FORTUNE

JULY 1, 2016 FORTUNE.COM

BRAINSTORM TECH 2016

SILICON VALLEY GOES TO DETROIT

Now, let's see. Behind us, on both sides of us, and down in front.

Let's put the days of scraping our wheels against the curb or scratching our side paint behind us. As well as nudging our front ends way out into cross-traffic to see what's coming. Cameras can help us with all that now. And you know what? They'll do it with clarity and in

July 1, 2016 Volume 174 Number 1

FORTUNE

features

BRAINSTORM TECH / **2016**

A fleet of self-driving Google prototype cars in Austin

COURTESY OF GOOGLE

COVER ILLUSTRATION BY **STEVEN WILSON**

July 1, 2016 Volume 174 Number 1

FORTUNE

departments

MACRO

VENTURE

PURSUITS

TECH

INVEST

CORRECTIONS
In some editions of the June 15 issue, "The Outsiders" noted that Netflix signed a deal with Disney in May; in fact the deal had been signed earlier, but its details were announced in May. "Picturing the *Fortune* 500" (June 15) misstated how much Netflix is spending on programming in 2016. The correct figure is $5 billion. *Fortune* regrets the errors.

DUFL: CHRIS HINKLE; WASHINGTON, D.C.: SEAN PAVONE—GETTY IMAGES

Philippe Dauman's Last Stand

The Viacom CEO argues that he deserves to keep his job.

THIS ISSUE of *Fortune* is a prelude to Brainstorm Tech, our annual gathering of technology leaders in Aspen, Colo. You can read about the self-driving car revolution on page 46 and get an inside look at how one big bank is embracing tech disruption on page 56.

But let's turn for a moment to the sordid struggle surrounding an old media company, Viacom, which is caught in a power game that threatens the tenure of CEO Philippe Dauman.

For most corporations, when to replace a CEO is the toughest question they face. For Viacom that decision has always rested in the hands of one man, Sumner Redstone, who controls the voting shares. It was Redstone who decided to make his consigliere, Dauman, CEO of Viacom in the first place. And now it's Redstone who has decided to replace him. Or has he? The courts must decide if the 93-year-old Redstone still has the mental faculties to make such decisions.

The embattled Dauman invited me to his Times Square office recently to make the case for why he should remain. (A fuller version of the interview is at Fortune.com.) Viacom's stock has rallied at the prospect of his ouster. But investors not named Redstone don't have a direct say in the matter—more proof that dual-class ownership is no way to run a company.

ALAN MURRAY
Editor
@alansmurray

Murray: In terms of return to shareholders, you've underperformed Fox, Time Warner, CBS, Disney.

Dauman: We were overperforming until two years ago, when we started to go through this transition. We take a long view. We have made these strategic moves for the future.

Murray: Your stock price has fallen about 50%; your revenues have been falling for two years.

Dauman: Anybody smart will look forward to what's going to happen in the very near term based on everything that we are doing now.

Murray: One of the knocks against you has been that you owned this young audience, but the audience moved to digital, and you haven't moved to digital quickly enough.

Dauman: We have moved to digital. We have our content everywhere. We have close relationships with all the social media companies. We have two brands on the Snapchat Discover platform ... We were the first company to engage with SVOD companies like Netflix and Hulu and Amazon. We were the first to put our content on mobile in a significant way. We are in conversations with all the digital players, and we are working to revolutionize measurement of the digital audience.

Murray: I don't see your shows in the top 10 lists.

Dauman: In cable we have more top shows than anybody else across our family of networks. For example, Nickelodeon now has nine of the top 10 shows for children. BET has the top shows for African-American audiences, bar none. Comedy Central's *Inside Amy Schumer* is a top show. *Lip Synch Battle* is a big global hit on Spike and now is in 90 countries.

Murray: Your pay, relative to shareholder performance, has been an issue. It was $54 million last year, during this period of stock price decline.

Dauman: What people fail to see there is that the vast majority of my so-called compensation is based on performance, so it's recorded according to Black-Scholes value when it is granted, but I don't realize that unless the stock performs ... In fact I have suffered along with shareholders. I have lost far more than the $54 million in this period. That's not inappropriate. I will be rewarded if and when the stock recovers.

Murray: What are people missing in all of this?

Dauman: People are missing the business story ... We have a great organization, and we hope we don't lose too much of that during all of this. This will pass and the company will endure.

PHOTOGRAPH BY ANNIE TRITT

Macro

CLOSER LOOK

THIS YEAR, CONVENTIONS MATTER AGAIN

In a typical year the nominating process looks like a four-day infomercial. But this is not a typical year. Here are the fights to watch in Cleveland and Philadelphia.

By Anne VanderMey

TRUMP/CLINTON: MARK PETERSON—REDUX

ORIGINAL PHOTOS, CLOCKWISE FROM TOP LEFT: ANDRIA HAUTAMAKI—REDUX; PETER DAZELEY—GETTY IMAGES; CARLO ALLEGRI—REUTERS; DAMON WINTER—THE NEW YORK TIMES REDUX

IT'S BEEN DECADES since America's two major political conventions weren't deeply boring. In 2012, Tom Brokaw described the quadrennial intra-party lovefests as "extravagant infomercials staged in a setting deliberately designed to seal them off from any intrusion not scrubbed and sanitized." In 2008, CNN called conventions "relics." And in 2004, *The American Prospect* called the whole practice "entirely irrelevant."

This year's events, though, promise to be a lot more interesting. To a degree not seen since the Vietnam War era, the specter of conflict and chaos looms over both parties' proceedings. And consequential fights over rules and platforms—with big implications for business—could have a showing on the typically staid convention floor.

In Cleveland, where Donald Trump is slated to become his party's nominee in late July, there are already more protest groups than there are marching permits. The ACLU is suing the city to make sure protesters aren't shut out. One local organizer warned of a potential "bloodbath" as demonstrators from different camps vie for time in the limited designated spaces, and activists are already invoking Chicago's infamous Democratic convention of 1968. Just one week after Cleveland, the Democrats will host their convention in Philadelphia, where more than 20,000 people have promised to converge to air their grievances with Hillary Clinton and back Bernie Sanders, whose supporters have a history of clashing with the party establishment.

But it's not just the protests that will make this year's conventions worth watching. "The whole process has become more significant," says Elaine Kamarck, a senior fellow at the Brookings Institution. In addition to nominating the party's candidate, conventions are where party rules and priorities get hashed out—and debates at the events will have implications for everything from U.S.-Israeli relations to business's relationship to government. For example, if Sanders representatives have their way with the Democratic platform, they could affect the party's official stance on issues like the minimum wage, banking regulations, and whether to keep "free" in the section calling for "free and fair trade."

While the party's platforms aren't binding, brewing fights over their contents reveal the documents' importance this year. Witness Sanders' rebuke of the Democratic National

Committee in May, accusing it of sidelining his supporters and writing in an open letter, “We are prepared to mobilize our delegates to force as many votes as necessary to amend the platform and rules on the floor of the convention.”

The GOP, meanwhile, will grapple with an even weightier question this summer: Could establishment Republicans still challenge Trump’s nomination? Sure, Trump has enough votes to win on the first ballot, but those delegates probably can’t technically be bound by state laws to support him—a procedural detail that has fueled persistent rumblings about the emergence of an 11th-hour candidate. Also driving anxieties: Trump has declined to moderate his tone in the run-up to the conventions. That, and a spate of dismal poll numbers, has stoked fears that his nomination could cost the GOP not just the presidency but even its majorities in Congress—an event that could lead to a radically different D.C. climate next year.

Any fight over Trump’s nomination will come down to the rules committee. Typically a scene devoid of cameras, the committee could see real clashes this year over RNC rules like whether a candidate must have won eight states in order to be nominated (a requirement that currently bars late convention challengers) and whether the early primaries should be closed (keeping them open to independent voters is thought to yield more centrist candidates). Rules committee member Solomon Yue says this year could see a volatile voting process: “From that perspective, I think there is a lot of uncertainty, to be honest with you.”

The heightened spotlight on convention politics has made business particularly wary this year. Some companies have pared back their convention giving or cut it altogether (see sidebar). Apple, for example, pulled out specifically over incendiary remarks made by Trump, according to reports citing company insiders.

Beyond the rhetoric, though, Trump’s protectionist and anti-immigration views also rankle. At the convention, for the first time in years, the GOP may be forced to litigate its pro-business allegiances. Count on the debate to resonate long after the election is over. ■

THE BUSINESS OF CONVENTIONS IN 2016

BY BEN GEIER

2016 CONVENTION SPENDING

Fundraising goal for GOP: **$64 million**
Fundraising goal for Dems: **$60 million**

THE CONVENTION SECURITY COMPLEX

Cleveland and Philadelphia get $50 million each in federal grants for convention security. Here, some items on the 2016 convention shopping list of the Cleveland police force:

2,000
SETS OF FULL-BODY RIOT SUITS

300
PATROL BIKES

24
SETS OF BALLISTIC BODY ARMOR

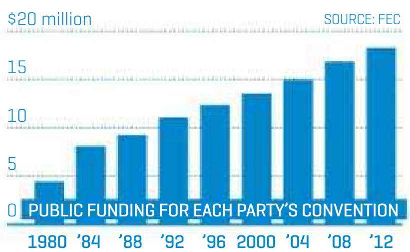
3.7 miles
OF INTERLOCKING STEEL BARRIERS

AS THE CAMPAIGN SEASON GROWS MORE DIVISIVE, SOME CORPORATIONS ARE SCALING BACK CONVENTION SUPPORT

★ **HP:** Won’t attend either party convention. It was a major RNC donor four years ago.
★ **Coca-Cola:** Will give $75,000 to both the Republican and Democratic conventions—considerably less than the $660,000 it gave to the Republican convention in 2012.
★ **Amgen:** A 2012 donor, the biotech company won’t be giving cash to either convention this year, though it plans to host events at both.
★ **Facebook:** Will provide financial support to both conventions, though exact figures aren’t known.
★ **Apple:** The tech giant will not be supporting the RNC event, according to reports, but it hasn’t indicated yet if it plans to be present at the Democratic convention.

NO MORE FEDERAL SUPPORT

Federal funding for conventions was cut off in 2014, leaving parties to their own devices to fund the events.



THE PEOPLE WHO MAKE THE CONVENTIONS RUN

DEMOCRATS

DEBBIE WASSERMAN SCHULTZ Chairwoman of the Democratic National Committee

REV. LEAH DAUGHTRY Convention CEO

BARNEY FRANK Former congressman and co-chair of the rules committee

REPUBLICANS

PAUL RYAN Speaker of the House and convention chair

PAUL MANAFORT Trump campaign manager

REINCE PRIEBUS Chairman of the Republican National Committee

WASSERMAN SCHULTZ: PAUL MORIGI—GETTY IMAGES; DAUGHTRY: MATT ROURKE—AP; FRANK: LOU ROCCO—ABC VIA GETTY IMAGES; RYAN: ALLISON SHELLEY—GETTY IMAGES; MANAFORT: BRENDAN MCDERMID—REUTERS; PRIEBUS: DENNIS VAN TINE—GEISLER-FOTOPRESS/PICTURE-ALLIANCE/DPA/AP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Seat 3
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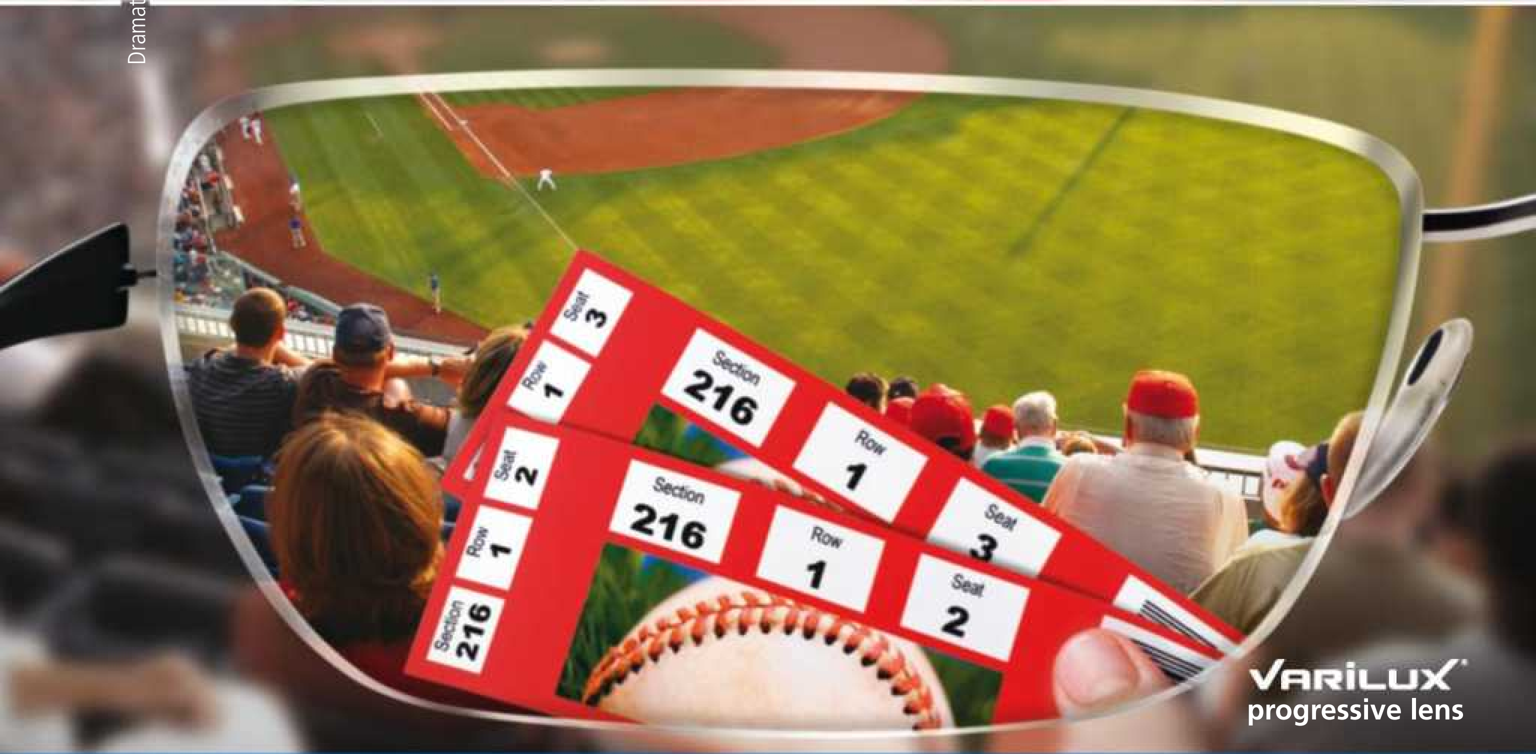
Seat 2
ordinary progressive lens
Dramatization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VARILUX®
progressive lens

WHAT WE KNOW

DID NORTH KOREA HAVE HACKERS STEAL MILLIONS FROM GLOBAL BANKS?

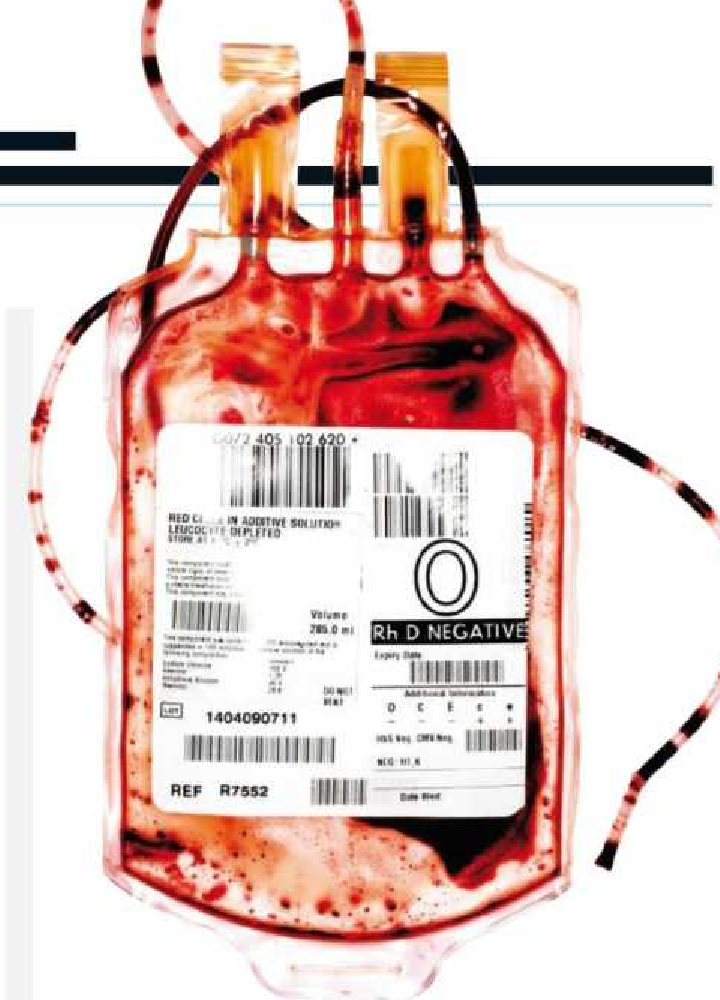
WHO: Experts finger the "Lazarus group," a shadowy computer-cracking corps with links to North Korea, credited with the 2014 Sony hack.

WHAT: The crew allegedly nabbed $81 million from the central bank of Bangladesh, and news broke this spring that they stole another $9 million from a Banco del Austro branch in Ecuador. More than a dozen banks may have been targets.

WHERE: Hackers hit banks' interface with the SWIFT network, a messaging system that essentially acts as the world's payment plumbing.

WHEN: Early 2015 to present.

WHY: Because they could. Lax world cybersecurity standards mean big chunks of cash are vulnerable to hackers with enough skill and scale.
—*ROBERT HACKETT*



BREAKTHROUGHS

BLOOD TESTING IS BOOMING

COMPANIES ARE BETTING A "LIQUID BIOPSY" CAN CHANGE CANCER TESTING. ***BY SY MUKHERJEE***

IF YOU THOUGHT that next-gen blood-testing technology had hit a wall because of the woes of Elizabeth Holmes and her hobbled unicorn Theranos, you'd be wrong.

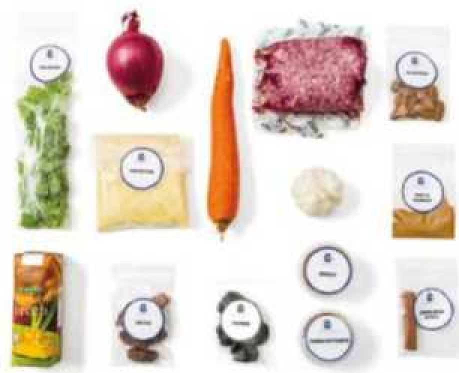
A growing number of biotech and pharmaceutical companies are ramping up efforts to create smarter, more effective blood diagnostics. This spring, California-based Freenome got a multimillion-dollar cash infusion from Andreessen Horowitz. Pharma giant Roche nabbed FDA approval for a first-of-its-kind blood test to assess the efficacy of its lung cancer drug, Tarceva, for different patients. And at June's American Society of Clinical Oncology annual meeting, Guardant Health unveiled a trove of data showing that its blood-testing tech was comparable to standard surgical biopsies for discerning cancerous mutations and matching patients to appropriate treatments.

These are just a few of the latest developments in the burgeoning field of personalized medicine and "liquid biopsies"—blood tests that seek to replace painful, pricey, and complicated procedures like the invasive tissue biopsies that currently dominate the cancer market. Guardant, for its part, hopes that one day its platform can be used as part of an annual physical to detect cancer as early as possible. The Theranos debacle notwithstanding, if this new class of blood-testing tech takes off the way investors think it might, cheaper, safer tests could replace old-school surgical biopsies altogether.

CHECK, PLEASE

MEAL KIT STARTUPS MAKE COOKING SIMPLER ... AND PRICIER

INCREASINGLY TRENDY meal kit companies like Blue Apron (said to be considering an IPO) have built hot businesses on the promise of making cooking at home easier. But not—even with their perfectly measured portions—cheaper. A new survey from NPD Group found that the average meal from a kit costs about $10 per person—more than double the price of shopping for yourself, according to NPD, and about equal to the average cost of eating out. This dynamic plays out differently depending on the market, of course, but it makes the economics of meals in a box a little less appetizing outside big, expensive cities. —*BETH KOWITT*



KEVIN CURTIS—GETTY IMAGES; EVAN SUNG—THE NEW YORK TIMES/REDUX

DESPERATE MEASURES

THE WEIRD WORLD OF NEGATIVE INTEREST RATES

CENTRAL BANKS ARE DOING WHAT WAS ONCE UNTHINKABLE. WILL IT SAVE THEIR ECONOMIES?

BY CHRIS MATTHEWS

IT WAS LONG THOUGHT that interest rates could never go below zero. People would surely hoard cash before they paid banks for the privilege of holding it for them. But this year the European Central Bank, the Bank of Japan, and others have officially ventured into negative interest rate territory. It's a bold experiment in economic stimulus—with big risks to global investors.

Right now there are a whopping $10 trillion in total negative-yielding sovereign bonds outstanding worldwide, according to a report by Fitch Ratings. Just as startling: 28% of the total value of J.P. Morgan's global government bond index has a below-zero interest rate. The dynamic has even trickled into the corporate sector, where there are more than $300 million worth of negative-yielding bonds.

That has caused serious headaches for money managers, especially pension funds and insurance companies in Europe, which must fight over the increasingly scarce supply of relatively safe but positively yielding assets. The U.S. is also affected, even while the Fed maintains positive rates. According to Alex Roever, head of U.S. rate strategy at J.P. Morgan, 48% of the positive-yielding sovereign debt not held by central banks is U.S. Treasuries, meaning competition to buy U.S. debt is tougher than ever before, and demand could drive Treasury rates even lower.

All this would be manageable if the negative rates were seriously juicing the European and Japanese economies. But there's not much evidence that it's actually leading to more lending or higher growth. Meanwhile, signs of distortions in the system are growing, like data showing that sales of cash safes are surging in Japan, as households lose confidence in the banking system to protect their savings.

Torsten Slok of Deustche Bank Securities argues that better results would come from targeted stimulus of governments. Central banks have done what they can, he says, and "now the politicians need to do their job."

Japan has seen a run on cash safes as interest rates go negative.

ECB -0.4% | JAPAN -0.1% | DENMARK -0.65% | SWEDEN -1.25% | SWITZERLAND -0.75% | U.S. 0.25 to 0.5%

SOURCE: J.P. MORGAN

WHITHER THE MBA?

1%

That's the share of new jobs listed on Monster that require or recommend applicants have an MBA, down about 50% from both last year and the average since 2012, according to data provided to *Fortune*. The degree's anemic showing jibes with warnings from tech titans Peter Thiel, Sheryl Sandberg, and Elon Musk, who say MBAs aren't necessary to succeed—even as schools beef up their tech and entrepreneurship offerings. To be sure, "education is still incredibly important," says DHI Group CEO Mike Durney, but it's specialized skills that matter more than ever. —*ANNE VANDERMEY*

EXCHANGES

THE NYSE IS THE NEW NASDAQ

GoDaddy CEO Blake Irving at the NYSE

THE NASDAQ has long been the exchange of choice for the country's hottest tech IPOs.

But recently more top tech companies are picking the NYSE instead. It's partly a hangover from Facebook's rocky Nasdaq IPO, but even more a result of NYSE's expanded services and intense marketing campaign in Silicon Valley. The biggest tech firms currently in registration to go public (Elevate Credit, Line Corp., and Twilio) and the year's largest tech IPO to date (Acacia Communications) all chose NYSE. So did most of last year's largest offerings, such as Box, Fitbit, First Data, GoDaddy, and Square.

But don't shed too many tears for Nasdaq. It still dominates in a biotech sector that now produces far more IPOs. Since the beginning of 2015 there have been 145 biotech IPOs in the U.S. (tech had 82). And of that 145, a whopping 142 listed on the Nasdaq.

—*DAN PRIMACK*

YUYA SHINO—REUTERS; BRENDAN MCDERMID—REUTERS

A worker uses a robot arm to weld elevator components at a factory in China's Jiangsu province.

IMAGINECHINA—AP IMAGES

LEADERSHIP

KNOWING THE LIMITS OF MACHINES

SOME JOBS REALLY MUST BE AUTOMATED; OTHERS NEED THE HUMAN TOUCH. WHICH ARE WHICH? THAT'S YOUR CALL.

By Geoff Colvin

WHEN STOCK MARKETS plunged early this year, managers at USAA's investments division noticed something odd. Customers who routinely conducted business online were suddenly lighting up the phones. USAA had nothing new to tell them—its fundamental advice hadn't changed, and they could have found that guidance online. Yet clients deeply wanted to talk to a real human being, and never mind why. They just did.

That reality illustrates a high-stakes decision that confronts managers in every industry: choosing which employees must be replaced by technology and which must not be. Growing numbers of jobs at every level can be performed by machines—not just faster and more cheaply than humans can do them, but better. In many of those jobs, such as in factories, failing to replace people could doom a company through uncompetitive costs. Yet in other jobs that machines can do well, such as giving financial advice, replacing too many humans could be a fatal error. How to decide? Three situations in particular seem to justify the costs, and quirks, of people.

WHEN CUSTOMERS VALUE THE HUMAN TOUCH. Many decisions that in theory are calculable—where to invest, whether to sue, how to respond to a medical diagnosis—are in fact laden with emotion. Many people need to interact with a person before choosing a course of action. In finance, law, medicine, and other fields, workers who handle those interactions most adeptly will be the least susceptible to replacement.

WHEN CONSTITUENCIES MUST BE REPRESENTED. All organizations are run ultimately by and for humans, and most are complex matrices of desires, incentives, budgets, and myriad other factors. If marketing can't get along with sales, or management with labor, nothing good can happen. Technology could optimize the whole intricate machine, but it will seize up if humans can't agree on how to make it go.

WHEN SOMEONE MUST BE ACCOUNTABLE. So long as humans and not machines are in charge—let's assume that's a long time—societies will demand that people be made to answer for decisions, even if technology recommends those decisions. Government officials, military officers, judges, business managers, basketball coaches, and others in leadership roles will remain where the buck stops. Technology may reduce the number of people in such roles—it's already taking over tasks of middle managers, for example—but responsibility will ultimately end up in human hands.

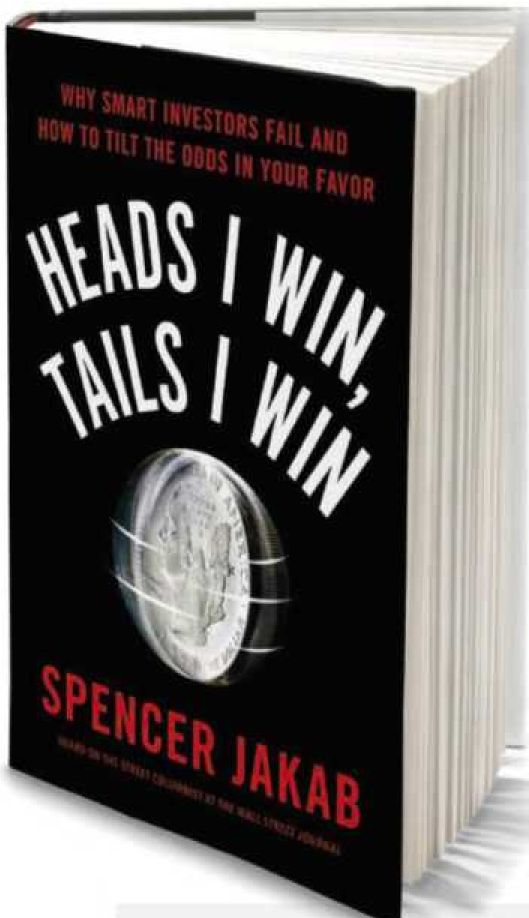
As machines grow more powerful, deciding who must go and who must stay becomes harder. A guiding principle: Just because technology can do a job brilliantly doesn't mean that it should.

