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CONTRIBUTORS

STEVEN BOYD SAUM has written for Orion, The Believer, and The Christian Science Monitor, QED FM, and other publications. His work as an election observer regularly takes him to Ukraine, and he was once a three-time champion on Jeopardy! His first memory in the Apollo 11 moon landing, so he was thrilled to journey with the engineers and scientists here on their next mission to Mars.

MATT CHINWORTH is an illustrator who creates most of his work for magazines, newspapers, and online publications. His work has been published worldwide and recognized by American Illustration, 3x3 Illustration, and Communication Arts. He lives in Tulsa, Oklahoma, with his wife and daughter.

ERIC MILLETTE has photographed everyone from world luminaries to CEOs, from U-2 pilots to an astronaut. He has created captivating portraits for a long list of clients, including Adobe, Bloomberg, Burberry, Charles Schrair, Forbes, Greylock Partners, Kiplinger's, LinkedIn, Salesforce, Splunk, Verizon, and The Wall Street Journal. He also cofounded the nonprofit photography organizations BigHornBlock and Editorial Photographers (EP).

APRIL WHITE is an award-winning writer, editor, and researcher who focuses on history and food. She is currently writing Divorce on the American Frontier and coauthored a shelf full of cookbooks, including her most recent, Lessons with Zest. She is an award-winning writer, editor, and researcher who focuses on history and food. Her work as a photographer has been published worldwide and recognized by American Illustration, 3x3 Illustration, and Communication Arts. He lives in Tulsa, Oklahoma, with his wife and daughter.

PHOTOGRAPH BY ERIC MILLETTE

TRANSMISSION
From the President of the Caltech Alumni Association

IN PURSUIT OF EXCELLENCE

As this year marks the 25th anniversary of my Caltech graduation, I have particular cause to reflect on the past and to look ahead. When I first arrived at Caltech in 1991, I could feel the aura of excellence. I still feel it when I walk the campus today, and when I engage with leaders, faculty, and staff. I especially feel it when I meet with you, fellow alumni. Each of us has something to bring to the table.

Our professions and interests vary, yet we are united by our technical foundation, early training in collaborative problem-solving, and pursuit of excellence. The Alumni Association is a prime example of what happens when we work together. Our board of directors is a passionate group I am proud to work with, and together with Caltech's exceptional Alumni Relations staff, we continue to make bold strides in improving the alumni experience. Additionally, I have Techers to thank for connecting me to my first job out of college, my last job, and my current position. I hope to contribute as much value to the network as I've been fortunate to receive.

This magazine illustrates our individual and collective excellence. In these pages you can witness how excited alumni are to share hard-earned expertise with students via new mentoring programs, learn from your fellow Techers' career transformations, entrepreneurship, and use of novel methods to answer scientific questions; and take pride in this year's Distinguished Alumni Award recipients.

We alumni play a significant role in ensuring Caltech's continued excellence. Our responses to the recent alumni surveys prompted initiatives that are helping Techers across generations develop in their careers. Our gatherings at Reunion Weekend, Seminar Day, and other events spark fruitful connections that advance entrepreneurship, research, and individual careers. Our leadership in the Break Through campaign is also helping Caltech continue to drive world-changing research, offer incredible educational experiences, and attract unprecedented support, such as the Breaks' recent $750 million pledge for sustainability science and innovation.

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CAMPUS HIGHLIGHTS

[January 14] CALTECH DEDICATES CALTECHER TO ADVANCE HUMANITIES AND STEM.
A Caltech-HP collaboration, Caltech Erato, a new humanities and STEM hub that will provide students with access to the vast collections of the Huntington Library. The initiative will catalyze conversations among historians, scientists, and engineers and promote dialogue between the humanities and STEM.

[January 21] NASA SELECTS SPHERES SPACE MISSION
A Cal Poly collaboration, SPHERES (Space Propulsion for the History of the Universe, Epoch of Formation and Islands of Science), will solve the key to spatial and social logic to study the birth of our universe. The cosmic history of our universe will be the realizable with new insights into the origins of water and the potential for life. Part of NASA’s Space Exploration Initiative, SPHERES will launch in 2023.

[February 1] CALTECH AND THE HUNTINGTON LIBRARY LAUNCH A RESEARCH INSTITUTE FOR THE HISTORY OF SCIENCE AND TECHNOLOGY
The new institute will create a new home for Caltech students to explore the history of science and technology, providing a unique opportunity to connect students with the world’s leading scholars and institutions.

[February 18] CALTECH LAUNCHES MERKIN INSTITUTE FOR TRANSLATIONAL RESEARCH
As leader of the institute, Mory Gharib (PhD ’83) will provide a unique opportunity for Caltech researchers to work on challenges that span multiple disciplines, from medicine to engineering.

[March 4] COMET INSPIRES RESEARCH FOR MAKING BREATHABLE OXYGEN ON MARS
The research, led by Caltech alums Bill Hiera and Freddy Sherman, will develop a new method for producing oxygen on Mars, a process that could have significant implications for human missions to the planet.

[March 11] CALTECH SCIENTISTS PROPULSE OBJECTS WITH LIGHT
Caltech researchers have developed a new method for propelling objects with light, a technology that has the potential to revolutionize space travel.

[March 18] RESEARCH FOR MAKING BREATHEABLE OXYGEN ON MARS
Caltech researchers have developed a new method for producing oxygen on Mars, a process that could have significant implications for human missions to the planet.

[April 1] CALTECH DEDICATES HAMEETMAN CENTER
The center is named in honor of trustee Fred Hameetman (BS ’62), who has been a long-time supporter of Caltech and its mission.

[April 8] THE SCIENTISTS ARE PROPEL OBJECTS WITH LIGHT
Caltech researchers have developed a new method for propelling objects with light, a technology that has the potential to revolutionize space travel.

[April 15] CALTECH’S REUNION WEEKEND AND SEMINAR DAY
This year, the Reunion Weekend and Seminar Day will feature a variety of events and activities, including a keynote address by Bill Nye and a performance by the Caltech wind ensemble.

[May 5] 125TH COMMENCEMENT
The commencement ceremony will be held on May 5, 2019, and will feature a keynote address by Gordon Murray, a long-time supporter of Caltech.

[May 12] DEXTER BAILEY IS NEW VP FOR ADVANCEMENT AND ALUMNI RELATIONS
Dexter Bailey will take on the role of vice president for advancement and alumni relations, a position that is critical to the success of the institution.

“Wherever you go, remember what brought you here. You had a vision of yourself, the big ideas that motivated you. Hold on to that.”
—France Cordova

[June 17] NEW POSTER HEART VALVE IS IMPLANTED IN FIRST PATIENT
The valve was developed by a team of Caltech researchers and has the potential to revolutionize the treatment of heart disease.

[July 21] RESNICKS PLEDGE $750 MILLION TO ADVANCE SUSTAINABILITY RESEARCH AND EDUCATION
Caltech trustee Robert Resnick and his wife, Lynda, have pledged $750 million to support sustainability research and education at Caltech.

[August 10] TIDEPOOL PROGRAM OFFERS MARINE SCIENCE OPPORTUNITY TO STUDENTS
The program, which is supported by a generous gift from the Andrew and Susan Aram double foundation, provides a unique opportunity for students to engage in marine science research.

[September 17] OTHERWORLDLY WOMEN HAVE THREE SEXES
A team of Caltech researchers has discovered new sexual forms in a group of water plants, opening up new possibilities for understanding the evolution of sexual diversity.

[October 10] THE SCHMIDT FOUNDATION SUPPORTS THE SCHMIDT CENTER FOR QUANTUM COMPUTING AT CALTECH
The new center will address fundamental challenges in reaching the full potential of quantum computing.

“Caltech has made substantial investments in both experimental and theoretical quantum science and technology over the years, and the new center will provide an extraordinary opportunity to maximize the impact of those investments.”
—David A. Tevd, Carl and Shirley Larson Provostial Chair and Ross ArCullen-Wallace Chair of Chemistry and Chemical Engineering

[November 22] CALTECH LAUNCHES SCHMIDT ACADEMY FOR SOFTWARE ENGINEERING
The academy, which is supported by a gift from the Schmidt Family Foundation, will provide a new opportunity for students to engage in software engineering and computer science.

