They hail from across the United States and beyond, migrating to engineering education via pathways as far flung as an entrepreneurial start-up, competitive gymnastics, medicine, and the Navy. Their research topics are equally varied, from cancer to energy storage and a field so rarefied – nanogeochemistry – that its Facebook page has just four “Likes.”

What these accomplished under-40 academics all share, however, is a demonstrated talent for teaching, real-world research, or – as is often the case – both. They were picked to highlight the role of engineering and engineering technology institutions in shaping a globally competitive workforce, based on recommendations by schools and colleagues and research by Prism staff. The 20 individuals profiled on the following pages are not a scientific sample. Rather, they represent a balance of geography, discipline, and type of institution. The common denominator is imagination.

Take Micah Stickel of the University of Toronto, one of the inventive young instructors transforming classroom practice. One of the first at his school to ditch the blackboard and teach from a tablet, he now is overseeing a review and revision of the freshman experience. While Stickel and physician-engineer Sujata Bhatia of Harvard are forgoing the research-oriented tenure track to concentrate on teaching and advising, Jim Pfaendtner, an assistant professor of chemical engineering at the University of Washington, is proof that great teaching need not be in zero-sum competition with research. Besides award-winning work on optimizing energy production from biomass, he routinely earns course evaluations that exceed the 5-point scale – a reflection of his commitment to mentoring and helping students, particularly women and underrepresented minorities, navigate the career maze. “I believe really strongly in the power of the university to change people’s lives,” he says.

Another driver of change is outreach. Stephanie Luster-Teasley, a chemical engineer at North Carolina A&T State University with appointments in civil, biomedical, and environmental engineering, runs a summer lab experience for African-American girls that has grown so popular she is launching a similar program for boys.

Looming large through these stories is government funding, particularly money that offers a leg up for young faculty struggling to see their ideas bear fruit in the lab. It’s a safe bet that the pathbreaking work described here, in such areas as earthquake-resistant construction, nuclear weapons detection, neuroimaging, and women’s reproductive health, wouldn’t have happened without the basic research dollars that flow from the National Science Foundation, the Department of Defense, and other government agencies.
When Abbie Liel arrived in L’Aquila, Italy, in April 2009, aftershocks could still be felt from a 6.3-magnitude earthquake that had killed 305 people, injured at least 3,000, and left 36,000 homeless. Examining 483 buildings in a two-year study, Liel and her colleagues at the University of Colorado, Boulder documented a major reason for the human toll: Most of the city’s concrete buildings were more than two decades old and lacked the tremor-resistant features of more modern designs.

A structural engineer who has always loved applying math and science to human problems, Liel is a leading researcher at the intersection of construction, risk assessment, and public policy. She zeroes in with precision on the “weak links” most likely to cause serious damage or casualties in an earthquake so owners and planners can make cost-effective retrofits, mitigate hazards, and rebuild wisely. In L’aquila and in temblor-prone California, where Liel earned a Ph.D. at Stanford on a National Science Foundation fellowship, a common problem is nonductile – brittle – concrete-frame buildings, which she calculates are 35 times as prone to collapse as recent, more deformable structures. But reconstruction is costly. That’s where “performance-based earthquake engineering” comes in: Simulating ground-shaking intensity and damage severity, it can assess which buildings in a community require retrofits based on their risk of collapse and the likelihood of residual casualties. Such measurements would be impossible without the computational advances of the past five years, Liel says, and occasional use of ClU’s supercomputer.

Her methods could lend credibility to risk assessments in other seismic zones in addition to California, including the Pacific Northwest, Alaska, and Memphis, Tenn., which in the early 1800s experienced the biggest earthquake in U.S. history. Beyond earthquakes, the same tools can assist building owners and policymakers in flood zones. Hence Liel’s newest project: an interdisciplinary exploration of how to win community acceptance of probabilistic damage models in Boulder, Colo., which witnessed disastrous flooding last year.

From the air or highway, America’s fruited plains present a uni- form vista of vast abundance. Not to Amy Kaleita. The associate professor of agricultural and biosystems engineering at Iowa State University sees a “nonlinear, somewhat chaotic” array of microplots, each with unique hydrology, root depths, soil characteristics – and ripe opportunities for smart technology to enhance both sustainability and food production.

“Precision conservation,” Kaleita’s research field, piggybacks on the precision farming that GPS-equipped combines launched in the 1990s. Beyond optimizing crop yields, she seeks to “maximize the agricultural impact by treating the soil differently,” applying data on erosion, fertilizer runoff, and other environmental factors to better manage land.