EXECUTIVE READ

HOW TO INVEST WITHOUT THINKING

A NEW BOOK RAISES THE QUESTION: CAN YOU BE A GOOD INVESTOR WITHOUT KNOWING ANYTHING ABOUT BUSINESS?

By Roger Lowenstein



INVESTMENT GUIDES are as numerous as swallows. Typically they begin with an acknowledgment that the world has little need for another investment guide—but that this *particular* book is different. So it is with *Heads I Win, Tails I Win* by Spencer Jakab, a writer and editor of the *Wall Street Journal*'s Heard on the Street column.

Jakab is not promising to make readers rich. Richer, to be sure, but not, as Polonius would have it, gaudy. *Heads I Win* is aimed at average Janes and Joes. It encourages them to dispense with any thought of beating the market. Everyone thinks he or she has above-average skill, says Jakab, but few actually do. He laments that people who would never presume to fix their own refrigerator have the burden of managing their money. "You're probably a lousy investor," he starkly observes, "and should be perfectly happy to get back to average rather than strive for greatness."

He urges investors to avoid market fashions and speculative vehicles, such as high-yield bonds. Above all they should avoid costly human management and invest in index funds. It is not lost on Jakab that most professional investors have lately fallen short of market indexes. Over the 10-year stretch that ended in 2015, a mind-boggling 82% of actively managed large-cap funds and 88% of small- and midcap funds lagged their benchmark indexes, according to S&P Dow Jones Indices. If the fashion of the moment is indexing, Jakab is its trumpet. Though one wonders whether, as more people crowd into popular indexing vehicles like the S&P 500, overvaluation and heightened risk may follow.

Jakab has plenty of sensible advice—especially for novices. They would benefit, he says, by doing less rather than more. He endorses portfolio "rebalancing," meaning automatically investing more after the market falls and trimming after gains. This has the advantage of enforcing a relatively contrarian bent; it has the disadvantage of being unthinking.

To Jakab, not thinking is an advantage. He is so soured on active money management that he favorably mentions studies that endorse random selection—even throwing darts at the newspaper. He does not quite urge readers to buy a set of darts, but the thought is there.

What is deeply unsatisfying is the lack of any appreciation that securities have a connection to an underlying business. In the real world, stocks rise and fall on the details of the enterprise. Assessing them requires painstaking work, which discourages most people and leaves rich potential rewards for the few who attempt it.

Jakab's investment-world view is, "We're all players in something called a zero-sum game." But it is not zero sum. Gambling is zero sum. Securities markets are a construct by which investors participate in capitalistic enterprises. It is no more zero sum than Exxon.

Jakab's writing is anecdotal and witty, and his advice will do more good than harm. But if his aim is to impart understanding, *Heads I Win* is an opportunity squandered.

FURTHER READING
TIME-TESTED INVESTMENT BOOKS

SECURITY ANALYSIS (1934)
By Benjamin Graham and David Dodd
The bible of "value investing" preaches business analysis as the foundation of stock buying—and later became the philosophical touchstone for Warren Buffett.

MARGIN OF SAFETY: RISK-AVERSE VALUE INVESTING STRATEGIES FOR THE THOUGHTFUL INVESTOR (1991)
By Seth Klarman
A private equity billionaire explains the importance of buying good stocks at a discount—think of it as anti-bubble insurance.

THE ESSAYS OF WARREN BUFFETT: LESSONS FOR CORPORATE AMERICA (1995)
Edited by Lawrence A. Cunningham
Smart investing principles and advice for corporate managers all go down a little easier when delivered in Buffett's homespun prose.

BOOK: MANFRED KOH; COVER: COURTESY OF PENGUIN RANDOM HOUSE

या दाता गरीब नवाज
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ARAVIND ADIGA, THE WHITE TIGER: A NOVEL
@ AMAZONKINDLE
किराणा का सामान, मेवा देशी घी, तेल
गुड, शक्कर, चावल,
amazon

BRAIN HEALTH

THE RIDDLE OF THE WALL IN THE BRAIN

THE BLOOD-BRAIN BARRIER HAS LONG STYMIED DRUG DEVELOPMENT FOR BRAIN DISORDERS. RESEARCHERS HAVE FINALLY BEGUN TO BREAK THROUGH IT. *By Erika Fry*

FOR YEARS the darndest thing kept happening to drugs in clinical trials to treat brain disorders: They never made it to the brain. For pharmaceutical companies this problem was as costly—developing treatments for the central nervous system takes an average of 15 years and $1.5 billion—as it was, in hindsight, kind of obvious. The drugs were impeded in part by the blood-brain barrier, or BBB, a formidable physiological feature whose properties were discovered in the 1880s.

Composed of blood vessels connected by "tight junctions" and studded with receptor proteins, the BBB is more a gateway than an impenetrable wall. It lets in materials the brain needs (sugars and amino acids), while pumping out or deflecting the many it does not. Alcohol, nicotine, and some small-molecule drugs can get in, but substances that do not pass include chemotherapy agents, "biologics," and other pharmaceutical breakthroughs. "Unfortunately the blood-brain barrier has effectively excluded the brain from the entire biotech revolution," says James Callaway, CEO of ArmaGen, a California biotech.

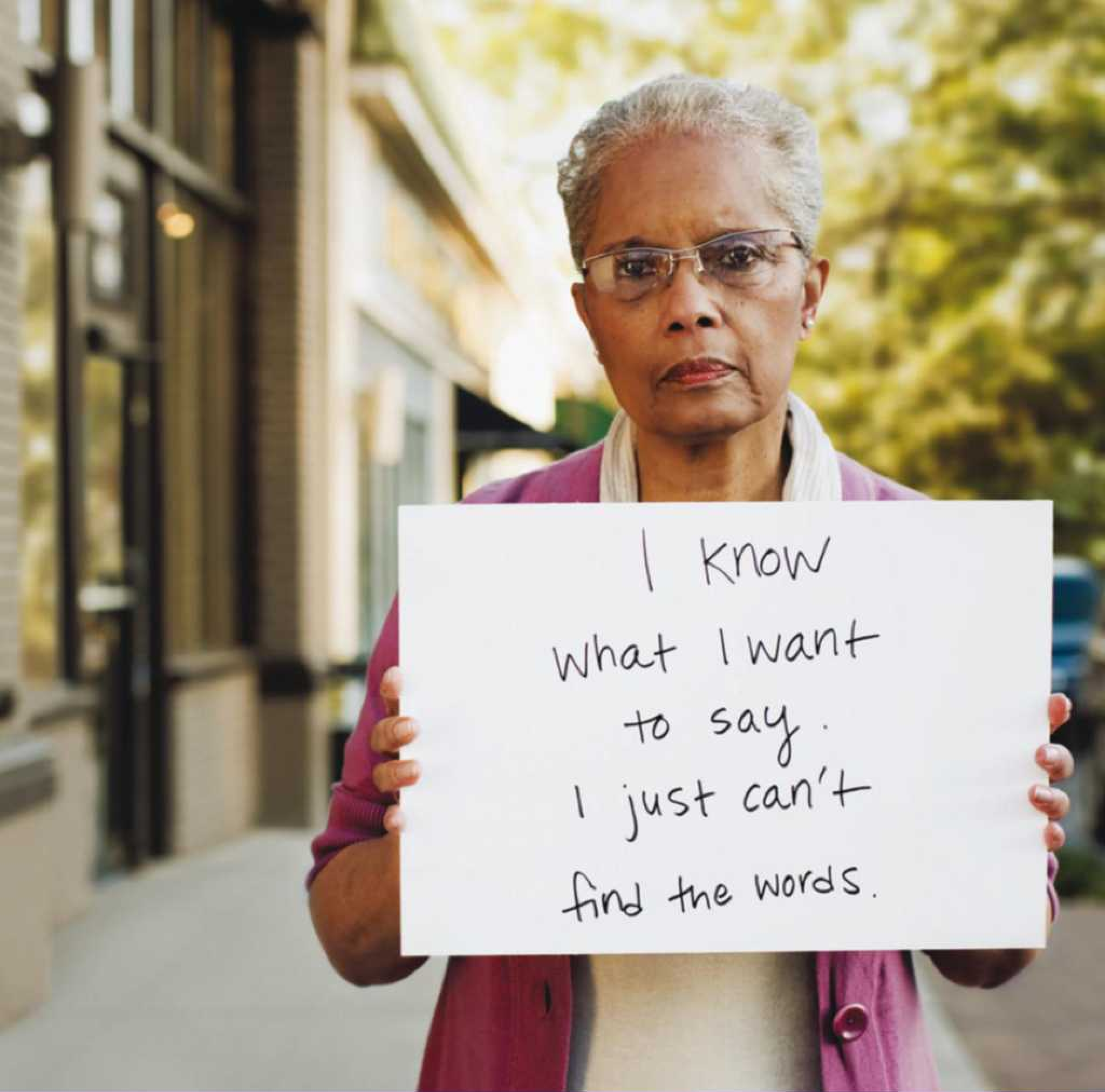
Increasingly research suggests that the BBB becomes leaky as we age—a weakening linked to neurodegeneration. People who suffer traumatic brain injury have a disrupted BBB, as do those with multiple sclerosis. And patients with Alzheimer's appear to have a leakier BBB than most, though whether it's a cause or a consequence of the disease is a matter of debate.

This porousness is one reason drugmakers have thought their meds might make it into the brains of such patients. But the race is on to find more certain strategies that could unlock treatments for diseases like Alzheimer's and brain cancer. Biotechs like Biogen and Genentech have dozens of researchers working on the issue, while Janssen, Johnson & Johnson's pharmaceutical arm, has sought partnerships (including with ArmaGen) to bolster in-house efforts. All are trying to hitch molecules to receptors on the BBB for delivery into the brain. (Key to some of these efforts: shark and llama antibodies.)

Impel NeuroPharma is trying to circumvent the BBB altogether, developing a device to spray a drug into the brain via the nose's passageways. Others are experimenting with lasers, nanoparticles, ultrasound, microbubbles, and the FDA-approved drug Lexiscan to either cross the barrier or briefly pry it open. While frequently disrupting the BBB may pose safety risks, the strategy is considered promising for attacking tumors.

It's likely to be a couple of years before a biologic engineered to breach the wall is approved. For now the most proven way to get drugs safely and effectively into the brain involves a method pioneered in 1979 by Ed Neuwelt, a neuro-oncologist at Oregon Health & Science University. He injects patients with a solution that temporarily shrinks the cells in the BBB, creating space for drugs to slip by. Patients endure 12 three-day hospitalizations in a year—but it works. (His 450 brain cancer patients include some who are healthy more than 25 years after treatment.) Neuwelt, too, hopes for less invasive methods of bypassing the BBB. "I need to be put out of business," he says.

ILLUSTRATION BY JVG



New problems with communication is 1 of the 10 warning signs of Alzheimer's, a disease that is often misunderstood. During Alzheimer's & Brain Awareness Month, the Alzheimer's Association® encourages you to learn how to recognize these symptoms in yourself and others. For more information, and to learn what you can do now, go to **alz.org/10signs** or call **800.272.3900**.

alzheimer's association®

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Venture

HOW I GOT STARTED

Yang, a cycling enthusiast, outside his company's offices in Torrance, Calif.

INVENTING PRODUCTS IS HIS LOT IN LIFE

Frank Yang, an immigrant from Taiwan, has used creative design and gleaming stainless steel to make **SIMPLEHUMAN** the Apple of housewares.

Interview by Dinah Eng

Few people would think to apply their spirit of invention to the humble kitchen garbage can. But Frank Yang did just that and created a new category: the most prosaic household items conceived with panache and stainless steel. Yang, 44, was a tinkerer as a child and first learned about business by helping his dad at flea markets. Today his company, Simplehuman, sells soap pumps, high-tech vanity mirrors (with sensors that automatically turn the light on when you approach), and more. Last year the company's sales were $150 million. Yang's story:

PHOTOGRAPH BY PETER BOHLER

I grew up in Taiwan. When people asked, "What do you want to do when you grow up?" I'd say, "I want to invent something and sell it." As a kid, I thought there should be automatic dog feeders and stoves that turn themselves off if there are no pots on them.

When I was 10, my family immigrated to Los Angeles. My father became an importer. At first we struggled. We'd go to swap meets, where we sold dead inventory from his business—like seat cushions or mugs that chill beer—to make ends meet. I learned how to display and talk about products and negotiate in Spanish.

I was always good at fixing things. In seventh grade, we had remote-control drag racing in my neighborhood, and there was a rich kid who was a bully. I couldn't afford an expensive car, so I fixed up a cheap one by changing the chassis and steering wheel to make the car lighter. Then I added an extra battery. It didn't look good, but I beat the rich kid.

I went to UCLA for political science but wasn't sure what I wanted to do. My girlfriend, who's now my wife, was a graphic design major; she suggested I take an industrial design class. I loved it, but it was too late to change majors.

After graduating, I worked for my father's company. I sourced products—and learned about the supply chain and how to deal with manufacturers. But I felt suffocated, so I quit and told my father I was going to design something to sell. He was doing well by then, so he gave me $200,000 to start my own company.

It was 2000, and I looked at housewares. I saw big displays of expensive, unattractive stainless-steel cans that weren't much more functional than cheap plastic ones. Back then, no real thought was given to design in household products. I thought, "Everyone has a trash can. I want to design one that's really cool." So I hired some freelance industrial designers and one employee. We figured out how to make the pedal lighter, while trapping the odor in the can, and made it all look good.

No manufacturer wanted to talk to me. I finally found a small factory in Taiwan, owned by Mr. Wang Ding-Chou. For six months we would fax designs back and forth. Through trial and error, we made a prototype, and I went to the International Home and Housewares Show in Chicago. The Target and Container Store buyers loved it. The Container Store gave us a $30,000 order, then Target placed a test order.

The hardest thing to work out was the tooling process, getting the manufacturing components and machines right, which affects output, quality, and pricing. At one point, Mr. Wang made a bunch of trash cans, and I rejected them all. He was ready to give up working with me. Manufacturers are all about faster, cheaper, and I'm about higher standards. So I visited the tooling company with him, and we were able to work things out.

The first year we had about $800,000 in sales. I'd cold-call retailers, and most didn't call back. But opportunities come up, and you have to be ready to take advantage of them. I remember sending some sample cans over to the Lowe's buyer, and the next day, he called to say another company he worked with was out of business. "Let's talk," he said.

Our company was initially called Canworks. When buyers wanted more products, we started making dishrags, but our name didn't fit. I wanted people to feel efficient when using our products. We talked with naming consultants, and they came up with Simplehuman.

Eventually retailers told us to expand into the bath category. So in 2010 we introduced bath accessories. We made a bamboo tissue-box holder, but the numbers weren't good—we were just one of many choices. I learned we can't make everything, and lost about $750,000 on the R&D and tooling for that line. But we stuck with the bath line and went on to make sensor mirrors and soap pumps.

For me, it's about creating something people love. We designed our soap dispenser to pump soap at 0.5 seconds. An engineer told me, "I can do it in 0.2 seconds." I said, "Okay, do it; we'll see what happens." When I put my hand under that second dispenser, soap appeared instantly. It was magical. Why? People's reaction times to visual stimuli average 0.25 seconds, so when something happens within 0.25 seconds, it's magical. That's what you get when you don't settle for "good enough."

HOW TO CREATE A WORKPLACE FOR SMART PEOPLE

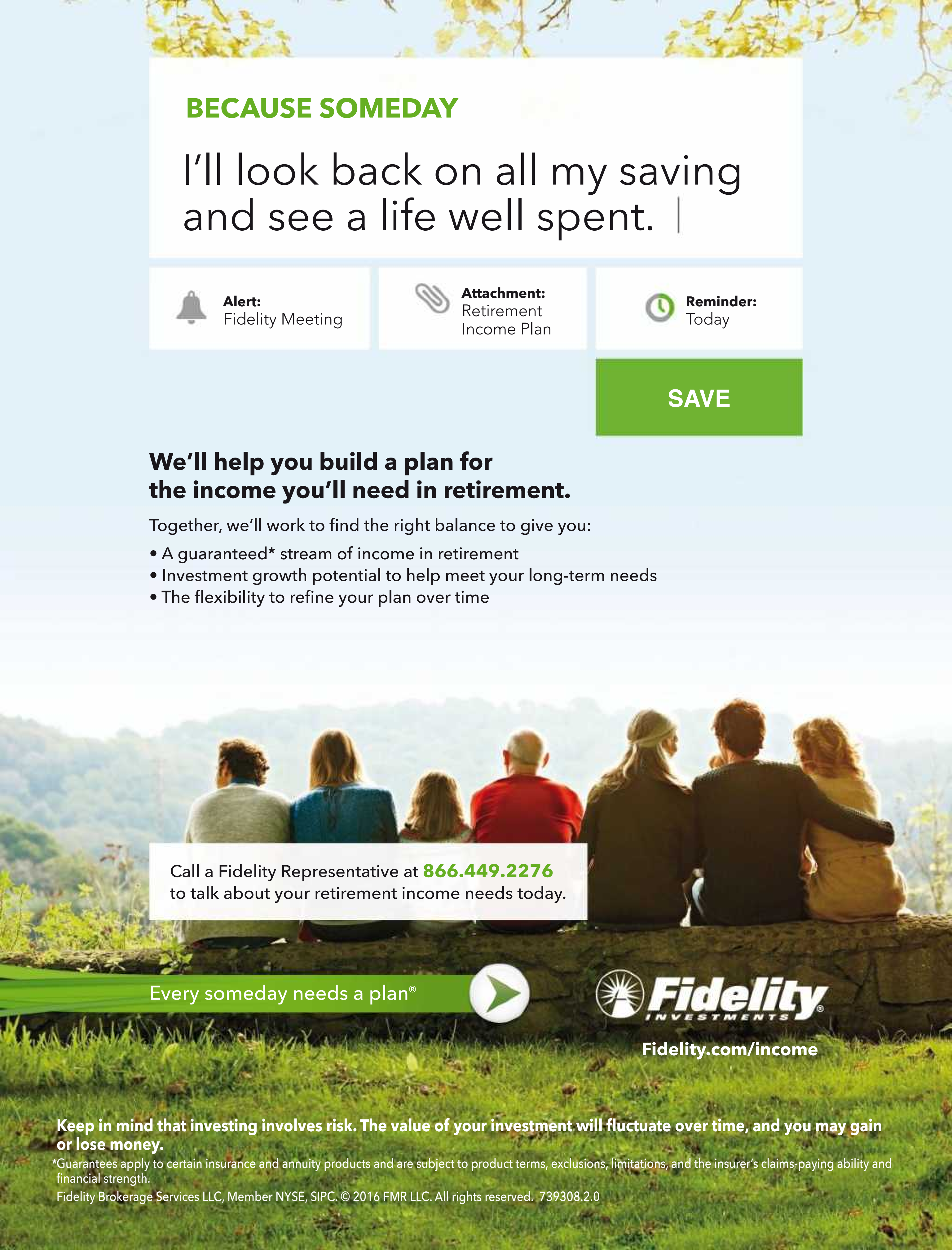
FRANK YANG, founder and CEO of Simplehuman

I believe in health and family first. At Simplehuman, individuals can set their own work hours. We're here to make a kick-ass product, but **if you need to leave for family, just go.** If it's spring break and you're not on vacation, bring your kids to work.

We have a **basketball court and gym in the middle of the office.** There's yoga at noon, Krav Maga on Friday afternoons, basketball games after work, and more. People shoot hoops while talking out product issues.

Every Tuesday a chef comes in to create healthy lunches. Every Friday we serve a breakfast built around different ethnic foods. After breakfast we have staff announcements and **talk as a group about what's happening in the company.**

It's not about partying all day. **We have an environment where people are more open about discussing things and solving problems together.** There's something different about arguing in a conference room with a guy who's also on the same basketball team as you are. We have very low turnover.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SAVE
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Together, we'll work to find the right balance to give you:
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Pursuits

TRAVEL TECH

A worker at Dufl's storage and management facility in Tempe, Ariz., meticulously wraps a client's clothing in plastic and tissue paper.

NEVER PACK YOUR BAGS AGAIN

PERSONAL VALET APP DUFL LETS YOU PACK LUGGAGE REMOTELY IN UNDER A MINUTE—AND WILL EVEN LAUNDER YOUR TRAVEL WARDROBE.

By Christopher Tkaczyk

IMAGINE having an assistant who, at the touch of a button, will launder and press your business clothing, fold everything neatly, pack it in your suitcase, and then arrange to have it delivered to your hotel before you arrive and picked up when you leave. No time wasted packing, no waiting in lines at the airport to check bags, no hotel laundry fees. That's essentially how Dufl works.

From its management facility in Tempe, Ariz., Dufl's small staff of 25 will photograph, inventory, and professionally clean your clothes, then pack them alongside your shoes and full-size toiletries before shipping everything to your destination. When you open the Dufl app to begin a new trip, you tap on the items in your Dufl "closet" to choose what you want delivered. The online clothing and luggage handler says it has served nearly 10,000 registered users since it launched in May 2015.

Dufl caters mostly to business travelers, executives, and celebrities, and each trip costs $99, in addition to a $10 monthly storage fee for each personal closet. The per-trip fee includes three-day domestic shipping via FedEx and all laundry service. International trips and overnight service incur extra fees, and a 24/7 concierge service handles any unusual problems, such as a late arrival or redirected flights.

"Our users say it saves them money. They don't have to pay baggage fees, and they don't have to pay for dry cleaning," says CEO and founder Bill Rinehart.

The company has already partnered with Concur to help users file work-related expenses more easily. And earlier this year it began handling sports gear, such as golf clubs, fishing poles, and skis. Dufl also plans to open a second facility on the East Coast later this year to accommodate its large number of users who fly in and out of New York City.

The real value of Dufl, says the company, is the time saved. "Per roundtrip, at least three hours is spent packing and unpacking. If you travel twice a month, that's three days a year," explains the company's chief marketing officer, Andrea Graziani, who says 89% of users report that Dufl is life changing.

"I don't have to gate-check anything. It gives me a lot of freedom that I didn't have before," says health care consultant Debbe McCall. "As a heart patient, I don't need any more stress while traveling. Between this and TSA PreCheck, flying is fun again."

PHOTOGRAPH BY **CHRIS HINKLE**


If You Want Your
Best Employees
Around in the Future,
Give Them One
Use the world's #1 talent management solution to recruit, retain and develop your people to their full potential.
Find Out More at csod.com
cornerstone
realize your potential

1

WHAT TO SEE (AND EAT) IN D.C.

America's capital isn't just for patriots—it's also a must for aesthetes and foodies. *By Adam Erace*

THE ROSEWOOD HOTEL IN GEORGETOWN, along the scenic C&O Canal, makes an ideal base for exploring Washington, D.C. Concierge Jason Denby offers tips for guests on the monument and museum circuit and for gourmets hoping to skip the line at the hottest new restaurant.

- **Best new restaurant:** Eric Ziebold's Kinship is hands down my favorite in D.C. right now. I would go there every day to eat the swordfish with capers, oranges, and ratatouille, and I also love the succotash with favas and polenta. It's the kind of place where you just can't wait to make your next reservation.

- **Line hack:** The American food at Rose's Luxury is sophisticated but the antithesis of fancy—one of the reasons it's so popular. For a fee, we offer to send someone to wait in line for our guests, who will receive a text when their table is ready.

- **Presidential dining:** Since they're a younger, fit couple who appreciate health and good food, it's not uncommon to see the President and First Lady at great restaurants like Maketto, Mintwood Place, and Masseria. The Obamas have embraced the modern dining scene in D.C.

2

[1] Chef Eric Ziebold in the dual kitchen of his restaurants Kinship and Métier. **[2]** "Luncheon of the Boating Party" by Renoir is a highlight of the Phillips Collection.

- **Power breakfast:** In Georgetown, Leopold's Kafe is a European-style eatery where power brokers go to make deals under the radar.

- **Hidden-gem museum:** A lot of people don't know about the terrific Phillips Collection, which has especially wonderful Renoirs. It's located in the Phillipses' former home, a mansion located near Dupont Circle.

- **Outdoor activity:** Rock Creek Park is a must-see national park that runs right through the city. There are great running and hiking trails and even a golf course.

- **Shopping spree:** Before the CityCenterDC development opened on the site of the former convention center, you had to go out to the Maryland border for luxury stores. Now you've got Carolina Herrera, Dior, Gucci, Hermès, and more, all within one city block. David Chang's Momofuku is there too, so there's excellent dining to go with the shopping.

- **Locals' secret:** Every day at 6 p.m. the Kennedy Center has free performances on the Millennium Stage. The shows aren't promoted much, so not a lot of people know about them. Make sure to grab a drink before the show and check out the rooftop terrace, which has great views.

- **Things to avoid:** Don't do the monument circuit during the day, when they're most crowded. Instead, see them lit up at night, when each takes on a vibe of its own. Or if you're into fitness, try running the National Mall or do an urban hike.

THE **$10,000** DAY

WE ASKED JASON DENBY TO PLAN US A SINGLE, SPECTACULAR DAY IN WASHINGTON, D.C.... Begin your day by waking up in the Presidential Suite of the Rosewood, and then take a short walk down the Chesapeake & Ohio Canal to Baked & Wired to enjoy a handcrafted coffee or espresso and fresh-baked biscuit or quiche. A chauffeured Bentley will pick you up and take you on an exclusive private tour of the Capitol, the National Gallery of Art, and the National Archives. Enjoy a special lunch at Daikaya, followed by a trip to Washington, Va., for a private cooking class with acclaimed chef Patrick O'Connell at the Inn at Little Washington, followed by dinner at the chef's table in the kitchen. You will retire to the Claiborne House at the Inn and wake up the next morning for your return to the capital.

For a longer, interactive version of this story, go to fortune.com/blackbook.

