ALFRED P. SLOAN FOUNDATION

2020 HIGHLIGHTS

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FOUNDATION

Cover: A solar panel array. Environmental engineering student Tongshu Zheng investigated how to use satellites to measure how much solar radiation is being blocked by dirt on solar arrays and thus how much additional electricity a thorough cleaning would generate. Zheng was one of a number of graduate fellows supported through a Sloan Foundation partnership with Duke University that is training young researchers to use data in novel ways that help speed the transition to a less carbon-intensive society. Zheng completed his Ph.D. in 2021 and is now an air pollution specialist at the California Air Resources Board.

Contents

The Alfred P. Sloan Foundation is a nonpartisan, not-for-profit grantmaking institution dedicated to improving the welfare of all through the advancement of scientific knowledge. The Foundation works in four different areas to help drive the research frontier forward.

RESEARCH & DISCOVERY The Foundation believes that scientific discovery is a chief driver of economic prosperity and that the research enterprise is a vitally important engine of human progress. We help scholars conduct cutting-edge research across a range of disciplines, from astronomy to particle physics to energy economics. Our research grants focus on underexplored topics; innovative methods; and risky, adventurous projects where success holds the promise of truly transformative discovery.

DIVERSITY, EQUITY & INCLUSION Scientific progress is too important to belong to any one gender, race, or ethnicity. We partner with researchers, educators, administrators, and students on initiatives to increase access to scientific education, enhance meaningful participation in the scientific process, and change the culture of scholarship in ways that make it more open, responsive, and affirming to all.

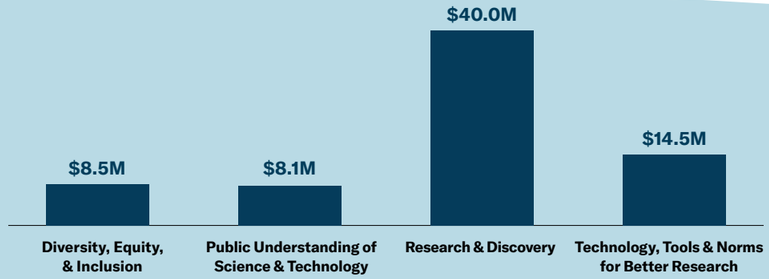
TECHNOLOGY, TOOLS & NORMS FOR BETTER RESEARCH In recent decades, developments like computing and the internet have created new challenges and opportunities for researchers. We work with technologists, programmers, engineers, and scholars to develop innovative tools, practices, and institutions that give researchers the ability to generate, analyze, and share knowledge at unprecedented speed and scale.

PUBLIC UNDERSTANDING OF SCIENCE & TECHNOLOGY In our increasingly technological world, it is more important than ever that the fruits of scientific discovery be accessible to everyone. We partner with artists across a diverse range of media to help tell stories that expand and deepen public engagement with science and technology.

Founded in 1934 by Alfred P. Sloan Jr., the industrialist who made General Motors a household name, the Sloan Foundation was created out of Mr. Sloan's firsthand experience watching scientific and technological innovation drive prosperity and lift American standards of living. Today, we strive to uphold the legacy of that founding insight and to be guided in all our actions by the values of the scientific enterprise: impartiality, empiricism, curiosity, rigor, and the conviction that a careful, systematic understanding of the forces of nature and society, when applied inventively and wisely, can make the world a better place for all.

2020 Grantmaking at a Glance

At year-end 2020, the Sloan Foundation had assets totaling approximately $2.1 billion. During 2020, the Foundation awarded over $71 million in grants to support projects across our four focus areas:



* The Foundation awarded an additional $4.5 million in grants in 2020 to support nonprofit initiatives and New York City-based projects that advance the Foundation's mission.

The Importance of Community

Faithful readers of the Sloan Foundation's Annual Report will notice that this year's edition differs significantly from those you've held in your hands in the past. Rather than a compendium of grants made in the prior year, we've decided to produce a report that focuses on stories about our grantees: who they are, what they're doing, and why it matters. We'll leave the comprehensive archiving function to sloan.org, where it properly belongs, in conveniently searchable form. Our annual financial reports can be found there, as well.

This move to render unto the website the things that are the website's gives us the opportunity, instead, to introduce the reader to some of our amazing grantees. Sloan Foundation grants support some 1,500 projects at any given time, every one of which has a story worth telling. Inside these pages, you'll find a few of those stories—stories of grantees, of their projects, and, particularly salient this year, of the communities within which they do their work.

The crises and traumas of the past year emphasize poignantly that the work we support is done by people, working within institutions, relying on communities—people, institutions, and communities whose health and even existence can be threatened by external conditions and events. At Sloan, we've long understood that in supporting projects we must attend to the larger context within which that work is done. Many of the stories we tell in this annual report—renamed Highlights—are about the intersection between the work grantees do and the communities that support that work and whom the work itself serves.

An excellent case in point is the Sloan Digital Sky Survey, which the Foundation has supported for more than two decades. The scientific achievements of SDSS researchers have been extraordinary, exemplified by their comprehensive analysis of the expansion of the universe from the Big Bang to the present day, as described in this report. Equally significant, however, has been the invention by SDSS of a new way of doing astronomy itself. The assembly and analysis of massive datasets; the sharing of data within the entire collaboration; the open publishing of data for anyone to analyze; a broad institutional membership model—all of this amounted to a new vision of what sort of community astronomers can form. In supporting SDSS for the past quarter century, Sloan has helped revolutionize astronomy in both a scientific and a social sense.

Many have followed the lead of SDSS, in astronomy and elsewhere. As scientific collaborations have grown, both in numbers of people and in their geographic dispersal, the need to attend carefully to their coherence and overall health has grown commensurately. This concern was only exacerbated by the global pandemic, which kept communities

dispersed and adopting purely virtual modes of engagement. To address this issue, many of them have, formally or informally, come to rely on the role of the community manager. Sloan grantee Lou Woodley, the leader of the Center for Scientific Collaboration and Community Engagement, has sought to formalize and professionalize this critical role, providing both training and a community for practitioners. We've been eager to support her work, which you can read about herein, precisely because it addresses head-on the question of how a scientific community is healthily sustained.

Central to the health of a scientific community is the question of who is welcomed into that community and supported to participate fully. There is little doubt that sexism, racism, and other forms of discrimination still pollute academic disciplines in science and economics (as they pollute, it must be said, much of our society). For decades, the Sloan Foundation has been funding programs, such as our University Centers for Exemplary Mentoring, to address these issues. But in supporting the progress of those who have been marginalized, it is essential that we listen most of all to the voices of those we hope to serve. This point is illustrated well by two pieces in this report, one on the film *Picture a Scientist*, and the other on the meeting Experiences of Black STEM in the Ivory. What the perspectives of women (in the film) and Black scientists (at the meeting) make clear is how much is lost because of the perverse, offensive, and sometimes ridiculous obstacles communities still put in the paths of talented academic scholars who simply want to contribute to their fields of study.

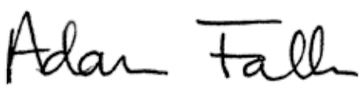
An academic scholar is, in fact, a member of a variety of different communities. Some, such as universities, are place-based; some, such as professional societies, are distributed; and some are a sort of hybrid. In economics, one of the most enduring and influential such hybrid communities is the National Bureau of Economic Research. Headquartered in Cambridge, Massachusetts, but drawing on economists throughout the country and the world, NBER is a critical nexus with the influence to shape both economic research and the larger economics community. For the past thirteen years, NBER has been led by James Poterba, during which time he has also been a valuable member of Sloan's Board of Trustees. By now a venerable institution, NBER turned 100 last year, and in this report, you'll find Jim's reflections on NBER and its very special role within the economics profession.

Just as important as hybrid communities like NBER are placed-based ones like the towns and cities in which we live. With this in mind, we highlight the work of Noel Hidalgo and his colleagues at BetaNYC, a civic technology group that helps equip residents of New York with the tools they need to effectively use public data to engage with city government. Funded within our small New York City program, this project brings together in one place so much of what we value at Sloan—science and technology, the use of evidence to address contemporary issues, and the strengthening of communities by broadly empowering those within them.

It was essential, during such a tumultuous year, that we at Sloan also looked inward to our own community and our own practices. First, with last year's reemergence of a vibrant global movement for racial justice, we thought it vital to renew our commitment to diversity, equity, and inclusion and to make that commitment both explicit and visible. The result of the process was a new public statement, as well as new grant guidelines to ensure all Sloan-supported projects are structured to promote inclusion.

Second, financial pressures faced by universities and other nonprofit organizations during the global pandemic remind us how essential these institutions are for fulfillment of the Foundation's mission. We took this opportunity to assess whether we should do more to support the communities within which our grantees do their Sloan-supported work. I am proud to report that in 2020 Sloan decided to raise our indirect cost rate from 15% to 20%. These funds go directly to offset real expenses associated with supporting the activities of our grantees. The new policy sets one of the most generous indirect cost rates in private philanthropy, and we view it as a concrete demonstration of a commitment that goes beyond individual scholars to the institutions that make their work possible.

I hope you will enjoy reading our newly configured annual report in its entirety, and that you will find the stories of our grantees, their colleagues, and their work as interesting and inspiring as I do.



— Adam F. Falk,
President, Alfred P. Sloan Foundation

Over two decades, the Sloan Foundation Telescope in Sunspot, New Mexico has been the primary instrument of the Sloan Digital Sky Survey, collecting optical spectra and other data on millions of celesitial objects.

The Cartographers Of Everything

Astronomers have placed a small telescope in the mountains of New Mexico in service of a giant ambition: to build a map of the universe.