In her dream scenario, outlined in a 2013 Gilbreth Lecture at the National Academy of Engineering, temperature and water sensors in the soil would help customize seed depth; aerial drones of audio and video to locating individuals in a dense crowd and having industrial robots perform advanced tasks.

Radke looked on with envy as his Rice University roommate re- searched computer graphics in film and entertainment. As a hobby, he began steering his own interest in computer vision, video surveillance intelligence, and digital cameras toward movies and television.
Suppose that instead of hauling a 1,000-pound battery, an all-electric car could store energy throughout its hood, doors, roof, and fenders. Now imagine that rather than recharging every 250 miles or so, the vehicle got an extra job every time it passed under a stoplight or through a toll booth. Cary Pint is working to make all this a reality. Embedding nano batteries and supercapacitors in advanced composite materials, the Vanderbilt University physicist turned engineer aims to transform energy storage — and not just for automobiles. With an extra step in manufacturing, he says, roof shingles and siding on a home could store energy from solar panels, providing power at night and on overcast days. A Boeing 747 could store enough energy in its fuselage to take off — currently the most fuel-guzzling part of a flight.

Pint, 32, an assistant professor of mechanical engineering and director of the Nanomaterials and Energy Devices Laboratory, sees the current state of grid-dependent energy storage and supply systems as a bottleneck, slowing down innovations in technologies requiring external power. His lab is working — from robotic aircraft to buildings — to turn all energy into energy depots. “This area is both exciting and overwhelming because there are so many materials and technologies where energy storage can be integrated.”

“A critical part of our research program enlists undergraduates, often early in their studies, to work in the lab,” Pint explains. “We throw them into an environment where they must be creative, to employ knowledge beyond that described in the literature. Some students love it. Some will struggle a lot. Much of learning, he says, is a process of acquiring technical language, which comes with lab experience. While Pint himself holds a Ph.D. in applied physics from Rice University, he enjoys making students realize “they don’t need a fancy degree to innovate.”

By the time she started teaching in her early 30s, Sujata Kumari Bhatia could claim a career’s worth of achievements. After earning an M.S. and a Ph.D. in bioengineering, she spent eight years as a research scientist at DuPont, securing one patent and filing three more, writing or co-authoring five books and 80-plus articles and papers, and snagging dozens of academic and professional honors. But two years as a senior project adviser, drawn by Bhatia’s work in natural bio materials, convinced a young woman’s thesis examined potential medical applications of corn stover into an environment where they must be creative, to employ knowledge beyond that described in the literature. Some students love it. Some will struggle a lot. Much of learning, he says, is a process of acquiring technical language, which comes with lab experience. While Pint himself holds a Ph.D. in applied physics from Rice University, he enjoys making students realize “they don’t need a fancy degree to innovate.”

Bhatia hadn’t been at Harvard long before a Nigerian student sought her out as a senior project adviser, drawn by Bhatia’s work in natural bio materials. The young woman’s thesis examined potential medical applications of corn stover into an environment where they must be creative, to employ knowledge beyond that described in the literature. Some students love it. Some will struggle a lot. Much of learning, he says, is a process of acquiring technical language, which comes with lab experience. While Pint himself holds a Ph.D. in applied physics from Rice University, he enjoys making students realize “they don’t need a fancy degree to innovate.”

Whether it was watching Star Trek episodes on Saturdays or devouring books on artificial intelligence while working at her local library, Laurel Riek knew at a young age that she wanted to build robots for a living. And what remarkable machines hers turned out to be: Riek, an assistant professor of computer science and engineering at the University of Notre Dame, makes robots that can respond to patient reactions. Her lab is advancing the field of patient simulators, which are used by over 180,000 clinicians each year to learn how to respond to patient reactions.

Riek’s gift for innovation took her first to Carnegie Mellon University, where she studied artificial intelligence on a scholarship, and then to a job as an AI engineer at MITRE, a research nonprofit. Over the next eight years, she worked on search-and-rescue robots, ground-based vehicles, and aerial vehicles. Eventually, she began writing proposals and acquired her own lab. “In retrospect, it was incredible to have access to those sorts of resources in my 20s,” Riek says. She went on to earn a Ph.D. from Cambridge University under a Qualcomm computing fellowship, specializing in robots that interact with humans.