COURTESY OF KINSHIP; PIERRE-AUGUSTE RENOIR COURTESY OF THE PHILLIPS COLLECTION

ILLUSTRATION BY MARTÍN LAKSMAN


BREITLING for BENTLEY
BREITLING
Breitling for Bentley chronographs stem from an encounter between two exceptional brands, two worlds dedicated to performance, two identical passions for excellence. Crafted by Breitling with an extreme concern for perfection, they combine highly distinctive designs, opulent finishing and mechanical movements chronometer-certified by the COSC, a token of superior precision and reliability. Breitling for Bentley: the best of two worlds.
BENTLEY B05
UNITIME
BREITLING BOUTIQUE
575 MADISON AVENUE • NEW YORK
AVENTURA MALL • MIAMI
THE FORUM SHOPS AT CAESARS • LAS VEGAS
THE MALL AT MILLENIA • ORLANDO

JULY 1, 2016

PERSON OF INTEREST: BRAINSTORM TECH EDITION

Tech

Mikkel Svane / Zendesk

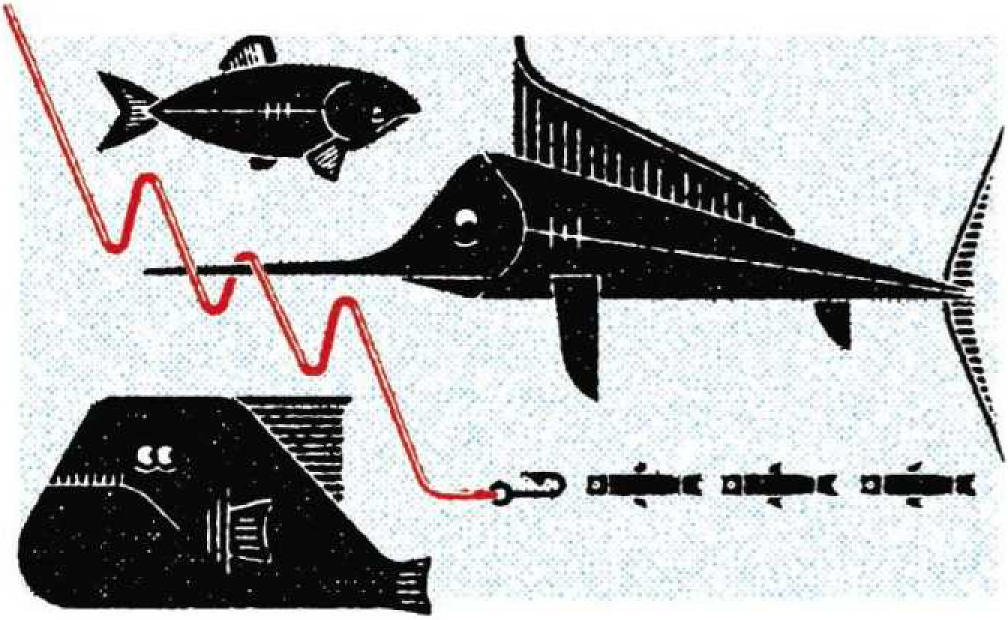
AGE: 45 FROM: Copenhagen HELP YOURSELF: The Zendesk CEO earned his title in 2007 because co-founders Morten Primdahl and Alexander Aghassipour were busy writing code for the trio's customer-service software startup. "We found happiness in doing something where we could each make a difference, have an impact, explore our own limits," Svane says. EVERYTHING ZEN: The San Francisco company's stock was recently trading at triple its May 2014 IPO price of $9 per share. It has 75,000 paid customer accounts, including restaurant reservation service OpenTable and business collaboration app Slack. PLEASE HOLD: Not everyone will pick up the phone to ask a question—something Svane observes in his young family. "It is a generational thing, no doubt about it. My kids are not going to use anything but the Internet." HUMAN TOUCH: Zendesk is investing heavily in bots that use artificial intelligence to respond to questions without troubling a human. Its startup incubator also backed Be My Eyes, a mobile app that connects visually impaired people with sighted volunteers. Says Svane: "There will always be a need for personal interaction." —*Heather Clancy*

TICKER TAPE
A collection of curiosities

$4 MILLION Average consolidated cost of a data breach

SOURCE: PONEMON INSTITUTE/IBM

PHOTOGRAPH BY BENJAMIN RASMUSSEN



FISH OR CUT BAIT

Well-funded cybersecurity firms are waiting for the right market conditions for an IPO. It might be a while.

By Robert Hackett

CHAMPION SAILORS have been known to learn their craft on Lake Travis, just outside Austin. The hills and topography surrounding the body of water whip up challenging winds, making it a sublime place for budding athletes to refine their tacking and jibbing skills ahead of a lifetime of competition.

SailPoint, a digital-identity-management firm with headquarters two miles from the lake, is preparing for a race of its own. Like many companies, SailPoint has contemplated an initial public offering. But global economic headwinds have given the company pause. "The markets are certainly uncertain," says Mark McClain, CEO and founder of the firm, which has more than $100 million in annual revenue.

At presstime, just two U.S. tech companies had gone public this year: SecureWorks, a cybersecurity unit spun off from Dell, and Acacia Communications, a fiber-optics purveyor. Dell shoved SecureWorks out the door in April on its way to a $67 billion mega-merger with EMC, only to watch the fledgling company's share price sag. Acacia made a far stronger debut in May. In June the Bain Capital–backed Blue Coat filed for a public offering before reversing course and selling out to Symantec, the lumbering antivirus software firm, for $4.6 billion. Line, Twilio, and AppDynamics appear most likely to go public next.

The biggest IPO drought in years has put a damper on an otherwise vibrant cybersecurity sector. Not long ago investors plowed funds into the firms at lofty valuations. Now there is a backlog of companies waiting for an exit, among them Veracode, Carbon Black, ForeScout, Okta, Zscaler, and Optiv.

"Financially, SecureWorks is making us all sit back and reevaluate," says Mike DeCesare, CEO of ForeScout, a network security company with $125 million in annual revenue and a billion-dollar valuation. "The question is, Why would you go public right now? If you don't need the money, what is it about the current environment that you find attractive?"

The clock is ticking. In the business of digital defense, the race to stay ahead of hackers' attacks means that innovative strategies steadily depreciate. "One of the risks of delaying an IPO is that you could miss your window," cautions David Cowan, an investor at Bessemer Venture Partners. "You don't want to be an old private cybersecurity company."

Furthermore, many cybersecurity firms aren't well suited for public markets, says Asheem Chandna, an investor at Greylock Partners. "We'll see over the coming couple of years a steady clip of M&A," he says.

SailPoint's McClain continues to hold his breath. "To use a silly sailing analogy," he says, "why would you launch your boat in this storm?"

ILLUSTRATION BY MICHAEL GEORGE HADDAD

"I'M POSITIVE **TWITTER** IS THINKING ABOUT IT." *Investor **Marc Andreessen** on upcoming tech mergers and acquisitions*
BLOOMBERG TECHNOLOGY CONFERENCE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WHAT WILL JOHN LEGERE DO NEXT?

The T-Mobile CEO's crusade for customers is paying off. *By Aaron Pressman*

T-Mobile CEO John Legere mugs for the camera at an "un-carrier" event in L.A.

T-**MOBILE LONG AGO** secured its place as the fastest-growing wireless carrier in the U.S. with a series of unconventional promotions intended to steal market share from rivals Verizon, AT&T, and Sprint. But its latest effort—free pizza, milk shakes, and a movie rental for every customer each Tuesday—tops them all.

When the promotion began on June 7, people downloaded the mobile application required to get the freebies more than 1 million times in 48 hours, overwhelming T-Mobile's servers and frustrating customers who couldn't secure their free medium pie. They took to Twitter in droves to complain—and that's when CEO John Legere entered the fray: "Still seeing huge #TMobileTuesdays app volume, but we're making good! You won't lose anything and we'll make this right ASAP! #StayTuned."

Today pretty much every company has a Twitter presence, and many CEOs tweet. But T-Mobile's chief executive goes way beyond the usual corporate pablum. Legere is tweeting about his travels, his kids, his slow-cooked meals, and his rainy runs through Seattle. He's constantly heckling his larger rivals, AT&T and Verizon, which he regularly refers to as "dumb and dumber." (Not that Sprint escapes criticism. Legere's dustups with CEO Marcelo Claure have become Internet legend.)

Legere's "bad-boy shtick" plays well with T-Mobile's customer base of urban millennials, says longtime telecom analyst Craig Moffett. But he also has a "remarkably sharp" strategic vision. "Behind all the bluster and profanity is a very cerebral CEO," Moffett says.

For years T-Mobile had the fewest subscribers among the big four U.S. wireless carriers. (It finally passed Sprint last year to become No. 3.) Its successful surge from behind is due in large part to a strategy to fashion T-Mobile into a rule-breaking, status-quo-busting "un-carrier." T-Mobile was the first U.S. wireless provider to ditch two-year contracts and slash global roaming fees. Since Legere took the top job in 2012, T-Mobile has doubled its customer base to 66 million. The company's stock price is up 140%, to about $42, since it began trading in May 2013.

Chief operating officer Mike Sievert says T-Mobile—and Legere—won't let up. "There's a lot more left to do," he says. And a lot more pizza to deliver. F

JORDAN STRAUSS—AP

1 IN 4 Share of U.S. tech workforce that's female

COMPUTERWORLD/U.S. CENSUS


Hello
my name is

HEY, JEALOUSY

Corporations desire to be nimble like startups at a time when startups crave profits like the big boys.

By Erin Griffith

OVER THE PAST FEW YEARS it has become common for senior executives at *Fortune* 500 companies to make a pilgrimage to Silicon Valley. Touring Mountain View and Menlo Park is the latest trend to sweep the C-suite, next to corporate mindfulness and adult summer camps.

You can imagine the awkwardness that follows. Stiff-haired corporate ladder climbers play dress-up in hoodies, trading their golf outings and steak dinners for drone flying and hipster tacos. They return to the home office in Parsippany or Peoria brimming with ideas about growth hacking. Maybe they rip out their cubicles and install an open floor plan. Perhaps they create "intrapreneurship" competitions. They might even hire a staff futurist or an overpriced "millennial consultant."

Startups have a term for this condition: innovation theater. It has been especially intense as leaders of staid categories, such as hospitality, transportation, and finance, realize their entire industry could be flipped on its head by some kids with an app. It took only seven years for Airbnb to become more valuable (on paper) than Hilton Worldwide; it took Uber six years to top Ford and General Motors. It's no wonder *Fortune* 500 CEOs can't shut up about transformation and "disrupting ourselves."

They're in an awkward position. If these executives dismiss the startups or do nothing, they risk irrelevance. If they engage in innovation theater, they risk the mockery of snarky columnists like me.

But now I'm wondering why we assume that Silicon Valley's way of doing things is automatically better. From Theranos to Zenefits, it's clear that the age-old startup philosophy of "ask forgiveness, not permission" is not a viable business strategy. "Hustling," in startup parlance, works only when you're a 10-person company making cute Internet distractions—not when people's health and safety are at stake.

Ironically, the hot new trend at startups today is corporate theater. As venture funding slows, startups are curtailing spending. They're learning their way around Capitol Hill and K Street too. "People are buttoning it up a bit," says CB Insights CEO Anand Sanwal. Before, startups "could get away with lots of questionable and bad behavior."

Some startups have even created positions like chief regulatory officer as a sign they're taking things more seriously. That's a lot less fun than roles like chief inspiration officer or vibe manager (Heroku, a cloud-platform-as-a-service company, has two of those). But the least fun thing of all is shutting down your company.

Thus startups' newfound focus on profits. That's good news for *Fortune* 500 companies seeking to emulate them: Making money is kind of your thing.

ILLUSTRATION BY MARLY GALLARDO

MORE BWAV
Follow Erin Griffith on Twitter (@eringriffith) or at fortune.com/boom.

How the PGA TOUR embodies—and leads—golf's giving spirit THAT'S GOOD

Wounded veterans John Cruz and Kevin McCloskey get instruction at a Birdies for the Brave Callaway Warrior Club Fitting event during practice for The Barclays. Plainfield Country Club, Edison, N.J., 2015.

ASK GOLFERS ABOUT CHARITY, and they're likely to talk about "gimmes," the term for imminently makeable putts that a player concedes to a match-play opponent—usually by saying, "That's good"—rather than forcing him or her to try to hole it. Gimmes are a nod to the honest and honorable mentality of golf. In fact, one of the game's signature moments of sportsmanship occurred when Team USA's Jack Nicklaus conceded a tricky but short 18th hole putt to his opponent, Tony Jacklin of Team Great Britain, ending the 1969 Ryder Cup in the first tie between the teams. Of course, golf being a sport of gentlemen, Nicklaus and Jacklin became lifelong friends and later co-designed a golf course in Florida named, naturally, The Concession.

Such generosity of spirit can be rare on the fairways and greens at any given competitive moment, but it is a general constant of the sport. Consider, for starters, the huge number of charitable golf events going on across the nation all year round. According to a 2011 study by the National Golf Foundation, approximately 143,000 charitable golf events take place annually in the United States, with an estimated annual philanthropic impact of $4 billion.

A significant chunk of that sum is directly attributable to professional golf's preeminent organization, the PGA TOUR. Last year alone, the TOUR and its tournaments produced more than $160 million for charity—a record amount that included donations made across all of the tours under the TOUR umbrella (the flagship PGA TOUR, the 50 and over PGA TOUR Champions, the Web.com Tour, and its three international Tours: Mackenzie Tour-PGA TOUR Canada, PGA TOUR

PHOTO BY CHRIS CONDON/PGA TOUR

China, and PGA TOUR Latinoamérica). The 2015 haul brought the TOUR's all-time total donations to an astounding $2.3 billion—all built on an inaugural $10,000 charitable contribution made by the Palm Beach Invitational back in 1938. The TOUR broke the billion mark in 2005, and it took only nine more years to surpass $2 billion.

THE TOUR BROKE THE BILLION MARK IN 2005. NINE YEARS LATER, IT SURPASSED $2 BILLION.

Leading the charitable money list for 2015 are the star-studded AT&T Pebble Beach Pro-Am, on California's idyllic Monterey Peninsula, and the Valero Texas Open, in bustling San Antonio. These are two of six PGA TOUR events that raised more than $8 million each for charity last year, a group that also includes the DEAN & DELUCA Invitational in Fort Worth, Texas; the Waste Management Phoenix Open; THE PLAYERS Championship in Ponte Vedra Beach, Fla.; and the John Deere Classic in Silvis, Ill. Seven PGA TOUR Champions events and three Web.com Tour events exceeded $1 million in donations as well, while The Presidents Cup international team match generated more than $6 million, a new record for the biennial event.

THE CHARITABLE STRUCTURE

The tremendous breadth and success of the PGA TOUR's community-minded efforts aren't all that make it unique. In contrast to other professional sports organizations, the TOUR depends on more than 100,000 volunteers each year to run its many tournaments, and almost all of these events are set up as nonprofit organizations in order for 100 percent of a tournament's net proceeds to go to charity.

Many different types of charities benefit from the TOUR's endeavors, and these dollars fund programs that primarily support youth development, education, leadership, health and medical research, the environment, the military, disaster relief, and community outreach volunteerism. There are also grow-the-game initiatives, in part to help ensure that golf continues to be able to give back on such a large scale. In total, more than 3,000 local and national charities are directly supported by the PGA TOUR, its players, and its tournaments.

You can see the tangible success of these programs at each TOUR stop, like on the driving range at the 2016 Valspar Championship at Innisbrook Resort and Golf Club in Palm Harbor, Fla. Birdies for the Brave—the PGA TOUR's primary vehicle to support the U.S. Armed Forces and their families—invited two Purple Heart recipients, Jason Ellis and Derek Austin, to take part in the Callaway Warrior Club Fitting Program. Air Force Staff Sergeant Ellis, from Riverview, Fla., and Army Sergeant Austin, from Safety Harbor, Fla., both suffered significant injuries during combat in Iraq and Afghanistan, respectively. The two men were each fitted with their own full set of Callaway Golf clubs, spent quality time talking golf with PGA TOUR pro Andres Gonzales, and took a tour of the Callaway equipment truck, learning the ins and outs of fitting a professional's clubs week to week. Callaway sponsors over 15 such fittings throughout the TOUR season.

"Golf is an extraordinary way for wounded warriors to heal from the physical and psychological wounds of war, as well as a great coping mechanism as they reintegrate into civilian life," says Nick Raffaele, Callaway's vice president of sports marketing. "We are honored to work in partnership with Birdies for the Brave to express our sincere gratitude and give something back to these courageous American heroes, who have sacrificed so much to help keep America safe and free."

Two weeks later, John Hamaliuk, a 15-year volunteer at the TOUR's CareerBuilder Challenge in partnership with the Clinton Foundation tournament, in La Quinta, Calif., donated $10,000 to the Boys & Girls Club of Cathedral City. Hamaliuk, a longtime Cathedral City resident, had been named the winner of the event's PGA TOUR Volunteer Challenge, a vote-based competi-

A free children's golf clinic at Valero Texas Open with assistance from The First Tee of Greater San Antonio instructors. TPC San Antonio, San Antonio, Texas, 2016.

PHOTO BY DARREN CARROLL

tion sponsored by Myrbetriq® (mirabegron) that takes place at 16 TOUR events each season that raises funds for charity and recognizes the efforts of all TOUR tournament volunteers. By attracting the most online votes of any CareerBuilder Challenge volunteer, Hamaliuk was afforded the chance to give $10,000 to his favorite charity among those supported by the tournament. The Boys & Girls Club of Cathedral City plans to use the funds within its college and career center, to encourage at-risk teens to further their educational and career goals.

"The CareerBuilder Challenge is a great way for volunteers to not only give back to their community, but also to experience the camaraderie of working alongside great people, and to help stage an internationally televised sporting event. It brings fun and fulfillment to their lives," says CareerBuilder Challenge tournament services manager Kristi Hanousek.

GIVING BACK DIRECTLY

Those same desires drive PGA TOUR pros and their spouses to engage in their own charitable initiatives. This spring, veteran TOUR player Marc Leishman and his wife, Audrey, launched the Begin Again Foundation, which provides assistance to people experiencing financial difficulties due to medical issues. Last year, the Leishmans experienced medical trauma firsthand: Audrey was diagnosed with toxic shock syndrome and acute respiratory distress syndrome—a situation so dire that Marc had to sign consent forms to have her placed in a medically induced coma. Her miraculous recovery led the Leishmans to start their charity, which partners with the Hampton Roads, Va.–based organizations Patient Advocate Foundation and Children's Hospital of the King's Daughters.

"Sudden illness can devastate a family's finances well after they have already been treated," says Marc.

"My illness completely changed our lives," adds Audrey. "Getting well is a burden in itself—financial stress shouldn't make it worse. We're just grateful we have the chance to help others going through a similar situation."

The Leishmans may be unique in the particulars and backstory of their charitable endeavor, but they have joined scores of PGA TOUR pros and their partners to lend a helping hand. Adam Scott began his eponymous foundation in 2005 to help support youth programs in his native Australia and in Asia. Ben Crane focuses his efforts on the St. Bernard Project in New Orleans, which creates housing opportunities for those who were impacted by Hurricane Katrina, while Ernie Els founded the Els for Autism Foundation to support the needs of families affected by autism—and the list goes on.

Likewise, the PGA TOUR Wives Association, a Florida-based nonprofit, was founded in 1988 with the goal of supporting needy children and their families. Its members conduct charitable events and engage in outreach and volunteer service projects throughout the year to further this mission. The group has raised more than $5 million in its 28-year history and participates in volunteer service projects that range from Habitat builds to cooking in soup kitchens to engaging with hospitalized children in communities where PGA TOUR tournaments are held.

Charity is an integral part of the PGA TOUR's fabric. The TOUR's worldwide Tournament Players Club (TPC) Network, which has hosted more than 200 professional events, last year raised more than $1.6 million for Birdies for the Brave, the brainchild of PGA TOUR star Phil Mickelson and his wife, Amy; the TOUR has raised $6.5 million for military-home-front charities since its inception. In 2015 the TOUR also awarded TPC memberships to the Wounded Warrior Project through its Adopt-a-Wounded-Warrior program and conducted charitable events for nonprofit organizations at TPC courses via its Adopt-a-Charity program.

On the course, golfers aren't always the most optimistic souls. During the unavoidable struggles with the game that affect even the game's elite players, some turn to Mark Twain's old witticism about golf being "a good walk spoiled." Considering the game's society-minded efforts, however, it's hard not to think instead of the PGA TOUR's charitable mantra: "Together, anything's possible." Or, put another way, "That's good."

Champion Charley Hoffman with some of the children who benefit from the tournament after the final round of the Valero Texas Open. TPC San Antonio, San Antonio, Texas, 2016.

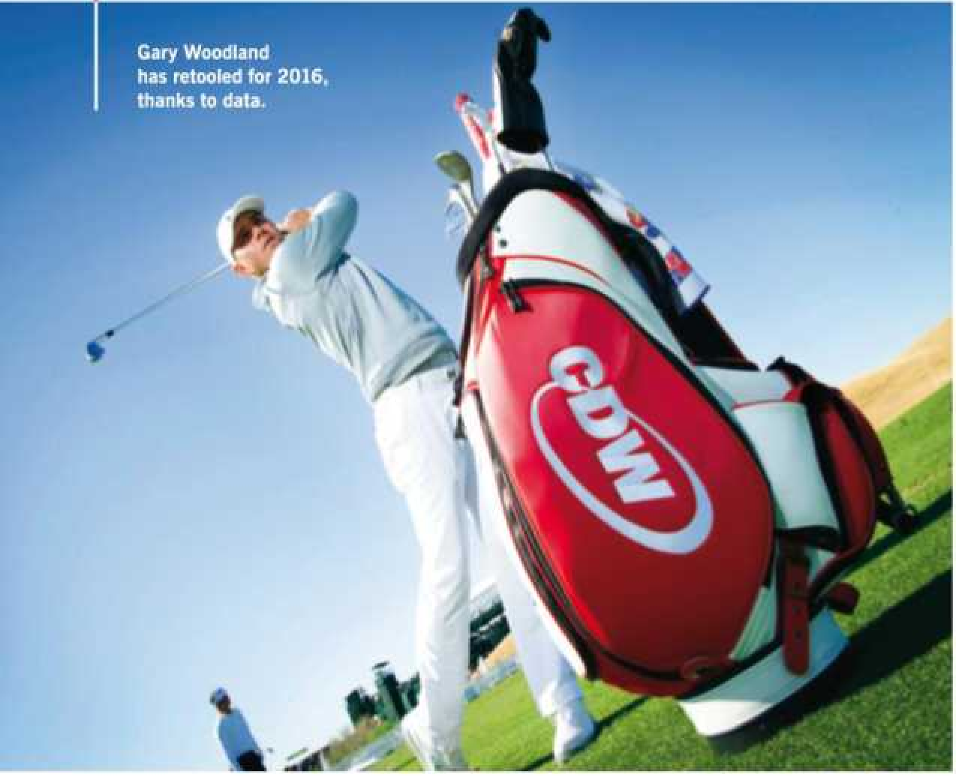
PHOTO BY MIKE O'BRYON

MUCH CONVENTIONAL GOLF WISDOM has been turned on its ear in recent years by data analytics provided by the PGA TOUR's ShotLink system, powered by CDW. By precisely documenting every shot hit by every TOUR pro in every round, understanding what drives success is a far more objective matter nowadays. But a chorus of data can be impossible to hear without orchestration, and PGA pro Gary Woodland is beginning to learn how key it can be to take a complex idea and simplify.

INNOVATIVE GOLF

DRIVE TO SUCCEED

SHOTLINK DATA, POWERED BY CDW, EXPLAINS WHY GARY WOODLAND PLAYS TO, AND PRACTICES, HIS STRENGTH.



Gary Woodland has retooled for 2016, thanks to data.

Imagine a conductor standing in front of dozens of musicians. If each oboe and cello and tuba plays at top volume, the audience gets little more than a chaotic cacophony of sound. But orchestrated properly, each instrument complements another to create a symphony.

Big Data in golf is all about figuring out which stats need to be turned up and which need to be turned down, in order to create a full and impactful image of what drives success. A century of golf wisdom decided that putting was the most important facet of the game. A deluge of data could have drowned out the fact that this was not true—the Driving Distance stat has been proven the most important difference maker on the PGA TOUR. Orchestration means that the key data has risen to the top.

Ranking in the top 20% in Driving Distance is much more valuable than Driving Accuracy or even putting. Woodland, 32, is perennially one of the longest hitters on the TOUR, so upon reuniting earlier this year with his old coach, the legendary instructor Butch Harmon, much of their work has focused on the driver. What might seem to the uninitiated a puzzling emphasis on what's already a strength is in fact a clear-headed, analytical choice.

"In the data we see, distance is a huge deal, and it certainly is for me," says Woodland, a two-time winner on TOUR. "When I drive the golf ball in play, I'm playing a game that most guys aren't playing—my length is a big advantage."

If Driving Distance is the first-chair violin of the proverbial data orchestra, Woodland has made sure to sprinkle in plenty of the other chairs as well. One seemingly fine-print number that Woodland watches closely is Left Rough Tendency, which measures how often a player misses the fairway to the left off the tee and is of greater value to him than the more generic Driving Accuracy stat.

"With the distance I hit the ball, I'm going to get some offline," he says. "What I generally want to do is eliminate one side of the golf course, in my case the left side, which allows me to swing more aggressively and still know where the ball is going."

Armed with similarly impressive modern data to amp up his own game, Woodland looks ready to conduct his way into golf's elite. — *Evan Rothman*

Invest

TECH STOCKS

PONDERING THE PUZZLE OF IBM

The tech giant is stumbling through a painful turnaround. Is the stock a bargain or a trap?

By Ryan Derousseau

SOME COMPANIES EMBRACE CHANGE. Some get suffocated in change's embrace. And shares of International Business Machines (IBM) have performed dismally in recent years because investors have no idea which of those categories it belongs to.

IBM, the Armonk, N.Y., tech giant that turned 105 years old in June, has been stuck at a junction since before Ginni Rometty took the helm as CEO in 2012. The older computing technology on which the company and its white-button-down, black-tie consultants built

ILLUSTRATION BY ROB BAILEY

their dominance in the 20th century, such as servers and mainframes, has crept toward obsolescence. IBM knows that its future lies in cloud technology and artificial intelligence—and Rometty steadfastly preaches that gospel. But the old tech is declining faster than the new tech is growing. Revenue has fallen for 16 consecutive quarters, to $81.7 billion in 2015, and since its March 2013 peak, IBM's stock is down 30%, trailing the S&P 500 by a mercy-rule-invoking 62 percentage points. "We don't know when that will end," laments Barclays analyst Mark Moskowitz.

The advent of cloud computing, which enables corporations to store and manage their data without investing in their own costly infrastructure, changed everything for IBM. The cloud slashed demand for both its servers and the highly profitable consulting and support services that IBM paired with them.

IBM is competing in the cloud, which accounted for $10.8 billion, or 13% of its overall revenue over the past year. But the company has thrown much of its effort behind so-called hybrid cloud services that incorporate private servers, allowing the company to continue providing "middleware" and support to clients. Middleware accounts for about 40% of IBM's profits, according to Moskowitz. But that business model puts the company at a disadvantage against competitors like Amazon and Microsoft that emphasize less expensive "public cloud" services. "You don't get fired for going with Amazon Web Services," UBS analyst Steven Milunovich says that company CIOs have told him. "It's the new IBM."

With IBM well below 10% in cloud market share by most estimates, few investors think that business will help the company turn its fortunes around. Bulls are placing their bets instead on IBM's machine learning and artificial intelligence (AI) efforts—represented in the public eye by Watson, the glib-toned box showcased on *Jeopardy!* and innumerable commercials.

Morgan Stanley analyst Katy Huberty, who earlier this year upgraded her recommendation on IBM from the equivalent of neutral to buy, considers IBM a front-runner in the AI race, since Watson's analytical capabilities have potential applications in fields ranging from travel to finance to retail. Huberty says she's encouraged by IBM's recent push to acquire a monster trove of AI-oriented data—especially in the health care sector, where IBM Watson Health bought Truven Health Analytics in February for $2.6 billion.

IBM doesn't break out figures for its AI work—a sore point among investors who are looking for clearer data, says Moskowitz. But analysts say that IBM's "strategic imperatives" business, which includes AI efforts as well as cloud, security, and other initiatives, will surpass 50% of revenues by mid-2017. The business accounted for $28.9 billion in sales in 2015, up 17% from 2014. While there's plenty of competition in this realm too—Google and Microsoft have their own AI ambitions—Huberty believes that if IBM manages even a 25% market share, AI will be "easily a $50 billion business" for the company.

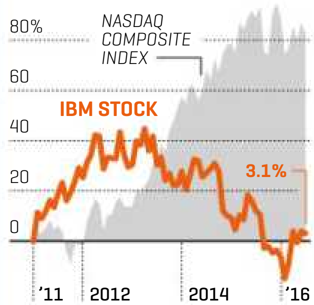
That, of course, is a big if, and one many investors aren't willing to bet on. Only seven of 26 analysts who follow the company rate it a buy or strong buy—an unusually low ratio in that bullish community. Institutional investors such as mutual funds and pension funds have also fled, accounting for only 66% of IBM shares, according to Morningstar; for comparable tech giants like Hewlett Packard Enterprise and Cisco Systems, that figure is 82% or more. But if IBM does finally reverse its revenue declines, those institutions could pile back into the stock—generating a nice pop for people willing to invest in it now. ("Another reason not to be super bearish," notes Milunovich.)

