

# On the **Leading Edge** of Higher Ed

by Jessica Stoller-Conrad



Caltech's new president, Thomas F. Rosenbaum, knows a thing or two about leadership. After all, he spent seven years as the provost of the University of Chicago, where he had previously served as vice president for research and for Argonne National Laboratory.

In his inaugural address on October 24, Rosenbaum spoke about what it means to lead an institute of higher education, echoing Robert A. Millikan to reflect on "the effective combination of the pure and the applied to advance knowledge and benefit society." The key elements of this successful mix "characterize the Caltech of today," he said. He went on to describe them as:

- **"An absolute commitment to excellence.** Every appointment—student, faculty and staff—matters. Intrinsic to this strategy is the need for diversity: diversity of thought, diversity of background, diversity of experience. We must cast the net as broadly as possible to recruit and retain the most inventive and original scholars.
- **"Ambition. . . .** We are at a time in the history of science and technology where competition for federal funds drives the system to conservatism, but the genius of Caltech is its fearlessness to try new ideas, its willingness to absorb risk and even fail if the potential is transforming discovery.
- **"Focus.** As the constraints become more pronounced, we will be challenged even more profoundly to define areas where the Institute can be a world leader and where it cannot. We will have to forge partnerships . . . while protecting our capacity to set the intellectual agenda.
- **"Intimacy and intensity.** This is a visceral feature of Caltech, built on an organizational structure with few disciplinary barriers and the cultural expectation of shared knowledge.
- **"Perspective.** The arts help us to function as life thrusts us into situations where we have to conceive problems outside of the structures that define them. . . ."

While challenging to achieve, Rosenbaum said, taken together these fundamental ingredients "yield intellectual magic."

As Caltech welcomes its new president, we at *E&S* thought it would be interesting to talk with other university leaders—all Caltech alumni, of course—about their roles and how they are adapting to an ever-evolving educational landscape.

Many of these systemic challenges stem from messages that students get in their K–12 experience, and at home, and in the media about, one, "What do scientists and engineers look like, and do they look like me?" and two, "What is the work of scientists and engineers, and is that work that I would be passionate about doing?"

—LAURIE LESHIN, WPI

## Looking Harder

Nearly 150 years ago, American politician, education reformer, and college president Horace Mann famously described education as the "great equalizer" of humankind—a tool that transcends cultural and socioeconomic divides to give anyone from any background an equal chance at success. Although the educational system in the United States has changed substantially since Mann's time, a college degree is still an undeniably important gateway to opportunity in our society.

Today, the fast-growing industries surrounding technology, alternative energy, and health care have spurred a need for more workers trained in the so-called STEM fields—those relating to science, technology, engineering, and math. Indeed, institutes of higher education have had a hard time recruiting enough students to meet the demand.

One approach to solving this problem is to diversify the traditional STEM classroom, opening it to a broader range of potential students. For example, although women now account for more than half of the enrolled college students in the United States, they are still underrepresented in many STEM fields—especially engineering. How can higher education recruit more women to pursue science and engineering?

"Of course that's a huge question—and if it was an easy nut to crack, we would have cracked it," says Laurie Leshin (MS '89, PhD '95), president of Worcester Polytechnic Institute (WPI). "I think the fact that progress has been slower than we'd all like to diversify STEM fields—both in higher ed and beyond—means that there are some real systemic challenges there."

Leshin—who is the first female president at WPI—says that one way institutions of higher education can address the gender disparity in STEM is to become allies in programs that encourage girls to engage with science at a young age.

As an example, Leshin points to Camp Reach, a program at WPI that shows middle school girls what a career in science or engineering is really like. "I'm on the Curiosity rover science team," she says, "and five of my women colleagues from Curiosity, who are engineers from JPL, are talking to the Camp Reach girls about what it's like to work in space exploration. We need to show examples of women doing really great and exciting jobs in the field, and that those jobs are all about interacting with others and making an impact in the world."