[December 2] WOODY WRIGHT, FOUNDER OF SAPIEN TECH, SELECTS CALTECH AS FIRST INSTITUTE TO ADVANCE BIODIVERSITY IN THE OCEANS
Woody Wright, founder of SAPIEN Tech, has selected Caltech as the first institute to advance biodiversity in the oceans, a project that has the potential to revolutionize the field of marine science.
Thanks to Techers and other friends, Break Through: The Caltech Campaign is making a tremendous difference across the Institute. Break Through aims to secure Caltech’s future as a source of transformative discovery for the world. Drawing on experiences on campus and as alumni, graduates protect the qualities that make Caltech special, strengthen its reputation, and help it evolve for the better. The strong, multifaceted involvement of alumni in the campaign inspires others to give. And every gift to Caltech, its people, and its programs during the campaign is a Break Through gift.

**STRENGTH IN NUMBERS**

- More than $1.13 billion in new gifts and pledges, FY19
  - $2,860,035,125 total gifts and pledges
- Largest ever commitment to Caltech: $750 million pledge from Lynda and Stewart Resnick for environmental sustainability research
- 38% of donors are lifetime Caltech supporters
- 41% contributed
- 59% endowed

Break Through public launch: April 2016

**FELLOWSHIPS:**

- 169 Graduate Students every year
- $241 million endowment raised

“Fellowships … are tremendously important for Caltech and our students. They give PhD students the freedom to focus their energy on studies and research.”

—RIP THORNE (BS ’42)
Fellowship donor and Caltech’s Richard P. Feynman Professor of Theoretical Physics, Emeritus

“[F]ellowships are tremendously important for Caltech and our students. They give PhD students the freedom to focus their energy on studies and research.”

—CALTECH TRUSTEE RICHARD MERKIN
Resnick Sustainability Institute

“[I] hope that just having my name on this gift will show female students that they can have successful careers and give back.”

—DONNA WEISTROP (PhD ’71)
Donor of the David Shaffer and Donna Weistrop Discovery Fund in Astronomy

**SCHOLARSHIPS:**

- 77 Under-Graduates every year
- $80 million endowment raised

“Fellowships … are tremendously important for Caltech and our students. They give PhD students the freedom to focus their energy on studies and research.”

—KIP THORNE (BS ’62)
Fellowship donor and Caltech’s Richard P. Feynman Professor of Theoretical Physics, Emeritus

“Fellowships … are tremendously important for Caltech and our students. They give PhD students the freedom to focus their energy on studies and research.”

—DANIELA BONAFEDE-CHHABRA (BS ’84)
Scholarship donor

**STUDENT SUPPORT**

Financial aid allows outstanding students to choose Caltech and excel on campus.

**WORLD-CHANGING RESEARCH**

15 Institutes, Centers, or Initiatives Established or Amplified, including:

- Tianqiao and Chrissy Chen Institute for Neuroscience at Caltech
- Richard N. Merkin Institute for Translational Research

“I am hopeful that this Institute will encourage exponential improvements for society by accelerating the transfer of groundbreaking science from Caltech’s world-class laboratories to the bedside.”

—Caltech trustee RICHARD MERKIN

“In order to comprehensively manage the climate crisis, we need breakthrough innovations, the kind that will only be possible through significant investment in university research.”

—CALTECH TRUSTEE STEWART RESNICK

**ONE DEPARTMENT ENDOWED:**

- Andrew and Peggy Cherng Department of Medical Engineering

**FREEDOM TO INNOVATE**

Endowments help Caltech leaders nurture high-potential initiatives and fledgling innovations.

- Leadership Chairs: 22 Leaders supported
  - $168 million endowment raised

“I hope that just having my name on this gift will show female students that they can have successful careers and give back.”

—DONNA WEISTROP (PhD ’71)
Donor of the David Shaffer and Donna Weistrop Discovery Fund in AdvaNanop

**CAMPUS ENHANCEMENTS**

6 Building and Renovation Projects

- Ronald and Maxine Linde Hall of Mathematics and Physics

**ALL FIGURES IN THIS REPORT REFLECT CAMPAIGN TOTALS AS OF 09/30/19**
Lure of the Rings

A new hyperrealistic computer simulation of underwater bubble rings—the kind often created by scuba divers—may shed light on the mathematics and forces that govern such phenomena. “When we make these abstractions, we still want to capture some fundamental truth about the universe,” says Peter Schröder, the Shaler Arthur Hansch Professor of Computer Science and Applied and Computational Mathematics, whose team built the simulation. “What drives me is finding these beautiful descriptions of something that looks terribly complicated but can be reduced to a few mathematical key concepts. Then the rest just follows from there.”

IMAGE: PETER SCHRÖDER/MULTI-RES MODELING GROUP
[ Transforming ]

INNOVATION

DISCOVERY CHANNELS

HOW ARATI PRABHAKAR AIMS TO TRANSFORM OUR INNOVATION ECOSYSTEM

BY APRIL WHITE

PHOTOGRAPH BY ERIC MILLETTE
Former Defense Advanced Research Projects Agency (DARPA) director and Caltech Distinguished Alumna Arati Prabhakar (MS ’80, PhD ’85) is ready to take on the biggest research and development challenge of her career: reinventing innovation. Rapidly advancing technology gives us the capacity to solve some of the greatest societal challenges facing the United States in the 21st century, she says, but only if we can quickly build a new innovation ecosystem as robust as the one we built for yesterday’s problems. “We’re seeing a turning point, a broad societal understanding that we have to act with urgency,” Prabhakar says. And she’s already gotten started. In 2019, Prabhakar founded the nonprofit Actuate, an experiment in building a new model for developing breakthrough technologies she describes as a “DARPA for the nonprofit.”

What shaped our current innovation ecosystem? The pivot point in research and development in the United States was World War II, when we discovered the foundations of biomedicine, and national security, technology, and the brighter future it could offer. It’s no accident that the things we are still very good at innovating for are information technology, national security, biomedicine, and the foundations of basic research. But now it is 75 years later, and it’s time to think about the challenges of the next era.

What are those challenges? Improving access to economic opportunity, lowering the exorbitant cost of health care, ensuring trustworthy data and information, and addressing climate change. We haven’t built effective innovation capacities in these areas because they haven’t been a priority to this point. The information age has opened up opportunities for us to understand and influence deeply complex systems. Using the data revolution and reasoning about causality to understand social systems is a particularly tantalizing prospect. Are the country’s innovators prepared to address these challenges? Since I left DARPA, this is what’s been on my mind. We need a generational shift in how we think about research and development, and that’s not going to happen overnight. There are already very interesting solutions emerging from research that can make a real impact. But how do you tie those pieces together and accelerate this generational shift? I think the shift will emerge naturally, but it would be nice if it emerged in 20 years instead of 50 years.

What are the potential drawbacks to turning to technology to solve societal issues? Technology is a raw power; that’s true of nuclear technology and it’s true of the internet. And history shows us that every power can be used for good and for evil. I do think that, over time, as societies deliberate about how to harness all the pieces of our innovation ecosystem—ivory-tower researchers, companies, and governmental resources—to solve hard problems that were critical in turning the course of the war. It’s no accident that the things we are still very good at innovating for are information technology, national security, biomedicine, and the foundations of basic research. But now it is 75 years later, and it’s time to think about the challenges of the next era.

What role do you hope your new venture, Actuate Innovation, will play in this evolving innovation ecosystem? We are an organization that raises funds, primarily philanthropic, and uses those funds to design and execute research programs with two focuses. First, we run research initiatives that can demonstrate potentially powerful solutions to societal problems. And second, in doing that work, we have an opportunity to model what the process of innovation can look like, because it’s not going to look like the last century of research and development. If you said the word “research” to someone in 1945, they pictured a scientist in a lab coat with a beaker full of chemicals. But today’s research is more than that. One of our initial programs will use research from cryptography, math, and computer science to create a new open-source platform for managing data in a way that allows researchers to link and use powerful data sets while protecting privacy. It’s so exciting. Think about how much better we could be at delivering health solutions, at educating our kids, at designing public policies to address everything from homelessness to the criminal justice system. The list is endless if we can harness what the data can tell us.