For twenty years, astronomers at New Mexico's Apache Point Observatory have stayed up all night, swapping out ten-pound metal plates collecting light from the eight-foot-diameter Sloan Foundation Telescope. Each plate is dotted with a thousand pinholes, machine-positioned with near micrometer accuracy to catch streams of photons from specific galaxies and funnel them to a thousand optical fibers. Researchers must change these one-time-use plates hourly, as our viewpoint on the Earth rotates away from some galaxies and toward others, requiring observations to be planned months in advance.

Last summer, the two decades of sleepless nights paid off as the Sloan Digital Sky Survey (SDSS) released the grandest map of the universe yet. Over twelve thousand plates finally captured enough light to chart the 3D locations and speeds of four million galaxies. This sweeping catalog has given cosmologists the definitive bird's eye view of our expanding universe.

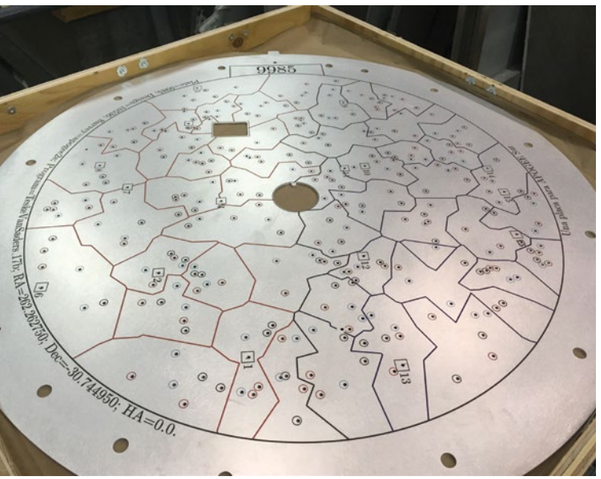
"With SDSS you can see the full picture instead of little parts of it," says New York University astronomer Michael Blanton, the director of the fourth stage of the cosmic map.

Thanks to the finite speed of light, the biggest cosmological map of the universe doubles as a time machine, with the Apache Point Observatory seeing galaxies as they were when their light departed billions of years ago. SDSS has been probing different regions of space and time over four phases of work, with the latest filling a crucial gap between 6 and 11 billion years ago.

Up until this epoch, gravity increasingly slowed a cosmic expansion that started with the Big Bang. But then some unknown ingredient in the cosmic environment—which currently goes by the nickname “dark energy”—took over and started pushing the universe to expand faster.

“That turnaround happens during that period,” Blanton says, “so it’s kind of a period you might want to look at.”

Earlier SDSS phases covered galaxies representing the most recent 6 billion years of history, and quasars—galaxies with blindingly bright central black holes that act as cosmic lighthouses—that offer a glimpse into the cosmos of 11 billion years ago. The fourth phase managed to fill the gap by simultaneously working inward with more quasar observations and outward with observations of strongly star-forming galaxies,



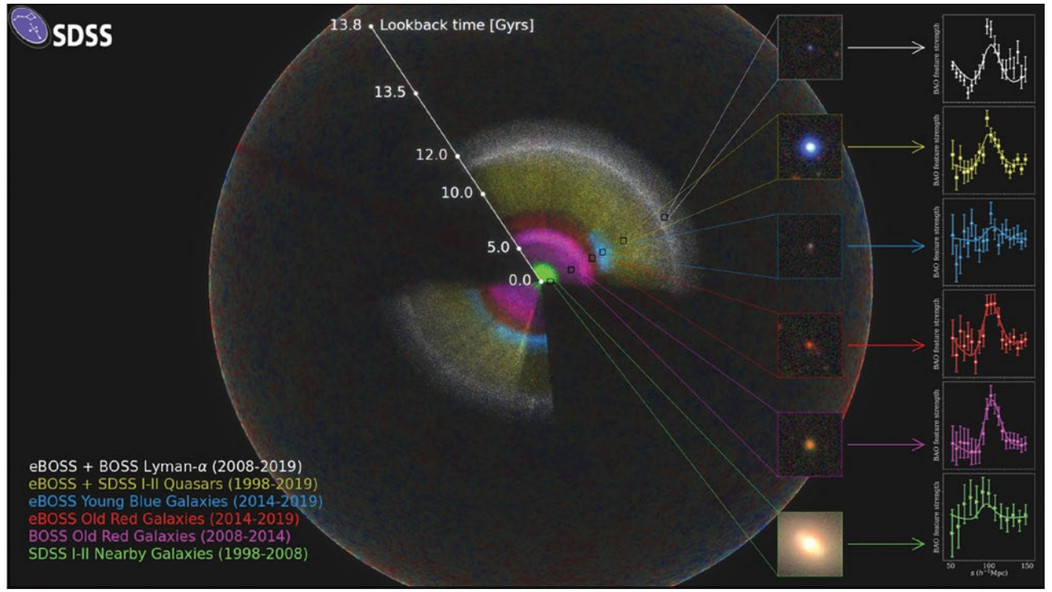
Over 12,000 plug plates, like this one, were used to catch photons from faraway galaxies. If you placed all the plates end-to-end, they would stretch out for 8 miles!

“With SDSS you can see the full picture instead of little parts of it,” says New York University astronomer Michael Blanton, the director of the fourth stage of the cosmic map.

which shine with a particular color that makes the dim objects pop in the darkness.

The results, which astronomers detailed in 23 peer-reviewed publications, considerably strengthen the leading theory of cosmology, which blends the influences of matter, light, dark matter, and dark energy to predict the evolving state of the universe. SDSS’s 11-billion-year chronicle confirms that the universe is close to exactly flat, and that expansion slowed and then sped up just when we’d expect.

But it also sharpens an emerging enigma. Using SDSS observations of how much a galaxy’s light has stretched, researchers can calculate how fast that galaxy is retreating. Astronomers can also infer an object’s distance from a peculiar property of the early universe; primordial ripples in matter left imprints on the sky, vast but subtle rings of galaxies all around a billion light years across. This universal yardstick reveals precisely how far away the galaxies are, and by combining distance and speed researchers can compute the rate of the universe’s expansion, then and now.



The largest ever three-dimensional map of the universe. Earth is at the center, surrounded by a medley of quasars and galaxies, extending all the way to the edges of the observable universe.

The conundrum is that the speeds appear to conflict. Cosmologists can forecast today's expansion from SDSS's revelations of how fast the adolescent universe was growing. But when astronomers measure the current rate with observations of nearby objects, they find that the modern cosmos is going through a growth spurt about 10 percent quicker than expected. The mismatch could come from a measurement error, or it could indicate that some new sort of dark material has started to act up. "It's either something very interesting, or something somewhere has gone very wrong," Blanton says.

"Part of the reason SDSS has been so impactful is it doesn't freeze in time," Kollmeier says. "It's always trying to be responsive to the cutting edge."

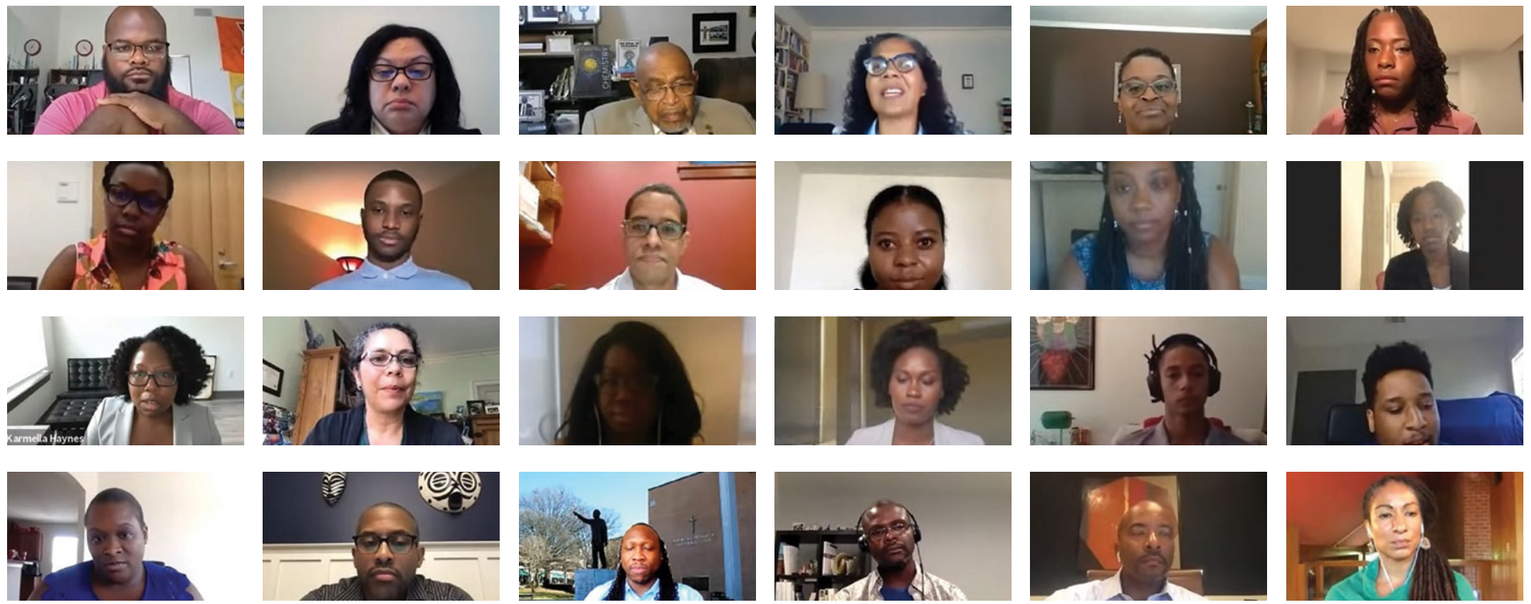
With the 20-year cosmology survey now complete, SDSS returns for a fifth phase under the leadership of Juna Kollmeier, an astrophysicist at the University of Toronto. Gone are the hefty plates that mapped the ancient universe. Taking their place are robots that will swivel optical fibers into position, without the need for an astronomer to wrestle in a fresh plate every hour or so. This speedy new technology will let SDSS survey more celestial phenomena, ensuring the endeavor's relevance for years to come. This phase will focus on observing stars, galaxies, and accreting black holes to unravel the physics of these objects.