Caltech's alumni leaders in higher ed say that a key to encouraging



We're in the midst of a revolution in terms of how technology is applied to both education and research. On every campus today there is an unrelenting quest for greater bandwidth and access to resources that are available on the Internet. And if the United States is to remain the leading center of innovation, we're going to have to have great infrastructure.

—MARK WRIGHTON, WASHINGTON UNIVERSITY

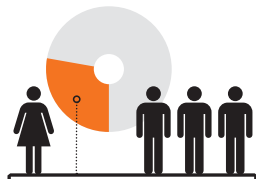
students from all backgrounds to pursue science and engineering is making schools more accessible and affordable. For Mark Wrighton (PhD '72), chancellor of Washington University in St. Louis, this means providing scholarships and supporting programs that encourage a talented and diverse student body.

"We need to be proactive with acquainting people with the opportunities for financial aid, but we also need to be more proactive in reaching out to talented people from families where people haven't traditionally gone to college," Wrighton says.

To assist first-generation college students in navigating the college

application process, Washington University provost Holden Thorp (PhD '89), along with colleagues from the University of North Carolina, helped create a program called the College Advising Corps. The corps, made up of recent college graduates, is sent into schools that lack the resources to help with college advising tasks that are essential to the admissions process, such as registering for the SAT and completing financial aid forms and other paperwork.

"There are also a lot of students out there who have the background to go somewhere like Caltech or WashU, but they don't apply because they might not know that they could be admitted, or they might not know that we have programs that would take care of most of their financial needs if they come," Thorp says. "So we have a lot of work to do to get the word out about what is available."



**28%**  
of individuals in science and engineering occupations are women

Philip Hanlon (PhD '81), president of Dartmouth College, points to his institution's College Horizons program, a six-day summer workshop that aims to attract more Native American students to campus, as helping diversify the student body. The program provides an opportunity for students to learn about financial aid and academic goal-setting as well as a chance to meet with college counselors, admissions officers, and essay specialists.

"The workshop is in support of Dartmouth's historic commitment to recruit Native American students and is partially responsible for a Native American student population greater than the rest of the Ivy League combined," Hanlon says.

And when students from under-represented backgrounds show up to campus, schools need to continue their encouragement and support, says Hanlon. "It's not enough to say, 'Here we are. Send in your application.'

We need to nurture students and make sure they have the opportunities to develop the skills needed to succeed at this level." At Dartmouth, this is done with a peer-mentoring program for first-generation college students, which offers a support network for those who don't have a family history to glean from during their transition to college.

With careful messaging, greater accessibility, and support, higher education can not only influence the classroom but also diversify the workforce of the future—which is integral to innovation, Wrighton says.

"The most challenging research questions that we're going to be asking in the future are going to be ones that will require different people with strengths in different areas," he says. And to address those questions, "we'll have to bring talented people from many different backgrounds together."

Higher ed is going to have to do more to make sure that we identify the people that we should be recruiting to our universities, and we have to do more to make sure that the folks who wind up here feel welcomed and are in a position to succeed.

—HOLDEN THORP, WASHINGTON UNIVERSITY *right*



#### Inside the Classroom

Expanding and diversifying the STEM student body is an important step in filling the growing pool of jobs in science and technology. However, STEM retention—the act of keeping students in a STEM field from their first class to the completion of their degree—is also a substantial challenge. Although around 28 percent of students seeking bachelor's degrees in the United States majored in a STEM field at some point during their college careers, only about half of *those* actually finish their degrees in STEM.

Many in higher education have attributed the high attrition rate in STEM to technical coursework that students have trouble getting excited about. One popular new methodology to resolve this problem is problem-based learning, which reinforces basic science principles in real-world situations. For example, at WPI, project-based learning experiences are required for all undergraduates, Leshin says. Each student spends a seven-week term at one of more than 40 sites around the world, working

as part of an interdisciplinary team to solve a real-life problem with a social impact—often for a company, a nonprofit, or a government agency.

Programs like WPI's have seen successes in improving students' knowledge retention and attitudes toward learning, and such positive results have encouraged many other college and university leaders to find ways of customizing problem-based learning for their own curricula.