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Why do you think philanthropy has a bigger role to play in the next era of research and development? There’s an opportunity here for philanthropy to step up. The kind of research we want to do is not going to be the stuff you can raise private capital for. It is going to be too risky, without viable markets. But if we’re successful, these philanthropic investments will create opportunities for governmental and commercial innovation. Philanthropy is a very important first step in this generational shift in R&D. It can fundamentally enable bigger, better solutions to our problems.
How Caltech alumni are shaping the big-data approach to health care

An infant with a congenital heart defect, an elderly man undergoing radiation treatment for head and neck cancer, and a young woman with infertility concerns: Each of these people could live a longer and healthier life thanks to entrepreneurial endeavors powered by big data and led by Caltech alumni. With innovative solutions that include everything from faster medical testing to artificial intelligence-assisted analysis, these start-ups are helping reshape the healthcare system for doctors and patients, one data point at a time.

BY APRIL WHITE

ILLUSTRATIONS
BY JULIEN PACAUD

CODEBREAKERS
“The more data we have, the more we can learn from it. The more we learn, the more we can improve health care.”

Recalculating Cancer Treatments

Every year, the top U.S. cancer centers collect medical information on hundreds of thousands of patients. "Current AI applications show the potential to offer insights that could lead to new courses of treatment and improved outcomes," says Christopher Herfind (BS '11).

"At Columbia Medical Center doctors put on virtual reality goggles to view Virtualitics' 3-D landscapes," says Amori (MS '07). "You need to consider what stage the cancer is, how old the person is, how long they've had cancer, and more."

When Columbia Medical Center doctors put on virtual reality goggles to view Virtualitics' 3-D landscapes, they gained a whole new perspective. They could even watch the data around them change over time.

Most important, Virtualitics' AI could direct the doctors to patterns that they otherwise might have overlooked in the vast amounts of data. "It's the interplay between AI and 3-D visualization in virtual reality that allows us to really see the insights in the data," Amori says.

Amori first encountered the technology he would adopt for Virtualitics at a time when he met George Djorgovski, director of the Institute's astrophysics group. "That's why no one had done it before," recalls Amori. "Because not every institution has the infrastructure to capture high-quality data, One scans the images in three spatial directions, so that the technology could be a boon in that sector as well. Together with Djorgovski, then-Caltech computational scientist Oiyon Bonakdor, and Scott Dorrid of the Jet Propulsion Laboratory, Amori launched Virtualitics in 2015 with the goal of bringing the technology to market in the coming years. It's a part of a broader trend toward consumer engagement with health care. "There's a change under way in how people interact with their health care," Brenner says. "They're much more proactive. They're fed up with not having answers, and they want to take control."

The data collected by bludiagnostics will allow a woman's physician to make diagnoses and monitor the impact of treatments in real time. It also could contribute to more significant advancements in the medical understanding of women's health, a traditionally understudied topic. With users' permission, anonymized bludiagnostics data will be used for "research to better women's health and to illuminate new pathways for diagnosis and treatment of women's health conditions.""We want women to have better options in the future."
Finding My Muse
Why I walked away from a successful career as a scientist to follow a calling to write

By Joram Patiogorsky
Illustration by Fabio Consoli

I doubt that my mother, the French sculptress born Jacqueline de Rothschild of the banking dynasty famous for their art collections, or my father, the renowned Russian cellist Gregor Piatigorsky, would have been surprised by my switch from science to writing. My parents lived art and knew nothing about science—my father, for example, fantasized about whales, elephants, and snakes as castles in the air, not matters of biology. Thus, I grew raised seeing the natural world tinged with magic and filled with mystery and beauty, a poetry of sorts, as well as an infinite challenge and never complete.”

As science and fiction blended as narratives in my mind, I wanted to write a more personal memoir through an artistic lens. However, I wondered, who would be interested in a privileged government scientist who had never experienced hardship? Marcel Proust came to my rescue. It was impressed by his extraordinary autobiographical novel, *In Search of Lost Time*, which is based on what I considered to be relatively uneventful experiences, such as intersexual social salons, visits to museums, and agonizing over sexual conflicts. I realized that it is not the events, but the personal reactions of the author that make a story compelling. What I chose to write about in my memoir, then, were instances stored in my mind that had changed me. These included my amazement when I first glimpsed the magnifying power of the clear eye lens, my awe when a tuna jellyfish—soon followed by others—eaten majestically at night toward a light by the deck in Las Parguas, Puerto Rico, the time Albert Einstein, the scientist I adored, told me when I was a novice graduate student at Woods Hole, “Only real scientists would be playing hooky at the beach on such a beautiful sunny day”; my curiosity when Professor Leigh Roodley asked the embryology class at Harvard, “What do you think would happen if a fertilized frog egg were less than half be cut in half?”; and my pride when my father, after he had played a concert with Zubin Mehta at the Casals Festival, played his own melody on his violin, which happened when a fertilized frog egg is cut in half, and the details of the concert my father played—of all, all the transient, personal moments outlasted the events themselves. So, I wrote my memoir, *The Speed of Death*, to reflect on these and other special happenings.

Today I devote my time to writing and exploring new careers outside academia. Prize funding—up to $65,000—gives winners the freedom to develop leadership skills and pursue projects that will have positive impacts on society. In October, Caltech announced the 2019 winners of the Chang Prize.

Preethi Periyakoil
(PhD ’18, computer science)

A neuroscientist, author, speaker, and meditation teacher, Periyakoil aims to combine her diverse skills to help rehabilitate women who have been incarcerated. She used funding from the Chang Prize to develop a program called “Beyond the Cell” to assist people who have experienced mental, physical, or emotional trauma.

“This opportunity provides imaginative freedom to create ‘Beyond the Cell,’” says Tetreault, who describes the work as “a transformative program to rehabilitate incarcerated women through teaching guided meditation, neuroscience, literature, and expressive writing to cultivate positive mental, verbal, and behavioral patterns for healing.”

Joram Patiogorsky is a retired scientist turned writer. His new collection of short stories, *Notes Going Underground*, will be published this year.
Etched in Your Mind

The key to lasting memories, Caltech researchers have determined, is teamwork. When recollections are encoded by "teams" of neurons firing in unison—as illustrated above—it helps memories persist over time. "For years, people have known that the more you practice an action, the better chance that you will remember it later," says Carlos Lois, research professor of biology, whose lab conducted the study. "Our results suggest that increasing the number of neurons that encode the same memory enables the memory to persist for longer."
Ready to Rumble
How Andrea Donnellan brings fault lines into sharper focus

BY ALEXANDER GEIFAND

PHOTOGRAPH BY CHRISTINA GANDOLFO

When the first of two powerful earthquakes struck near the town of Ridgecrest, some 100 miles northeast of Los Angeles, this past July, geophysicist Andrea Donnellan (PhD ’91) was scuba diving in Hawaii. As a principal research scientist at the Jet Propulsion Laboratory who studies the underlying dynamics of earthquake faults, Donnellan receives automated quake alerts and knows a lot of earthquake experts. So news of that first Ridgecrest quake reached her fast. “I surfaced, and I had 85 text messages,” she says.

Donnellan was soon back in California and out in the field, using a drone to take aerial photographs of a section of the fault system that generated the Ridgecrest quakes, which caused billions of dollars in damage. By periodically taking additional photographs of the system’s surface and manipulating the images with software, she plans to create three-dimensional topographic maps of the area as it changes over time. This type of information, along with measurements from GPS stations and orbital imaging satellites, helps Donnellan understand how the earth’s crust deforms through the movement of the vast tectonic plates deep below its surface. Other scientists use her findings to generate earthquake forecasts that help shape disaster plans and focus seismic retrofitting efforts to make buildings earthquake-resistant, saving both lives and money.

Shaky ground
Earthquakes in California are caused by the motion of the Pacific and North American plates—the world’s two largest plates, covering nearly 70 million square miles—as they grind past each other and fracture the earth’s crust to form faults. When opposite sides of a fault slip violently against one another, the earth literally moves beneath our feet. Measuring how many millimeters a fault slips or how many centimeters a mountain grows in the wake of an earthquake helps Donnellan develop computer models of fault behavior: how faults capture, accumulate strain, and even heal over time. “I look at the surface motion,” she says. “From that, I model what’s going on at depth.”