"Part of the reason SDSS has been so impactful is it doesn't freeze in time," Kollmeier says. "It's always trying to be responsive to the cutting edge."

Experiences of

Black STEM in the Ivory

An emergency forum held in the midst of a racial reckoning is showing how the voices of Black students and scholars can be powerful forces for change.



The murder of George Floyd in the early summer of 2020 was a tragic and catalytic event, sparking protests in cities across the nation as thousands joined together to call for an end to anti-Black injustice and for decisive action to address systemic racial inequities in our social institutions.

Those institutions include academia, where graduate programs across the sciences and engineering have sought, and often failed, to create inclusive environments for Black scholars and students. According to the American Council on Education, Black students are the least likely to pursue a STEM major—just 13% of Black students who completed a bachelor's degree did so in STEM. This trend continues into graduate education and the professoriate. National Science Foundation data shows that just 2.6% of tenured or tenure-track science faculty at America's four-year colleges and universities are Black.

Georgia Institute of Technology, home of one of eight Sloan-supported University Centers for Exemplary Mentoring, seized the events of last summer as an opportunity to address these inequities. Partnering with the University of Washington, Boston University, the University of Chicago, and the University of Texas, Austin, Georgia Tech joined in organizing a virtual event, *Experiences of Black STEM in the Ivory: A Call to Disruptive Action*, to start a national conversation about the barriers facing Black scholars in STEM fields and to catalyze efforts for systemic change.

Opening a panel on the first day of the event, Professor Alshakim Nelson at the University of Washington, said: "Instances of racial violence are reminders of the systemic racial inequities that exist and which persist in the STEM fields of academia… and this swelling call to action has created a moment that allows us to institute real changes."

Over the course of two days, the group held nine hours of challenging, emotional, and constructive discussions that centered on the Black experience in academic STEM settings. Students, staff, faculty, and leadership came together to discuss their own encounters with systemic inequities and to challenge one another, and those watching, to become agents of change.

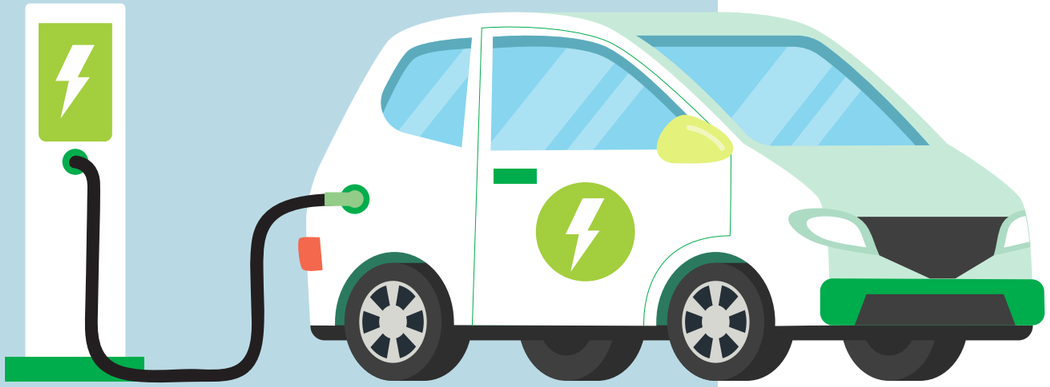
Reflecting on the event, Professor Mitchell Walker, chair of the Georgia Tech College of Engineering's DEI committee, said: "There was a lot of energy last summer that needed to be brought into focus. *Black STEM* was great because it provided a forum to channel that energy. And the fact that we were remote worked to our advantage: it provided people with a level of safety in talking more freely. If we'd have been sat in the same room, I doubt we'd have made as much progress."

Black STEM placed equal value on talk and action. On day one, the event offered a platform for students and scholars to share and reflect on their experiences. On day two, the deans from each institution's College of Engineering identified steps that colleges could take to address racial inequities on campus, including prioritizing DEI efforts inside the offices of campus presidents, reforming hiring practices, and investing in formal support structures for underrepresented students.

At Georgia Tech, *Black STEM* participants have since spearheaded a series of reforms, including using metrics to improve representation in faculty hiring, forming a DEI committee that reports directly to the college president, and partnering with organizations in the local community to celebrate the contributions of Black faculty. Student participants, meanwhile, are hosting regular forums where students of color can come together and are advocating for diverse representation on student-faculty governance committees.

Professor Stephen Ruffin, who runs the University Center for Exemplary Mentoring at Georgia Tech, says: "This event provided a remarkably powerful forum for passionate students, faculty, and academic leadership to directly face the challenges faced by Blacks in higher education. The reflection, conversations, and planning strengthened the national network of those who are agents of change and is leading to actions which help dismantle barriers to diversity, equity and inclusion in STEM."

Shockingly Good Reasons to Switch



Policymakers couldn't understand why cabbies weren't buying electric. Two researchers had a radical idea: Let's ask them.

Deepak Rajagopal bought his first electric car—a Chevy Bolt—a year ago. His is part of a surging wave of electric vehicle purchases as the U.S. transitions to a lower carbon economy. But Rajagopal knows that, as an infrequent driver, he is not the ideal electric car owner. If those who drive the most make the switch to electric vehicles, carbon emissions will come down faster. This University of California Los Angeles industrial ecologist and energy economist is leading an effort to figure out how to make that happen.

"We need targeted policies aimed at people who most need support and who give the biggest societal benefit," says Rajagopal. "We also need to understand the reasons why people might not want to switch."

Rajagopal's research focuses on drivers who drive all day: those working for ride hailing services like Uber and Lyft. More than two million drivers supply rides for the companies, and a paltry half a percent of their vehicles are electric. But obtaining a first-hand understanding of how these drivers think isn't easy. "The ride hailing data is proprietary information," he says. "It's very hard to get."

To get around the lack of publicly available data, Rajagopal decided to generate his own. Joining forces with Nicole Sintov, an environmental psychologist at the Ohio State University, the duo went straight to the source.

They trained a team of students who, armed with iPads and stacks of paper surveys, hailed as many Uber and Lyft rides around west Los Angeles as they could. A few minutes into a ride, the student would ask if the driver could spare ten minutes to fill out a paid questionnaire about their driving habits, interest in electric vehicles, and concerns about going electric. After four months and dozens of hours split across more than 400 rides, the group managed to collect about 150 complete responses. The project is part of a larger Sloan-funded partnership with the Network for Digital Economy and Environment to better understand the energy and environmental implications of emerging technologies like AI, blockchain, and app-enabled ride hailing.

Ride hailing drivers are prime candidates for electric vehicle adoption. They drive a lot—more than three times farther than typical households and about four times farther than typical electric vehicle owners.

Nicole Sintov

Deepak Rajagopal

The survey reveals that, in some ways, ride hailing drivers are prime candidates for electric vehicle

adoption. They drive a lot—more than three times farther than typical households and about four times farther than typical electric vehicle owners—and the savings in fuel and maintenance costs matter a lot to them. They are also green-friendly. Drivers generally want to act sustainably and enjoy trying out new technology. So why are they sticking with gasoline-powered vehicles?

Rajagopal and Sintov discovered that the likes of Uber and Lyft drivers face three main challenges to electrifying their fleet, each of which suggests policies that would encourage people to switch.

First, many drivers aren't familiar with the advantages of electric vehicles. Many don't realize, for instance, that while electric vehicles cost more up front, lower fuel and maintenance costs save their owners money over time. Education campaigns and creating short trials for would-be buyers to experiment with electric vehicles before committing to a purchase could help overcome this obstacle.

Second, most ride hailing drivers have lower incomes than typical electric vehicle adopters, so subsidies could help drivers afford to change vehicles. This financing could come in the form of subsidized loans to soften the sticker shock of an electric car's price, which the driver could repay through maintenance and fuel savings later on.

Third, drivers need places to charge their cars, especially since they may not have spacious suburban homes with garages. Surprisingly to Rajagopal, however, drivers don't mind waiting an hour to recharge—provided they have someplace comfortable to rest—since many have substantial downtime during off-peak hours. This suggests that building convenient charging infrastructure could be more effective than focusing exclusively on speedy charging technology, which has received a lot of attention in debates on the topic. "We don't need five-minute charging," Rajagopal says. "We don't need to go that fast."