Investors who take that gamble would be buying a still-profitable company for a very low 11 times 2017 earnings, and collecting a 3.4% dividend (far above the S&P 500's average) while they waited. They would be waiting in prestigious company. Warren Buffett's Berkshire Hathaway, IBM's single largest shareholder, has bought more than 12 million shares since the end of 2013, giving it a total of 81 million. Buffett bought nearly 200,000 in the quarter that ended in March.

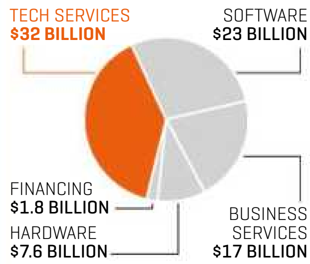
Of course, Buffett has also admitted that he may be wrong. The takeaway: Don't bet money on IBM that you can't afford to lose. ■

LOST IN THE CLOUD

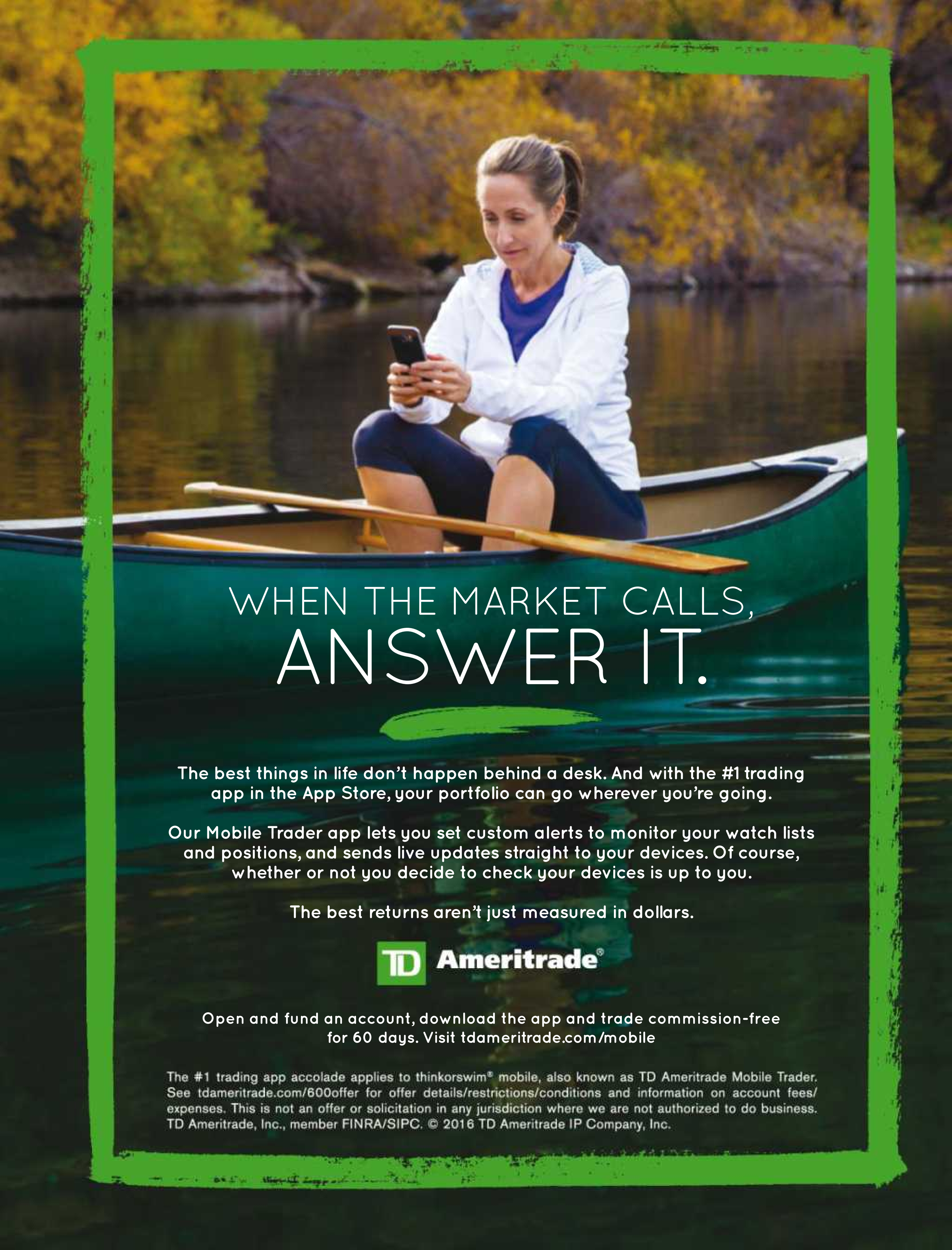
The growth of the "public cloud" and declining demand for IBM's consulting services have hurt the company.



IBM REVENUE BY SEGMENT, 2015



SOURCES: S&P GLOBAL; IBM


WHEN THE MARKET CALLS,
ANSWER IT.
The best things in life don't happen behind a desk. And with the #1 trading app in the App Store, your portfolio can go wherever you're going.
Our Mobile Trader app lets you set custom alerts to monitor your watch lists and positions, and sends live updates straight to your devices. Of course, whether or not you decide to check your devices is up to you.
The best returns aren't just measured in dollars.
TD Ameritrade®
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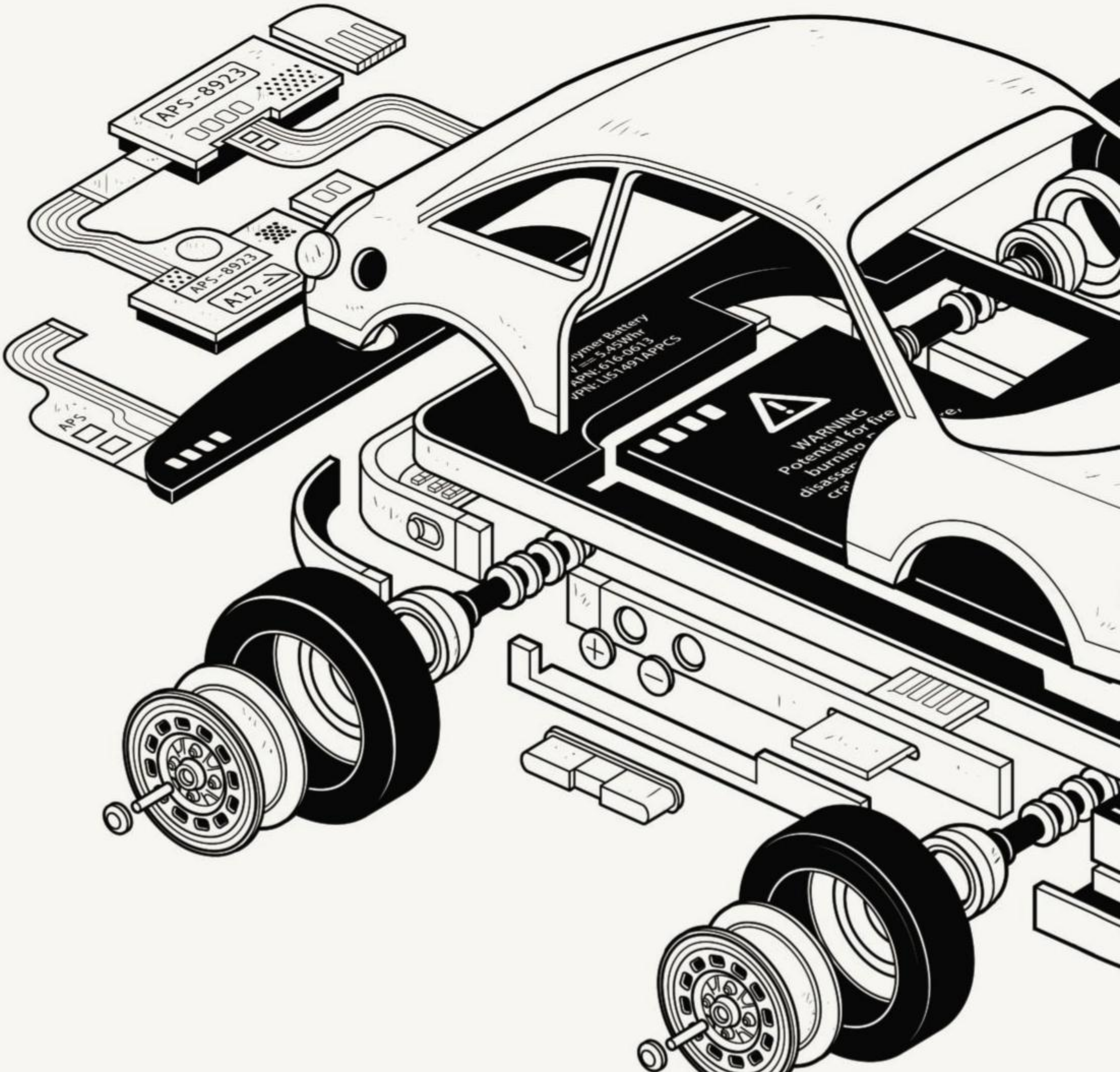
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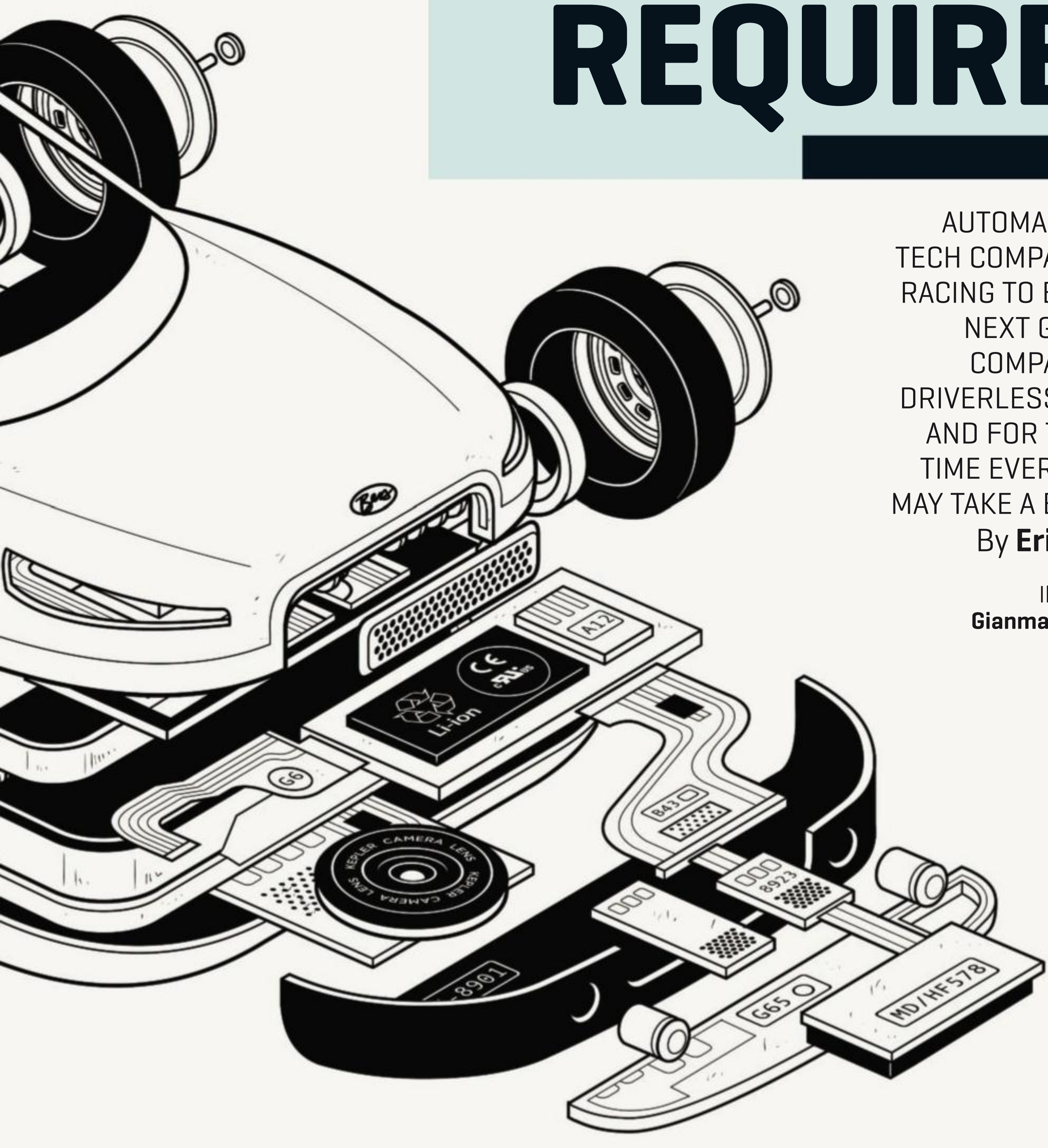
WARNING
Potential for fire

SOME ASSEMBLY REQUIRED

AUTOMAKERS AND TECH COMPANIES ARE RACING TO BUILD THE NEXT GREAT CAR COMPANY FOR A DRIVERLESS FUTURE. AND FOR THE FIRST TIME EVER, THE CAR MAY TAKE A BACKSEAT.

By **Erin Griffith**

Illustration by **Gianmarco Magnani**



BRAINSTORM TECH / **2016**

> My brain knows that this demonstration has been carefully staged and will work exactly as planned, but the rest of my body tenses up as I step on the gas of a Ford Fusion sedan and accelerate directly toward the "parked car" in front of me.

Rear-ending cars on purpose is not a natural act. It takes a metric ton of concentration to resist slamming on the brakes, so I play the role of distracted driver. To the right, a parking lot packed with brightly painted Ford vehicles sparkles in the afternoon sun. In the distance, an American flag waves from its pole. Ford's iconic blue logo is painted into the side of a grassy hill.

I hear a warning beep from the car's dashboard. A red light flashes on the display panel. I imagine that I'm a character from the movie *Mad Max: Fury Road*, chanting in my head, "I live, I die, I live again." Inches from the decoy car, I let out a shriek as the automatic brake kicks in, jerking the Fusion to a sudden halt.

From the passenger seat, Scott Lindstrom, manager of driver-assist technologies at Ford Motor Co., assures me I'm not the first person to scream during this demo. I ask how he simulates accidents day after day. "It is very nerve-racking," he says. Also, he's hit the decoy plenty of times. In 2012 he even did it in front of Ford's board of directors.

Back then the idea of self-driving cars looked, to Ford's leadership, like a frivolous Silicon Valley moonshot. Four years later things have dramatically changed. Today Ford's vehicle lineup features more than 30 options for semiautonomous features, including the automatic brakes I tested, and the company is aggressively working on cars that fully drive themselves. By year-end the company expects to have the largest fleet of autonomous test vehicles of any automaker.

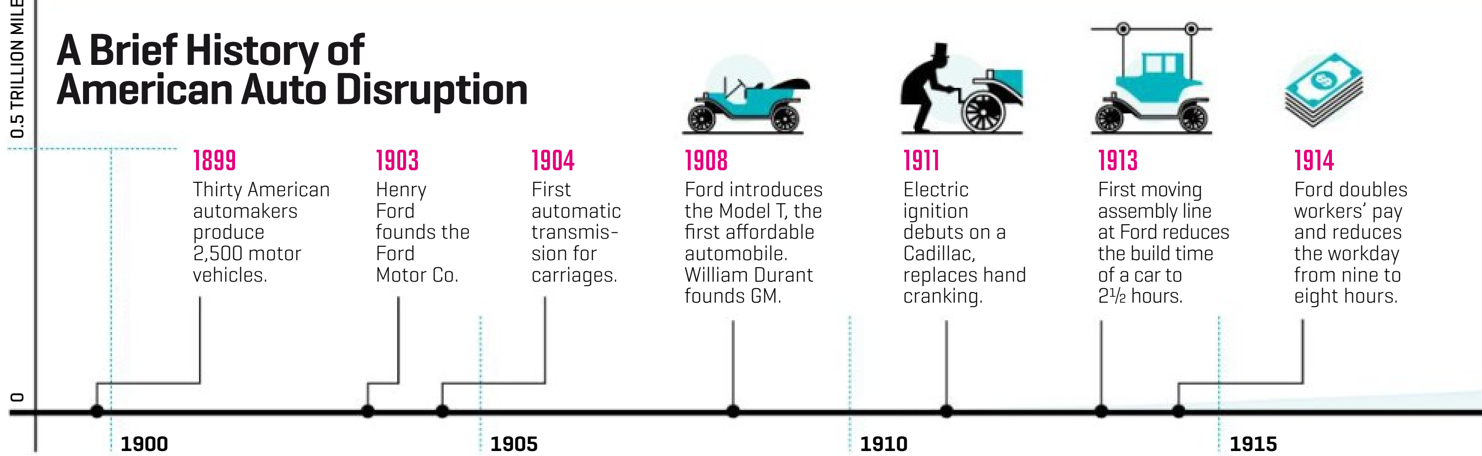
Ford is not alone. The entire automotive industry is in the midst of a radical transformation that is reshaping the very definition of what it means to be a car company. There is hype, hope, fear, and insecurity—and at the center of it all is the self-driving car. Thanks to cheap sensors, powerful machine-learning technology, and a kick in the butt from the likes of Google and Tesla Motors, driverless vehicles are becoming a sooner-than-you-think reality. General Motors, Toyota, Nissan, Volkswagen, Fiat-Chrysler, BMW, and just about every other auto company are wading—some cautiously and some with big, headline-grabbing moves—into territory that executives in Detroit and elsewhere not long ago considered a science-fiction fantasy.

Everything changed in March, when GM spent $1 billion on a tiny self-driving startup called Cruise Automation. For months tech companies, startups, and automakers circled one another, unsure of whether and how to partner. In an industry moving this quickly it's hard to know if a friendly partner will turn into a competitor. It happened when Google's venture capital arm invested $258 million in Uber in 2013; now the ride-hailing company is poised to directly compete against its investor with its self-driving project.

But the hesitancy ended after GM's deal. In May, Toyota struck a partnership with Uber, Volkswagen invested $300 million in ride-hailing company Gett, Apple poured $1 billion into China's Didi Chuxing, and Google partnered with Fiat-Chrysler to outfit 100 Pacifica minivans with self-driving technology. All in the span of one month.

No one is sure how our driverless future will look. Will we be able to scroll through our Instagram feeds from the backseat while our cars drive us to work? Will we even need to own private cars anymore? Some people expect that regu-

A Brief History of American Auto Disruption



"Any good company has a point of view of the future," Ford CEO Mark Fields says. At left, a Ford Fusion Hybrid autonomous research vehicle.

FORD FUSION: COURTESY OF FORD MOTORS; FIELDS: QILAI SHEN—BLOOMBERG VIA GETTY IMAGES

lation will limit self-driving cars to closed-off areas in major cities. Others believe that the first driverless fatality will set the whole effort back by a decade. Predictions as to when fully autonomous vehicles will actually hit the road range from 2050 to as soon as next year. (The answer for Tesla owners is last fall—they have been posting "Look, Ma, no hands!" videos online since October, when Tesla updated its software with an "autopilot" feature that steers the vehicle on highways—not fully autonomous, but a strong start.)

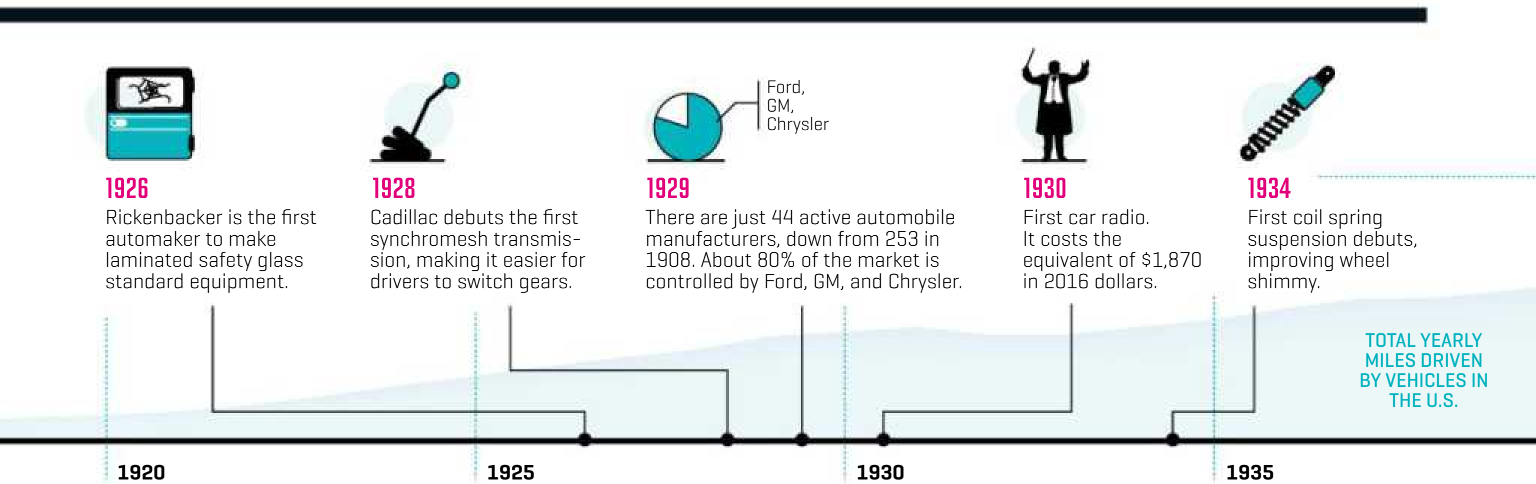
Automakers, technology companies, and ambitious startups all agree that this transformation isn't just headlines and hype, but inevitable. Every person I interviewed for this article deliberately pointed out that, no, really—*this is happening*. Even regulators are onboard. "We've got a clock ticking," U.S. Transportation Secretary Anthony Foxx told Reuters in April. "This technology is coming. Ready or not, it's coming."

Sure, there are hacking fears and privacy issues and ethical questions and infrastructure challenges and concerns about lost jobs. But those will all be worked out, the industry's thinking goes, once everyone realizes how many lives could be saved with this technology. Car accidents cause more than 1 million deaths and 15 million injuries globally each year. Over 90% of them are caused by human error. For some executives, the argument is so obvious it's worth blowing a gasket over. "How could you accept that? Why is this not a national crisis?" bemoaned Eric Schmidt, executive chairman of Google's parent company, Alphabet, at a shareholder meeting in June. "I am, frankly, beside myself over the lack of consensus on how important this problem is."

Beyond saving lives, consider the money saved (traffic accidents cause $500 billion in economic damage worldwide each year), the benefits to cities (parking lots become green spaces), the increases in productivity (commuters can work in transit; truckers can sleep without pulling over), and improvements in accessibility (the elderly, blind, and disabled get affordable robot chauffeurs!).

But most important from a business perspective, driverless vehicles are poised to threaten the $570 billion that Americans spend each year on new cars. For 125 years U.S. auto companies made their money on the manufacture of motor vehicles. Now they must be in the business of ride-hailing apps, shuttle buses, 3D maps, and computers on wheels that drive themselves. They're no longer automotive companies either—they're now calling themselves "mobility" companies, just in case all those predictions about the end of car ownership come true. At stake is a transportation services market that Ford believes is worth $5.4 trillion, a sum that makes you wonder why it took the auto industry so long to go after it.

It's telling that ride-hailing leader Uber got its start while the auto industry was facing bankruptcy in 2009. Now Uber is worth more than GM and Ford by tens of billions of dollars, despite generating approximately $145 billion less in revenue. Alphabet has enough cash lying around to buy Ford or GM outright if it wanted to. Apple, which is widely



TIMELINE ILLUSTRATIONS BY NICOLAS RAPP

rumored to be working on its own car, could buy them both plus Fiat-Chrysler in a Big Three value pack.

The Silicon Valley invasion has not gone unnoticed. "There are enough people working at legacy companies in Detroit who have read *The Innovator's Dilemma*. They know all the business school case studies about how incumbent organizations can't sit around and ignore innovators," says Brian Johnson, a Barclays analyst who has argued that the economy will reach "peak car" ownership in the next year. "The incumbents are willing to move more quickly than I would have expected. There is almost an eagerness to show they're not dinosaurs."

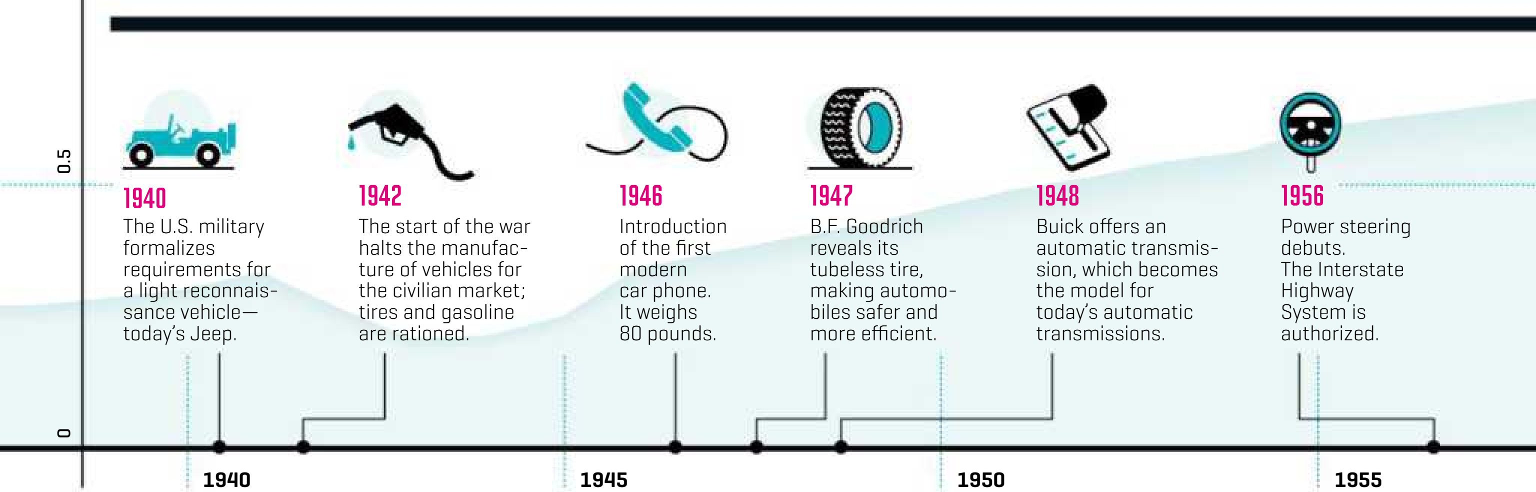
Ford president and CEO Mark Fields, for example, has taken to declaring that his company needs to "disrupt itself" before Silicon Valley players get the chance. The sentiment raises several questions: Does he really mean it? And does he understand what that takes? Even if the answer is yes to both, a much bigger question looms: Can he?

FOR SIX YEARS Anthony Levandowski worked on Google's self-driving car project, developing sensors, creating policies, and testing technology. He's credited as one of the architects of the company's famous driverless vehicles. In turn Google, the online advertising giant that's increasingly known for its ambitious research projects, is credited with showing the world how fast this loopy curiosity could become a business reality. Despite that progress, Levandowski and Lior Ron, a product lead on Google Maps, couldn't stand the idea of waiting any longer to bring autonomous driving technology to market. In January they left to launch Otto, a startup that retrofits commercial big rigs with fully autonomous driving systems.

After only five months of development, the founders made their first public demonstration, sending an 18-wheeler barreling down California's 101 highway at 55 mph with no human interference. There's a sense of urgency at the company. "We've been moving as fast as we can," says Ron. "It's not going to be a 10-year or even a five-year horizon. We intend to bring the technology to market faster."