When Richard Miller (PhD '76) became the founding president of

**Not only do we need to teach applied science, math, and calculus but also what a patent is and how you make money from these ideas. We need to teach how to work in a team. I don't know of a company that hires people and pays them for answering multiple choice tests and not talking to their neighbors.**

—RICHARD MILLER, OLIN COLLEGE OF ENGINEERING *center right*



Olin College of Engineering in 1999, he got the chance to build a brand-new college focusing on design- and problem-based learning.

At Olin, Miller says, he wanted to focus on educating a new kind of engineer—one who can find creative solutions to messy, real-world problems. To do this, he says, technical concepts should be taught by applying the basic principles in interdisciplinary classes that combine science and engineering with subjects like art, business, and history. "Students learn best from stories about people, but traditional STEM courses usually leave this out. To improve learning and retention, we need to insert people back into STEM wherever we can," he explains.

Olin faculty members have experimented with this concept by teaching the basics of materials science, for instance, by recreating metals using Paul Revere's metallurgical techniques—metals that are then studied using modern tools, like electron microscopes. When these students who've seen STEM in action this way move on to their core courses in science and engineering, Miller says, they are better able to understand key principles.

An "applications first, equations later" approach isn't the norm in engineering education today, but Miller says that other fields have long embraced this method.

"If music schools taught violin prodigies the way that many engineering schools teach engineering, in the first year you'd just study the physics of violin strings," he explains. "In the second year, you'd study composition. In the third year, you'd study orchestration. Then in the fourth year, if you're still here, we'd have you play a scale on a real violin.

"In engineering, we learn how to derive all these equations about stuff, but it turns out, if you actually get a job in engineering with a bachelor's degree, very little of your job depends on using these equations," continues Miller. "Instead, you have to work on a

team, you have a budget, and the thing you're making has to work in the field or you lose your job. These are skills that we need to be teaching."

Dartmouth's Hanlon says that student entrepreneurship is also an important applied learning opportunity. "Student entrepreneurship is as compelling an example as you'll find of experiential learning, where innovation is required and the risk of failure is ever present," he says. He and his Dartmouth faculty hope to capitalize on this learning opportunity through their new student entrepreneurship center.

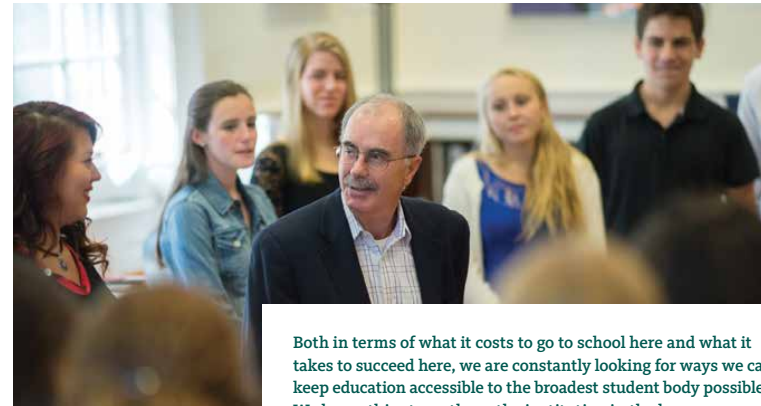
"In talking to students when I arrived back on campus last summer [2013], I was somewhat surprised to learn about dozens of really interesting business start-ups, product developments, and social entrepreneurship efforts that were receiving little or no formal help or guidance from the college," he says. "These students were working in relative isolation, navigating the entrepreneurial path alone, engaged in experiential learning of the harshest sort, as any entrepreneur can tell you!"

So Hanlon created the Innovation Center and New Venture Incubator to give students interested in start-ups and social ventures a place to gather to collaborate and share ideas. As the students work through their creative process at the center, faculty members are available to advise on legal matters, the basics of starting a business, and design feasibility. An accelerator associated with the center will even provide the opportunity for \$250,000 a year in seed funding to a select few of these early-stage student projects.

"What we want to do is coordinate the brilliant minds on campus and within our global alumni family so the student entrepreneur can fast-forward into the realm of *doing*, and not have to play catch-up by learning the hard way the lessons our faculty and alumni have already learned and lived," Hanlon says.