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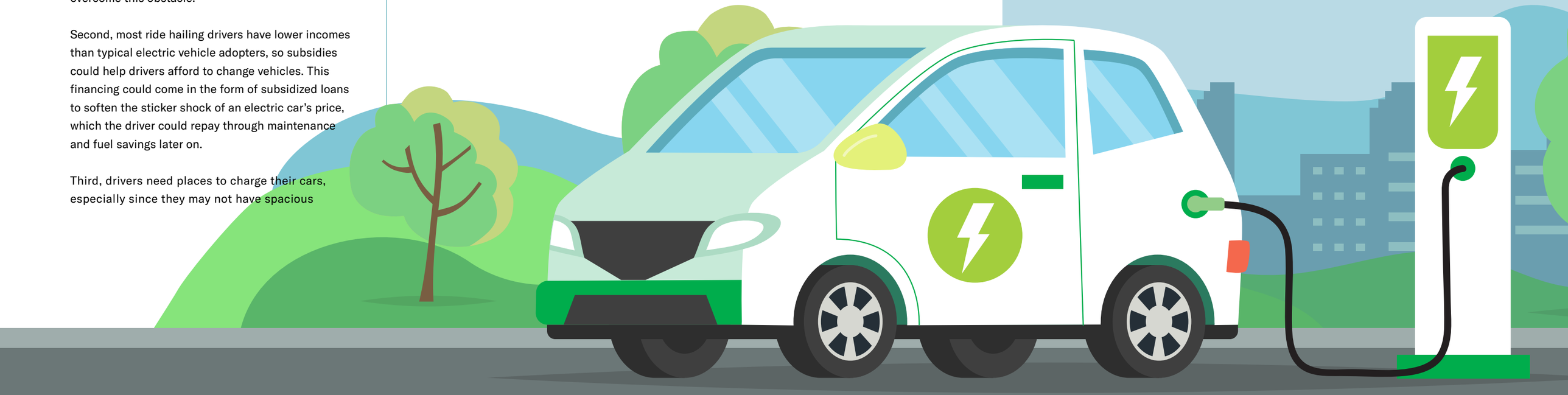
The question of how to electrify ride hailing fleets is more than an academic exercise. Since Rajagopal and Sintov published their report, the state of California has cited it multiple times in its new Clean Miles Standard, legislation that requires services like Uber and Lyft to reduce their greenhouse gas emissions to zero and get to at least 90 percent electric by 2030.

Rajagopal hopes the research will help guide ride hailing companies through the upcoming transition, as well as persuading drivers from all walks of life that electric vehicles are worth considering today. Electric cars used to have a range of issues, but those issues are dissolving, he says. "I think the time is right for most people to make the switch."

Evidence-based policies that help get ride hailing drivers fully on board would be a major step forward.



The Alchemist

Science and storytelling

In her latest book, *The Alchemy of Us*, author Ainissa Ramirez practices some alchemy of her own—turning science into stories.

Materials science isn't an obvious candidate for a popular science book. How do you bring it to life?
You're right—physics is arguably an easier sell and certainly has its share of science communication sweethearts. I have struggled for *years* to make materials science compelling, even though it's pertinent to so many things around us. I've found that the best way to get people excited is through stories. There's plenty of science in this book, for sure, but it's storytelling that attracts and then pulls the reader along.

Which of the stories in the book do you think does the best job sparking curiosity?
The story people talk about over and over is the chapter in which I discuss Polaroid's instant film technology and how it was used in nefarious ways

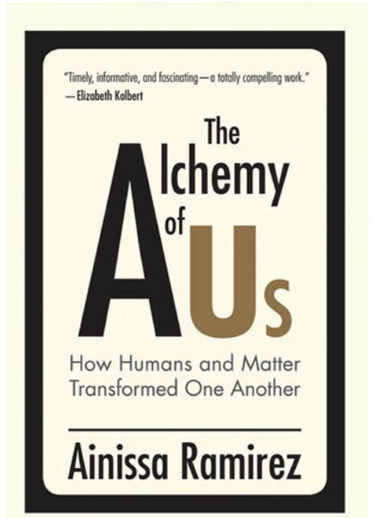
People can easily understand an invention like the telegraph but may feel uncomfortable pondering the complexities of AI.

to buttress the apartheid system in South Africa—by providing the photos used in the pass book that monitored and restricted the movement of Black South Africans. This example is so compelling because it's a technology people *think* they know about. Then you show them a different side.

THIS PAGE: An apartheid-era South African "pass book" (dompas). The Pass Laws Act of 1952 made it compulsory for all Black South Africans over the age of 16 to carry one at all times to prove their identity and where they could live or work. Ramirez explores how Polaroid's instant film enabled this technology and, by extension, the oppression and segregation of Black South Africans.

How can familiar inventions from the past spark curiosity toward emerging technologies?
That's exactly the point—like a gym, I think of historical examples as smaller weights that people can train on before moving onto heavier ones. People can easily understand an invention like the telegraph but may feel uncomfortable pondering the complexities of AI. My aim is to prepare readers to ask questions about emerging technologies. We're at a time when people *need* to think critically about these things.

How does the book encourage people to engage more with the act of inventing?
Inventors are often veiled in the "genius" myth. People feel detached from inventing, so I wrote the book to bring them along on the journey. As they read, they can make decisions *with* the inventor, which makes people feel like they can invent, too. A small number of the inventors in the book were trained as scientists—but they all had persistence and a problem to solve. I want my readers to understand that we're all inventors.



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Have you been surprised by any reactions to the book?
One of the most surprising things is the number of people who have told me they'd been turned off by science and they never would have picked up a science book—but this book gave them a second chance. *That* is the power of storytelling. There's a tendency for us to preach to the choir, but I wanted to convert more souls. So, I'm thrilled to introduce more people to the fascinating world of inventing.

What do diverse perspectives bring to storytelling and, in particular, science writing?
Diverse writers offer fresh ways of looking at the canon. Take Samuel Morse, for example. He's a popular inventor, and widely written about, but nobody has considered that his wife died while he was travelling and his inability to say goodbye might have influenced his work on long distance communication systems. For me, it was unavoidable to see the broken-hearted man and his likely inspiration.

What can academics and institutions do to foster curiosity among public audiences?
I think we teach science because we want to create future scientists and I think this is a misstep. Most people won't go on to become scientists. We should teach science to create informed citizens, by presenting science to them in a way that's meaningful in their lives, in a way that has practical value. To do that, of course, we also need to encourage scientists—to come out of the lab and share great stories!

A Century of Economics

Over its hundred-year history, the National Bureau of Economic Research has gone from scrappy start-up to an indispensable lynchpin at the center of modern economic thought.

The Sloan Foundation made its first grant to the National Bureau of Economic Research (NBER) in 1953, $1.2 million to study U.S. wage and productivity trends. In the seven decades since, scarcely a year has gone by when the Foundation has not supported the NBER in some way. On the 100th anniversary of NBER's founding, President James Poterba discusses the special role NBER plays in the economics research community, its relevance to policymaking, and what's in store for the next hundred years.

Congratulations on your centennial. Would the people who worked at NBER in its first days recognize it today?
Absolutely. NBER was launched in the aftermath of World War I by two unlikely partners: the chief statistician at AT&T, and a labor organizer whose economics Ph.D. thesis translated some writings by Marx. The two disagreed on prescriptions about the economy, but realized that data could be harnessed to improve policy. They founded the NBER to enhance the role of scientific inquiry in public policy by generating and disseminating data and research about the economy. In light of their disagreements, however, the NBER charter forbids making policy recommendations. We still abide by that directive; it's been a central component of the NBER's DNA for 100 years.

How has NBER evolved over the last century?
For its first 50 years, the NBER was small, with distinguished researchers working on a limited range of issues like business cycles, monetary policy, productivity, and labor markets. In the 1970s, the NBER re-launched as a network of academic economists. Today, more than 1,600 researchers at nearly 180 colleges and universities in North America are NBER affiliates. The organization brings economists together for academic meetings, disseminates economic scholarship through a widely-followed working paper series, and supports and administers economics research projects.

Are there any achievements at NBER you're particularly proud of?
There have been many influential NBER research projects. Milton Friedman and Anna Schwartz's *Monetary History of the United States* and Gary Becker's *Human Capital* were both supported by NBER projects. The NBER has also played an important role in nurturing emerging fields. In the 1990s, a working group on behavioral economics, co-directed by Robert Shiller and Richard Thaler, two of the field's pioneers, played a pivotal role in developing the field. The group's meetings provided a space for exploring approaches that were not yet widely embraced in the broader economics profession.

Today, one of our most exciting initiatives, in a partnership with Sloan, is bringing together economists with different backgrounds—labor, public finance, industrial organization, productivity—along with experts on science funding to analyze how to best support the scientific enterprise. There is tremendous leverage in convening small groups who have common interests and can learn from each other's research styles and subject matter expertise.

How does NBER influence budding economists?
Research projects administered at the NBER employ hundreds of students. I joined NBER as a research assistant the summer after my sophomore year in college, and my experience convinced me to pursue my Ph.D. Later, as a graduate student and assistant professor, NBER conferences connected me with extraordinary mentors and researchers on the cutting edge of my field. Many other researchers had similar experiences. One of the reasons I was attracted to my current role was a desire to provide similar opportunities to the next generation of economists.

"There is tremendous leverage in convening small groups who have common interests and can learn from each other's research styles and subject matter expertise."

What's next for NBER?
The pandemic has created challenges, but has also revealed opportunities for research organizations like NBER. Videoconferencing technologies have allowed us to expand our Summer Institute to include thousands of new participants and to draw in international researchers without costly and time-consuming travel. New tools are enabling us to bring scholars together, to share our work, and to exchange new ideas. I look forward to working with our program directors and research affiliates to position the NBER to enable innovative economics scholarship for at least another hundred years.

COVID-19

Our response to an evolving crisis

For over a year, the world has been at war with COVID-19. It's a special sort of war, though, one with science at its center, whose weapons are epidemiology and genomics, and whose field marshals are doctors of virology and public health. It's a war whose front lines are hospitals and laboratories, where the enemy is not a virus but our ignorance of it, and where victory lies not in winning battles but in answering questions. Never has the need for science been so obvious or so urgent, or the fate of inquiry so plainly bound to the commonweal.

At the Sloan Foundation, our mission is to advance science, technology, and economics in promotion of the public good. In 2020, the Foundation adapted its strategies and grantmaking to continue this mission while helping researchers, policymakers, and the public rise to the challenges posed by the global pandemic.

Of those challenges, the most daunting is perhaps the simplest to state: understanding what's happening on the ground. Many government-sponsored surveys take weeks or months to complete, appropriate in normal times, but perilously slow in an emergency. Early in the pandemic, the Foundation responded by funding the Data Foundation to field a large-scale, weekly survey measuring the impact of coronavirus on American families. This provided timely, accurate information across a range of topics essential to understanding the social, economic, and health effects of the virus, including how many American workers had been furloughed or laid off; the prevalence of mental health conditions; and compliance with preventative health directives like mask-wearing.