However soon you believe that driverless vehicles are coming, Silicon Valley innovators want them even sooner. Big and small tech companies alike have decided that transportation is the next frontier in need of disruption. They're not adopting Detroit's historical approach of incremental improvements, deploying ever more semiautonomous features until the robots finally take over. Rather, they're plotting revolution. Google's self-driving pod-cars don't even have a steering wheel or pedals. (The National Highway Traffic Safety Administration defines this as "Level 4" autonomy—the agency's highest level.)

Google argues that revolution is the safest option. Requiring a licensed driver be able to take over from the computer actually increases the likelihood of an accident because people aren't that reliable, the company says. (Plus, keeping a human element in the driving mix destroys the economic and accessibility benefits that autonomous technology promises.) Chris Urmson, Google's director of self-driving cars, made the case for full autonomy—in vain—to California regulators earlier this year. GM, meanwhile, is pro–steering wheel and pedals, according to recent comments made by CEO Mary Barra. The U.S. Department of Transportation plans to announce a new set of guidelines in July.



Self-driving technology could reduce spending on roadways, parking, and public transit, says Chris Urmson, director of Google's self-driving car project. At far left, Google's first self-driving concept.

CAR: COURTESY OF GOOGLE; URMSON: DREW ANGERER—BLOOMBERG VIA GETTY IMAGES

Zoox, a Menlo Park, Calif., startup, is firmly on the revolutionary side of things. According to a snazzy computer rendering from the company, it's building perfectly symmetrical, bidirectional, neon-green-and-black robo-taxis that look like giant remote-control toys. The vehicle is not really a car, founder Tim Kentley-Klay likes to say. "It's what comes after the car." That's because Zoox is not bothering with incremental, semiautonomous features like the automatic brake I tested with Ford. That approach is "not going to give us the changes we want to really solve mobility issues in our cities going forward," Kentley-Klay explained at a 2014 conference in Berlin. Zoox has not yet shared its progress beyond the early rendering, but it has big plans. The company is currently raising $252 million in funding at a reported valuation of $1 billion.

Many people assume Zoox, Google, and Uber (which revealed its own driverless test car in May) will eventually launch their own urban fleets of on-demand autonomous vehicles. Basically robo-taxis. For Uber, reducing or eliminating its army of more than 1 million contract drivers would slash the unprofitable startup's costs. Uber currently pays about 75% of its income to drivers. Eliminating that outlay would likely make up for the new expense of buying, maintaining, and storing a fleet of driverless cars.

For Google, a ride-hailing service allows the company to turn one of its most expensive moon shot projects into a real moneymaking business. Google will reportedly make its driverless car project a standalone subsidiary this year. Executive chairman Schmidt told investors the company believes the cars will be commercially available in "some years, not decades." But first Google needs to reduce the cost of its sensor-covered vehicles from around $170,000 today to less than $30,000, according to a person familiar with the company's plans.

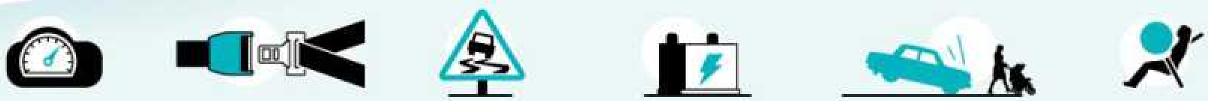
And that's a key problem in Silicon Valley's robo-taxi plan: The nerds have little experience bending metal. Tesla, the one Silicon Valley company that's managed to actually make a car, has been late to deliver every new model it has released since the launch of its very first vehicle (the Roadster, thrice delayed) in 2008. Tesla operates at a much smaller scale than its established peers in Detroit, Japan, and Germany, but its manufacturing problems aren't just normal growing pains. For its latest Model X sport-utility vehicle, Tesla blamed a components shortage in part on its own hubris. It tried to add "far too much new technology" to the vehicle, the electric-auto maker said in a statement.

Auto revolutionaries, take note: If Elon Musk, the real life Iron Man, struggled with manufacturing, then everyone else will too.

WHEN GOOGLE UNVEILED its fleet of zippy little pod-cars in 2014, executives in the automotive industry could barely hide their smirks.

"No automotive manufacturer would ever have dared to show such an ugly potato in public,"

1.5 TRILLION MILES TOTAL YEARLY MILES DRIVEN BY VEHICLES IN THE U.S.



1958 Engineer Ralph Teetor develops cruise control.

1959 Volvo develops the three-point seatbelt system and releases the patent for all manufacturers to use.

1966 Federal standards for automotive safety are established.

1969 Engineers at auto supplier TRW invent a transmission capable of mixing combustion and electric power sources.

1971 Bendix develops the first computerized antilock braking system for a production vehicle.

1973 The first car equipped with an airbag arrives to market. The first production catalytic converter also appears.

1960 | 1965 | 1970 | 1975

1.0 | 0.5 | 0

said Ulrich Weinberg, a professor at the Hasso Plattner Institute in Germany, in an interview published in Audi's 2014 shareholder letter. Auto critics had a similar reaction. (Google's first self-driving concept looked "like a vintage Japanese cartoon character had an illegitimate child with a computer mouse," wrote Andrew Krok.) "People were literally laughing at Google and Tesla," says Lars Reger, chief technology officer of NXP Semiconductors, a supplier of self-driving vehicle technology.

The dismissal shows just how different the two industries' worldviews are. In a vehicle, Google saw "a robot that by accident has four wheels," Reger says. Traditional car manufacturers saw "a horse carriage with a combustion engine." Tech companies launch ideas and iterate on them with continual improvements. "That doesn't work in our business," Ford's Fields says. "You can't hit control-alt-delete when you're going 70 miles an hour."

It's easy to be dismissive when times are good, as they have been for Detroit lately. For the past three years the auto industry has delivered record sales, profits, and growth. GM and Ford are still *Fortune* 10 companies.

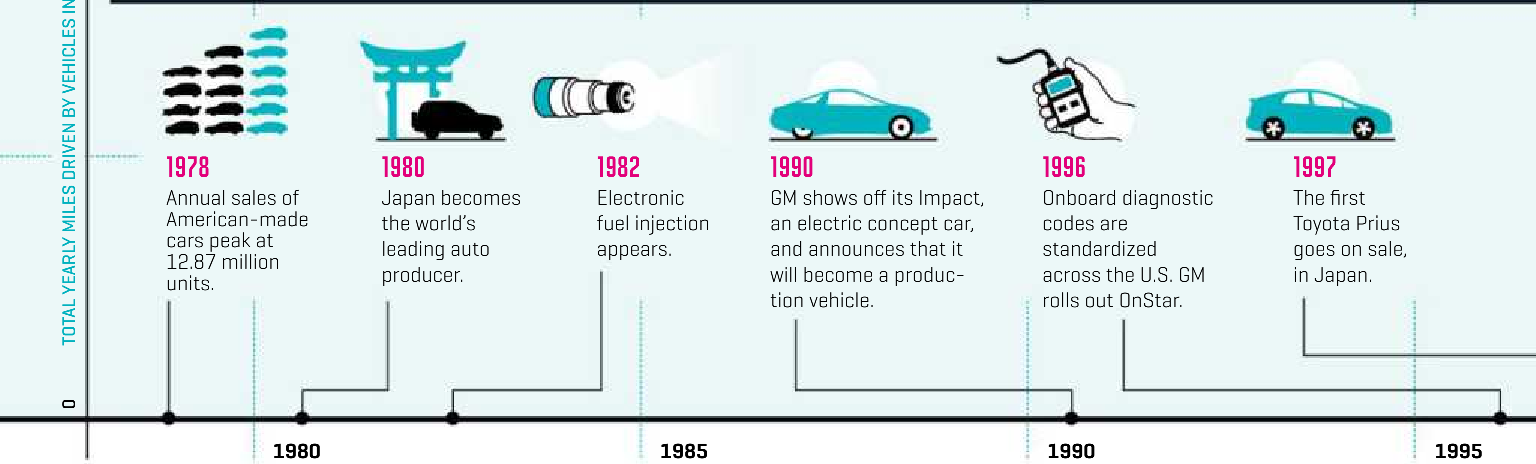
Yet Ford's stock has fallen by 12% in the past year. GM's stock has dropped by 19% despite an announced $9 billion of share buybacks. At Ford's annual shareholder meeting in May, a frustrated investor even asked about bringing former CEO Alan Mulally out of retirement to boost the company's share price. The existential threat facing automakers is compounded by investor fears that the automakers' recent boom is as short-lived as today's low interest rates and cheap gas prices.

Worse, analysts have long speculated about the coming of peak car, comparable to the peak in horse ownership in 1920. With cheap robo-taxis available to chauffeur people around cities, households that spend an average of $9,000 a year on transportation could lower that outlay to just $2,000. "Can the mobility sector capture all of that? I think no," says Robin Chase, co-founder and former CEO of car-rental company Zipcar. "Car companies will still make money selling cars, but the whole market will shrink because we'll use those vehicles more efficiently."

Meanwhile, young people are increasingly uninterested in driving. The percentage of people between the ages of 16 and 44 who obtain a driver's license has been steadily declining since 1983, according to a study by the University of Michigan Transportation Research Institute. Automakers bristle at the notion that millennials hate cars—GM president Dan Ammann calls it an "overly cliché story written by lazy journalists"—but it's clear that automakers are no longer laughing at Google's ugly potatoes.

The U.S. auto industry has been caught flat-footed before. In the 1980s, Japanese imports came to quickly dominate the low end of the North American market as European brands secured the high end. The specter of Google, Apple, Uber, Tesla, Lyft, or even Zoox cornering the future market of How Americans Get Around has created two kinds of paranoia in Detroit: a fear of taking on too much risk and a fear of not taking on enough. "Nobody wants to go too far and pull a Time Warner–AOL," one exec told me. On the other hand, "nobody one wants to get iPod-ed like the music industry," said another.

That fear is driving the great mobility transformation. In early 2015, Ford CEO Fields was preparing to deliver a "change the world"–style speech at CES, the annual consumer electronics trade show, spanning urbanization, the



Anthony Levandowski, one of the architects of Google's self-driving car, left the company to start Otto, which retrofits tractor-trailers with autonomous technology. At far left, an Otto truck.

COURTESY OF OTTO (2)

middle class, air quality, and millennials. It included lines like, "Mobility is about far more than motion—it's really about progress. Human progress."

Preparing for that event was the moment Ford's executives realized they needed to shift, says Ken Washington, Ford's vice president of research and advanced engineering. "It kind of jelled for us that, wow, this is really about being a mobility company," he says. "Over the last year that messaging has gotten more and more crisp."

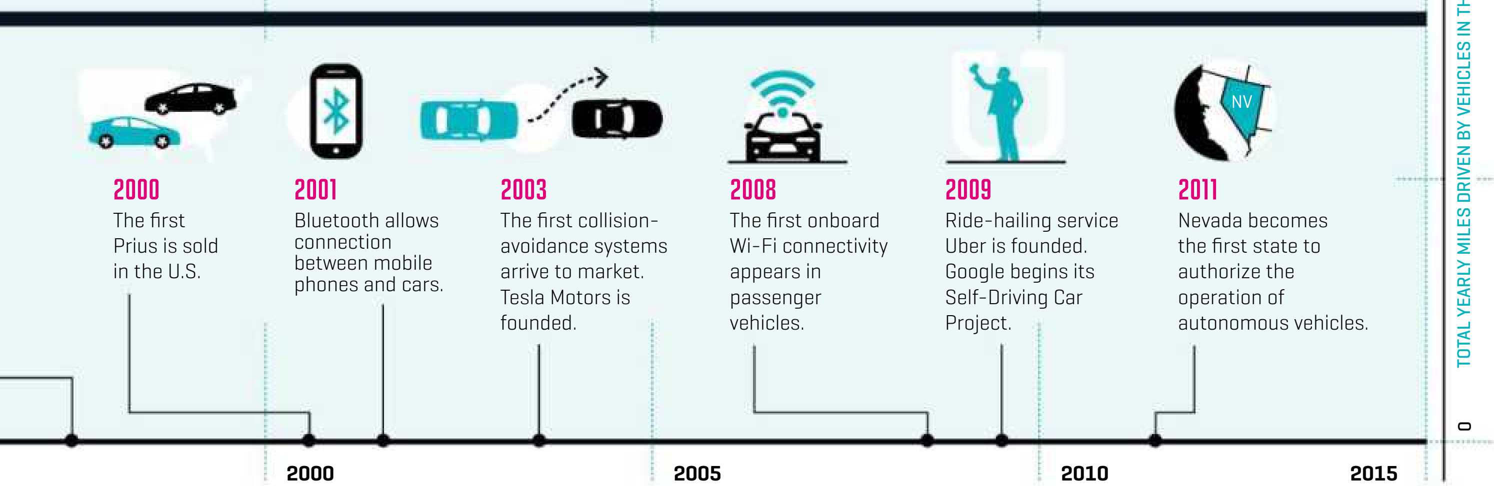
That epiphany led to the creation, in March, of Ford's Smart Mobility subsidiary, a separate LLC that will develop software, tech services, and business models related to transportation in the same way Apple makes software like iTunes and the App Store to complement its hardware businesses. "We're viewing ourselves as the kind of company that gets that there's more than one way to be mobile," says Washington, adding that he doubts Ford's Smart Mobility subsidiary "will have the famous Thursday business process review meetings that Ford is known for."

GM president Ammann had a similar revelation two years ago. Ammann is a car person; he likes to drive his 1961 baby-blue Cadillac Series 62 convertible. But he found himself increasingly relying on a company-provided driver to chauffeur him to work and back because it freed up an extra hour and a half each day to get work done. "There's this significant opportunity cost of the time people spend driving," he says. GM's customers were also telling the company that they wanted to use cars without the cost and hassle of actually owning them—the same need that gave rise to on-demand ride-hailing services like Uber and Lyft. "We see our customers behaving in this way," Ammann says. "We need to move with them."

At the Los Angeles Auto Show in November, Ammann watched Lyft president and co-founder John Zimmer deliver an ultimatum to the automotive industry: "You can fight [the end of car ownership], and that will probably not turn out well. Or you can acknowledge that this is happening. This is real, serious, and going to change your world." The room, full of insurers, regulators, auto dealers, and parts manufacturers, was silent for a moment before a "slow golf clap" began to build, Zimmer says.

After the speech Ammann pulled Zimmer into a hotel suite, where the two quickly hashed out a deal for GM to invest $500 million into Lyft, valuing the company at $5.5 billion, investment included. The meeting, which Zimmer kept secret from his entourage, went for three hours. Zimmer has had plenty of meetings with auto executives over the years, but it was strange to explain his vision of the future and have one respond with "I agree," he says.

A few months later Ammann met with Daniel Kan and Kyle Vogt, co-founders of Cruise, a 2½-year-old startup building a software platform for autonomous vehicles. As with Lyft, they shared visions, Ammann said "I agree," and boom—a big, splashy deal. The companies considered merely partnering but realized they could move faster with an acquisition. "Every time we visited, they'd



moved along another nine steps," Ammann says. At the time, Cruise didn't even have a plan to bring its technology to market. It had explored everything from pizza delivery and package transport to semitrucks and ride sharing, Kan says. Ammann was still convinced, and GM plunked down $1 billion for the 40-person firm in March.

The three companies plan to work together—using Lyft's ride-hailing service, Cruise's self-driving technology, and GM's vehicles—to launch an on-demand driverless ride service to compete with Google, Uber, Zoox, and anyone else that comes along. Says Ammann: "We feel we have the three key pieces we need at this point."

It matters little that the motivations of automakers (fear of being iPod-ed) and tech players (desire to change the world) stand in opposition. More important is that both parties share a goal: to get driverless cars on the road. Indeed, a lobbying group called the Self-Driving Coalition for Safer Streets formed in April, linking Google, Uber, Lyft, Ford, and Volvo. Digital transformation makes for strange bedfellows.

IN THE 1930S a driverless Tin Lizzy called the Phantom Auto toured the country to dazzle crowds with its self-driving capabilities. Imagine, gushed the *Free Lance-Star* of Fredericksburg, Va., an empty automobile traveling the streets: "No one touching it, no wires or strings attached to it, weaving in and out of traffic, climbing hills, turning corners, stopping for traffic lights, just as though there were an invisible driver at the wheel!"

The glory lasted until 1932, when the Phantom Auto mowed down 10 people, hospitalizing two and fracturing numerous limbs (and a skull) at a demonstration in Hanover, Pa. The car's operators, who remotely controlled the vehicle from a trailing car, were arrested on charges of assault and battery, and the driverless vehicle was retired.

Just as the thrill of self-driving cars is not new, neither is the fear of them. Eighty years later, in Google's hometown of Mountain View, one of its pod-cars ran into a bus. In May, Google posted job listings for test drivers in Arizona, which tech bloggers painted as a dream job. Who wouldn't want to make $20 an hour sitting in a car doing nothing for eight hours a day? But the social media reaction from nontechies was a glimpse into the public's fears of robot cars. "You're gonna have to pay more to get me in that tin can with a mind of its own," wrote one Facebook commenter. Fueling the fear, Google filed to patent a grim-looking "human fly paper" material for the outsides of its vehicles in case one of its cars hits a pedestrian, complete with images of bodies stuck to cars.

Silicon Valley is great at building hype. Trust is a different story. Yet just about everyone working on self-driving vehicles believes that people's fears will dissipate once they experience the technology in person. Regardless of whether they're skeptics or enthusiasts, riders always react in the same way, according to Ziv Aviram, whose company, Mobileye, provides collision-avoidance systems to 25 automakers. During that first nervous minute, riders position their hands above the steering wheel and their foot above the brake, poised to take over in the event of a glitch. By the second minute they relax, and by the fifth minute they take their eyes off the road and chat as if they weren't in the driver's seat. After that, "there's no way back," Aviram says.

Auto execs understand this phenomenon well, rattling off examples of vehicle features that the public initially re-

The end of car ownership is "real, serious, and going to change your world," Lyft co-founder and president John Zimmer told auto-industry executives at the Los Angeles Auto Show in November.

sisted: seatbelts, airbags, antilock brakes, cruise control, even automatic transmission. "I don't want any computer stomping on the brake for me," says Ford technical leader Jim McBride, remembering pushback from drivers of the past. "I don't want an airbag blowing up in my face and I can't see out the front window." Even today, Ford's self-driving test vehicles contain giant red fail-safe buttons next to the gearshift that are essentially for looks. (No one has ever used them, the automaker told me.)

Despite all this—the technological advancement, the sudden rash of dealmaking, the this-is-happening clarity stretching from Motor City to the City by the Bay—self-driving cars today remain a Phantom Auto curiosity. Our self-driving future requires interstate cooperation, ubiquitous connectivity, regulatory approvals, and buy-in from ancillary players like parking garages, insurance providers, and dealerships. "It's not enough to throw some sensors and software on a two-ton projectile and say 'Look, Ma, we made it smart,'" says Jamyn Edis, CEO of Dash, an automotive software startup based in New York City.

Many experts don't expect that the world will adopt Level 4 autonomy—the ability to summon a car that goes from point A to point B without human interference—for 25 years, or a full generational change. But partial autonomy arrived much sooner than anyone expected. Google already has demonstrated "A to B" technology that works. By 2021, one of Mobileye's automotive clients (Aviram won't say which) will have it too. Five years may seem like forever to the hoodie-wearing tech crowd, but "in our industry," Aviram says, "2021 is like tomorrow."

Until then GM, Ford, and other auto giants will endure investor skepticism over whether their investments in apps and robo-taxis can ever become profitable businesses. Disruption, by definition, requires making one's existing business smaller. It's why so few *Fortune* 500 companies have managed to pull off what Mark Fields is attempting with Ford: disrupting themselves. That challenge is not lost on Big Auto executives. "Will Ford as a company be the size and scale it is today in 15 years?" asks Zipcar founder Chase. "Probably not."

That doesn't mean they won't try like hell. Next year GM will launch a semiautonomous Super Cruise feature that allows for hands-free driving in its Cadillac CT6 at the same time that it develops "straight to Level 4" technology within its subsidiary Cruise. Ford is also trying to strike a balance between evolution, with its vehicle lineup's semiautonomous features, and revolution, with its test fleet of driverless cars. Ford executives insist it is not totally contradictory to protect the company's existing business while also building technology that will make it obsolete.

I think about that conundrum as I accelerate down a ramp along Interstate 94 on my way out of Detroit in my non-self-driving rental car. I squint and stare at the tractor-trailer in front of me while a reckless driver swerves between lanes at 80 miles per hour to my left. I realize that everything around me—from the radio ads for auto dealerships and cheap car insurance to the billboards for accident settlement attorneys—will be completely transformed by the self-driving car. And then I nearly rear-end the truck.

ZIMMER: PATRICK T. FALLON—BLOOMBERG VIA GETTY IMAGES

BRAINSTORM
TECH / **2016**

CITIGROUP DOES 'FINTECH'

AN EXPLOSION OF NEW FINANCIAL TECHNOLOGY STARTUPS IS THREATENING TO USURP THE MULTITRILLION-DOLLAR BANKING INDUSTRY. HERE, AN INSIDE LOOK AT HOW ONE GLOBAL PLAYER IS TRYING TO "FINTEGRATE" FAST ENOUGH TO STAY AHEAD OF THE REVOLUTION.

By **Stephen Gandel**
Illustration by **YASLY**

What he needed was a SWAT team.

The week after being put in charge of Citigroup's consumer banking business last year, Stephen Bird went to Silicon Valley to meet with venture capitalist Marc Andreessen and other tech luminaries in hopes of gaining insight on how to counter the challenge from "fintech"—the rapidly proliferating class of technology startups bent on disrupting every facet of the traditional financial services business. Together they represent perhaps the No. 1 threat facing large banks today.

It was Salesforce.com CEO Marc Benioff who gave him the idea. Benioff told Bird that he could never hope to change the culture or operations of a banking behemoth, with $1.8 trillion in assets, all at once. But if he put together an elite group within Citi, one that could operate with startup-like speed and agility, he might just get somewhere. Bird decided that to push big changes inside the company, he would first need to think small.

Today the skunkworks operation that Bird created, known as Citi FinTech, is made up of about 40 employees handpicked from various parts of Citi and poached from tech companies such as Amazon and PayPal. In keeping with the outsider mentality Bird wants, the operation is based not in Citigroup's Manhattan headquarters but across the East River in Queens, on the 10th floor of a Citi building that also houses the credit card business. On one wall there's a five-by-10-foot chart listing all of Citi's new fintech competitors and which of the megabank's business lines each startup puts in jeopardy—from payments to commercial lending to wealth management. Not far away is the requisite appurtenance of every startup: a foosball table.

But Bird, 49, is well aware that props alone won't suffice if Citi is going to stay, in his words, "future compatible." An 18-year company veteran, he began his career at General Electric, and he's prone to spouting nuggets of management wisdom—and even quoting legendary GE CEO Jack Welch—in his native Scottish burr. (He grew up outside Glasgow.) Bird says companies don't progress evenly. Instead, referencing a pivotal period in the evolution of life on earth, he describes how businesses leap forward thanks to "Cambrian explosions" of innovation.

To increase the odds of such a transformative event happening at Citigroup, Bird has his team focused on rapid prototyping—working on projects in two-week sprints. He says Citi is on track to release the new iteration of its mobile-banking app in the fourth quarter of this year, after 10 months of development. The gee-whiz feature: facial recognition. Just look at your phone and you will be logged in to your account. It's a project that in the past would have taken Citi years to complete.

Given how quickly new competitors are arising, Citi can't move too fast. Last year investors poured $19 billion into finance startups, up from less than $2 billion five years before. In March, research firm Venture Scanner said it was tracking 1,379 fintech companies, with combined funding of $33 billion. The opportunity for the startups is huge. Revenue in the North American consumer-banking business alone was $850 billion in 2015. It's projected to grow nearly

PREVIOUS SPREAD PHOTO: PETER DAZELEY—GETTY IMAGES

Heather Cox, CEO of Citi FinTech, and Stephen Bird, CEO of global consumer banking for Citi. Bird chose Cox to launch a financial technology startup within the megabank last year.

50% over the next seven years, to more than $1.2 trillion.

The most wrenching period for the big banks is almost certainly yet to come. In March, Citigroup's own research department put out one of the direst assessments yet. The 112-page report, titled "Digital Disruption," was produced for the bank's investment clients and reads like a Jerry Maguire manifesto. The gist: Radical change is coming. Citi says that fintechs have nabbed $9 billion in business so far, a small percentage of what banks bring in each year. But in just four years, the Citi analysts predict, fintech revenues will leap more than 10 times, exceeding $100 billion. By 2023 fintech will account for 17% of consumer-banking services in North America, or $203 billion.

If that bit of prognostication didn't get the attention of the average midlevel bank exec, this one surely did: The Citi researchers predict that the fintech revolution will wipe out nearly a third of all the employees at traditional banks in the next 10 years.

Such a stark outlook helps explain the seriousness with which Citi and its big-bank peers are suddenly treating the latest threat to their hegemony. "Fintech is different," says Bird. "It will change your life and my life. And will change this institution and every other bank."

Veering back to another paleontology metaphor, Bird puts the financial industry's situation in perspective. "I describe it as the extinction phase," he says. "What happens in an extinction phase is that you either rapidly adapt and new means of competition are created, or you go extinct." Citi, then, is in a Darwinian fight for its life.

TO LEAD HIS intracompany startup, last fall Bird tapped Heather Cox, 45, who had originally joined Citi a little over two years ago from Capital One to run a different digital business unit. The fast-talking, high-energy Cox has a deep history in financial technology. She headed the team at E*Trade that in 2004 was the first to offer the ability to use a scanner to deposit checks through a website.

Perhaps just as important, Cox is a self-described fintech junkie—which makes her a good test case for the kinds of customers that Citi and the other big banks will have to win over. On Cox's phone are payment apps Venmo and Square Cash, as well as stock-gifting app Stockpile. On top of that, Cox has apps of five traditional banks and a brokerage firm. Cox says she started using Square Cash a year and a half ago, and she's hooked. She uses it to pay her kid's tutor, among other things.

Is it okay for the head of Citi FinTech to admit that she uses the competition's products? Absolutely, says Cox, clad in a hoodie as we chat on a recent Tuesday, explaining that her team needs to learn how to "fintegrate"—a word she says she coined—the good stuff that the competition is doing.

That's the challenge in front of the banks: They had the customers; they let fintechs carve some away; and now they have to get them back.

Cox understands this. Her solution: Citi's new mobile app will have an open architecture in order to give Citi's customers access to the best functions of the smartest fintech apps. Imagine the app store if it were solely for banking services—all accessible with a Citi sign-in on your phone.

Will it work? Cox says it has to. "I've had this 'fintegration' notion for 18 months now," says Cox. "But we've got some new religion around here."

PHOTOGRAPH BY **PATRICK JAMES MILLER**

The good news for Citi and other big banks is that they appear to be waking up to the challenge at a moment when fintech is stumbling. Recently a number of the more successful startups have hit rough patches—none more so than Lending Club. Shares of the peer-to-peer lender, which was backed by A-list investors such as Kleiner Perkins and Google, have tumbled 80% since it went public at the end of 2014. And the company recently pushed out its founder and CEO after an internal review by the board raised questions about management's disclosure practices. Shares of small-business lender OnDeck have tumbled as well. Other fintech lenders now appear to be having more trouble finding the funding they need to continue making loans.

"A number of these fintech companies have had a good start, but they are going to have a very hard time scaling their businesses," Jaidev Shergill, who is in charge of investing in new technologies at Capital One, said in June at a fintech conference.