Now director of a robotics, health, and communications lab, Riek won an NSF CAREER award in 2013 for her work on simulations of human patients that can express pain, strokes, drowsiness, and other neurological impairments. Most simulators can already breathe, bleed, and respond to medications. Riek says. Her lab is tackling that one step further and creating robots that can mimic signs of stroke, neurological impairment, and other symptoms. General pain using accurate facial expressions that are based on those of real patients. Just as humans can change their behavior depending on what others are doing, she says, “We’d like to enable robots to do the same thing.”
Blanka Sharma joined the Cleveland Clinic as a postdoctoral fellow in 2009 just as nanotechnology and gene therapy combined to break promising new ground in cancer treatment. Soon she became a major contributor to the growing field. Zeroing in on the tumor-suppressing p53 gene, which mutates and goes awry in half of cancer patients, she and her colleagues demonstrated how polymeric nanoparticles carrying gene therapy concepts could be delivered to tumors and suppress prostate cancer in mice.

In 2010, she developed hands-on experiments to teach 4-H young-sters about global warming that have since gone viral, teaching millions of kids worldwide about the buildup of carbon dioxide in the atmosphere by putting Alka-Seltzer in a paper bag. More recently, she launched the Engage 2BE program, which provides mentoring, stipends, academic support, and professional development to North Carolina A&T students interested in bio- and environmental-engineering careers.

Luster-Teasley, an associate professor of chemical, civil, environ-mental, and biological engineering, pushes her university students to enter co-op programs and attend conferences. “It’s really important to get kids out of their seats,” she says. Having worked in industry after earning a Ph.D. in environmental engineering at Michigan State, she laces her lectures with case studies and examples from her former professional practice, like finding dead beavers after their pond had been remediated. Equally credible is her admonition to students “to work on your writing” because, she tells them, “80 percent of what I did as a consultant was writing papers.” Her latest helpful and practical project: using social media to alert students to grants, internships, and other opportunities to help them start earlier and submit stronger applications.

"Women, listen up," Jim Pfandermetric commands, commencing his senior chemical engineering class at the University of Washington by outlining his students’ next career steps. Laying out the stubborn gender gap in pay for identical degrees, the assistant professor offers help to negotiate salaries or navigate a job fair. The coaching is open to all students, but Pfandermetric wants women and underrepresented minorities to know he means it. So far, he has mentored all who asked.

As career counselor, award-winning teacher, and adviser to first-generation college students and campus organizations, Pfandermetric wins accolades from students and faculty alike. His course evaluations are literally off the charts, topping 5.0 in point scale. Chemical engineering student Kathryn Cogert calls him “a force of nature.” Peers praise such innovations as the way he transformed senior-level courses by linking their content and flipping the classroom. The NSF-funded biofuels-production lab he helped develop lets students for the first time evaluate the effects of decisions up and downstream. He seems to possess the bandwidth to succeed in research as well as the classroom, having won an NSF CAREER award – from two divisions – funding his lab’s use of state-of-the-art computational tools to improve the efficiency of enzymes in converting crops to fuel. But the educational component is never absent. While his doctoral students publish in top journals, Pfandermetric started a book club to encourage “ownership over their careers.” His must-read: A Phi D. Is Not Enough.

He also opens the lab to under-graduates through the Louis Stokes Alliance for Minority Participation. “The thing that’s just burning inside of me is using my position of influence and authority to improve people’s lives,” explains Pfandermetric. Besides, he notes, “we graduate 65 newly minted chemical engineers a year and we owe it to society to train them well.”

"A terrible chemistry student" in high school, Pfandermetric discov-ered his own talent and awakened to the subject during a summer pro-gram at Georgia Tech. He enrolled there, "fell in love" with chemical engineering, and now calls himself “a cheerleader” for the discipline.
Rodney Priestley says his Princeton polymer lab may be just a few years away from cracking one of the biggest enigmas in nanotechnology. “The nanoscale, the properties of materials change markedly in various ways, such as electrical conductivity. Working with glassy polymers, Priestley and his colleagues are gaining the potential to control and [visualize] these alterations in behavior. “One of the things that is surprising is that incontinence, pelvic-organ prolapses, and other disorders affect a third of female U.S. adults. startling, too, was the lack of scientific research guiding surgery – costing Americans $1 billion annually – to treat such conditions.”

De Vita suddenly saw where her work could make a difference. Weeks after giving birth, she refined and submitted a winning NSF CAREER proposal to study the elastic and viscoelastic properties of two major ligaments supporting the uterus and the vagina. The following year, 2013, she won a President’s Early Career Award for Scientists and Engineers (PECASE).

"Having a baby really inspired this research," says De Vita, who never imagined as a daughter of an Olivetti worker in Italy that her career trajectory would include a Ph.D. in mechanical engineering from the University of Pittsburgh and meeting a U.S. President. Since struggling to find her initial collaborator, an Army gynecologist and researcher, De Vita has seen growing interest in her field with the world conference of biomechanics holding sessions on female reproductive mechanics. Meanwhile, her email is flooded with requests for guidance on disorders that many women were, until recently, too embarrassed to discuss. Not so her kids, 3 and 8, by now accustomed to clinical talk, laced with words like ‘vagina.’