The Foundation's core conviction is that scientific advance is an essential tool for reshaping our world for the better.

Other Foundation grants supported further efforts to understand the pandemic's impact. A grant to economist Michael Greenstone at the University of Chicago supported a project to develop methods that allow researchers to accurately measure sensitive, underreported behaviors, like disobeying mandates or engaging in risky activities that expose oneself or others to COVID-19. A grant to researchers at Tufts University supported efforts to use electricity consumption data as a real-time proxy for economic activity, enabling researchers to more quickly measure the economic impacts of the pandemic.

One of the Foundation's core convictions is that scientific advance is an essential tool for reshaping our world for the better. That tool, however, depends on increasing access to the fruits of scientific inquiry and ensuring the best information gets into the hands of those who need it. In 2020, the Foundation

A grant to the NYC Community Trust's COVID-19 Response and Impact Fund provided emergency relief to key NYC nonprofits, allowing them to continue providing vital services to NYC communities during the pandemic. Supported nonprofits included Sapna NYC (food insecurity - above), Afro Latin Jazz Alliance (arts and music programming - overleaf, left) and Street Lab (community event programming - overleaf, right.)

made grants to the Societal Experts Action Network, an initiative that connects public officials with actionable, evidence-based guidance on a host of COVID-related issues. Guidance produced by the network touched on topics such as strategies for building confidence in vaccines, increasing safety inside prisons, and addressing disaster vulnerability among the homeless.

Other grants focused on disseminating essential information to the public. A partnership with the Urban Justice Center supported *COVID Straight Talk*, a citizen preparedness campaign that, among other things, informed workers about what we know about indoor transmission of coronavirus and the practices and technologies that can make workplaces safe.

Another grant supported the production of *Science of the New Normal*, an initiative to produce public-facing, accurate, and unbiased articles about COVID-19 and its effects. The initiative was spearheaded by *Knowable*, a nonprofit web magazine that reaches some 320,000 monthly readers.

At Sloan, we are concerned not only with what science investigates, but in how that investigation gets done. Across the globe, necessary safety measures closed universities and labs, forcing scientific communities and collaborations of all kinds to experiment with and adapt to new ways of working together. Sloan grants in 2020 funded several projects to help document these changes, which will likely have long-lasting effects on scientific practice. A grant to researchers at the University of Tennessee is supporting a global study of how coronavirus is changing communication practices among early-career researchers. Other supported projects focused on technological impacts on the scientist's role as teacher, with one documenting how college faculty used technology to adapt their courses to online formats, and another providing resources and tutorials for professors struggling to continue instruction without recourse to the lab or lecture hall.

Social burdens are rarely shared evenly, and disproportionate consequences are often shouldered by the vulnerable or marginalized. This is true both throughout society and also within the institutions of scientific education and inquiry. Understanding how those burdens fall, and why, is essential to crafting equitable science, technology and educational policy, and at Sloan we view it as a central part of our mission to understand the mechanisms of inequality and how we can effectively combat it.

In 2020, the Foundation made several grants on these themes, including funds for a study of how COVID-19 was exacerbating energy insecurity in America and a survey of how researchers at U.S. colleges and universities were adapting to the challenges of pandemic-created shutdowns. Published in *Nature* magazine, the latter study found that family care obligations were falling disproportionately on women scientists, particularly those with young children, with potential long-term consequences for their careers. The research led to a follow-up study by the National Academy of Sciences that will identify policies to effectively address this disparate impact.

The Foundation made several grants in 2020 providing emergency relief to first responders and those most directly affected by the virus.

Finally, the Foundation made several grants in 2020 aimed at providing emergency relief and other resources to first responders and those most directly affected by the virus, particularly in New York City, where the Foundation has been headquartered since 1934. Grants supported the life-saving work of the New York City Department of Health and Mental Hygiene, developed online training materials for some 30,000 first responders and volunteers, and provided emergency cash to small- and medium-sized nonprofit organizations in NYC whose existence was threatened by the pandemic.

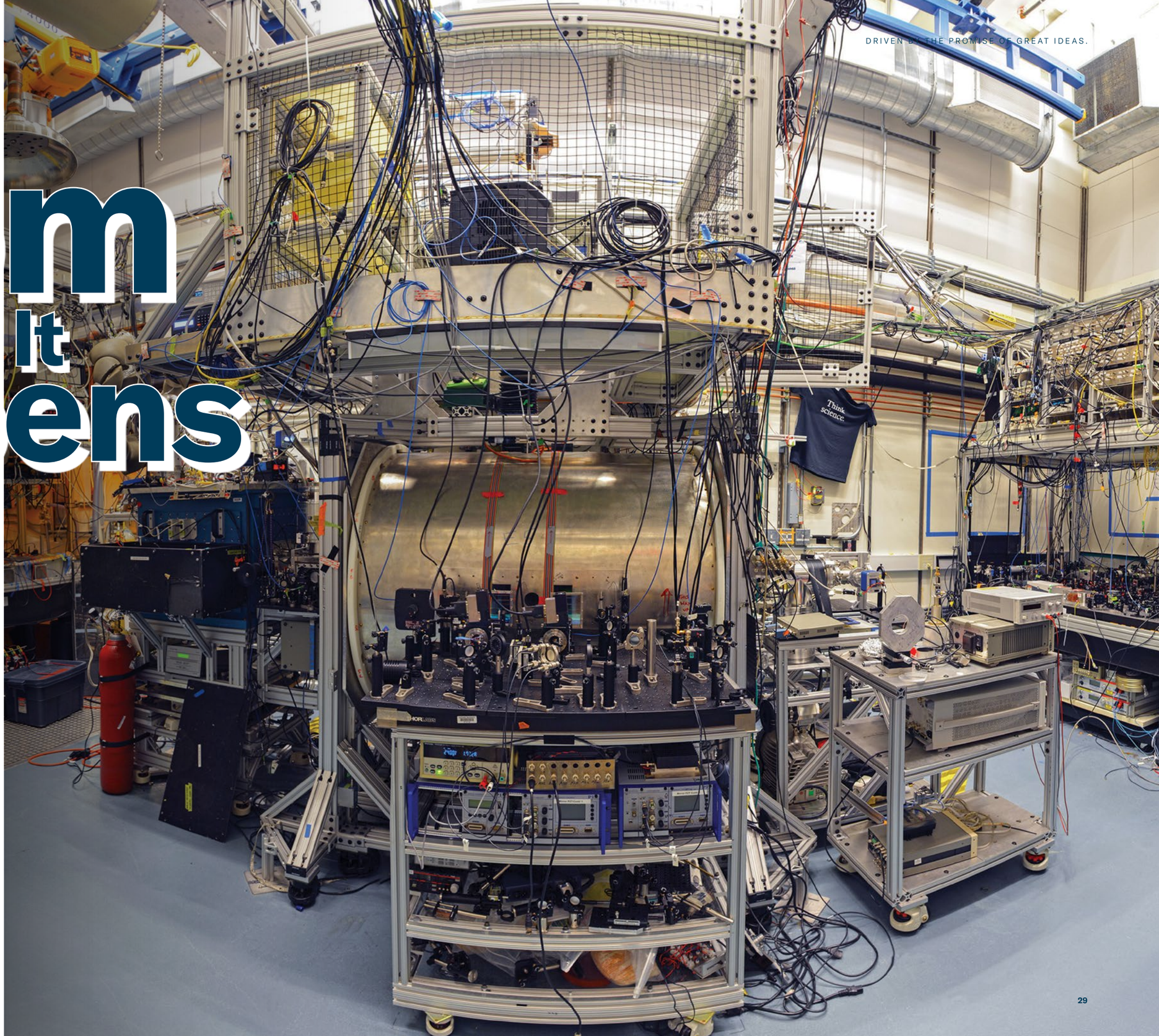
In total, the Foundation's grantmaking addressing COVID neared $6 million in 2020. We expect further grantmaking in 2021 and beyond. The war is far from over. But the armies of inquiry have been on the march for 18 months now. There is reason for hope—and even optimism—that the worst is behind us.

The Room Where It Happens (Maybe)

In a room in Evanston, Illinois, three men are building an intricate contraption that just may change the course of modern physics.

A wily trio of researchers and a cadre of students have set their sights on improving the most successful theory in physics—a task at which several massive international collaborations with access to colossal machines have not yet found success. Like Wile E. Coyote chasing the Road Runner, the team relentlessly pursues a game-changing prize they might never catch.

"The leading theory of particle physics is definitely incomplete," says John Doyle of Harvard University, a co-leader of the project. "It lacks explanations for dark



matter, and the predominance of matter over antimatter." Gerald Gabrielse of Northwestern University, another co-leader, adds, "Whether or not we'll be the lucky ones who first see evidence of missing particles, we can't predict. But by George!—someone is going to!"