Few doubt, however, that the fintechs will continue to disrupt their bigger peers. For one thing, the startups tend to concentrate on one line of business, giving them the advantage of focus vs. the more diverse megabanks. And nearly every service the banks offer is now under attack by some startup—or 10. There are now more than a dozen fintech companies focused on lending. Payment services is another big area. Even the relationship world of investment banking has a number of fintech startups coming after it.

In the past year or so a number of startups have popped up that specialize in blockchain, the technology that forms the foundation for cryptocurrency Bitcoin. The companies are looking to do everything from moving money around to trading difficult financial instruments to coming up with better systems to transfer a title when you buy a house—functions that haven't changed for decades and that have largely been done only by banks, though not always done especially well.

Indeed, it's been a long time since the banking business has had real competition from anything besides other banks. Not that various companies haven't tried. In the 1980s, Sears bought Dean Witter and launched the Discover credit card in an effort to be a major player in financial services. But just a decade later it sold off the unit. In the early 1990s, Microsoft bought tax-software company Intuit in an effort to push into banking. (Bill Gates at the time called banks "dinosaurs.") But the effort went nowhere, and the software giant soon moved on. There has long been speculation about Walmart opening bank branches in its stores, but retailers have always been put off by banking laws that make it hard for firms that take deposits (i.e., operate like banks) to be in businesses other than banking.

Over the past five years, however, a combination of technological advances—particularly the mass adoption of smartphones—and regulatory changes have opened the door to a new group of nontraditional entrants into the banking business. Also helping was the weakened state that many of the big banks were in after the financial crisis. What's more, recently there has seemed to be an unlimited supply of capital for firms, like Uber and Airbnb, that are looking to upend traditional industries. Fintechs have ridden that financing wave as well.

The big banks are well aware of this new challenge from the tech world. In his annual letter to shareholders last year Jamie Dimon remarked that "Silicon Valley is com-

Four Fintechs the Banks Should Fear

RECENT RESEARCH BY CITI PROJECTS THAT REVENUES OF FINANCIAL TECHNOLOGY STARTUPS WILL LEAP 10 TIMES, TO MORE THAN $100 BILLION, IN THE NEXT FOUR YEARS. HERE ARE A HANDFUL OF COMPANIES WITH MAJOR GROWTH POTENTIAL. —*S.G.*

DIGITAL ASSETS HOLDINGS

YEAR FOUNDED: **2014**
NOTABLE INVESTORS: **CITIGROUP, IBM**

High-frequency traders can swap stocks in milliseconds, but it still takes a day or more for the money to move in many of Wall Street's markets. Digital Asset Holding plans to speed that using blockchain—the technology behind Bitcoin. Blythe Masters, a pioneer of credit default swaps at JPMorgan Chase, joined as CEO last year.

KENSHO

YEAR FOUNDED: **2013**
NOTABLE INVESTORS: **GOLDMAN SACHS, XFUND**

It's Siri for Wall Street. The AI software uses big data to analyze new events, answer traders' questions, and spit out reports predicting where markets are headed. Kensho has the potential to replace the Street's trove of market strategists, and its ability to crunch data and offer advice should make investment bankers nervous too.

SOFI

YEAR FOUNDED: **2011**
NOTABLE INVESTORS: **PETER THIEL, SOFTBANK**

SoFi, the online lending platform, made a splash earlier this year with a Super Bowl commercial trying to appeal to upwardly mobile millennials. The lender has drawn scrutiny for using an internal hedge fund to fund its loans. But SoFi has a lower default rate than its rivals, and Moody's recently rated the company's debt triple A.

STRIPE

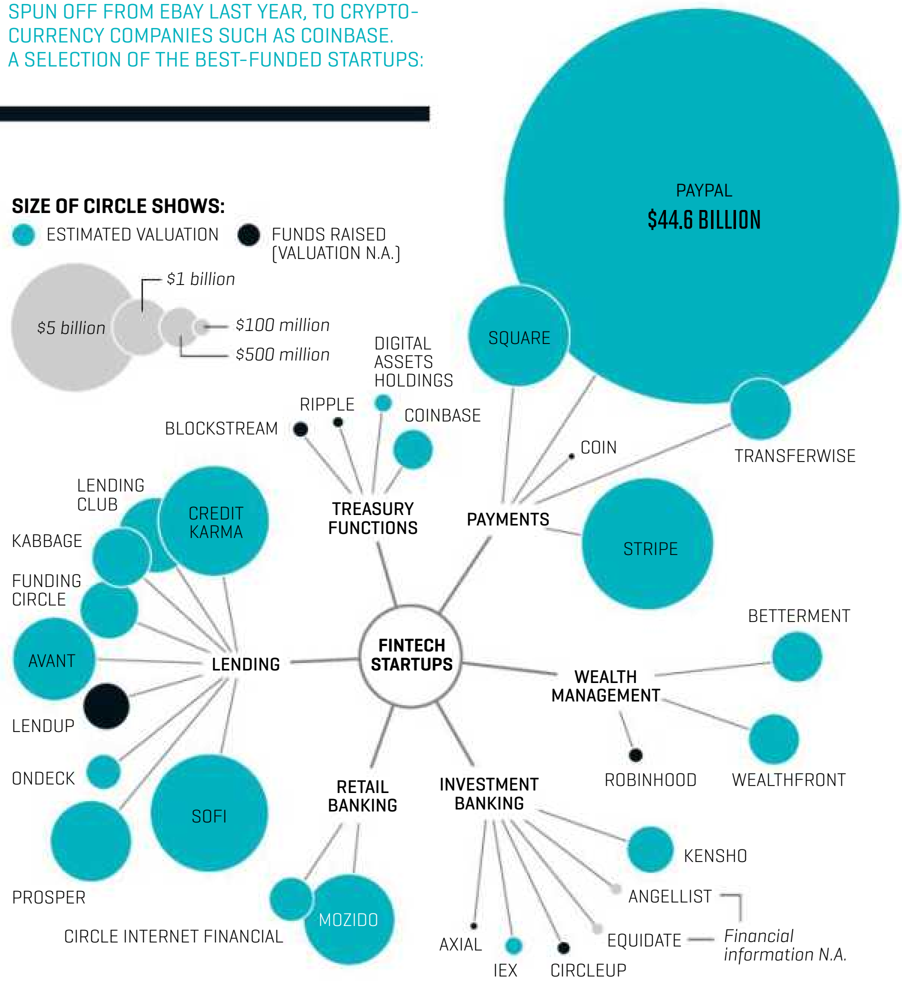
YEAR FOUNDED: **2011**
NOTABLE INVESTORS: **ANDREESSEN HOROWITZ, ELON MUSK**

Stripe's platform allows any company to begin accepting customer payments in minutes—either by credit card or directly from a bank account. And Stripe wants to compete globally. In early June, when rival PayPal said it was pulling out of Turkey, Stripe CEO Patrick Collision tweeted in Turkish that his company was open for business.

Disruption From Every Direction

LAST YEAR, INVESTORS POURED $19 BILLION INTO FINTECH, AND STARTUPS CONTINUE TO PROLIFERATE. CHALLENGERS TO THE BIG BANKS NOW RANGE FROM PAYPAL, THE

GRANDDADDY OF E-PAYMENTS, WHICH SPUN OFF FROM EBAY LAST YEAR, TO CRYPTO-CURRENCY COMPANIES SUCH AS COINBASE. A SELECTION OF THE BEST-FUNDED STARTUPS:



SOURCES: CB INSIGHTS; CRUNCHBASE; FUNDERBEAM; BLOOMBERG

MARKET DATA AS OF JUNE 10, 2016.

ing.” But among the big banks none seems to be taking the threat from Silicon Valley more seriously than Citi. It has the largest portfolio of investments in fintech startups of any of them.

Not all banks will be hit the same. And it appears Citigroup could be one of the most vulnerable. Citi today generates roughly 51% of its revenue from consumer banking, which is the area where Citi's own analysts see the highest vulnerability. But the company generates another 11% of its revenue from payment processing, or the business of moving money anywhere around the globe for big businesses. Citi has long been one of the leaders in international payments—that's where the whole "Citi never sleeps" marketing line comes from. And after consumer banking, payment processing is likely to be the next big target for fintech.

"Cross-border [money] transfers are a pain in the ass," says Nilesh Dusane, a VP at Ripple, which has a blockchain-like technology that it believes is much better at transferring money than the system that is currently used by banks. There are a lot of customer pain points when it comes to moving money under the current system. Both bankers and entrepreneurs say that it's a big opportunity for fintech—and a challenge for Citi and its peers.

DESPITE THE common threat, each of the big banks are attacking fintech differently. Bank of America, for instance, has consolidated its efforts under the leadership of one executive, Cathy Bessant, who serves as the head of technology and fintech for the entire bank. She has an "innovation budget" of $3 billion to spend on fintech and other new technology projects this year. If anyone in consumer banking at BofA wants to upgrade the bank's mobile app or partner with a fintech company, for instance, he must go to Bessant for approval.

JPMorgan Chase appears to be looking more to partner with fintech companies rather than to build its own technology. In December, Chase signed a deal with business fintech lender OnDeck Capital, one of the most significant partnerships yet between a big bank and a finance startup. Chase also has a partnership with blockchain startup Digital Asset Holdings. (For more on promising fintech startups, see box.)

Citi, meanwhile, is tackling fintech with a decentralized approach—and Bird's team in retail is just one piece. Unlike BofA, Citi has no single fintech czar for the whole company. Each division of Citi is allowed to make its own strategic decisions on how to counter the challenge from fintech and how much to spend to do so. Bird and Cox say that the plan in the retail division is to do a mix of partnering and developing technologies themselves.

Things are very different in the Citi institutional payments business. There is no dedicated fintech unit inside the group. The two men who run the business, Naveed Sultan and Hubert J.P. Jolly, do so from Citi's worldwide headquarters in lower Manhattan rather than from Queens. They dress in dark suits and wear cuff links. And they host visitors in Citi's private dining room, which serves a delicious cream of asparagus soup with morel mushrooms. They don't have a foosball table.

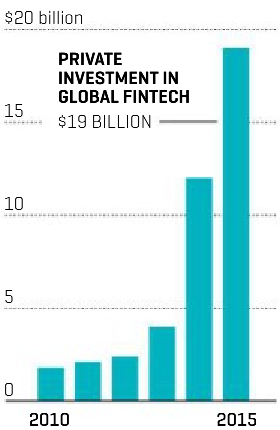
More than one arm of Citigroup is investing in financial startups directly. Citi's head of fintech for the investment bank, which is based in New York, runs a fund that invests in startups, including fintech companies. Then there is Citi Ventures, a venture capital operation based in Silicon Valley that is very much focused on fintech opportunities. The investments that these units make in startups don't necessarily lead to partnerships with Citi. It's the responsibility of the individual business units to negotiate those deals.

For now, Citi's try-everything approach seems to be working. The bank has consistently been in the vanguard in terms of tech innovation among its peers. It was one of the first to offer check depositing from a phone, though nearly all banks offer that now. And it continues to rapidly get more digital.

According to Citi's latest numbers, which were put together by a third-party consultant and are now nearly a year old, just over 46% of its customers use some sort of online banking, either on desktop or mobile. That was ever-so-slightly better than 45% for peers. But an impressive 36% of Citi's consumer-banking-product sales volume came from one of Citi's digital platforms. That compares with around 15% at the other big banks. Over the past year Citi's number of mobile users rose nearly 26%.

Several fintech entrepreneurs say that Citi does tend to move faster than many of the other big banks. But it's not always clear who is the decision-maker at the bank—a possible downside of the decentralized approach.

Cox says she thinks there are more benefits to Citi's plan of fintech attack than drawbacks. She says the benefit of Citi's structure is that it is running faster and harder than its competitors and that in the long run the bank benefits from having multiple teams working on the same problem at once. Citi will get better outcomes, she argues, when the people in the businesses—"the people on the ground"—are deciding what their customers will want. She acknowledges that it's a challenge if outside partners don't feel they have a "single point of entry" into the bank. "We've heard the feedback, and we are working on it," says Cox. In fact, she says, her team is working on a number of partnerships with fintech firms that it hopes to announce later this year.



SOURCES: CITI; CB INSIGHTS

DURING THE COURSE of reporting this story, I had a chance to test the limits of Citi's fintegration. I'm a Citigroup customer, and on the day I met with Bird and Cox in the Citi FinTech headquarters in Queens, I happened to be trying to buy a car in Atlanta. To do so I needed to wire a significant sum of money to the dealership that day.

When I asked Bird if I could do so online or if I had to go to a branch, he told me I had great timing. Wire transfers had just been added to Citi's mobile app. I could complete the transaction right from my phone! But when I met with Cox later in the day, she told me that wasn't quite right. Wire transfers aren't built into Citi's app yet.

Nonetheless, Cox said getting the wire transfer done would be no problem. I could still do it through my phone by going to Citi's website. Turns out, that doesn't work yet either. You need to use a desktop computer. But I was told that if I went to the branch in the basement of the building, they would be able to help me.

They couldn't. The branch didn't have any computers that customers could use, so they couldn't show me how to make a transfer online. But a representative there said that if I traveled to a Citi branch on 52nd Street and Fifth Avenue in Midtown Manhattan, someone could show me how to do it there.

After a 20-minute subway ride and a short walk, I arrived at the location, which is one of Citi's designated "smart branches," and spoke with a representative at the Citi version of a Genius Bar that had three computers and a blue halo light over the desk. To complete the transfer, he explained, I needed not only my log-in information but also the number on my wife's debit card, even though it's a joint account. I also needed the nine-digit routing and 10-digit account numbers for the dealership's bank. The representative walked me through the process. A number of times along the way, red warning messages popped up on the screen. The Citi employee said I could ignore them.

After another 20 minutes, the transaction was complete. The smiling Citi rep standing over me said, "See, wasn't that easy?" No, not easy, exactly. But nobody ever said that radical evolution would be.

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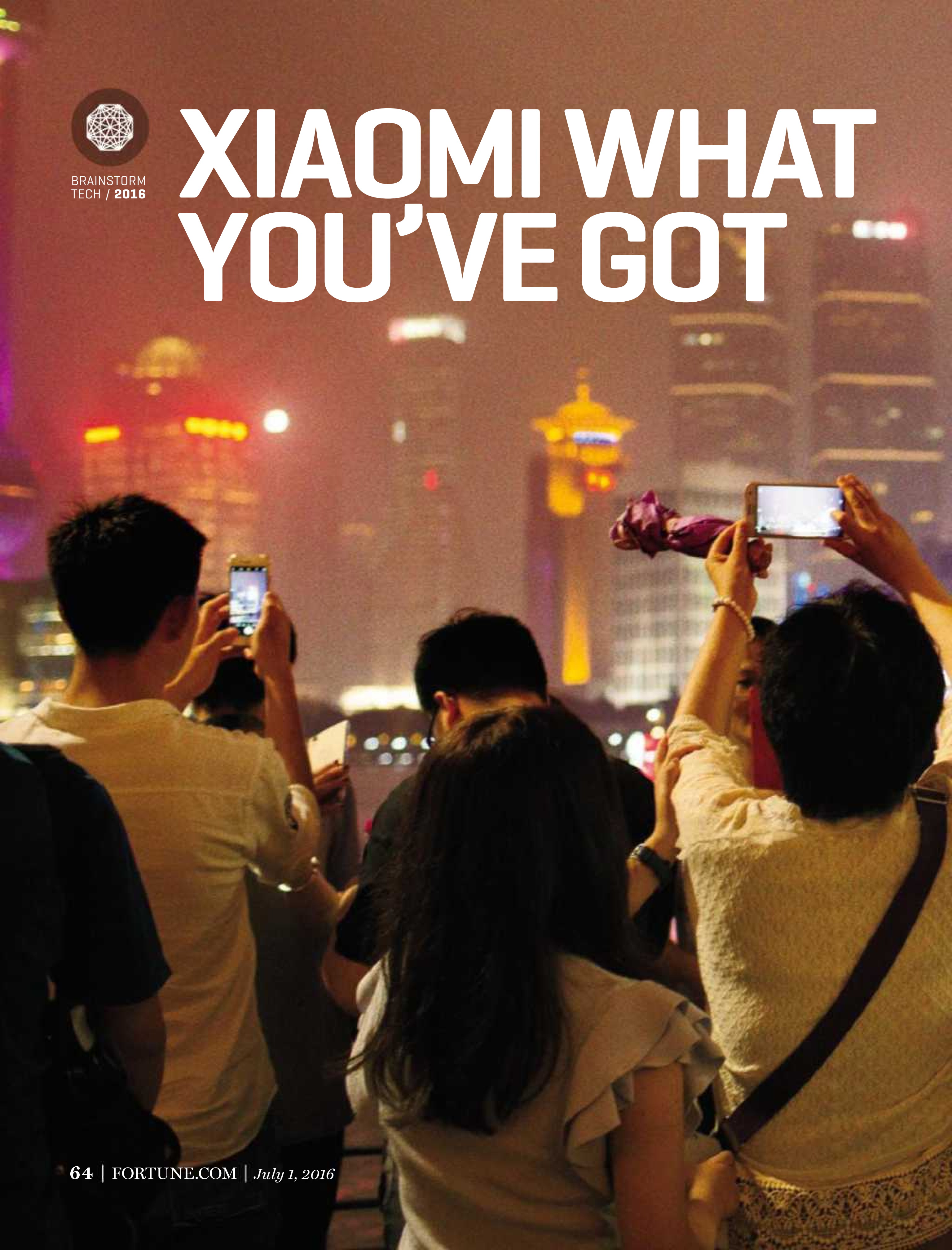
XIAOMI WHAT YOU'VE GOT



THE RUNAWAY SUCCESS OF XIAOMI'S CHEAP, STYLISH SMARTPHONES HELPED THE CHINESE STARTUP BECOME ONE OF THE WORLD'S MOST VALUABLE PRIVATE COMPANIES. NOW ITS SALES ARE SPUTTERING. CAN XIAOMI'S "ECOSYSTEM" EVER LIVE UP TO ITS $45 BILLION HYPE?

By **Scott Cendrowski**
Photographs by **Julie Glassberg**

A crowd socializes on Shanghai's Bund waterfront. Smartphone sales have tailed off in China over the past year, and Xiaomi lost its top spot for market share.

BRAINSTORM TECH / **2016**

January 15, 2015:

Inside a Beijing convention hall big enough to fit a brigade, Chinese tech upstart Xiaomi is rolling out its newest big-screen phone, the Mi Note. The event has the hype of a Hollywood premiere, and $15 tickets have sold out to this crowd of thousands of buzzing fans.

When CEO Lei Jun takes the stage, in distressed jeans, sneakers, and a blue button-down, he's confident—cocky, even. You can hardly blame him. Xiaomi, the company Lei founded in 2010, has become the world's fourth-largest smartphone seller, hawking affordable, stylish phones that cater to China's immense middle class and its youth culture. Xiaomi has just completed a funding round that made it the world's most valuable private startup, with an astounding valuation of $45 billion—reflecting investor excitement about not only its phones but also its "ecosystem" of online services and smart-home products, which could turn phone buyers into loyal customers for years to come.

Tech journalists have begun calling Xiaomi the "Apple of China." The name rankles designers at the actual Apple, who grouse that Xiaomi phones are merely cheap iPhone copies. Lei begs to differ. In fact, he tells the Beijing crowd, his phones are better: "The Mi Note is lighter, thinner, narrower, and shorter than the iPhone 6 Plus, but our screen is larger," he gushes. Over the next few months customers validate his exuberance, as Xiaomi has its best quarter ever for smartphone sales—while monthly users of its games, apps, and services top 100 million.

May 21, 2016:

Beijing again, but this time at a government-sponsored tech conference in an older exhibition center. Smartphones are a topic most attendees would rather avoid, since sales have sputtered. But in an interview with Chinese media, a Xiaomi public affairs official lets slip that Xiaomi's sales rose just 3% in 2015, to $12.5 billion. A year earlier, Lei Jun had boldly predicted that figure would be $16 billion. As for the much-touted ecosystem, investors say it produced half the services revenue Xiaomi had expected.

Apparently this news wasn't supposed to go public: Chinese websites quickly delete references to the interview, and Xiaomi declines to comment on the numbers. Still, the setback reinforces what industry watchers already suspect: Xiaomi's sales have flatlined, and its revolution is in jeopardy.

Xiaomi's tale may sound like merely another iteration of that now familiar headline, TECH UNICORN GALLOPS INTO WALL. But Xiaomi (pronounced "SHAO-me," with the first syllable sounding like the "show" in "shower") isn't just any privately held, multibillion-dollar startup. It's a rising power in a nation eager to prove that its consumer-oriented companies can compete globally. "Xiaomi's mission is to change the world's view of Chinese products," Lei said last year. While Xiaomi no longer wears the most-valuable-startup crown—that now belongs to ride-hailing service Uber—its $45 billion valuation remains a powerful symbol of its aspirations, so much so that Xiaomi proudly includes it in product catalogues. (Some analysts put the figure slightly higher.)

The company didn't attain that valuation on the strength of its phones, though those get raves in the tech press (and have even made Xiaomi modestly profitable) while selling for half the price of an iPhone. No, private investors judged Xiaomi to be more valuable than FedEx or Caterpillar or Delta Air Lines because of the promise that it could build a network of products, services, and recurring revenues—an ecosystem like Apple's—not just in China but around the world.

A customer peruses the gear at a Xiaomi store in a Shanghai mall. Xiaomi's smartphone models won early accolades for offering sleek designs at about half the price of comparable iPhones.

If anything, Xiaomi's idea of an ecosystem is more ambitious than Apple's. Apple focuses on services like iTunes and a tightly focused suite of tablets, computers, and smartphones. Xiaomi envisions a sprawling Internet of things. The company hopes you will someday control your Xiaomi water purifier, Xiaomi air filter, and Xiaomi mood lighting—an entire Xiaomi smart home, essentially—with a few taps on your phone. Executives and investors say today's disappointing numbers are merely a stumble en route to this goal. "In terms of the ecosystem build-out and international expansion, Xiaomi's still at the very early stages," Richard Ji, the venture capitalist and former Morgan Stanley tech analyst whose Hong Kong–based All-Stars Investment led Xiaomi's big 2014 funding round, tells *Fortune*.

A bet on that build-out is a bet on several transformative trends: the rise of China's middle class, the incorporation of average Joes and Janes into the Internet of things, and the capacity of consumer-focused Chinese companies to make inroads in Europe and the U.S. But as Xiaomi's progress slows, there's growing skepticism that a startup without innovative technology of its own or much success outside of smartphone sales can produce an ecosystem anywhere nearly as big or "sticky" as Apple's and Google's. "I think the wheels are wobbling," says Duncan Clark, an Internet consultant based in China and an early adviser to e-commerce giant Alibaba. And that makes a bet on Xiaomi look more and more like a long shot.

XIAOMI EXECUTIVES hate it when their company is called a smartphone startup. They much prefer "Internet company." And Xiaomi hewed to that identity even as it shipped 175 million smartphones over the past five years. The company had no retail locations until recently, selling most of its phones via its website. In China, the phone ships with Xiaomi's operating system, a heavily tweaked version of Google's Android, complete with its own online music and app store.

Xiaomi realized a few years ago that phone buyers alone weren't generating much recurring revenue—nor were they luring return traffic from customers who might be enticed to upgrade to a new phone. The company started selling smartphone batteries in different colors as accessories, and those did well enough to spark an aha moment, says Hugo Barra, Xiaomi's head of international business: "Why not new products?" Barra, a Brazilian-born MIT grad who once led the Android new products team at Google, had been poached to turn Xiaomi into an international brand. "We don't care about selling phones, but about getting as many users as we can," he has said. If devices attract users, Xiaomi brass reasoned, let's assemble a fleet of devices.

The ecosystem campaign aims to do just that. Its core is a team of 170 people with expertise in product development, supply chain, and design. But unlike, say, Jony Ive and his design hive at Apple, Xiaomi's team works primarily with outside companies. The company partners with hardware startups (and often creates new ones), providing seed money for ecosystem products. Xiaomi avoids taking full control, encouraging the founders to act like risk-taking entrepreneurs. The company gets an exclusive deal to sell most of the startups' products, and in turn the startups, now numbering 55, get access to Xiaomi's supply chain, marketing, and even its industrial engineers.

Liu De, a 43-year-old former dean of industrial design at Beijing University of Technology, leads the ecosystem effort with a blanket approach, in which almost everything fits. Xiaomi sells headphones, Bluetooth speakers, a fitness wristband that doubles as a buzzing alarm clock. So far its bestsellers have been everyday, non-"smart" products: a power strip, a portable smartphone charger. But the bigger goal is to create an entire synced smart home. In April, Xiaomi invited 300 journalists to its Beijing unveiling of its $150 smart rice cooker. (From their phones, users can track rice transforming from the "water absorption" phase to one called "big fire.")

Xiaomi's ecosystem sales were about $750 million last year, although most of that flows to its startups through revenue-sharing agreements. Smart homes may be a $15 billion market in China by 2018, according to Juniper Research, and Liu says Xiaomi's ecosystem revenue might equal its smartphone revenue in less than five years. Last year, 90% of Xiaomi's $12.5 billion total revenue came from smartphones. So in essence, Liu and Xiaomi hope to catapult a $750 million, mostly domestic business into at least an $11 billion, increasingly global one.

Xiaomi CEO Lei Jun promotes his company's smartphones at a product-release event in Beijing. Smartphones account for more than 90% of Xiaomi's revenue. The company believes that its other Mi-branded "smart" products (featured at right) will become global top sellers, though sales so far have been modest.

ZHANG JIN XINHUA—EYEVINE/REDUX

A VISIT TO YEELIGHT, one of Xiaomi's startups, suggests how complicated that effort could be. Headquartered in the formerly German-controlled coastal city of Qingdao, the 60-employee company sells a "smart" mood light generating 16 million hues, as well as a Bluetooth-enabled lightbulb—a dead ringer for the Hue lightbulb from Dutch electronics giant Philips.

In 2014, after Google bought Nest for $3.2 billion, smart-home startups were in vogue, and Yeelight founder Eric Jiang found himself being courted by venture capitalists. Xiaomi's offer seemed like a godsend, Jiang says. Xiaomi would help with everything from branding to quality control. It also let Yeelight bypass traditional retailers, who typically take a 40% cut of the purchase price. Instead, Yeelight's products were put in front of what Jiang calls the fire hose of traffic on Xiaomi's website—which averages more than 140 million unique monthly visitors, according to China Rank.

Yeelight has sold 500,000 lightbulbs and mood lights since last summer, 10 times the rate before Xiaomi invested, says Jiang—at prices 80% lower than the Philips Hue starter kit. That makes Yeelight the kind of symbiotic success story on which Xiaomi wants to build its ecosystem.

But Yeelight is also the kind of company that fuels Xiaomi's skeptics—and one whose challenges mirror many of its ecosystem startups. Yeelight sells products that aren't daily necessities, a sticking point for Chinese consumers, who have only about 20% as much discretionary income as Americans. And if Yeelight wants to reach consumers outside China, its rock-bottom prices are bound to rise. Even lightbulbs have intellectual property that needs to be licensed outside China. (China has strong IP laws on paper, but enforcement is lax.) Jiang, a former software engineer at Lucent, speaks frankly: To sell in the U.S. or Europe, Yeelight will have to license patents from other companies, which would boost its retail prices by several percentage points. And since Xiaomi's e-commerce site has virtually no traction outside China, Yeelight would have to pair up with traditional retailers, raising its prices another 30% to 40%. The bottom line: Unless Yeelight rolls out innovative technology of its own, it loses a lot of its price advantage outside China.