These models allow Donnellan to tease out the mechan- ics of what’s happening miles underground. They also improve our ability to gauge the risk of future earth- quakes, such as the catastrophic Big One that experts believe will inevitably strike the San Andreas Fault, so that we can better prepare for them.

With enough high-quality data, Donnellan can deter- mine whether a fault system is likely to produce earth- quakes at all and, if so, how big they might be.

Digging deep
Donnellan wasn’t always interested in earthquakes. She started off studying the motion of ice sheets in Antarctica, and her work in glaciology proved so sig- nificant that a glacier now bears her name. But when the magnitude-9.3 Whittier Narrows earthquake struck Southern California during her first semester of PhD studies at Caltech, Donnellan switched her focus to faults.

For her doctoral thesis, Donnellan used GPS data to analyze a large fault system in California’s Ventura Basin. It was groundbreaking work. At the time, researchers had to lug 90-pound GPS receivers powered by car batteries up mountainsides to gather just a few data points per year.

It was also prescient. Donnellan and several colleagues estimated that the Ventura Basin could generate a 6.4 magnitude temblor, and, within two months, the magni- tude-6.7 Northridge earthquake struck the San Fernando Valley along one of the faults she had modeled.

Donnellan is quick to point out that she did not predict when and where the earthquake would occur. No one could have. Experts have gotten better at estimating whether a quake might occur within a fault system within the next 10 years, but predicting that a tremor will strike a specific location on a specific date remains impossible. And the higher the magnitude, the more difficult forecasting becomes. “The big ones are hard,” Donnellan says.

The future of forecasting
Improving forecast accuracy is possible, Donnellan says, but it requires better data and a deeper understanding of the physical processes associated with earthquakes. And Donnellan sees progress on both fronts.

Rather than relying on sparse GPS data alone, Donnellan now can feed her models continuous measurements gathered by a network of more than a thousand GPS stations, along with optical and radar imaging data from airplanes, satellites, and drones. Advances in computing power allow her to run many of her simulations on a laptop rather than a supercomputer, while machine learning and data mining reveal patterns in her data that weren’t visible before.

“I embrace new technologies and see them through— from difficult-to-use and error-prone to operational and scientifically mainstream,” she says.

All of this helps Donnellan see more clearly into the earth. Using radar images and computer modeling, for example, she and her colleagues showed the connection of a fault system that extends all the way from northern Mexico to Southern California. The researchers also gained new insight into how earthquakes transfer stress from one fault to another—findings that could improve estimates of whether a quake south of the border might trigger one in Los Angeles.

The planned launch in 2022 of a new radar satellite that will provide unprecedented global coverage of changes in the earth’s crust will only make things better. (The sat- ellite is being developed through a partnership between NASA and the Indian Space Research Organization, with JPL managing and implementing NASA’s contributions.) “That will give us a fire hose of data,” Donnellan says. And it just might make the science of earthquake forecasting a little less shakey.
Caltech alumni at JPL have starring roles in the dramatic three-act play of the Mars 2020 mission: Send a rover to the surface of the Red Planet, collect samples, and bring them back to Earth. Success could advance our understanding of the planet’s history—and its potential for future human exploration.

BY STEVEN BOYD SAUM
EXPLORATION

It’s a warm autumn day in Southern California, but inside a pair of buildings on the campus of the Jet Propulsion Laboratory, liquid nitrogen floods the walls and conditions are distinctly chillier—hovering around −80° Celsius. The air pressure is a fraction of Earth’s, and the atmosphere is mostly carbon dioxide.

Those are exactly the conditions that the Mars 2020 rover will find at its ultimate destination. It’s the most ambitious Mars mission yet, and JPL—which is managed by Caltech for NASA—is running the show.

Today is the last day of testing for the rover. “We’re putting the vehicle through some day-in-the-life stuff,” says Adam Steltzner (MS ’91), chief engineer for the mission. “We’re very much in the thick of it now.”

For the project engineers and scientists, the pressure is considerable. By February, the rover will ship to Cape Canaveral. Meanwhile, two anomalies have been discovered: one in the battery control board, and the other in the robot-powered sampling system designed to collect dozens of Martian samples that will be brought back by another craft on a future mission.

In Building 248, where that sampling system is being put through its paces, Steltzner watches as a couple of engineers send commands to the robots to take another swing at moving the drill bit into the round clamp that holds it while it does its work. That sampling system is ambitiously complex, comprising three—or—depending on whom you ask—four robots. On Mars, no humans will be able to tinker with it hand-on, so that’s not allowed during testing, either. The first time around, the drill bit didn’t slip in as easily as expected. “As the first sampling tube was put into the bit, the forces were about 10 times higher than we anticipated,” Steltzner says.

The rover’s drills and sample tubes also have to be designed to avoid contamination from Earth. And that hypercritical requirement poses challenges. First, expose a perfectly clean titanium sample to air, and within seconds particles will begin to accumulate on its surface. Second, almost everything we know about friction is based on how materials behave in Earth’s atmosphere. So what was the problem with the bit? “We don’t know whether to attribute it to dust or to changes in the friction coefficients between the various hardware elements,” Steltzner says as he buffalo the door from Building 248 to a meeting to figure it out next moves for the drill. “Testing is an act of humility,” he said.

In 200 minutes, seal it up, and move on. The new system is 100 percent autonomous—and I can assure you I’m always looking around the corner, constantly questioning whether you’re making a good decision, whether you have the right people doing that work, or whether you’ve done enough testing in this domain—that comes with the territory,” Wallace says. “If you’re not doing that, then you’re probably not doing it right.”

Matt Wallace (MS ’91) / Deputy Project Manager

“Light, Camera, Action”

We can thank Matt Wallace (MS ’91)—and his daughter’s love of gymnastics—for the rover’s array of cameras. When she was about 9 years old, she saw videos of gymnasts doing flips wearing GoPro-style cameras. “She said, ‘Dad, I want one of those!’” Wallace says. “He saw her in action with it and thought, ‘We really need one of those on the spacecraft.”’

Wallace is deputy project manager for Mars 2020. The EDL cameras (for entry, descent, and landing) are designed all over the spacecraft, to look up at the parachutes deploy and the propulsion system fires, and down as the rover descends. “For the first time ever, we’re going to have high-definition videos of a spacecraft landing on another planet,” Wallace says.

In addition to the cool factor, there is of course some valuable engineering knowledge to be gained. Mars 2020 is meant to be a precursor to human travel. Spacetime material will go along for the ride to test for radiation exposure. Additionally, the Mars Oxygen In-Situ

Resource Utilization Experiment (MOXIE) will employ electrolysis to convert CO₂ into oxygen, which could be used for both rocket fuel and breathing.

Some tech used in 2012 turned out not to be as plug-and-play as expected. The heat shield cracked early in testing; a new one had to be built. The supersonic parachutes turned out to need an upgrade; they’re the same size as Curiosity’s—21.5 meters in diameter—but with a stronger canopy, and they show the rover’s descent from 1,000 mph to around 200 mph before the sky crane takes over. As for the anomalies: “Always looking around the corner, constantly questioning whether you’re making a good decision, whether you have the right people doing that work, or whether you’ve done enough testing in this domain—that comes with the territory,” Wallace says. “If you’re not doing that, then you’re probably not doing it right.”

Adam Steltzner (MS ’91) / Project Chief Engineer

NASA’s Mars 2020 will land in Jezero Crater, shown here. The image was taken by instruments on NASA’s Mars Reconnaissance Observer robot, which regularly takes pictures of potential landing sites for future missions.

From the Daily Californian; NASA/JPL-Caltech/ASU
INTO THE DELTA

When the rover lands, the engineering team will hand over the keys to the science team. The landing site is Jezero Crater, an ancient lakebed about 40 kilometers across, where a one-time flowing river formed a delta rich with sediment. From Jezero, the rover may head into highland terrain known as Northeast Syrtis, which has its own distinctive geology. For project scientist and Caltech's W. M. Keck Foundation Professor of Geochemistry Ken Farley, it's an unprecedented opportunity to learn about the history and geology of the Red Planet. Here on Earth, deltas are good places to find fossilized evidence of past life.

