Chrysler Leaders for Global Operations Professor of Management at MIT Sloan; President and Dean of the Asia School of Business, in collaboration with MIT Sloan) sees a future of greater mobility, convenience, and personalization—he just doesn't necessarily see cars at its core. Along with co-authors Venkat Sumantran and David Gonsalvez (CEO and rector at MIT's Malaysia Institute for Supply Chain Innovation), their book *Faster, Smarter, Greener: The Future of the Car and Urban Mobility* envisions shifting away from the dominance of cars in urban transport through the application of "CHIP" architecture: systems built on connectivity, heterogeneity, intelligence, and personalization. (Much of this research was made possible by crucial contributions from ASB, the Asia School of Business, from Bank Negara Malaysia.)

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ON WHY CHIP IS IMPORTANT

"Every city will have its own unique topography, architecture, and environment," Fine explains, "but whether it's Mumbai or London, Rio or Los Angeles, core principles like CHIP can guide innovation that's directed toward what people will actually want—and use." By incorporating key aspects of user experience,

personalization, and leveraging of big data, CHIP holds the potential to guide any given city in creating interlocking systems of mobility that can give any individual what they need, based on their own priorities.

ON HOW CARS WENT FROM SOLUTION TO PROBLEM

For the last century, cars made lots of sense: In Fine's description, they're "relatively cheap to operate, comfortable, have entertainment in them, feel safe, and are relatively speedy." The political and economic muscle thrown behind automobiles in mid-20th-century America also helped shape our current infrastructure, often to the direct (and deliberate) detriment of other forms of mobility: "General Motors notoriously bought up all the rail lines in Los Angeles to pave them over." But while cars worked effectively for a while, times have changed. And the sheer number of vehicles on the road virtually assures levels of congestion, pollution, and greenhouse gases that have become unsustainable.

ON HOW PUBLIC AND PRIVATE PARTNERSHIPS MUST DRIVE THE FUTURE OF URBAN MOBILITY

"The system needs to encourage innovation and ought to encourage entrepreneurs to come up with new ideas, like Uber, Tesla, or Zipcar," Fine asserts. "But at the same time, we need to create a framework whereby entrepreneurs can enter into the system in a way that's going to help it, not hurt it." In his estimation, "There aren't easy answers, but urban and regional governments have a key role to play. We need a regulatory structure and government actors who will push for the well-being of society as a whole."



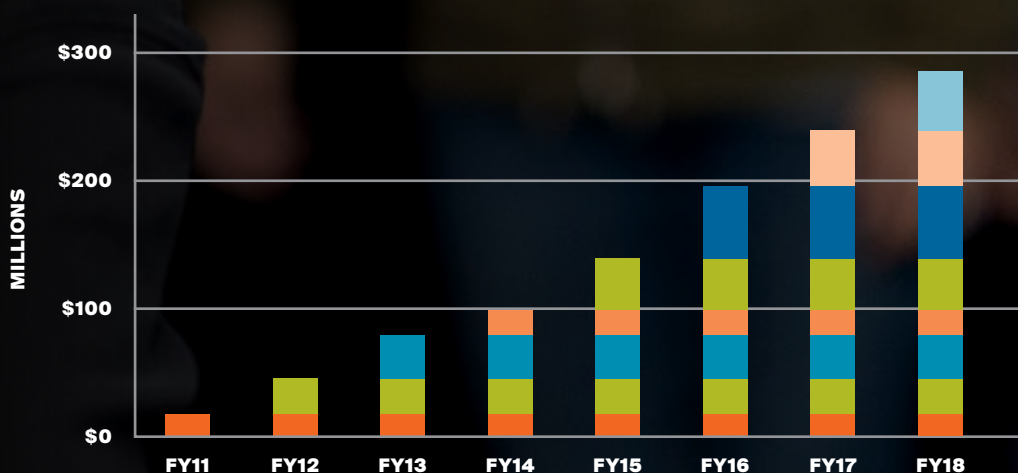
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The MIT Campaign for a Better World has been launched because worldwide we find ourselves at a critical inflection point. Technological, environmental, economic, and demographic trends are converging to present new—and complex—challenges. In the MIT community, complexity is our call to action. By harnessing the collective ingenuity of the school and Institute, we can take on the greatest issues of our time, if given the resources to do so.

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- Human Health
- Innovation and Entrepreneurship
- Teaching, Learning, and Living
- The MIT Core

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