Xiaomi's phones have encountered comparable IP headaches abroad. Swedish telecom giant Ericsson for years accused Xiaomi of using Ericsson wireless tech without licensing it—and after Xiaomi began selling smartphones in India in 2014, Ericsson won an injunction against it. (The case is ongoing; Xiaomi declines to discuss pending litigation.) In May, Xiaomi announced a deal with Microsoft that will help address the phone IP problem, buying 1,500 patents. But those patents won't do much for the lightbulbs and water purifiers. "At least some of the ecosystem companies have this problem" with IP, Liu admits. And without the support of Xiaomi's website, only a few ecosystem products have made the leap abroad. They aren't exactly high-margin, statement gear. The Mi Band fitness tracker has been modestly successful in the U.S., for example, but it sells for $15.

Three years ago, Lei Jun told the *New York Times*, "We're not just some cheap Chinese company making a cheap phone." But many Chinese consumers still see Xiaomi that way because of some of its stumbles in making trustworthy products. Its first Mi air purifier was criticized this year by a

MI BAND 2
(FITNESS TRACKER)

MI HEADPHONES

MI NOTE
("PHABLET" PHONE)

MI POWER STRIP

MI PRESSURIZED
RICE COOKER

Shanghai regulator for the amount of clean air it produced. (The company says the purifier has "passed all standards required by regulators in Beijing.") Complaints about Xiaomi's $620 4K TVs appear on Xiaomi's own consumer forums.

Even Xiaomi's reputation-making phones have been fallible. Though Xiaomi relies on a web of suppliers, including iPhone-maker Foxconn, its products haven't proved as reliable as those of more mature competitors. Some Mi phone users lament cracked screens and static from earphone slots. Xiaomi's newest flagship phone, the Mi 5, has attracted complaints since its release in March, with buyers reporting that new handsets often reached a scorching 120° F.

Xiaomi says the handset complaints involve "isolated cases" and says, "We do investigate all reasonable complaints." But the phones' perceived unreliability has had an impact. Clark, the Internet consultant, recently surveyed phone owners in China. Only 37% of Xiaomi owners said they would buy another Xiaomi phone, while 74% of Apple users said they would get another iPhone. "Xiaomi isn't sticky," Clark says. "It's not what an ecosystem should be."

THE GROWING PAINS would matter less if smartphone sales were soaring. No such luck. Before the Mi Note launch, Lei announced a smartphone sales goal of 100 million units for 2015. The company ultimately shipped only 71 million, according to IDC. In the first quarter of 2016, Xiaomi shipped 10.9 million phones, a 26% year-over-year decline. (Global phone sales were down 0.5% over that stretch.)

These numbers make Xiaomi's $45 billion valuation look shaky. If Xiaomi delivers a 10% operating margin on its $12.5 billion in revenue, it would be valued at a bubbly 38 times its earnings. Since Xiaomi sells phones at close to cost to gain users, a 5% margin seems more likely (and even generous). After taxes, that would imply a value of 80 times earnings, and four times sales. If Xiaomi were publicly

China's Homegrown "Globals"

CHINESE FACTORIES ARE FAMOUS FOR MAKING INEXPENSIVE GOODS FOR FOREIGN-OWNED COMPANIES. BUT RELATIVELY FEW OF CHINA'S COMPANIES SELL THEIR OWN GOODS AND SERVICES WIDELY ABROAD. HERE ARE A FEW NOTABLE EXCEPTIONS.

LENOVO

2015 REVENUE: **$66.7 BILLION**

REVENUE SHARE FROM OUTSIDE CHINA: **73%**

Lenovo's global reach rests on two acquisitions of U.S.-based businesses. It bought IBM's personal-computer operations in 2005, and in 2014 it bought the Motorola handset business from Google. Lenovo's smartphone unit has struggled, and the company now holds the dubious honor of world's largest PC maker.

HUAWEI

2015 REVENUE: **$62.9 BILLION**

REVENUE SHARE FROM OUTSIDE CHINA: **55%**

Huawei is practically a household name across Europe and Latin America thanks to its smartphones, wireless networks, and sponsorship of English soccer club Arsenal. The Shenzhen-based company remains effectively blocked in the U.S., however, over national security concerns.

POWER CHINA

2015 REVENUE: **$43 BILLION**

REVENUE SHARE FROM OUTSIDE CHINA: **25%**

This state-owned maker of hydropower dams and power plants has projects in countries from Pakistan to Laos; nuclear energy and wind-power projects are also part of its portfolio. Its services have become a way for China to extend its soft power abroad in developing countries.

MIDEA

2015 REVENUE: **$22.2 BILLION**

REVENUE SHARE FROM OUTSIDE CHINA: **36%**

China's biggest manufacturer of consumer appliances sells air conditioners and refrigerators in the U.S., Mexico, and elsewhere. It's considered a high-quality white-goods maker in China. One of its Chinese competitors, Haier, recently agreed to buy GE's appliance business.

WH GROUP

2015 REVENUE: **$21.2 BILLION**

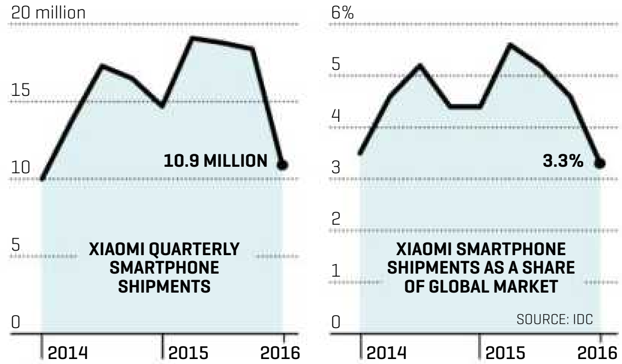
REVENUE SHARE FROM OUTSIDE CHINA: **71%**

After buying Smithfield Foods in 2013, mainland China's state-owned Shuanghui changed its name to WH Group and listed itself on the Hong Kong stock exchange. It's now the world's dominant pork processor, far larger by revenue than U.S. meat-packaging giants like Hormel and Dean.

traded, it would need to at least quadruple its revenue to bring that valuation closer to, say, Apple's.

If Xiaomi were public, it's also safe to say that distraught investors would have fled the stock. Apple's shares are down 12% since April, when it reported the impact of slowing smartphone sales on its top line. Apple's tech ecosystem is the world's most successful, generating $6 billion in quarterly revenue—roughly 12% of Apple's total sales. But that revenue is highly influenced by device sales growth. When their phones are new, people spend more on apps and services; when the shine fades, spending plummets.

Xiaomi, of course, is private. And its sales have been strong enough to keep it from needing to raise more money. That has helped the company avoid a headline-grabbing "down round" where it might raise money at a lower valuation than its previous round (although there are reports the company is looking to issue debt). Tuck Lye Koh, an early Xiaomi backer and a co-founder of Shunwei Capital in Beijing, says



A Unicorn Rises and Falls

XIAOMI'S SURGING SMARTPHONE SALES EARNED IT A SKY-HIGH VALUATION, BUT ITS OUTLOOK HAS SAGGED ALONG WITH THE BROADER SMARTPHONE MARKET.

he and others are confident Xiaomi will dominate China's Internet of things. They see Xiaomi as both an Internet company, blessed with low costs, and a future Ikea, a maker of high-quality, low-cost goods that sell in mass volumes.

Richard Ji of All-Stars Investment says Xiaomi's lower smartphone prices mean its potential customer base is much larger than Apple's. To skeptics, Ji also replies: Just look at Tencent. That Chinese Internet giant was largely dismissed by investors until it introduced WeChat, which has become China's most popular social network, helping Tencent's revenue more than quadruple since 2011.

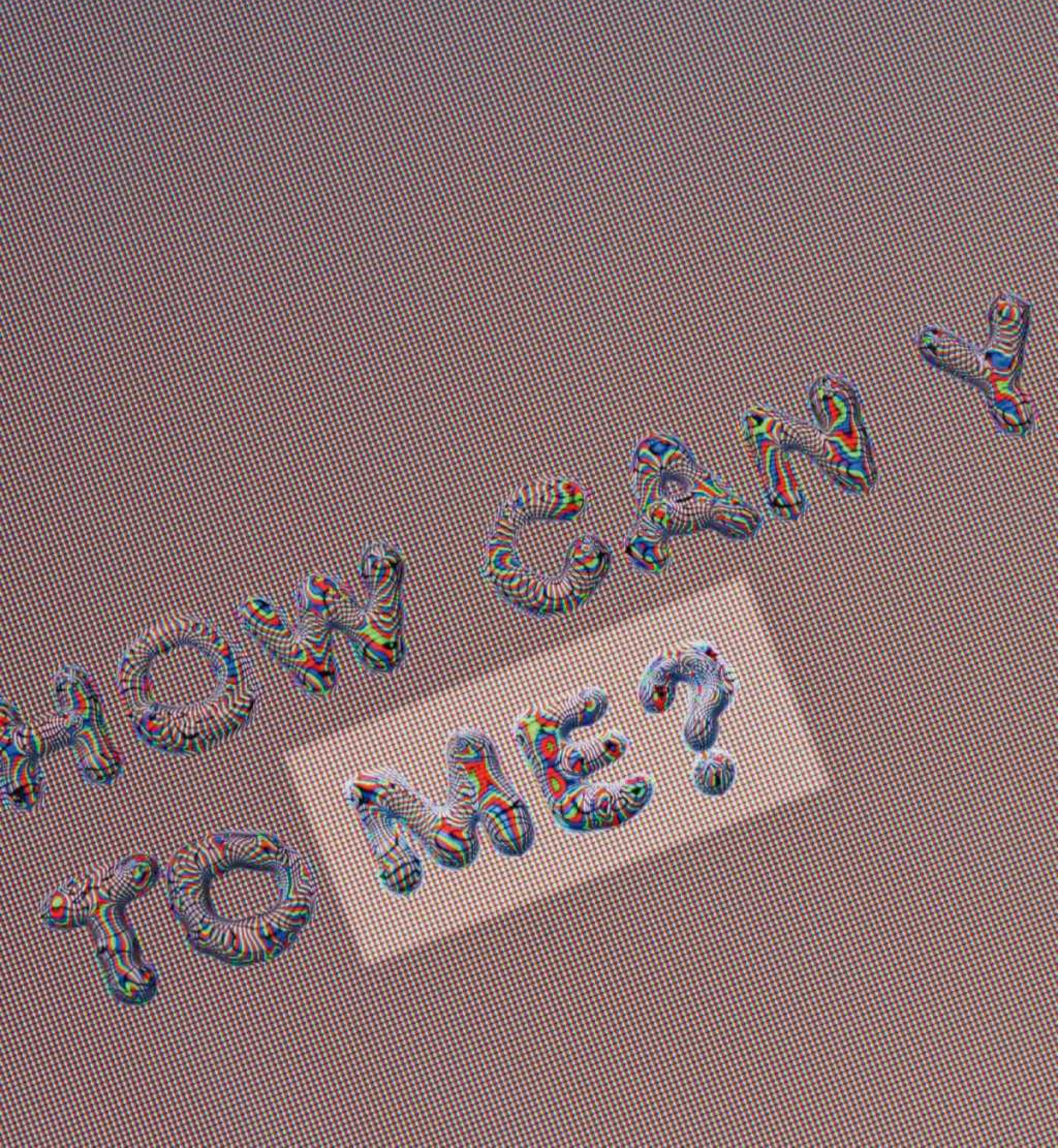
Ji envisions a similar trajectory for Xiaomi. But it hasn't materialized. Xiaomi's revenue from apps and games missed its $1 billion sales target last year, hitting $560 million in 2015, according to one current investor. And unlike Tencent and Apple, Xiaomi's ecosystem growth hinges on making bestsellers out of devices like rice cookers and drones—products for which competition is stiff and margins are low. "These are one-use-type products," says Neil Shah of Counterpoint Research in Mumbai. "The rice cooker will only cook rice. It won't consume content. It won't get you additional revenue."

IF XIAOMI doesn't live up to its $45 billion valuation, you won't need to shed a tear for the investors who gave it that status. The Singaporean sovereign wealth fund GIC, Ji's All-Stars fund, Russian billionaire Yuri Milner's DST, and Yunfeng Capital, a fund affiliated with Alibaba founder Jack Ma, were among the core investors in late 2014 that raised $1.1 billion for Xiaomi. Though investors would not discuss the deal with *Fortune*, the fact that the funding came relatively late in Xiaomi's development makes it likely that it's a "ratchet" deal—one that will give investors more equity if Xiaomi raises money or goes public at a lower valuation.

Xiaomi could mature into a successful company even if it doesn't reach the potential its investors foresee. The Mi 5 phone, which Xiaomi unveiled this spring at Barcelona's Mobile World Congress, could reignite sales, while its Microsoft patent deal could help its phones crack more foreign markets. Thanks to inroads in India and Brazil, the company derives about 9% of revenue outside China—a rare accomplishment for a Chinese company.

There's also that dream of a smart-home ecosystem—though Xiaomi won't have that field to itself. Huawei, which sold 108 million phones last year to seize the Chinese market-share lead from Xiaomi, is now advertising its own smart-home suite, with partners including Haier, the appliance maker that paid $5 billion for GE's appliance business this year. "I don't want to be considered second to anyone," Lei once told a crowd at a Xiaomi publicity event. But despite a magical few years of growth, first place is looking ever more out of reach.

TWITTER *@scendrowski*


HOW CAN Y
TO ME?

SPY TECH THAT READS YOUR MIND

LEAKS, THEFT, AND SABOTAGE BY EMPLOYEES HAVE BECOME A MAJOR CYBERSECURITY PROBLEM. ONE COMPANY SAYS IT CAN SPOT "INSIDER THREATS" BEFORE THEY HAPPEN—BY READING ALL YOUR WORKERS' EMAIL.

By Roger Parloff

TYPOGRAPHY BY RUS KHASANOV

N ANY GIVEN morning at a big national bank or a Silicon Valley software giant or a government agency, a security official could start her day by asking a software program for a report on her organization's staff. "Okay, as of last night, who were the people who were most disgruntled?" she could ask. "Show me the top 10."

She would have that capability, says Eric Shaw, a psychologist and longtime consultant to the intelligence community, if she used a software tool he developed for Stroz Friedberg, a cybersecurity firm. The software combs through an organization's emails and text messages—millions a day, the company says—looking for high usage of words and phrases that language psychologists associate with certain mental states and personality profiles. Ask for a list of staffers who score high for discontent, Shaw says, "and you could look at their names. Or you could look at the top emails themselves."

Many companies already have the ability to run keyword searches of employees' emails, looking for worrisome words and phrases like *embezzle* and *I loathe this job.* But the Stroz Friedberg software, called Scout, aspires to go a giant step further, detecting indirectly, through unconscious syntactic and grammatical clues, workers' anger, financial or personal stress, and other tip-offs that an employee might be about to lose it.

To measure employees' disgruntlement, for instance, it uses an algorithm based on linguistic tells found to connote feelings of victimization, anger, and blame. For instance, unusually frequent use of the word *me*—several standard deviations above the norm—is associated with feelings of victimization, Shaw says. *Why me? How can you do that to me?* Anger might be signaled by unusually high use of negatives like *no, not, never,* and *n't,* or of "negative evaluators" like *You're terrible* and *You're awful at that.* There might be heavy use of "adverbial intensifiers" like *very, so,* and *such a* or words rendered in all caps for emphasis: *He's a ZERO.*

It's not illegal to be disgruntled. But today's frustrated worker could engineer tomorrow's hundred-million-dollar data breach. Scout is being marketed as a cutting-edge weapon in the growing arsenal that helps corporations combat "insider threat," the phenomenon of employees going bad. Workers who commit fraud or embezzlement are one example, but so are "bad leavers"—employees or contractors who, when they depart, steal intellectual property or other confidential data, sabotage the information technology system, or threaten to do so unless they're paid off. Workplace violence is a growing concern too.

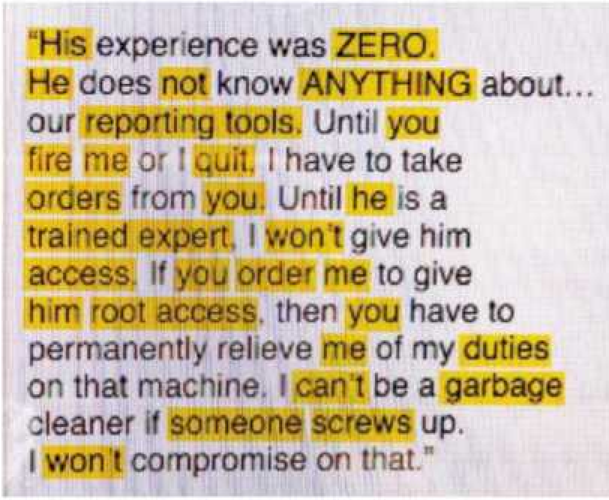
Though companies have long been arming themselves against cyberattack by external hackers, often presumed to come from distant lands like Russia and China, they're increasingly realizing that many assaults are launched from within—by, say, the quiet guy down the hall whose contract wasn't renewed. The most spectacular examples have been governmental—the massive 2010 data dump of more than 700,000 classified files onto WikiLeaks by Chelsea Manning (then known as Pfc. Bradley Manning) and the leaks by former intelligence contractor Edward Snowden in 2013. While those events were sui generis, they opened the world's eyes to the breathtaking scope of every organization's vulnerability.

About 27% of electronic attacks on organizations—public and private—come from within, according to the latest annual cybercrime survey jointly conducted by *CSO Magazine,* the U.S. Secret Service, PricewaterhouseCoopers, and the Software Engineering Institute CERT program. (CERT is a Defense Department–funded cybercrime research center at Carnegie Mellon University.) About 43% of the 562 participants surveyed said their organizations had endured at least one insider attack in the previous year. Though targets of these assaults often keep the incidents secret, known victims in recent years include Morgan Stanley, AT&T, Goldman Sachs, and DuPont.

Insider threats are now sufficiently well recognized that their victims—especially financial institutions—may face regulatory sanctions as well as civil liability for not having taken adequate steps to prevent them. In June the Securities and Exchange Commission fined Morgan Stanley $1 million for failing to prevent a rogue financial adviser from compromising 730,000 customer accounts, even though the bank itself caught and reported the employee, who later pleaded guilty to a federal crime.

Since 2011, government agencies that handle classified information have been required to have formal insider-threat programs in place. And in May that rule was extended to private contractors who handle such data—some 6,000 to 8,000 companies, according to Randall Trzeciak, who heads CERT's Insider Threat Center. With increasing awareness of the problem, Trzeciak notes, the tools marketed to combat insider risk have proliferated. At the annual RSA conference on security two years ago, he says, only about 20 vendors displayed such wares. At

DROP CAPS BY RUS KHASANOV


"His experience was ZERO. He does not know ANYTHING about… our reporting tools. Until you fire me or I quit, I have to take orders from you. Until he is a trained expert, I won't give him access. If you order me to give him root access, then you have to permanently relieve me of my duties on that machine. I can't be a garbage cleaner if someone screws up. I won't compromise on that."

Psycholinguistics: Finding Clues in an Ordinary Email

THIS TEXT WAS ADAPTED FROM ACTUAL EMAILS THAT A SYSTEMS ADMINISTRATOR, WORKING UNDER CONTRACT FOR A BANK, WROTE TO HIS SUPERVISOR. AFTER THE MAN LATER LOST HIS POSITION, HE SABOTAGED THE BANK'S SERVERS. THE ILLUSTRATION AT LEFT SHOWS WHICH WORDS STROZ FRIEDBERG'S SCOUT SOFTWARE WOULD PICK UP AND "SCORE," USING PSYCHOLINGUISTIC PRINCIPLES, IF IT ANALYZED THE EMAIL TODAY. BELOW, AN EXPLANATION OF WHY THOSE WORDS RAISE RED FLAGS, ESPECIALLY WHEN THEY APPEAR UNUSUALLY FREQUENTLY. —*R.P.*

"Negatives" like *no*, *not*, and *n't* may signal anger, which Scout treats as a component of disgruntlement.

The word *me* used in excess can signal victimization, another component of disgruntlement.

Direct references, especially *you*, can signal blame, yet another sign of disgruntlement.

Words in all caps are "intensifiers" and can signal anger. Strong words and phrases [like *garbage* and *screws up*] are intensifiers and "negative evaluators," which both signal anger.

Since much anger and negativity in emails relate to marital conflict, which is often not the employer's concern, Scout uses words relating to employment, like *fire*, *quit*, and *root access*, as a filter. A client can opt to see only emails that contain such references.

this year's, in February, he counted more than 125.

The vast majority of these tools, known as technical indicators, provide ways to monitor computer networks, prevent data loss, alert security to suspicious conduct, or even record keystrokes and take video of individual computer screens. Such solutions let an organization see, for instance, who's logging onto her computer at odd hours, messing around with electronic tags that demark confidential information, or simply departing from routine in some sudden, marked fashion. (See the box, "Tools for Stopping the Enemy Within.")

Still other tools are available to comb through employees' emails, looking for keywords. But Scout appears to be the email-scanning tool most specifically and ingeniously tailored to try to sniff out insider threats *before they occur*.

SCOUT WAS SOFT LAUNCHED as a client service by Stroz Friedberg in late 2014, though the firm has long used earlier versions for internal investigations. The firm was founded in 2000 by Ed Stroz, a 16-year FBI veteran in Manhattan, and Eric Friedberg, an 11-year Brooklyn federal prosecutor. Each had led his office's computer crime unit. Today, with more than 500 employees in 14 offices, the firm is one of the leading outfits of its kind, with specialties in digital forensics, incident response, and e-discovery. Though most of its assignments are confidential, it claims to have worked for 30 of the *Fortune* 50, and publicly identified clients have included Target and Neiman Marcus (after their massive data breaches), Facebook, Google, and the Justice Department.

As impressive as Stroz Friedberg's credentials are, discussion of its Scout product must come with caveats. The firm declined to introduce *Fortune* to a single client using it, notwithstanding our promise to protect the organization's identity. (Companies don't like to discuss their insider-threat programs, in part because doing so makes workers feel mistrusted.) While the firm described instances in which Scout had been used as a forensic tool—say, identifying the sources of anonymous threats—it furnished no specific case in which Scout proactively warded off an insider attack. Stroz Friedberg did cite an instance in which it said that the system had flagged an employee's extreme stress; upon follow-up, officials learned that the person was planning a suicide. They intervened, and Scout may have saved the worker's life.

Ed Stroz acknowledges that Scout does not supplant the many technical tools already available to fight insider threat. But those solutions help only after someone is already "touching, reading, copying, and moving files" he's not supposed to, he says. He likens Scout's aspirations to those of the FBI after the attacks on the World Trade Center. "After 9/11 it became 'disrupt and prevent,' not just 'react and investigate,'" he says. "How do you get in front of something and protect somebody from themselves?" The answer is through language. "Language is being used by everybody," he observes. "Google is using it to sell you jeans." Why not use it to "get to the left" of the actual event—getting ahead of it on a metaphorical timeline, in other words—"so that disasters don't happen?"

ERIC SHAW, 63, practices a rare specialty called political psychology. After earning his Ph.D. from Duke, he did a stint with the Central Intelligence Agency, from 1990 to 1992, and then worked as a consultant to other intelligence offices while building a private practice and teaching at George Washington University. (Shaw says he still spends two days a week consulting for an intelligence agency, which he won't identify but which, he says, has installed Scout to monitor its own personnel.)

Political psychologists draw up mental-health profiles of foreign leaders—Kim Jong-Un, say—to assist policymakers at the State and Defense departments, intelligence agencies, and the White House. Is a hostile chief of state a madman, or can he be reasoned with? If the latter, what is the best way to approach him? These psychologists can't examine their patients on the couch. One tool they use instead is language. They look for clues to a leader's personality in his unconscious speech patterns as captured at public appearances.

In the late 1990s, Shaw recounts, the Defense Department asked Shaw to study insider cyberattacks after a couple of alarming incidents, including one in which an administrator at a Navy hospital encrypted patient records and held them for ransom. The FBI computer crime squads had the most experience with such crimes, so Shaw was put in touch with Ed Stroz, who then headed the flagship unit in Manhattan.

The first case file that Stroz showed Shaw involved a systems administrator at a bank who had butted heads with his supervisor. The supervisor eventually terminated him, prompting him to leave behind a "logic bomb" embedded in the network, which exploded and shut down the bank's servers. Shaw examined the email traffic between the disputants prior to the termination and then marked them up by hand to show Stroz the linguistic red flags.

"It was fascinating," recalls Stroz. At the FBI, he focused on white-collar crime, a realm in which the perpetrator's state of mind is often the only contested issue. Shaw's analysis provided entrée into that realm. "At some point," Shaw continues, "[Stroz] is watching me code the emails, and he said, 'You know, we have computers that will do this now.' That was the beginning of the idea of creating this psycholinguistic software."

Stroz left the bureau in 2000 and co-founded Stroz Friedberg. A few months later he contacted Shaw, after receiving client calls that required forensic linguistic expertise. These were often "anonymous author" cases, in which a client was receiving threats or demands. Shaw would try to identify the perpetrator by comparing distinctive aspects of his writing style to those of a series of suspects. He relied in part on traditional forensic techniques—distinctive formatting conventions, odd diction, telltale misspellings—but also on the linguistic principles political psychologists used. In a case written up in the *New York Times* in 2005, for instance, Shaw's work helped identify a cyberextortionist who had been demanding $17 million from MicroPatent, a patent and trademark company he had hacked. (The perpetrator pleaded guilty and was sentenced to prison.)

Ed Stroz became interested in psycholinguistics while investigating white-collar crime as an FBI agent. He says his Scout software is designed to "protect somebody from themselves."

To assist in analyzing writings, Stroz and Shaw developed an internal software tool, which they named WarmTouch. "Terrible name," Stroz admits, "but the idea was, the keyboard exists only because human beings need a way to interface with the computer. The human being begins where he touches the keys." Meanwhile, Shaw continued studying insider-risk cases, poring over case files at CERT's Insider Threat Center. He looked for missed warning flags that preceded these crimes and then tried to design features that would enable WarmTouch to pick up the linguistic precursors of bad behavior.

To test and hone his hypotheses, he hid actual emails written by insiders prior to crimes in portions of a large, publicly available database of emails known as the Enron corpus. (The corpus consists of about 600,000 emails written by 175 Enron employees, the vast majority of them innocent of any wrongdoing, whose emails were collected by the Federal Energy Regulatory Commission during an investigation of market manipulation.) Shaw then had both human coders and WarmTouch use principles of language

PHOTOGRAPH BY **SPENCER HEYFRON**

psychology to try to filter out red-flag emails without also catching an unmanageable number of false positives. The results, some of which were published in two articles in the peer-reviewed *Journal of Digital Forensics* in 2013, suggested that WarmTouch could be a useful, if imperfect, filtering tool. By late 2014, Stroz Friedberg was ready to offer the latest version, renamed Scout, to customers.

Scout uses about 60 algorithms and tracks a vocabulary list of about 10,000 words, though that list is fine-tuned for each client. About 50 of the algorithms focus on insider threat. The rest can be used for a variety of purposes, Stroz Friedberg maintains, including some nonforensic ones—like detecting intra-office strife, evaluating managers, and identifying emerging leaders. Scout is typically provided to clients with a service contract, calling for "licensed clinicians"—outside contractors overseen by Shaw—to interpret the results.

To oversee the new product, Stroz Friedberg hired Scott Weber, who had previously been a partner at law firm Patton Boggs and headed the government business at big-data company Opera Solutions. "Scout is not dispositive," Weber admits. "It's not going to say that Carolyn's going to come in tomorrow and steal, or that Scott's going to commit an act of workplace violence." What it does do, he continues, is "take a massive amount of information in an organization and filter it down to an operationally friendly pool."

As an example, Weber displays a PowerPoint slide of Scout's user interface tackling a data set of nearly 51 million emails and text messages from more than 69,000 senders. Weber says this represented, at the time, a full data set from one governmental client. When directed to search for aberrantly high scores across four insider-risk variables, Scout winnowed out just 383 messages from 137 senders, representing 0.0008% of the total data set.