Farley headed Caltech's Division of Geological and Planetary Sciences for a decade. It was in his lab that a now widely practiced technique was developed to use helium isotopes and other noble gases to establish the cooling and exhumation history of rocks. Farley describes his groundbreaking work in deceptively simple terms. “I do things like geochronology,” he says. “I date rocks.” One key instrument for that is a mass spectrometer that uses a 1,000-pound magnet. The spectrometer can't go to Mars, so Mars is coming to the magnet in the Mars 2020 sample tubes—where they'll be investigated by the full arsenal of a terrestrial lab and its experts.

We know a couple of things already. Farley says. “Mars had a traumatic climate change event. There were rivers, lakes, glaciers, all sorts of features that certainly don’t exist today.” What happened? To try to answer that question—and others scientists don’t yet even know to ask—the rover will take samples from about 35 locations and rock types. NASA is presently considering a plan that could have samples back on Earth as early as 2021. Then, Farley says, we’ll face a deeper question. “How do you look for life as you don’t know it?”

ART OF THE POSSIBLE

At the end of the day, over the hills above JPL, a couple of canary-yellow Canadian Super Scooper planes fly by, carrying water to dump on wildfires burning to the west. Adam Steltzner huddles to pick up his four-year-old son from the JPL’s early childhood education center. (Steltzner is a father of three, with two older daughters.) He has his rover—a mid-spattered SUV mid-’80s vintage, with off-road tires and jerry cans on the back. U2’s “Beautiful Day” is playing on the radio.

“When we start a mission, we have a pretty good idea of the thing that needs to be done, but it’s imperfect,” Steltzner says. “As the mission progresses, our understanding of exactly what we need to accomplish and how to do it evolves and improves.”

The fact that the samples from Mars 2020 will come back to Earth gives this mission a whole new dimension. “We don’t have to cluelessly ask the questions we need to ask,” he says. New questions can be posed as scientists test the samples. “We can have the full impunity of this nation to answer them. People who look at the sampling system think it’s far too ambitious. I agree. We have a standing invitation to the universe to teach us how to do this more simply.”

Meanwhile, Sarah Milkovich (BS ’90) and her team, who are working(0,5),(999,995)
Moran Cerf (PhD ’09) started his career as a hacker: first to improve his own video gaming, and later for the Israeli army and private security firms. “I am still a hacker,” says the professor of neuroscience and business at Northwestern University, “just with a different black box to peer into: our human brain.”

For the last 15 years, Cerf has investigated how people think, feel, make decisions, and dream by eavesdropping on the activity of neurons in their brains. This research could lead to the creation of devices controlled entirely by thought and allow scientists to reprogram people’s brains to help them change negative behaviors.

For a hacker like Cerf, the first challenge was to find a way to glimpse the inner workings of the brain. To peer inside a living brain, Cerf’s mentor, then-Caltech professor Christof Koch, established a collaboration with neurosurgeons who were using an innovative new treatment to help patients with severe epilepsy. The doctors opened patients’ skulls, attached electrodes directly to the brain, and left them in place for several days to capture data on the next epileptic seizure. During this period, the patients participated in a thought-mapping experiment in which Cerf showed them pictures and observed how their brains reacted. When a patient saw images of her mother, for example, certain cells in her brain were activated repeatedly. The same was true if the patient simply thought about her mother.

This thought-mapping approach led Cerf to think about decoding additional narratives created by the brain—including aspects of dreams that have long mystified humankind. “Dreams are something humans have been enchanted by since the dawn of time,” Cerf says. “But even Freud and Jung, who are the epitomes of dream researchers, could only study the stories you tell when you wake up from your dreams.”

Now, instead of waiting for people to wake up and describe their dreams, Cerf and other scientists are trying to watch neurons fire in the brain to understand what sleepers are dreaming about. It is a first step toward influencing the unconscious, Cerf says. Already, some researchers have discovered that dreams can be affected by outside stimuli. For instance, if you spray the smell of rotten eggs at the right moment during the sleep cycle, the subject will report having had a bad dream. The scent of roses will nudge the dreamer toward a positive one. Other olfactory cues can steer dreams to specific memories and, at times, specific thoughts and ideas that can then influence awake behaviors.

The ability to change behaviors is powerful, Cerf says, and as the science advances, society will have to think carefully about its consequences. “Imagine that someday we could give people full access to their dreams,” he says. “Scientists could then rewrite the script for those who relive trauma in their sleep, or use dreams to deliver narratives.” He imagines giving people control over their dreams, a kind of virtual reality played out inside the brain. “That said, that same technology could be used for commercial purposes,” Cerf cautions. “Many companies are already after our attention and choices. In the wrong hands, this could help people back into our minds. Your brain is programmable. If you don’t program it, someone else will.”

Cerf’s work is driven by big, fundamental questions such as: What is consciousness? And, can we explain how dreamed content and experiences can change our personality? He is the first to admit that his research sometimes sounds like science fiction. “But the difference between science fiction and science,” he says, “is timing.”
The Life of Clouds

A study that used supercomputers to simulate clouds and their motions raises new concerns about climate change. The issue: Marine stratus clouds could face extinction if atmospheric carbon dioxide (CO₂) concentrations get too high. And without the clouds’ cooling effect, the planet’s surface temperatures would rise. “I think and hope that technological changes will slow carbon emissions so that we do not actually reach such high CO₂ concentrations,” says lead author Tapio Schneider, Theodore Y. Wu Professor of Environmental Science and Engineering, senior research scientist at JPL, and head of the Climate Modeling Alliance (CliMA), a multi-institutional consortium that is building a new climate model. “But our results show that there are dangerous climate change thresholds that we had been unaware of.”
THE 2019 DISTINGUISHED ALUMNI AWARDS

Caltech recognizes five graduates who have become respected leaders in fields ranging from astronomy to entrepreneurship.

First presented in 1966, the annual awards recognize a particular achievement of extraordinary value, a series of such achievements, or a career of extraordinary accomplishment.

PHOTOGRAPHS BY MARIO DE LOPEZ

ANNEILA I. SARGENT

[MS ’67, PhD ’77, ASTRONOMY]
Ira S. Bowen Professor of Astronomy, Emeritus, Caltech

For her contributions to our understanding of how stars and planetary systems form and evolve, her dedication to expanding observatory capabilities for the scientific community, and her national and international leadership in her field.

Anneila Sargent is among the most respected astronomers in her field, and as she reflects on her career, she expresses deep gratitude about her trajectory. “I was amazed to be admitted as a graduate student to Caltech,” she says. “I was amazed to become a tenured professor. And I am even more amazed to be a distinguished alumna. It’s a series of amazements.”

Like most astronomers, Sargent keeps a largely untraditional schedule. She often labors into the early morning to analyze data from late-night telescope sessions, a task that was even more challenging during the early years of her career as she parented her young children. “I would do my computing in the office—there were no laptops then—and eventually I would go home because the babysitter had to leave,” she recalls. “I’d come in the next morning to finish up.”

The juggling act had its challenges, but she excelled. She went on to pioneer the use of rapidly advancing technologies to understand how stars and planetary systems form and evolve over their lifespans. The advances she made in millimeter-wave astronomy, a cutting-edge field at the time, helped illuminate inflection points in very early stellar evolution as well as potential sites for planetary formation. “It was wonderful to be on the ground floor of something,” she recalls.

In addition to making groundbreaking discoveries, Sargent has directed Caltech’s radio observatories and helped shape international millimeter-wave astronomy through her leadership on various boards. She has served as chair of both the National Research Council Board of Physics and Astronomy and NASA’s Space Science Advisory Committee, and was appointed to the National Science Board by President Obama.

Sargent is a fellow of the American Academy of Arts and Sciences and an honorary fellow of the Royal Society of Edinburgh. She received NASA’s Public Service Medal, and asteroid 18244 Anneila was named in recognition of her achievements. The accolades and professional recognition are rewarding, she acknowledges, but her drive to succeed comes from within. “I like interesting problems,” Sargent says. “I like finding things that nobody has ever imagined before.”