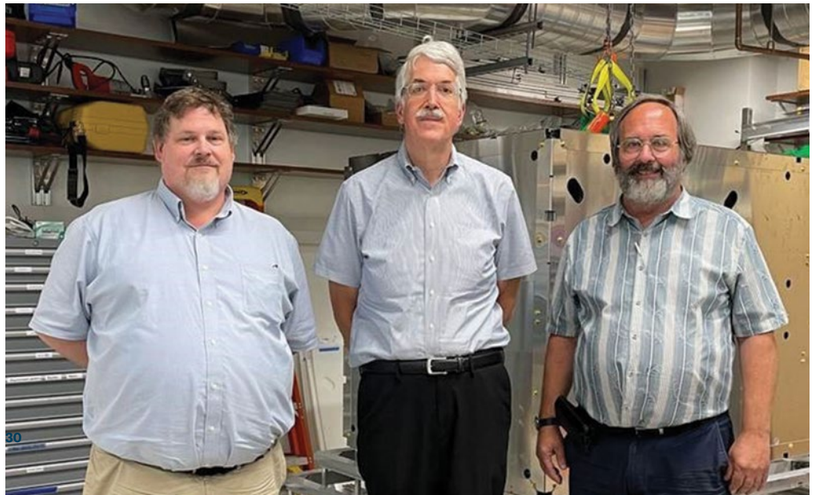
The trio, which includes Dave DeMille at the University of Chicago along with Doyle and Gabrielse, has dubbed their project ACME, a playful reference to Wile E.'s fictional corporate supplier and a nod to the slightly

"Not only does our small experiment have a chance to be the first to show that particles beyond the Standard Model really exist, but we're also like a scouting party for high energy collider physicists."

quixotic nature of their quest. Now in the 14th year of pursuit, the team is preparing the third generation of their experiment. This incarnation will bring them closer to catching their quarry than ever before. If, that is, it can be caught.

The ACME team is chasing an elusive irregularity in the electron's electric field. The Standard Model of particle physics, which has so far nailed every detail that physicists have been able to test in the lab, predicts that the electron is a point particle with no size and a perfectly symmetric electric field.

But the same theoretical framework also insists that no electron is an island. Every electron comes cloaked in a cloud of "virtual" quantum particles that continually wink into and out of existence. The entourage welcomes all possible particles, even those missing from today's Standard Model, and certain mystery guests could put a slight bulge in the electron's otherwise symmetrical electric field. Detecting such a distortion—known as the electron's Electric Dipole Moment (EDM)—would provide definitive evidence that entirely new particles exist. It wouldn't identify exactly which particle is responsible, but its size would tell collider physicists just how large a collider they would need to build to finger the culprit.



Left to right: David DeMille, John Doyle, and Gerald Gabrielse.

"Not only does our small experiment have a chance to be the first to show that particles beyond the Standard Model really exist, but we're also like a scouting party for high energy collider physicists," DeMille says.

Tiny electrons are difficult to study directly, so the ACME experiment, which stands for Advanced Cold Molecule Electron EDM, leverages the mighty electric field inside a molecule known as thorium monoxide. Doyle explains, "If the electron's electric field really is lopsided, it will more easily snap to align itself with the thorium's electric field," a configuration that will make the whole molecule turn faster in a magnetic field. By firing an ensemble of painstakingly prepared molecules down a magnetized path under a range of conditions, then seeing how laser light scatters off the molecules, the ACME team can measure the particles' rotations and infer the shape of the electron's electric field.

The ACME collaboration's first measurement in 2014 was ten times more precise than the previous leading experiment, a feat some had thought impossible to do so quickly. The ACME 2 result, published in 2018, was another ten times "more impossible," Gabrielse says. The second-generation experiment was so sensitive that, if the cloud of virtual particles around an electron expanded to be as large as the Earth, the team could have detected an extra layer 10,000 times thinner than a sheet of plastic wrap laid over the northern hemisphere.

ACME 2, like ACME 1 before it, failed to detect any perturbations in the electron's electric field. Yet that failure, in itself, is significant. The exquisitely spherical electron revealed by the team's work so far makes the existence of broad classes of heavy hypothetical particles less likely. It especially puts pressure on the theorist champions of supersymmetry, a once-popular theory that every particle has a heavier twin. "They're feeling very, very uncomfortable," DeMille says.

"With enough cleverness mixed in with a lot of tenacity, you can use tabletop experiments to actually learn about physical reality at its most fundamental level."

Now the group is assembling ACME 3 which, among other upgrades, will feature a path that allows molecules to travel five times farther than those of ACME 2, giving their electrons more opportunity to manifest an EDM by noticeably rotating the parent molecules. The researchers expect their room-sized apparatus to probe the electron ten times more precisely than its forerunner did.

The next result, which the team expects in two to three years, may launch a new era of particle physics. Or it might send the ACME crew back to the drawing board to design an even wilier contraption. Either way, they'll have contributed at least partial answers to some of researchers' most profound questions from their modest lab.

Says Gabrielse, "With enough cleverness mixed in with a lot of tenacity, you can use tabletop experiments to actually learn about physical reality at its most fundamental level."

A Declaration of Interdependence

A new training center is challenging outdated cultural norms in science—and teaching scientists how to join forces for better results.

Scientific collaborations are becoming more complex, often operating at a larger scale and across multiple locations and disciplines, and relying on new technology platforms to bring people together. The outdated myth of the lone genius is being replaced by a greater appreciation for team science and community-led inquiry. But it's not just scientific research that's changing. The cultural norms of science—annotating and sharing data, creating more inclusive environments, and communicating work—are all evolving, too.

Lou Woodley is a preeminent community builder who has long championed the importance of communities in evolving the culture of STEM. And as founder and director of the Center for Scientific Collaboration and Community Engagement (CSCCE), she's working to support an emerging role she sees as crucial for this new era of collaborative work: the scientific community manager.

"It's becoming increasingly important to focus on *how* we work together," says Woodley. "At CSCCE, we believe every large-scale collaborative effort in STEM should include a role focused on supporting members in aligning their goals, co-creating norms for good communication, and ensuring all members are empowered to contribute."

An early CSCCE survey found most individuals who find themselves in a scientific community manager role have a Ph.D. but lack formal training in community-building. This spurred Woodley to develop the first curriculum for scientific community managers, including a year-long fellowship program that launched in 2017. The inaugural cohort included 18 community managers from a range of STEM organizations including scientific societies, research collaborations, and infrastructure organizations, and ultimately sparked the formation of a new community of practitioners.

Lou Woodley

CSCCE has since grown into the leading research and professional development organization focused on supporting community building in STEM, with a membership of 350 and growing.

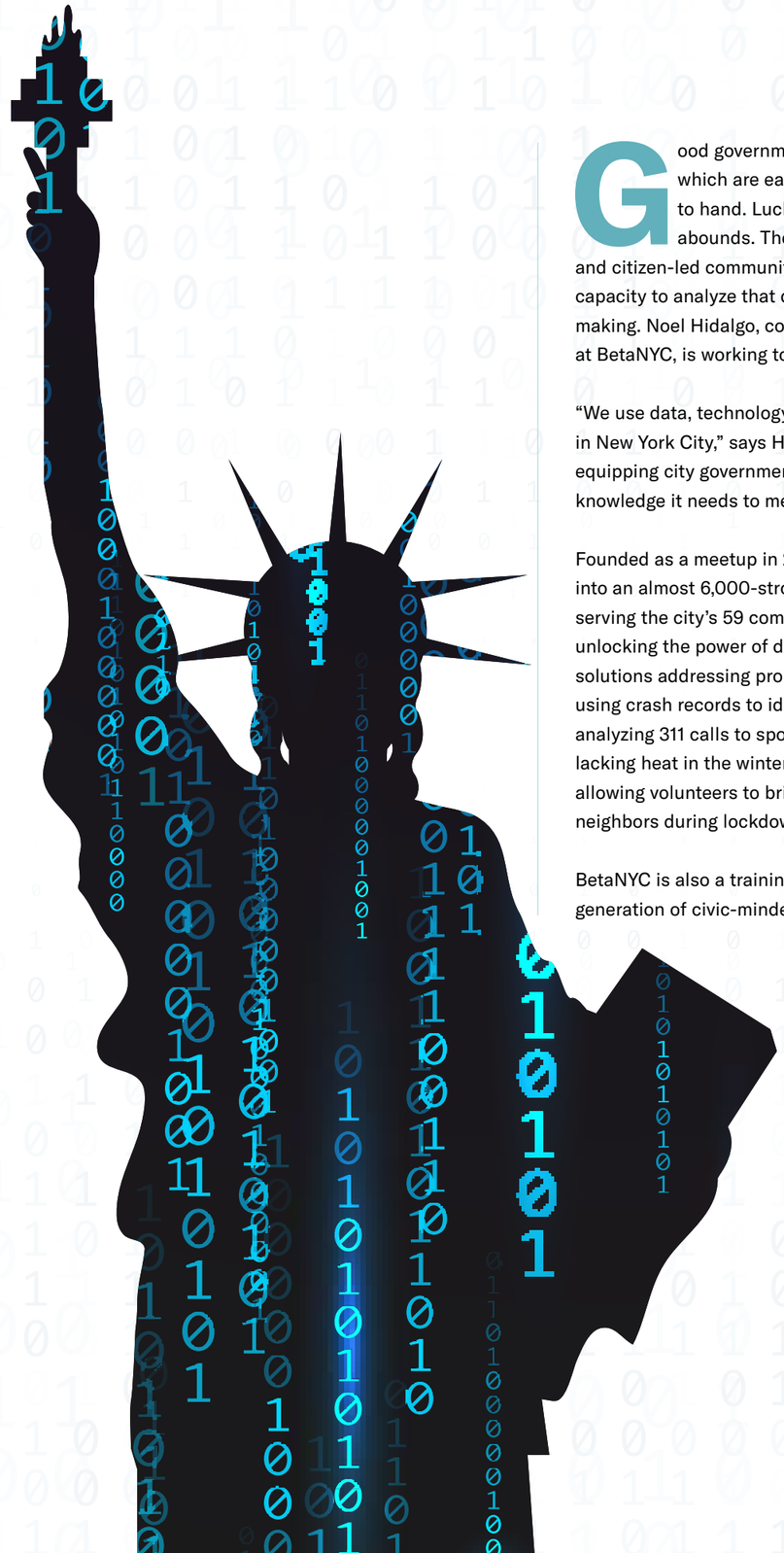
"The need for these skills has boomed over the last year," says Woodley. "Remote working has left people hungry for meaningful connection and desperate to avoid another anemic Zoom call. We've been creating new online resources and training courses to help facilitators, and we've been delighted by how well they've been received."