#### Facing the Future

While expanding STEM programs



**Both in terms of what it costs to go to school here and what it takes to succeed here, we are constantly looking for ways we can keep education accessible to the broadest student body possible. We know this strengthens the institution in the long run.**

—PHILIP HANLON, DARTMOUTH

is essential for the future success of industry, the additional space and improved infrastructure for technology, laboratories, and classrooms come at a cost.

And while public money will probably remain a key source of funding in higher education for the foreseeable future, funding structures are changing, says Eric Kaler (BS '78), president of the University of Minnesota—and leaders of colleges and universities will need to make stronger arguments of relevance to receive those limited funds for student programs and research.

One way to do this, he says, is to focus on the ways that a university can have an impact on local industries, showing how the university's research priorities align with the needs of the state and the surrounding community. "Legislators and the public expect accountability and a return on the investment they make in a university in a way that's more quantitative and specific than it was in the past, and I think state institutions are not alone in that," he says.

Kaler and his colleagues at the University of Minnesota have found a way to do this with Minnesota's

Discovery, Research, and Innovation Economy—or MnDRIVE—program.

"What we did was identify areas in which we had strengths and the state has needs and opportunities," he explains. These areas, he says, include food safety, water management, and robotics and advanced manufacturing. The program allows the state to make an investment in its own economy by providing a source of funding for research and creating an opportunity for outreach and experiential learning for students.

"On every front, MnDRIVE is benefiting students and fulfilling the

University of Minnesota's teaching, research, and outreach land-grant missions," Kaler says. Recently, for instance, MnDRIVE provided funds for a PhD student to develop a product prototype based on his research—a first step on the path to creating a start-up company. The program also provided support for a student group to lead a robotics summer camp for a diverse group of middle school students interested in exploring STEM careers.

In addition to developing creative funding strategies for research and student programs, college and university leaders are preparing for the future



In 2012,

**60.9%**

of college students received some form of financial aid



of higher education by exploring the best ways to engage students through online communications, both socially and academically.

Online education has already become an important part of many colleges and universities, but WPI's Leshin says that the future will likely bring an increase in such offerings. And while many critics believe online education will lead to the loss of connection between students and faculty, Leshin says that these resource-

es—used in the right ways—actually may help to increase meaningful learning opportunities between students and faculty.

"Online education can sometimes get too far away from that interaction between faculty and students, but our faculty members are great resources, and if we are just using highly trained faculty to transmit data in a lecture hall, that's probably not the most effective use of those resources," she says. "In the future, we need to

create an environment where faculty and students interact in a way that maximizes learning."

As president, one way that Leshin interacts with students is via Twitter, which she says is a quick and informal way to break down the communication barriers between students and administrators—as well as between the university and the public.

"The amazing thing that's really true about social media is that it makes you feel more connected to people... and our students are there," she says. "On the day of the announcement of my election to the presidency here, it was amazing how many messages on Twitter I got from students."

Kaler says that, in the future, universities may rely more heavily on Twitter and other social media platforms as a viable option for more formal communications as well.

"We've found that our students in particular get a lot of their information through Twitter," he says. "Sending a student group an email is not a very effective way to be in touch, so we've tried to adapt the ways that we deliver our messages and provide connectivity."

As higher education relies more and more on online communications and coursework, many have begun to question the relevance of traditional colleges and universities. But Kaler says that the physical presence of a college campus offers something that *can't* be found online.

"I believe firmly that brick-and-mortar institutions are not going to go away," he says. "In our country, there are just a handful of pathways that constructively take an adolescent from that stage to a young adult, and going off to college is a pretty important part of our culture. That won't change. But what happens when you get here is going to be different." E&S

*Read more about the leaders featured in this article at [alumni.caltech.edu](http://alumni.caltech.edu).*



**I think that clearly technology is going to change an enormous amount of what we do and how we do it. It's no longer about getting information to students. What we need to spend more time on is teaching students how to use that data.**

—ERIC KALER, UNIVERSITY OF MINNESOTA

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