Eureka moments can strike in odd places. Raffaella De Vita, a soft-tissue expert and associate professor of mechanical engineering at Dartmouth College, discovered her niche at the forefront of reproductive health while seven months pregnant with her second child. She was crossing campus, pondering how to craft a ligament-research proposal “novel” enough to pass NSF muster, when she felt pain on both sides of her abdomen. “That’s interesting,” she thought, and hit Google for possible causes. Nothing turned up. Even the names and anatomical descriptions of ligaments supporting the uterus and vagina varied widely. “It was really a mix!” recalls De Vita. That seemed surprising given that incontinence, pelvic-organ prolapses, and other disorders affect a third of female U.S. adults. startling, too, was the lack of scientific research guiding surgery – costing Americans $1 billion annually – to treat such conditions.

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Priestley, an assistant professor of chemical and biological engineering who is supported by grants from the National Science Foundation and Polymer Physics at Texas Tech University, where he also performed well at the long jump. His interest deepened when he helped develop artificial bone material from polymers at a University of Connecticut lab under the federally supported Research Experiences for Undergraduates program. He went on to earn a Ph.D. in chemical engineering, whose own creative endeavors include taking Organic Chemistry II at Dartmouth’s sunny lawn in whimsical di-wheeled vehicles they created in his advanced computer-aided mechanical engineering design course. With an affirmative roar, the drivers begin pedaling and hand-cranking through a four-lap contest that constitutes their final project. “It’s easier to stimulate creativity and the ability to invent in a space that’s carefree,” explains the associate professor of engineering, whose own creative endeavors include advanced neuroimaging technologies.

That teaching philosophy reflects a lifelong zeal for invention. Growing up in rural Bath, N.H., where his family operated an industrial-scale hydroelectric generator and a computer business, Diamond crafted rubber-band dart guns, assembled PC. The亲自te, and learned to repair heavy equipment. In eighth grade, the self-taught database expert set up inventory-tracking systems for local businesses.

As a Dartmouth engineering major, Diamond worked with a local entrepreneur on a water jet device that potentially could break up kidney stones. That launched him on the biomedical technology path. A senior capstone project with the same mentor resulted in an exercise machine for elderly, bedridden hospital patients – and two U.S. patents. He went on to earn a top teaching award from Harvard while paying for grad school with the help of several students. , funded by the National Institutes of Health, combines EGs with near-infrared spectroscopy and fMRI imaging to study the connection between neural activity and blood dynamics, a potential key to understanding multiple sclerosis.

To balance research and teaching, Diamond has “learned to be efficient in the classroom” – and expand the teaching space. He invites students home to dine and conduct energy audits at his super-insulated, net-zero house. “One of the great things about teaching is you get to share some of your life with students and vice versa.”

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As a Purdue graduate student in 2005, Shawn Jordan co-led his team to victory in a Rube Goldberg contest—and snatched a Guinness World record—with a machine that took 125 steps to turn on a flashlight. The following year, his team won again, this time with a contraption that “site my homework” in 215 steps, including a player-piano rendition of the school’s fight song.

To Jordan, the exercise of turning simple tasks into complex contraptions takes creative engineering to its limit, spurring students to “design the problem as well as the solution.” Thus it’s an ideal teaching tool. He introduced Rube Goldberg to high school students while pursuing an engineering education degree. Now, as an assistant professor of engineering at Arizona State’s College of Technology, he is using it in a project to develop a next-gen science and engineering curriculum for Navajo middle school classrooms. In the process of designing and building the machines, students produce stories about their culture and daily lives. He also incorporates Rube Goldberg ideas in STEAMLabs, a rapidly growing series of labs that combine engineering design and art.

Jordan’s approach, which merges social science and engineering, has struck a chord with funding agencies eager to identify successful STEM teaching techniques. Since 2011, he has obtained $1.9 million for his research, including a National Science Foundation CAREER award. Currently, NSF is backing his study of the community of “makers,” whose inventions draw crowds to Maker Faires around the country, to learn what compels them to tinker and innovate. The resulting evidence, he argues in an abstract, “will transform the conversation of who young makers could become, linking making with engineering in the same way that students who excel in science and math are pointed toward engineering by parents and career counselors.”

The project appeals to his interest in the human side of engineering. “I was always drawn toward psychology,” he says. “Engineering education brought together my interests in people with my interests in engineering.”