CSCCE's work has struck a chord: their resources to support community building have been downloaded more than 15,000 times in the past year. And with some new ways of working, like reduced business travel, expected to persist beyond the pandemic, Woodley predicts there is opportunity aplenty to help organizations adapt to the change—by encouraging them to prioritize the hiring and training of scientific community managers.

"We're ultimately trying to change the way science is done by putting fresh emphasis on the human elements of collaboration. Taking a community-minded approach will not only result in more inclusive projects, where all members are valued, it will also support the cultural shifts that are required to meet the needs of today's science."

In Data We Trust

Meet the technologist partnering with New York City officials to build a better, more inclusive democracy out of zeros and ones.



Good government requires good decisions, which are easier to make when there's data to hand. Luckily, in New York City, data abounds. The problem is that city offices and citizen-led community boards often lack the capacity to analyze that data and use it in decision-making. Noel Hidalgo, cofounder and executive director at BetaNYC, is working to change that.

"We use data, technology, and design to improve lives in New York City," says Hidalgo. "And we do that by equipping city government with the training, tools, and knowledge it needs to meet its citizens' needs."

Founded as a meetup in 2008, BetaNYC has evolved into an almost 6,000-strong membership organization serving the city's 59 community districts. The team is unlocking the power of data to create elegant, practical solutions addressing problems across the city—using crash records to identify unsafe intersections, analyzing 311 calls to spot old buildings perennially lacking heat in the winter, and creating a database allowing volunteers to bring food to their quarantined neighbors during lockdowns, to name a few.

BetaNYC is also a training ground for the next generation of civic-minded techies. The Civic

Participants take part in the first hackathon inside New York City Hall. 130 students and 30 teachers used open data to create prototypes for software solutions addressing local community needs.

“We use data, technology, and design to improve lives in New York City, and we do that by equipping city government with the training, tools, and knowledge it needs to meet its citizens’ needs.”

Innovation Fellowship is a Sloan-backed initiative and one of its flagship programs. Program director Emily Goldman explains: “The fellowship brings motivated and tech-savvy students into city government. We teach them the fundamentals of data analysis—how to read, interpret, and visualize—then work with them on the city government’s digital and data challenges.”

The fellows have been working to improve the city’s community boards, groups of about 50 volunteers who represent each of the city’s community districts. They wield considerable decision-making power across a range of issues: identifying agency budget priorities, making recommendations on housing developments, and educating citizens on ranked-choice voting.

Those powers are most effectively wielded when community boards reflect the diversity and values of the communities they serve. At the invitation of the Manhattan Borough President’s Office, BetaNYC fellows have been combining community board application data with the U.S. census to understand if the boards are, in fact, faithfully representative. What began as static maps has blossomed into a polished set of interactive visualizations and survey tools that allow city government to finally access the untapped wisdom lurking in its datasets.

“Our analysis showed that, in order to faithfully represent their districts, some Manhattan community boards needed more renters, younger people, people without graduate degrees, women, and other ethnicities,” says Goldman.

Since the fellows unearthed these findings, the Manhattan Borough President’s Office has taken steps to improve representation. A number of community boards have since increased the numbers of women; Asian, Black and Hispanic residents; nonprofit workers; and people living in social housing serving on their boards.

“Manhattan was an excellent testing ground to show this approach works,” says Zhi Keng He, assistant director of BetaNYC’s Civic Innovation Lab, which hosts the fellowship program. “It also set the standard in defining the wide-ranging demographics we now want to capture in other boroughs.”

Building on the work in Manhattan, He has been leading a new project with the Queens Borough President—a complete redesign of its community board appointment process. Bringing the application online led to a surge in the number of applicants, allowed the office to properly track its process, and led to the most diverse set of board appointees ever seen in Queens. BetaNYC now aims to extend this work across the remaining boroughs.

“Our work with community boards exemplifies what BetaNYC is all about,” says Hidalgo. “Using data analysis and digital tools to build a more inclusive democracy in New York City.”

When you Picture a Scientist, who do you see?

A new documentary is revealing the uncomfortable reality of gender-based discrimination in STEM—and the extraordinary women fighting for change.

Sharon Shattuck trained as a forest ecologist. After graduating, she put her training into action at some of the country's leading research institutes and museums. But like many women navigating careers in STEM she couldn't help noticing that, from her graduating class through to leadership positions, women scientists were in increasingly short supply: "Things may be improving, but it's pretty obvious who's still in charge."

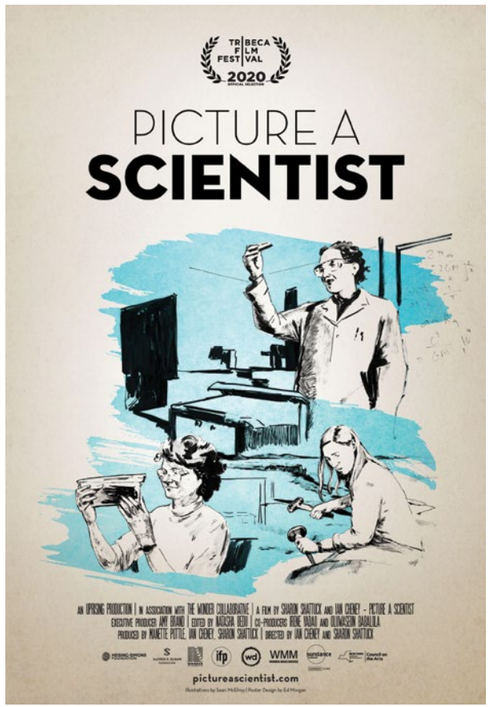
Sharon has since traded in her botany kit for a camera, and she uses her platform as a filmmaker to help address issues of representation through documentary. She recently teamed up with old friend, long-time collaborator, and Peabody Award-winning filmmaker Ian Cheney to co-direct *Picture*

Molecular biologist Nancy Hopkins examines her tanks of zebrafish. Hopkins' pioneering research used the fish as a model organism to illuminate the genetic mechanisms underpinning development.

a Scientist, a Sloan-supported doc confronting the uncomfortable reality of gender-based discrimination in STEM.

"The project began as a biopic of Nancy Hopkins, a pioneering molecular biologist at MIT who has contributed so much to her field while also moving the needle on unconscious gender bias," says Ian. "We were immediately struck by her story," adds Sharon, "but we quickly realized that Nancy's experience was emblematic of a much wider story we wanted to tell."

Picture a Scientist portrays the experiences of three women scientists—each facing different forms of gender-based discrimination in different fields and at different points in their careers. In addition to Nancy



"The project began as a biopic of Nancy Hopkins... but we quickly realized that Nancy's experience was emblematic of a much wider story we wanted to tell."

Hopkins, the film features Jane Willenbring, a Scripps Institute geologist who was harassed by her mentor while working in Antarctica, and Raychelle Burks, an American University chemist who discusses the interplay of gender-based discrimination with race and ethnicity.

"We spoke with so many people who didn't want to appear on camera, which I completely understand," says Sharon. "But Nancy, Jane, and Raychelle dared to speak up so that others could learn from their stories."

"The film critic Roger Ebert said that movies are 'like a machine that generates empathy'," adds Ian, "and our collaborators' stories are a testament to that. They're a powerful opener, an invitation for the audience to step into someone's shoes and participate in a broader conversation."

While the film skillfully uses storytelling, it also includes shameful stats that back up its claims. Sharon explains, "When you see data, you can't deny the issue." Studies, like those showing women being called for fewer interviews than men despite sending identical resumes, are peppered throughout the film to relate personal stories to larger, systemic problems.

Jane Willenbring has developed techniques using cosmogenic nuclides—rare isotopes created when cosmic rays strike atoms inside rocks and soil—to measure erosion, weathering, and other changes to the Earth's surface.

An iceberg appears as a recurring motif to illustrate the scale and nature of the problem—unwanted sexual attention is just the cap of the iceberg, while the majority of gender-based discrimination involves subtler exclusions that skulk beneath the surface. Ian says that the iceberg is also symbolic as a "weighty object with a lot of inertia", much like the unyielding systems addressed in the film.

Picture a Scientist was broadcast on PBS's *NOVA*, was an official selection of the 2020 Tribeca Film Festival, and is now available for worldwide streaming on Netflix. Beyond its release in the film circuit, it's also having international success as a teaching tool—and has now been screened and used to spark conversations at over 1,500 colleges, universities, scientific societies, and biotechnology companies.

"The response in the scientific community has been absolutely mind-blowing," says Sharon. "We're both just so thrilled," adds Ian. "Cold Spring Harbor Laboratory has the film as required viewing for every new hire. And it's been screened at NASA and the National Academy of Sciences. To see our film being used at institutions we admire is more than we could have ever hoped for."

"It was such a pleasure to get to know our contributors and be invited into their worlds," says Sharon. "Lately I've been thinking about Jane, who features in the film with her daughter. I'm about to become a mother and I'm having a girl. Jane's definitely inspired me to think about how I can juggle my career and family life—while also thinking about how we can create a better world for my daughter's generation."

For a full selection of Sloan-supported films visit: sloan.org/programs/public-understanding/film/list

The Columbia Aging Center's Age Smart Employer Awards honored NY area businesses with innovative workplace practices designed to maximize the potential of workers of all ages. Winners included Brooks Brothers (above) and Metro Optics Eyewear (overleaf, left).

Working Longer

Retrospective

The good news is we're living longer.