TECHER
EMILY A. CARTER
[PhD ’87, CHEMISTRY]
Executive Vice Chancellor and Provost, UCLA

For her visionary leadership in sustainable energy and engagement with the broader scientific community and for her development of powerful theoretical methods based on quantum mechanics that have greatly influenced chemistry and engineering.

When Emily Carter studied under the tutelage of legendary chemistry and applied physics professor Bill Goddard (PhD ’65) at Caltech, she did more than advance her knowledge as a theoretical physical chemist—she internalized a philosophy that continues to guide her today. “Bill Goddard taught me that it’s not enough to generate data,” she says. “You should extract insights from the data that can change the way that people think. It’s great to dare to go out on a limb.” Her life’s work has embodied that fearlessness and ambition.

Carter’s research has included nuanced investigations of fuel cells, biofuels, and lightweight metal alloys, all linked to sustainable energy production. Her findings have helped scientists understand the fundamental process used in solar fuels applications. In addition to breaking new ground throughout her career, she has broken glass ceilings. In 2017, she became the first woman to receive the prestigious Irving Langmuir Prize in Chemical Physics from the American Physical Society. A year later, she was the first woman to receive the American Chemical Society Award in Theoretical Chemistry.

Her 15-year tenure at Princeton University included serving as founding director of the Andlinger Center for Energy and the Environment, where she oversaw an interdisciplinary and innovative program of research that was committed to finding sustainable energy solutions for the world. From 2016 to 2019, she was dean of the School of Engineering and Applied Science.

In the public sphere, Carter has been a powerful advocate for science education. She has dedicated decades of her career to understanding the hepatitis C virus (HCV), which affects 71 million people worldwide and results in 400,000 deaths annually. Around this same time—the early 2000s—Rice was returning to The Rockefeller University, to continue his studies of HCV and pursue his vision to cure the disease. In 2016, Rice and his team were recognized for their work on a new course of treatment that cures hepatitis C in almost all cases.

The American Association for the Advancement of Science, and a recipient of the Benjamin Franklin Medal in Chemical Sciences, a fellow of the National Academy of Sciences, a fellow of the American Academy of Arts and Sciences and the American Association for the Advancement of Science, and a recipient of the Benjamin Franklin Medal in Chemical Sciences, a fellow of the National Academy of Sciences, a fellow of the American Academy of Arts and Sciences and the American Association for the Advancement of Science.
WILLIAM (BILL) DALLY
(PHD ‘86, COMPUTER SCIENCE)
Chief Scientist and Senior Vice President of Research, NVIDIA
Professor of Computer Science and Electrical Engineering, Stanford University

For his significant contributions to the architecture of interconnection networks. He developed much of the technology found in modern interconnection networks, including wormhole routing, virtual-channel flow control, global adaptive routing, modern network topology, deadlock analysis, performance analysis, fault-tolerance methods, and equalized high-speed signaling.

To Bill Dally, few fields felt as dynamic and transformative as computing in the mid-1980s. “The technology was improving so rapidly that not things became possible every year that hadn’t been possible just a few years before,” he says. So, when he went looking for a PhD program that would connect him with some of the most important ideas in the field, he chose Caltech. Dally was inspired by the pioneering contributions of Carver Mead (BS ’56, MS ’57, PhD ’60) to very large-scale integration (VLSI) technology, a process that greatly increased the number of transistors that could be placed on a semiconductor chip. At Caltech, Dally worked with Charles Seitz on multiprocessors. After earning his degree, he joined the faculty at MIT, where he focused on fundamental issues in parallel computer systems that demonstrated fast-communication and synchronization mechanisms.

Dally also created much of the underlying theory for interconnection networks. Later, at Stanford, he developed stream processing, which led to a graphics processing unit (GPU) computing. He also constructed accelerators that enhanced the performance of deep learning and bioinformatics applications, including the rapid assembly of genomes. Even though Dally’s academic pursuits centered on fundamental theory, he often had an eye to practical applications. Together with classmates, he founded his first start-up while still at Caltech, and he founded three others before landing at the technology company NVIDIA.

At NVIDIA, Dally has helped pioneer advances in deep-learning platforms that support everything from image analysis to language translation to self-driving cars. “Here, you get to see ideas go from theory to prototypes to the lab to real products for real people,” he says. He sees enormous promise but left much to be proven. In the 1960s and 1970s, Blum became a pioneering entrepreneur in this field. He founded GigaBit Logic, the first GaAs digital circuit company, and cofounded Nitres, a venture company that developed world-leading GaN LEDs for lighting. He eventually sold Nitres to Cree, which became a preeminent LED lighting manufacturer. Semiconductor GaAs and GaN devices have grown to be a $40 billion industry.

Critical infrastructure enablers of much of today’s digital world, their revolutionized cell phones and fiber optic communications, enabled internet networks, and made high-efficiency LED lighting possible. They also were the basis for Nobel Prize in physics awarded in 2000 and 2014. (Two awardees had been university consultants to Blum’s organizations at Rockwell and Nitres.)

Now retired, Blum gives back as CEO of his nonprofit, Tullium Research, which supports the integration of biology and neuroscience into the social sciences.

From the beginning, Blum’s aim has been to pursue meaningful work with curiosity and ambition. “In the 20th century, we mastered the physical sciences and brought unimaginable changes to the way we live, move, travel, and work,” he says. “In the 21st century, we will master the life sciences, bringing on unimaginable changes in 10 years, how we think, and how we relate and govern.” I have spent my life in search of centerfield, hoping I would make a difference to society and mankind.”
When Caltech’s Department of Computing + Mathematical Sciences started thinking about how to connect students to alumni, they decided to buck the trend of traditional high-end mentoring programs, in which alumni act as generals for all things post-graduation. Instead, they developed the CMS Mentoring Program, which connects students with mentors who offer more specific guidance. For example, one mentor may help with presentation or interview skills, while another might offer insights into a potential employer.

The program launched in February 2017, and, thanks to an endowment recently funded by Phil Naecker (BS ’76), it now boasts 25 alumni mentors who come to campus several times a year to spend one-on-one time with everyone from undergraduates to postdocs to other alumni.

“Our alumni have incredible networks and know a ton about industry, so to have them come here to offer advice and open their networks is so valuable,” says Claire Ralph, who directs the program as well as Caltech’s Career Development Center. “Alumni can be really great allies to the current student body.”

Career Development Center. “Alumni can be really great allies to the current student body.”

We asked Adam Slovik (BS ’88), a current mentor in the program, and one of his mentees, Myra Interiano (BS ’17), to share what the experience has taught them.

CMS MENTOR
Adam Slovik (BS ’88)
ANGEL INVESTOR

From CEOs to students: In my work, I like to be a very hands-on investor; so I roll up my sleeves and sometimes take an operating role. I just love the whole energy and atmosphere of start-ups—and I love mentoring the CEOs, other managers, and staff. So when I heard about the opportunity to mentor at Caltech, I was excited.

“You’re as good as anyone else out there.” One of the things I tell Caltech students over and over—because I needed someone to tell me this—is that you might feel like you are barely keeping up, like everyone else is doing better than you. Maybe you’re getting a B for the first time in your life. I was constantly struggling at Caltech. But then you go into the real world and realize how lucky you were to have had access to the professors you did, as well as your fellow students.

What he gets out of mentoring: First, I really enjoy it. I enjoy talking to students and learning about their projects. Second, I want to make Caltech a place that I could unreservedly recommend to my kids and know that if they went there, they would have a great experience. And finally, if I gained access to some of these students as interns or potentially as alums I could hire into my companies, that would be absolutely fantastic.

On mentoring Myra: I got a call about Myra, a recent alum who was working an hourly job somewhere. So we had a Skype call, and, like so many Caltech graduates, she was comparing herself to all the other Caltech graduates. I said, “Listen, I’m going to get you a job at one of my companies—not because I’m so magnanimous, but because any company of mine that has you on its staff is so much more likely to succeed.” I didn’t realize at the time how much impact this would have. I found out later that what I said made her feel more confident.

You CAAN, too
Interested in mentoring Caltech students and alumni? Find yourself in need of career direction and advice?