In 1955, a typical 65-year-old American man could expect to live another 12.5 years. In 2014, thanks to a combination of better diets, less smoking, and advances in health care, that number ballooned to 20 years—a 60 percent increase. Married couples fare even better. Half of American couples who reach traditional retirement age can expect that at least one of them will live to the age of 90. Again, this is good news, but it's good news with profound implications. Americans are facing, for the first time in history, the prospect of retirements lasting upwards of three decades. Working people are taking note of that new reality. For most of the twentieth century, the traditional age of retirement got younger and younger. But in the 1980s, that century-long trend reversed. Today, Americans on average retire later than at any point in recent history. We're working longer.

That simple observation became the core, and the name, of a nine-year grantmaking effort, one designed to advance our understanding of the economic, social,

and policy implications of an aging U.S. workforce. Designed and led by program director Kathleen E. Christensen, the Foundation's Working Longer program launched in 2010 and set its sights on answering a series of important, pressing, practical questions. What factors drive the labor market decisions and performance of older workers and how do those factors differ from their younger colleagues? Which employer policies and practices facilitate or discourage work at older ages? What sorts of incentives do state and federal policies create that inhibit or promote working later in life? How does working at older ages affect our mental and physical health and wellbeing?

Over nine years, in 170 grants totaling more than $63 million, the Foundation helped create and sustain a multidisciplinary network of researchers to examine these and related questions. Drawing from a diverse variety of fields—including economics and econometrics, policy analysis, sociology, medicine, industrial organization, and psychology—these researchers collected and analyzed data, designed and fielded experiments, held conferences and workshops, developed innovative new analytic methods, trained graduate and postdoctoral scholars, and disseminated their work to the wider scholarly community, policymakers, and the public. Through their work, a detailed picture of the complex interplay between aging and work has emerged.

A survey of older Americans found that 40 percent of retired Americans in their 60s and 70s would re-enter the workforce for the right job. But what's the "right job?"

New Knowledge

The central project of the Working Longer program was to create new, actionable social scientific knowledge. After nearly a decade of scholarship, the results impress. More than 450 papers have been produced as of this writing, with more surely to come in the months and years ahead. While we cannot hope to recount, even in summary, everything these researchers discovered, a sample will give some sense of the depth of their insights.

- ***Most people don't "retire" in anything like the traditional, stereotypical sense.*** An analysis of the seminal federally-sponsored Health and Retirement Study revealed that more than half of all American workers instead either move from their "career job" into a part-time job or retire fully for a limited time, returning to the workforce after a period.

- ***Older Americans want to work, but value different things than younger workers.*** A survey of older Americans found that 40 percent of retired Americans in their 60s and 70s would re-enter the workforce for the right job. But what's the "right job?" Older workers, studies show, value distinct qualities in a work environment, placing less value than younger workers on salary and more on non-salary factors like flexibility in scheduling and hours worked.

- ***Older workers face significant job instability.*** An analysis by researchers at the Urban Institute found that, over the 15-year period studied, about half of all steadily employed workers over the age of 50 were either laid off or were forced out of their jobs involuntarily. Nine out of ten of these workers never find another job as good as the one they lost, with significant impacts on their lifetime earnings and retirement security.

- ***Current state and federal law provides significant disincentives to work at older ages.*** An analysis of dozens of state and federal laws and regulations revealed the ways in which their interplay can provide significant disincentives to working longer for both individuals and the businesses that employ them. These include

A comprehensive study that matched health outcomes with features of work performed found that continued work at older ages was associated with slower rates of cognitive decline.

regulations that require claiming Social Security by age 70, mandatory age-related distributions from tax-protected retirement accounts, insurance and pension regulations requiring higher employer payments for older workers, and regulatory incentives for the employed to forego Medicare as their primary health insurance. One analysis found that hidden taxes on worker compensation increase steadily from 15 percent at age 60 to 30 percent at age 70. The combined (if unintended) effect of these laws is to significantly reduce the economic returns to work at older ages.

- ***Age discrimination in hiring is gendered.*** A study involving the analysis of some 40,000 job applications sent to employers found that older women candidates were contacted for an interview at significantly lower rates than similarly qualified, similarly aged men, an effect that became more pronounced the closer women were to traditional retirement age. Further work suggested that the incidence of age discrimination in hiring was not affected by strong state anti-age-discrimination laws.

- ***Work at older ages is good for your brain, but it has to be the right sort of work.*** A comprehensive study that matched health outcomes with features of work performed found that continued work at older ages was associated with slower rates of cognitive decline. This effect, however, was concentrated among workers in jobs that involved "novel information processing," jobs that called on workers to solve new problems in innovative, creative ways.

Foundation grants in the Working Longer program sought to create resources and institutions that would far outlast our grantmaking dollars and leave the research community stronger and better able to push forward the research horizon. Sloan grantees engaged in major efforts to increase the quality of data and models available to researchers, including linking the seminal Health and Retirement Study with the Business Register maintained by the U.S. Census, fielding a new iteration of the High School and Beyond survey, funding a major upgrade to the Urban Institute's DYNASIM economic forecasting model, and helping to create the Research Network on Aging and Work, a scholarly network that facilitates information-sharing and research collaboration across disciplinary boundaries.

Investing in the research community is about more than datasets and survey instruments. Above all, it's about people. The Foundation spent significant resources training and educating early-career scholars. Young researchers don't just bring energy and new perspectives to a field, they will become the next generation of senior scholars who will define and drive a field's research agenda in the years and decades to come. Approximately 175 doctoral students and more than 30 postdoctoral researchers were supported over the course of the Working Longer program. Of the 450 papers produced during the program, more than a third were authored or co-authored by researchers just starting their careers.

Formal grantmaking in Sloan's Working Longer program ended in 2020. The important work it started, however, continues. Adjusting our institutions to reflect the new realities of a changing workforce is a critical challenge for twenty-first century America. Due largely to the passion, perseverance, and creativity of researchers in the Working Longer program, we are better positioned to meet that challenge.

Meet the Fellows

At the Sloan Foundation, we don't just support research, we invest in it. That's why the Foundation's oldest program targets the youngest researchers. Since 1955, the Sloan Research Fellowships have identified the very best early-career scientists and provided them with funds and recognition at a pivotal stage of their careers. Here are just a few of the 126 extraordinary researchers that make up the 2020 Sloan Research Fellowship class.

Christine Constantinople

Neuroscience

Identifying the neural mechanisms underpinning behavioral economics.

"Losses loom larger than gains," wrote Daniel Kahneman and Amos Tversky in their foundational work on behavioral economics. To put it another way—a $50 loss makes people upset, but an equivalent $50 gain has less of an effect on mood—an intriguing disparity that drives our decisions about insurance, medical treatments, labor, and more. Loss aversion is a well-documented behavioral phenomenon, but scientists haven't yet pinpointed the neural mechanisms underpinning this behavior.

Christine Constantinople is a systems neuroscientist using reinforcement learning to explore some of the mechanisms that may be responsible. Rats display many of the same decision-making biases as humans, and Constantinople is now training groups of them en masse, manipulating and monitoring neural circuits to uncover the basis of behaviors like loss aversion. Her goal is to eventually connect neural dynamics with psychological phenomena—to understand how brains assign values that ultimately shape choices and guide behavior.

Christina Delimitrou

Computer science

Automating design and management decisions with machine learning.

Microsoft, AT&T, and other companies are deploying machine learning to optimize their massive, warehouse-scale datacenters. Human optimizers tend to be cautious, over-allocating resources to datacenters such that they're typically only 25% utilized. This poses scalability challenges for cloud computing, particularly as user demand grows. Replace the human optimizer with a properly trained AI, however, and utilization leaps to 80%. Automation resolves those scalability challenges—and illuminates an approach for addressing resource inefficiencies in other systems.

Christina Delimitrou is a datacenter architect doing just that. After successfully optimizing datacenters, she's turning her attention to hardware design and software engineering. Take computer chips, for instance. They're found in virtually all electronics and, just like datacenters, they aren't always optimized for maximum efficiency. Software applications, meanwhile, aren't always written in the most efficient way. Delimitrou uses machine learning to spot inefficiencies and automate design and management decisions so that these systems can perform to their full potential.

Zhizhen Zhao

Mathematics

Extracting signal from noise in scientific datasets.

Cryogenic electron microscopy (cryo-EM) is a powerful technique that reconstructs elaborate three-dimensional images from two-dimensional ones. It's been used productively in vaccine discovery and design, uncovering important protein structures in both Ebolavirus and SARS-CoV-2. But the reconstruction of 3D from 2D images involves finding useful, meaningful signals hidden inside large quantities of noisy, disordered, and incomplete data—properties that are common among scientific datasets in disciplines as disparate as atmospheric science and multi-messenger astrophysics.

Zhizhen Zhao is an applied mathematician and data scientist who specializes in developing new methods for extracting useful information from cacophonous data. Her work explores ways to use the geometry of complex datasets to separate signal from noise. Zhao's aim is to develop general theoretical principles that can be used to develop provably efficient algorithms with real-world applications in modern science.

Abraham Badu-Tawiah

Chemistry

Developing new diagnostics for early disease detection.

Identifying the prevalence of diseases in resource-limited settings is a challenging task, particularly because high costs and limited access to quality equipment make medical diagnosis challenging in large parts of the world, from developing nations to rural communities in the U.S. The lack of cheap, reliable medical testing means a host of treatable medical conditions, from colorectal cancer to malaria, go undiagnosed in asymptomatic patients, leading to unnecessary community spread, illness, and death. Accurate, affordable diagnosis is essential in detecting these problems and, by extension, people in need of treatment.

Abraham Badu-Tawiah is an analytical chemist developing new, low cost, high performance disease diagnostics for resource-limited communities. He is developing simple, paper-based microfluidic devices capable of detecting malaria and other deadly infections using only a few drops of blood. The paper devices are extremely resilient, designed to be used in the field and outside the clinic, and are opening the possibility of bringing reliable medical care to the most vulnerable.

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