The online CALTECH ALUMNI ADVISORS NETWORK (CAAN) connects Caltech students and alumni to a broad network of graduates who can offer career insights and advice. From negotiating a salary to crafting a personal statement to plotting a career path, CAAN helps students and alumni find the advice they need.

JOIN THE NETWORK AT
ALUMNIADVISORS.CALTECH.EDU

EMBRACING A WINDING PATH
After graduation, I realized there’s this whole level of knowledge about the job search that I was totally unaware of. My older sister had attended college, but neither of my parents did. I started going to career programming through the Alumni Association and forced myself to talk to people. I asked them about their trajectories and realized there’s no straight line—even once you’ve had a job. That helped me be less hard on myself.

Connecting mentors:
I want to be one of the CMS mentoring presentations on technical interviewing given by Caltech alums Phil Naecker and Mason Smith (BS ’88), which was super helpful in demystifying the process and helping me feel better about interviewing. I was introduced to Phil at another CMS mentoring event and had a one-on-one session with him where I got more feedback about interviewing and projecting confidence. Since then, the mentoring program has taught me a lot about the possibilities that are out there when one has a Caltech education and is willing to engage with other alumni—something I honestly didn’t fully appreciate until I had all of these conversations.

Her first (nervous) meeting with Adam Slovik: At first, I was scared because I wasn’t sure what to expect. I looked Adam up beforehand, and he’s featured in YouTube videos. I thought he might be a tough person to talk to. But no, he was really supportive, telling me: “Caltech’s a tough place, and you get through it. Tell me what you can do, and let’s see if we can find a place that matches your interests and skills.” I ended up with two job offers from his companies, and the CMS mentoring program helped me figure out how to make a decision. For instance, “If the right thing to say when I’m asking for more time to make my decision? And how do I ask for an interview without being pushy because I need to tell the other company you or me?” That’s the kind of information I would never have known on my own.

On her new job as data analyst at Blip: On day one, my supervisor said, “Okay, this is what you need to do, get started.” They give me a lot of autonomy; nothing, “You’re really good at working by yourself—we can just tell you what we need, and you go get it done.” That type of problem-solving, where every step isn’t spelled out, is what I learned doing research and problem sets. I like that. I welcome it.
HOW TO DO IT ALL

From solving a Rubik’s Cube® in a matter of seconds to starting a podcast, Techers offer tips on how to do just about anything.

BY RENÉE OLSON
ILLUSTRATIONS BY MATT CHINWORTH
Once people hit middle age, it’s common to put a marathon on the bucket list. While older athletes lack the strength of the young, they’re better at learning to pace themselves for endurance sports.

HOW TO Train for a Marathon

Spurred on by the 2008 Beijing Olympics, Riya Suising (BS ’88), whose longest run at that point had been five miles, gave herself less than a week to train for her first half-marathon. “Now I race almost every weekend,” says Suising, a massage therapist and CEO of Silicon Valley Body Renewal. And she trains others to meet that 26.2-mile mark.

FIND YOUR PEOPLE

“After I did two half-marathons, I thought, ‘Oh, I can do this; I can train myself,’” Suising says. “But then I thought, ‘I want to shoot for a full marathon,’ and I knew that I needed some help.” She joined the Leukemia and Lymphoma Society’s Team in Training, which offers volunteer coaches and mentors in return for raising money for cancer research.

A TRIO OF TRAINING METHODS

Training involves running intervals on a track “at a strong speed, about 80 or 95 percent of your maximum,” Suising says, and resting for three minutes before repeating the sequence for a total of three miles of “hard work.” (By the way, resting doesn’t mean standing, but rather staying in motion and allowing your body to recover.) Tenglo training involves running a simulated five-mile race as part of a group, keeping a steady pace. Endurance training is what helps “condition your body” by adding two miles a week until you reach 20 miles.

DON’T LET MATURITY STOP YOU

Once people reach middle age, it’s common to put a marathon on a bucket list, despite the fact that running a full marathon “is like torture,” Suising says. While older athletes lack the strength of the young, they’re better at learning to pace themselves for endurance sports.

ON YOUR FEET

“Shoes are the most important equipment,” says the budget-minded Suising, who ran her first half-marathon in “gym shoes” and the next in cheap running shoes. “Now I’ve ended up with some actual foot shoes.”

KNOW YOUR LIMITS

Suising has no interest in tackling a 100-mileer, which can take up to 20 to 30 hours. Says Suising, “I really prefer to finish a race, eat a good dinner, have a warm shower, and then sleep in a bed.”

FUEL UP

The night before a run, Suising likes carb-loading. “The night before a run, I eat a good dinner, have a warm shower, and then sleep in a bed.”

HOW TO Manage Your Mess

Former mechanical engineer and misplaced-cell phone survivor Meghan Smith (BS ’02) owns OrganizeSmith, a Phoenix-based company that offers solutions for the cluttered home. Her engineering background helps. “Organizing is about being able to think analytically and logically,” she says, “then coming up with creative solutions.”

DON’T CONFUSE ORGANIZING WITH DOWNSIZING

Organizing doesn’t make more space. Smith says. “When you put stuff in a container, the container takes up more space than just shoving your stuff in the corner. What organizing does is make it easier to find everything—and a good system makes it easier to keep things tidy.”

MASTER THE ART OF NEATNESS

Smith thrives on creating order out of chaos. “I’m able to take the bigger picture and chop it up into smaller, more manageable pieces,” she says. “It’s a lot of space management—being able to visualize things, problem-solving, and coming up with unique and creative solutions.” Sometimes that’s helping a cook whittle down her spices collection by keeping only the ones to use for the week. Or advising a tech enthusiast that he doesn’t need to hold on to a computer from the 1980s. Or digitizing photos and receipts to clear off the dining room table for meals. But the client always has a say.” Sometimes you just have to talk it through,” Smith says.

REPURPOSE, SAVE SPACE, SHARE THE LOVE

Reorganizing has worked especially well for clients who are dealing with the emotional weight of a deceased relative’s belongings. “Some people create ‘memory boxes,’ which are stuffed animals made from loved ones’ apparel,” Smith says. “Another person took her family quilt and cut pieces to fit into shadow boxes. It had been in a chest, buried under stuff. It wasn’t being seen, it wasn’t being loved. Now it is.”

DEFINE YOUR SPACE

“My crafting supplies have to fit on one shelfing unit, and if they don’t, something’s got to go."

JOB WELL DONE

“I’ve had customers who keep greeting cards that just say ‘Love, Mom.’ It’s a greeting card. Its job is to say ‘Hey! Did it? Then let it go.’"
Train Your Puppy

How to

PUP STARTS

“We start training as soon as we get the puppies at eight weeks, working on ‘sit’ and ‘down.’ And we cuddle with them and play with their paws and ears, and make sure they are well socialized from an early age.”

FOOD FOR THOUGHT

Training treats don’t always have to be special. Choi and Flatt put regular kibble in a food pouch that they carry around for day-to-day training activities. Sometimes, they use “high-value treats,” such as sausage or tasty dog biscuits, when they want to teach a difficult command or train in distracting environments.

STEADY HAND

Work on one command at a time. And remember, consistency is everything. “If you’re consistently praising the dog for the behavior you want,” Choi says, “the dog will learn over time.”

DOWNWARD GREETING DOG

Dogs that meet new humans with a leap? “We call that the exuberant greeting,” Choi says. “It’s one of the harder habits to break.” Why? Because environments aren’t always easily controlled—sometimes the “exuberant greeting” can be the result of the activity around a dog at any given time. In Choi’s and Flatt’s Canine Companions for Independence (CCI) program, they ask our friends to look away, not to move, and not to give the dog attention.

Work on one command at a time. And remember, consistency is everything. “If you’re consistently praising the dog for the behavior you want,” Choi says, “the dog will learn over time.”

Food for Thought

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Puppy Training

How to

BEAT THE CUBE

Tyson Mao (BS ’06) took two hours to conquer his first Rubik’s Cube while working at a summer camp in 2003. “I want to say I was July 24, 2003, if indeed July 24 was a Thursday,” he says. (Editor’s note: He’s right, of course.) Today, he’s a cofounder of the World Cube Association and 2005 world-record holder for fastest Rubik’s Cube solved while blindfolded—one minute and 58.32 seconds. Mao, who is also a product manager at Google, offers advice for aspiring cube masters.

UPGRADE YOUR RIG, NOT YOUR BUDGET

“You can buy fantastic cubes now for less than $10 each on the internet, and they turn fabulously. Back in 2000, you would have to break a cube in, you’d have to prepare it, and it just didn’t turn as well. Now a faster-turning cube allows different types of turning techniques.”

KNOW THE DEFINITION OF FAST

Mao notes that his record for solving a cube allows different types of turning techniques. "If you're consistently praising the dog for the behavior you want," Choi says, "the dog will learn over time."
ALUMNI VOICES

We Asked
RESULTS FROM THE ALUMNI ATTITUDE STUDY

Caltech’s continued distinction is closely tied to the achievements of and support from you, our alumni. Similarly, Techers enhance their lives and careers by connecting with the Institute. This mutually beneficial relationship requires ongoing dialogue in order to promote alumni engagement and enable Caltech to deliver on your requests for programs that enrich your lives, accelerate your professional success, and strengthen our global alumni network.

With this in mind, the Institute and the Caltech Alumni Association (CAA) partnered with the Performance Enhancement Group to conduct Caltech’s first all-alumni survey in 2016. In 2019, we reached out to you with a second survey. I am happy to present a summary of your latest responses here, and to highlight the innovative programs the CAA has implemented in response to what you told us in 2016. Your feedback directly fuels and informs our programming. Don’t wait until the next survey to share your thoughts; we are listening.

---

You Answered

RESPONSES FROM 2,008 ALUMNI

Performance Enhancement Group

37%
Graduate degrees

Undergraduate degrees

45%
Both undergraduate and graduate degrees

SECOND HIGHEST
in your ranking of important things for alumni to do

Loyal
Not Loyal
Coltech in general
My house
My lab group
Serving as ambassadors promoting Caltech to others

Promoting CalTech

46%
if you reported that you promote Caltech to others regularly or all the time

LOYAL

UNDERGRADUATE

GRADUATE

YOU VIEW
YOUR RELATIONSHIP
WITH CALTECH?

93%
Value of respect for degree

89%
Accomplishments of alumni, faculty, and students

75%
Global impact

WHAT INFLUENCES
YOUR OPINION
OF CALTECH?

92%
Consider attending Caltech as Good or Great decision

79%
Describe the alumni experience as Excellent or Good

88%
of you described your overall current opinion of Caltech as Good or Excellent

83%
Report having had an Excellent or Good experience as a student

We Listened

CALTECH ANALYZED YOUR MOST REQUESTED TYPES OF PROFESSIONAL DEVELOPMENT SUPPORT FROM THE 2016 STUDY AND TOOK ACTION.

Networking with alumni in your field

61%
Access to research

41%
Career advice and counseling

37%
Career-transition support

36%
Networking with alumni outside your field

34%
Continuing education in your field

33%
Management-skills development

30%
Résumé/CV development

29%
Mentoring matches

28%
Negotiation and conflict resolution

27%
Networking by industry

23%
Writing and presentation skills

22%

ACTION LIFETIME EMAIL ADDRESSES

All alumni are invited to claim their lifetime @alumni.caltech.edu email addresses.

The Milton (PhD ’69) and Rosalind Chang Career Exploration Prize

The prize enables recent alumni to explore opportunities to make a positive impact on society outside of academia and their current career paths.

Handshake

This online recruitment tool, sponsored by the Career Development Center, enables alumni, postdoctoral scholars, and graduates and undergraduate students to search for jobs, connect with employers, and claim their lifetime @alumni.caltech.edu email addresses.

Caltech Alumni Advisors Network (CAAN)

This online mentoring platform connects alumni and students with graduates who are willing to offer career insights and advice.

TecherTalks

These panel discussions bring alumni back to campus to speak with students about life after Caltech and to showcase the diverse array of career opportunities open to Techers. The CAA hosts one TecherTalk with each division over the course of each academic year.
The Stack

Why These 12?
Why not any of the remaining 89.83%?
CREATED BY STACEY HONG, CALTECH ADVANCEMENT COMMUNICATIONS

Figured out which 12? And why these 12?

FOR HINTS, ANSWERS, AND MORE PUZZLES: ALUMNI.CALTECH.EDU/STACK

NOTE THAT NE IS ABOVE AR, AND AL, GA, AND IN ARE STACKED. [3]

Complete the sequence below to discover the missing three [3]
Homage to a Rose Bowl hoax, with an air of distinction [4]
BEDECK OR DECORATE =
GREETING, HYBRID NAG =
CARNITAS-LIKE, OR BACONY, PLUS N =
STRONG, DOMESTICATED TAURUSES =

For more info: alumni.caltech.edu/reunion

Click on the image of the page for the full text.
IN MEMORIAM
We mourn the loss of the following members of our Caltech alumni family.

[Obituaries]

1931
Harry Moates (BS 31)

1932
Jack W. Schwartz (BS 32, MS 36)

1939
Walter H. Monk (BS 39, MS 40)

1940
Randall Smith (BS 40, MS 41)

1941
John H. Corr (BS 41, MS 43)

1943
Robert M. Bragg (BS 43)

1944
Robert C. Boger (MS 44)

1945
Kenneth R. Burrell Jr. (BS 45)

1946
John A. Anderson (BS 46)

1947
L. Edward Klein (BS 47)

1948
Mihiran S. Agababian (MS 48)

1951
Arthur F. Vieweg (BS 48, MS 48)

1953
Eugene S. Rose (MS 43, PhD 47)

1954
Arthur B. Pardee (BS 48, PhD 50)

1955
L. Edward Klein (BS 49)

1959
Frank D. Minkowski (BS 50, PhD 54)

1961
William L. Torrey (BS 51)

1967
Earl D. Reiland Sr. (BS 57, MS 67)

1971
James E. Leininger (BS 69)

1972
Paul S. Zypschulte (BS 72, PhD 73)

1973
Arnold J. Sierk (BS 58, PhD 63)

1974
Joseph F. Raminsky (BS 74)

1976
Theodore D. Tarbell (BS 65, PhD 70)

1979
Jesse A. Ral (PhD 79)

1982
Jamel A. Kiwi (PhD 80)

1983
Jay W. Ellison (BS 80, PhD 85)

1986
Kavous D. Koo (BS 81, PhD 86)

1988
Michael D. Crawford (BS 86)

1992
Robert A. Millikan (BS 60, PhD 64)

1997
Richard C. Compton (BS 61, PhD 67)

2002
Thomas E. Bowman (BS 30, PhD 34)

2003
Eugene H. Gray Jr. (BS 64, PhD 67)

2006
Robert J. Melissa (BS 84, PhD 87)

2007
Robert A. Millikan (BS 60, PhD 64)

2008
Joseph F. Karnicky (PhD 73)

2010
Paul S. Zygielbaum (BS 85, PhD 89)

2012
Robert A. Millikan (PhD 62)

2013
Robert A. Millikan (PhD 62)

[From the Archives]

Recording Electroscope

Among other interests, Robert A. Millikan, Caltech's cofounder and the Institute's first Nobel laureate, was captivated by a kind of radiation initially believed to emanate from Earth. When electric charges associated with it were detected in the air, this cost doubt on its earthly origins. Millikan helped design a tiny electroscope to record charges at extreme altitudes. He had four built in the Caltech physics shop in 1922 and sent them aloft via balloons. Data from the two that reached the stratosphere suggested that the radiation must originate in space. Millikan dubbed it "cosmic rays." The name stuck, although scientists later proved that the radiation is made of charged atomic fragments rather than rays.

DO YOU KNOW MORE about this specific instrument, or did you use one like it while you were at Caltech? Send us a note at alumni.caltech.edu/ from-the-archives.
Join us for Seminar Day, featuring talks by faculty and researchers from all six divisions and JPL.

» More than 18 different seminars
» Presentation of the Distinguished Alumni Awards
» Tours, open houses, and exhibits

Learn the latest from those pushing the boundaries of discovery.

For more info: alumni.caltech.edu/reunion