In a real-life case, a human clinician would then pull up the actual emails, via Scout's interface, and examine them individually. He would present any messages judged truly worrisome to the client. The client would then decide what action to take, says Weber, after drawing input from managers and its human resources, legal, and security departments. Scout is currently being used in government and in the financial sector, Weber asserts, and is now being tested by clients in manufacturing, health care, and pharmaceuticals. He declines to give numbers.

S**HAW JOKES** that he originally wanted to call Scout "Big Brother." Doesn't it, in fact, invade employees' privacy?

"It's really very respectful of privacy," Weber insists. He stresses that only a tiny fraction of emails are ever read, and most of those are reviewed only by the outside clinician—never coming to the attention of co-workers or supervisors. From a legal standpoint, Weber explains, in the U.S. a company needs "informed consent" to look at employees' emails. "If you have a policy that informs your employees that it's not their computer, it's not their data, it's subject to search, there's no expectation of privacy—you're covered," he says. (Most large U.S. companies already have such policies in place.)

Weber even argues that privacy concerns cut in favor of Scout. "In many cyberattack cases we're brought into," he says, "privacy is exactly how people were wronged. Intruders went through their network, read stuff, copied things, photographed them, turned on the microphone or the camera inside the computer—those are huge privacy violations."

Against that backdrop, the Stroz Friedberg crew claims that Scout is an enlightened approach to a grave, intractable problem. Clients are saying, "'I want it to be something I'm not going to be ashamed to be doing, to have it be part of a caring working environment,'" says Stroz. "You have to get to the left of the line so that disasters don't happen. But you have to do it responsibly."

Tools for Stopping the Enemy Within

CYBERSECURITY PROS HAVE DEVISED A RANGE OF TECHNICAL TOOLS TO COMBAT INSIDER THREATS: DATA THEFT, FRAUD, AND SABOTAGE. HERE ARE FOUR CATEGORIES OF PROTECTION.
—*ROBERT HACKETT*

SIEMs

Security information and event management is the art of monitoring all the data generated by a company's security software and appliances. Information managers store info to be studied later; event managers create data feeds that staff can track in real time. SIEM players include **Hewlett Packard Enterprise, IBM,** and **Splunk.**

DATA LOSS PREVENTION (DLPs)

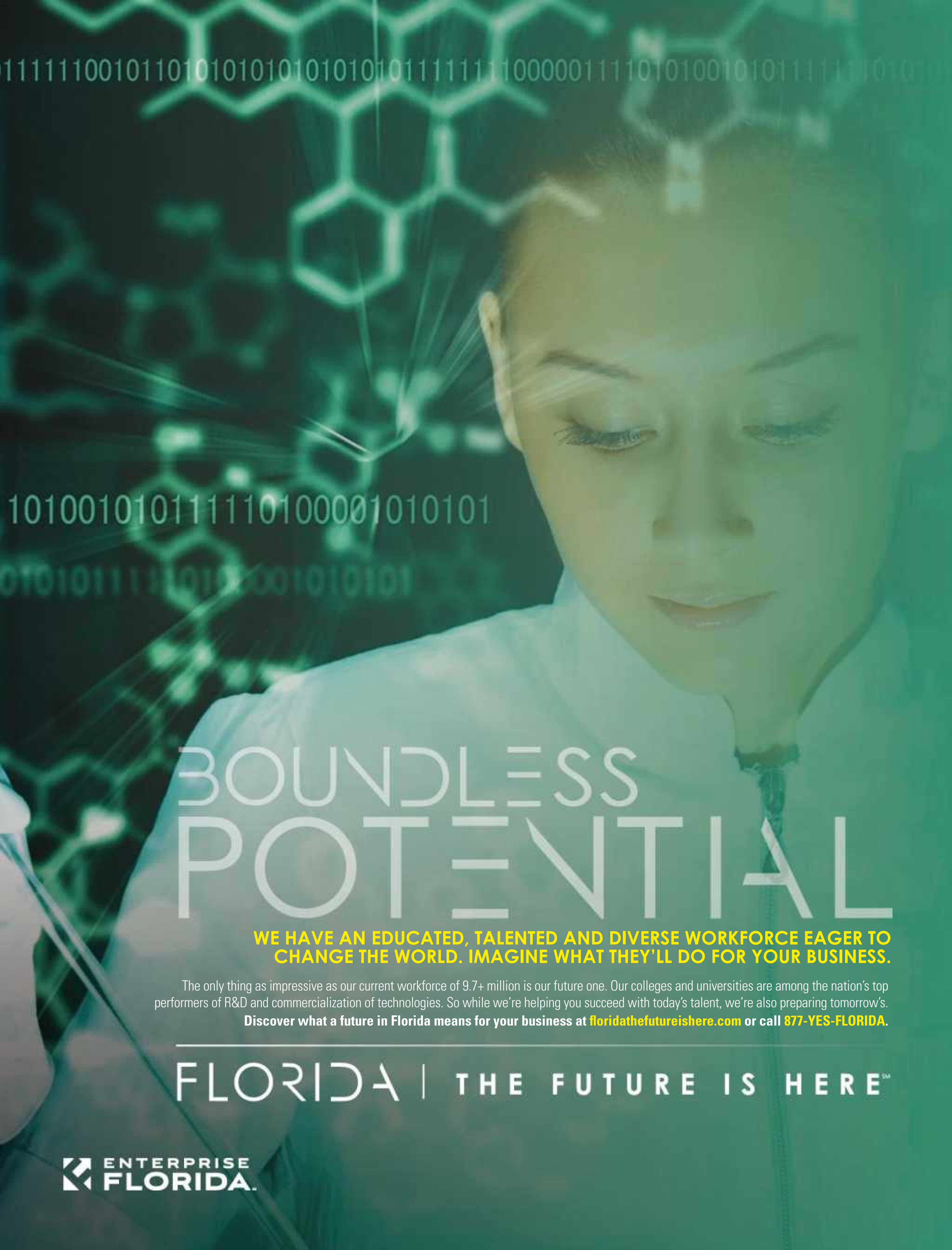
This technology spots—and blocks—unauthorized attempts to move around sensitive information. RSA, a cybersecurity unit owned by EMC (and soon Dell), has been winding down its DLP services, but other widely used products include **Intel Security's** McAfee DLP, **Comodo's** MyDLP, and the free and open source **OpenDLP.**

BEHAVIOR ANALYTICS

This nascent field combines data crunching and machine learning to pinpoint insider threats and compromised accounts. Analytics tools raise a flag whenever people's actions deviate from a given norm. Companies that offer such analytics products include **Rapid7, RedOwl,** and **Securonix.**

ACTIVITY MONITORING

Let's say an employee triggers an alert—by, for example, removing a data tag on a document marked "company's most valuable." A monitoring tool would kick in and start recording his keystrokes, capturing screenshots, or disabling outgoing email traffic. **Raytheon** and **Digital Guardian** sell activity-monitoring tools.


BOUNDLESS
POTENTIAL
WE HAVE AN EDUCATED, TALENTED AND DIVERSE WORKFORCE EAGER TO CHANGE THE WORLD. IMAGINE WHAT THEY'LL DO FOR YOUR BUSINESS.
The only thing as impressive as our current workforce of 9.7+ million is our future one. Our colleges and universities are among the nation's top performers of R&D and commercialization of technologies. So while we're helping you succeed with today's talent, we're also preparing tomorrow's.
Discover what a future in Florida means for your business at floridathefutureishere.com or call 877-YES-FLORIDA.
FLORIDA | THE FUTURE IS HERE℠
ENTERPRISE FLORIDA.

THE FUTURE OF WORK IS * (YOUR ANSWER HERE)

____
* adjective

(if not EXCITING) but it's also rather ___________
* adjective * adjective

and most certainly INTRIGUING. You may think
* adjective

the future of work is ___________. (You may just
* adjective

find it ___________.) Whatever the case,
* adjective

we can all agree that it's IMMINENT.
* adjective

Fortune asked 15 people in different industries

how the future is changing their work today.

Their answers? EYE-OPENING.
* adjective

ILLUSTRATION BY KYLE WILKINSON

GOVERNMENT

Ted Ross, CIO, City of Los Angeles

A MOVE TO THE CLOUD CHANGED HOW L.A. RESPONDS TO A CRISIS.

TED ROSS is proud of the state-of-the-art Emergency Operations Center on which more than 4 million Los Angeles residents will rely in the event of a terrorist attack, a flood, or an earthquake. "It's truly Kiefer Sutherland, *24*-esque," says Ross, the chief information officer for the City of Los Angeles. It's a resource that helps America's second-most-populous city be more resilient, acting as a staging area for emergency responders to coordinate efforts. But there's only one of its scale—which is why the choice to add redundancy keeps Ross (and the rest of L.A.) sleeping soundly at night. Los Angeles has long maintained alternative emergency operations centers across the city, but over time it became clear that the aging facilities weren't capable of handling the load of the main EOC should it go down. "We all started to get this horrible feeling that would keep us up at night—should there be a horrible disaster that impacted our main EOC, our alternate EOC would not be up to snuff," says Ross. So last year the city decided to move to the cloud. Now backups for its evacuation tracking, hazard mitigation, and emergency communications systems reside on Amazon's global network of data centers. Initially the move was meant to be temporary, buying the city time to repair the cooling systems in its secondary centers. But Ross never looked back. A cloud backup costs the city just $300 a month, saves time, and maintains operations when they're needed most, he says. "We can set up a virtual EOC anytime, anywhere."—*Andrew Zaleski*

51% OF BUSINESS LEADERS CITE AN INSUFFICIENT UNDERSTANDING OF DISRUPTIVE CHANGES AS A BARRIER TO THOSE CHANGES SOURCE: WORLD ECONOMIC FORUM

AUTOMOTIVE

ROBOTS HELP MECHANICS IDENTIFY FIXES.

When faced with a tricky automotive repair, Jamie Ludolph used to turn to a tome-like service manual. Today at the Atlanta car dealership where Ludolph is a master guild technician, he can turn to a robot.

The Audi Robotic Telepresence, or ART, is a remote-controlled robot on wheels. Outfitted with cameras and a screen, it lets mechanics at Audi of America dealerships talk to experts at the company's technical center in Auburn Hills, Mich.

"At the beginning I wasn't really sure how helpful it would be or if there were any advantages to it," says Ludolph, who has been a mechanic for more than two decades. "The first time I used it, though, I realized how much time it cut off of what my normal routine would be."

ART isn't used for every problem, and today's mechanics have several high-tech diagnostic tools at their disposal. But the robot is the latest example of how dealership repair shops have transformed from grease pits into high-tech service centers loaded with computers.

"In the last 10 years the technology has gotten a lot more advanced, a lot quicker," says Ludolph.

Despite that pace, Ludolph isn't nostalgic for the old days. The job "is a little bit cleaner than it used to be," he says, "although sometimes you still have to get in there and get dirty."

—*Kirsten Korosec*

ICON ILLUSTRATIONS BY MARTIN LAKSMAN

PHOTOGRAPH BY MICHAEL LEWIS

"You can't stop learning. You have to continue to change and adapt." —MIT MEDIA LAB DIRECTOR JOI ITO AT LA VICTORIA LAB'S FEST 15 IN LIMA, PERU

RETAIL

ALGORITHMS PUT A SOMM IN EVERY HOME.

The ancient world of wine doesn't seem ripe for technological revolution. But that's exactly what Brian Smith set out to do when he co-founded Winc, an online wine club in Los Angeles, in 2012.

Though the U.S. wine market continues to grow steadily—$38 billion in 2015 sales—many producers still have a hard time reaching consumers daunted by the discovery process. The solution was once a good shop owner or sommelier. But what if an algorithm could make recommendations based on a person's preferences?

Winc asks customers to fill out a brief online survey about their affinity to certain flavors (Coffee: Black or with cream and sugar? Salt: A little or a lot?) and recommends bottles accordingly.

The data allow winemakers to take more risks. The surprise popularity of 2014 The Bluffer Valdiguié, for example, demonstrated that people were willing to try wine from an unknown varietal.

"Thanks to technology," Smith says, "we can use data to develop our own wines." And, of course, winners.

—Rachel King

AEROSPACE

MORE DESIGN IDEAS, FASTER.

WITH NEARLY 2 million lines of code and a host of futuristic technologies, the F-35 Joint Strike Fighter isn't the kind of product one designs with only a pencil and paper. But Bob Ruszkowski, a longtime aircraft engineer for Lockheed Martin and its secretive Skunk Works lab, remembers when the company did just that.

"When I started here in 1985, we were still drawing new designs on drafting boards," says Ruszkowski, now director of advanced air dominance, unmanned systems, and directed energy. "Today computer-aided design is commonplace, but it is still advancing in a lot of important ways."

Advances in computing have given aircraft engineers a wealth of sophisticated new capabilities. For example, engineers once built separate models for different kinds of analysis—one to test an aircraft's aerodynamic properties, another to test its potential radar signature, and so on. Today a single model can output data to various analysis tools simultaneously.

"Before, we would optimize the design of an aircraft in a serial fashion," Ruszkowski says. "Now we are doing parallel optimization and looking at thousands of iterations within a very short period of time."

Today's aircraft engineers optimize designs faster than ever before. In the future technology will allow them to continue doing so even after an aircraft is in production.

"Imagine a point in time when you can change the features of an aircraft using 3D printing technology," he says. "You can have an aircraft that evolves its capabilities over time." *—Clay Dillow*

ITO: EARL MCGEHEE—GETTY IMAGES; F35: U.S. NAVY PHOTO—LOCKHEED MARTIN VIA GETTY IMAGES

PHOTO ILLUSTRATIONS BY RACHEL AKE

CONSTRUCTION

Robert Kipp, Superintendent, Tutor Perini

A DEVICE TO GET THE JOB DONE.

ROBERT KIPP'S must-have tool when he steps onto a construction site isn't a walkie-talkie or a hard hat, though you'll never spot him without them. It's an eight-inch Apple iPad Mini on which he stores blueprints, field documentation, and other relevant information.

"Carrying blueprints under your arm while climbing up a ladder at a dangerous, high-story construction site just wasn't practical," says Kipp, 36, a supervisor and project manager for construction giant Tutor Perini.

At a site like the 17-million-square-foot Hudson Yards project in Manhattan—Kipp's latest assignment and the largest private real estate development in the history of the U.S.—paper is quickly disappearing. The former U.S. Army captain is just fine with that. "It minimizes errors in construction because you can see the documents clearly," he says.

On his silver tablet computer Kipp has installed Plangrid, software that helps architects and construction managers collaborate on different versions of the same document in the cloud. Kipp and his team also use the software to keep on hand the 300 permits needed for the job, not to mention the 13,780 sheets of blueprints. Another piece of software, the Autodesk-made modeling app Revit, allows Kipp to visualize in three dimensions the buildings he's constructing.

Not all of Kipp's colleagues have been quick to welcome iPads to the work site. One foreman Kipp worked with called tablets "bullshit" and requested paper versions of blueprints instead. But he soon relented, and today the foreman swears by an iPad Pro.

The construction industry has not been at the forefront of technology adoption, Kipp says. No longer. "Construction is filled with inefficiencies," Kipp says. "Technology can change that." *—Leena Rao*

"We're seeing a fundamental shift in the way that people want to work."

—TASKRABBIT CEO STACY BROWN-PHILPOT IN A SPEECH AT THE 2016 NEXT WEB CONFERENCE EUROPE IN AMSTERDAM

BROWN-PHILPOT: SIMON DAWSN—BLOOMBERG VIA GETTY IMAGES

PHOTOGRAPH BY **PATRICK JAMES MILLER**

FOOD

A SIMPLE SOLUTION FOR KEEPING ICE CREAM COLD.

What's the worst thing that could happen to an ice cream maker? Melting product. The problem kept happening to Brian Smith, owner of Ample Hills Creamery in Brooklyn, usually because an employee would forget to firmly close the freezer door. "It's a heart-sickening moment when everything you made the day before is gone because the freezer door is open," he says.

Fed up with more conventional means of enforcement—"We've yelled and screamed enough," Smith concedes—the owner and operations manager Andy Wandzilak deployed a mobile application called Modularm that alerts them to drops in freezer temperatures. The creamery can now record historical data for health inspections and avoid the possibility that an absent-minded employee could ruin a day's worth of treats.

When Ample Hills Creamery first opened in 2011, its most advanced technology was an ice cream scooper. "I wanted to create a place where everyone knows your name," Smith says. Now, with $4 million in funding, Ample Hills is slowly embracing the notion that technology can help standardize processes across its six locations.

Smith says the "cold quotient" was once one of his biggest business problems. Now it's just the long lines. *—Larissa Zimberoff*

BEVERAGE

IN PURSUIT OF BETTER BEER.

Ask Danny Kahn how technology is changing brewing, and he'll take you back 7,000 years to its origins in Mesopotamia. "That's one of the coolest things about brewing," says Kahn, technical director for the Sierra Nevada Brewing Co. in Chico, Calif. "There's such a rich history."

Not that beer can't taste any better. Last year Sierra Nevada figured out a way to preserve the more delicate flavor contained in wet-hopped ales.

Brewers harvest hops for several weeks in August and September. Most are dried and preserved for the rest of the year, but brewers use a small fraction immediately to essentially create the holy grail of beer. Tragically, it lasts only for harvest season.

"I don't think most people realize how complicated beer is," Kahn says. "We're not just mixing water and flavors."

So Sierra Nevada brewers apply steam to wet hops, which "carries the oil away," Kahn says. They condense the vapor and separate the oil from the resulting liquid. Adding even a tiny amount of the oil to dry hops gives the resulting brew the flavor and aroma of wet hops.

"Nobody else is doing that," Kahn says. It's not a high-tech solution. But in an increasingly competitive craft-brewing industry, standing out on store shelves matters. *—Jasper Scherer*

45% **OF TASKS PERFORMED BY U.S. WORKERS CAN BE AUTOMATED BY CURRENTLY EXISTING TECHNOLOGIES** SOURCE: MCKINSEY & CO.

CAPITOL: GETTY IMAGES

GOVERNMENT

A DATA-DRIVEN WAY FOR LOBBYISTS TO PERSUADE.

THE PUBLIC SECTOR may be behind on embracing modern technology, but lobbyists are way ahead. And it's radically changing the way they do business.

Bryan Miller, senior vice president of public policy for San Francisco solar energy provider Sunrun, says the rise of online communications platforms—from Google to Facebook to Twitter to Snapchat—has upended his approach.

"Money is not what it used to be in politics, because the world of online advocacy has really reduced the impact of lobbying," says Miller. "Mail and TV were the traditional forms of communications, and they're expensive primarily because they're imperfect," but social media and online advertising have since emerged as more affordable and precise alternatives for basic outreach.

The benefits also run in the opposite direction. Miller says today's lobbyists can easily look up relevant bills circulating among policymakers and intervene well before the process is over. They can also reference videos of lawmakers discussing potential laws, which can come in handy down the line. "We've found many occasions when our legislative friends said something very different 10 years ago," Miller says. "It's a lot harder to get away with stuff."

Concerned, lawmakers? You shouldn't be. Miller says his only guideline is to tell the truth. "If you don't have anything to hide, you don't have anything to be worried about," he says. Not that public officials are taking him at his word. "We've certainly see some legislative bodies move to reduce access to public records," he says. The bureaucracy-busting Internet may have made democracy much easier, but not everyone in office is comfortable with that reality. *—Kia Kokalitcheva*

COMMUNICATIONS

NEW SKILLS TO KEEP UP WITH THE GLITTERATI.

Last year Jen Betts, the president of Pivotal Public Relations, a Los Angeles–based lifestyle PR firm, went back to school—Snapchat school, to be specific. "It was a free class offered by a third party as part of Social Media Week," she says.

She was moved to hit the books, as it were, because of a shift in client asks that began about a year ago. Instead of enlisting Betts's firm to help them get mentions in celebrity tabloids, clients wanted Snapchat impressions. And that required a very different approach.

"They were asking for Snapchat monetization and participation at events," she says. "I took the class to perfect my usage of all the different features"—and ultimately to make her clients' stories more engaging.

Betts has embraced her new skills, but they have made her job trickier. Because Snapchat content is ephemeral, Betts has to hound "influencers" (whom brands pay to snap on their behalf) to publish more photos and videos to fulfill their contracts. She also has to pay for analytics from a third party because Snapchat doesn't provide them.

It's all a part of keeping up with her customers, Betts says. "Their views on Snapchat were higher than on Instagram. I was like, 'I have to get on this. I have to figure out what's going on.'"

—Sheila Marikar

MEDICINE

A NOVEL TECHNIQUE FOR SHAPING PROSTHETIC PARTS.

JUAN GARCIA'S JOB isn't like yours. As an associate professor in the Department of Art as Applied to Medicine at Johns Hopkins University, he's in the business of anaplastology—the creation of prosthetics such as eyes, ears, and noses. As the name of his department suggests, the field is as much art as science, requiring a careful eye, a steady hand, and lots of patience.

In the past, Garcia looked at a form and sculpted it into a 3D object using wax and heated tools. From this, molds were made to cast the prosthetic device using silicone matched to the patient's skin tone. But lately he's been using a 3D printer to make patterns for body parts. Garcia uses a Printrbot Simple Metal to scan and print a mirror image of the unaffected side of a body, which he then duplicates into a wax pattern of the prosthetic device. Garcia then uses that to create a mold to cast the silicone part.

The technology has its pros and cons. On the one hand, the file is digital and virtual, allowing him to make multiple versions that he can later revisit. It also allows him to break through his traditional production workflow, which limits him to casting only what he can obtain from the mold, saving considerable time.

On the other hand, there is no way to directly print out a silicone prosthetic part at a high enough resolution and an accurate enough color match for his liking. Technologists will address these problems soon enough. But it is clear that 3D printing has given him new ways to moonlight as Mother Nature.

Says Garcia: "I see it as an integral extension of what the medical artist can do." *—Maxine Wally*

"In the face of great uncertainties, prediction is a fool's game."

—NEW AMERICA CEO ANNE-MARIE SLAUGHTER AND BLOOMBERG BETA HEAD ROY BAHAT IN THEIR "MEMO TO CEOs: YOU CAN'T PREDICT THE FUTURE OF WORK" ON FORTUNE.COM

DOCTOR: GETTY IMAGES; SLAUGHTER: CHRIS RATCLIFFE—BLOOMBERG VIA GETTY IMAGES; BAHAT: CHRIS MICHEL

HOSPITALITY

NEW MENU, NEW MIND-SET.

Paper menus are as old as time. But at Da Legna, an Italian restaurant in New Haven, those documents (which once did double duty as place mats) haven't touched a table in a year. Good thing: At $500 a month, they cost the business a pretty penny. "We were turning them out like you wouldn't believe," says Derek Bacon, co-owner of Da Legna.

Why not go digital? Frequent customer Jeff Hong pitched the proprietor on Bite, his tablet-computer ordering system. At $20 per month for each device—Da Legna started with 10 and now rents 30—the setup offered customers far more for the same cost. Bacon, you might say, bit.

Customer reactions have run the gamut—some are delighted by the interactivity; others reel from the LED glare. But it has completely changed how people spend time in the restaurant. Better still, it's giving the business better insight into what food customers really want, Bacon says.

"We're saving money, which is a benefit we didn't anticipate," he says. And there isn't a cheesy laminated menu in sight.

—*Larissa Zimberoff*

HEALTH CARE

A TRUSTED TOOL IN THE OPERATING ROOM.

When doctors first approached Hormuz Irani, a surgical oncologist based in Bakersfield, Calif., to suggest he participate in the hospital's robotic-surgery training program, he resisted. He'd been performing laparoscopic surgery since 1995 and heard that the Da Vinci robot was bulky, expensive, and time-consuming. But when he actually started using what he refers to as the "workhorse," he saw the future of surgery. The optics were clearer. Tremors from his hand vanished because the robot moved in a fluid motion. Smaller incisions left his patients with less pain and shorter healing times. The arms of the robot swiveled 360 degrees, allowing it to do things the human wrist cannot—sew backward, for example, or sew underneath tissue.

"And it's ergonomic, so you're not hunched over a patient," Irani says. "That's definitely a big plus because we all end up with back, neck, and wrist issues."

The Da Vinci Surgery System was approved by the FDA in 2000, and many more technological advancements have been made since then. Irani sees no sign of that progress slowing, and unlike before, he's looking forward to it.

"A robot could be that much more advantageous to use in the future," Irani says. "Better, lighter, cheaper."

—*Maxine Wally*

EDUCATION

Joan O'Neill, HR Manager, Menlo Park City School District

ONE COMPLIANCE SYSTEM TO RULE THEM ALL.

THERE'S GOT TO BE a better way to do this," Joan O'Neill thought as she pored over the master schedules, student case loads, and credentials of dozens of schools and teachers. O'Neill is now a human resources manager in the Menlo Park City School District. But in 2015 she was a credential analyst in the San Francisco Unified School District, where she had to perform an audit of 36 elementary, middle, and high schools. She first requested from each school printouts of the teachers' credentials and the classes they led. Then she cross-referenced the classes to ensure they were in compliance with various education codes. She also checked California credentialing websites to make sure instructors were teaching the right classes.

"It just drove me insane," O'Neill recalls. "I spent so much time flipping through pages."

So O'Neill got to work on a project dubbed Access, which linked courses and credentials for each class in the district. After writing the logic, O'Neill worked with the district's technologists to create the application. Now one click runs a report that displays each error in the district. The system also includes employee information, allowing for far easier review of records for arrests and credential revocations.

"We're in the heart of Silicon Valley," O'Neill says. "Technology surrounds us, and we should try to incorporate that into our work." —*Maxine Wally*

64% **OF PEOPLE BELIEVE TECHNOLOGY WILL IMPROVE THEIR JOB PROSPECTS**
SOURCE: PRICEWATERHOUSECOOPERS

WAITER: GETTY IMAGES

PHOTOGRAPH BY **BRAD WENNER**

AGRICULTURE

AN EYE IN THE SKY FOR THE GOODS IN THE GROUND.

Before Lincoln Hughes tended the land on his farm in Nevada, Mo., so did his father and his grandfather.

"My dad worked to leave the land better for me," Hughes says. "My goal is to leave the ground even better for my children, and hopefully their children. It's all about taking care of the land."

For Hughes that means turning to the skies. On his corn, wheat, and soybean farm, he monitors everything from seed count to nitrate levels with drones equipped with specialized cameras. When equipment malfunctioned and began laying too many seeds, a drone caught the error. When abnormal rains caused a drop in nitrates, a drone spotted the exact soil regions that needed replenishment—a formerly inexact process that required the family to send soil samples to a laboratory. It all saves Hughes between $30 and $40 an acre, which can add up to hundreds of thousands of dollars a year.

"We have a large farm, and there's no way I can get to every field in a timely manner," Hughes says. "The drone solves a lot of my problems. We've got data running out of our ears."

—Signe Brewster

RELIGION

TAKING DISRUPTION AS GOSPEL.

YOU'LL BE hard-pressed to find a churchgoer who carries a Bible to Church at the Springs on Sundays—and lead pastor Ron Sylvia doesn't mind.

At "the Springs," as it's known—a multisite church based in Ocala, Fla.—most of its 3,000 or so members follow along during services with the YouVersion Bible app on their phones. Up front, Sylvia teaches from an iPad. Toss in contemporary-rock worship music, state-of-the-art LED screens, and Text to Give software (to simplify tithing), and it's not difficult to see how the pastor has cultivated such a following. "I don't want people to step into a time warp to meet God," Sylvia says. "The message will never change, but the method must. And our method is our delivery system."

The 57-year-old pastor, a self-professed lover of numbers and technology, was studying for a bachelor's degree in accounting when he entered the church ministry at age 21. What followed was two decades of trial and experimentation as Sylvia—moved by "a clear calling to start a contemporary church"—founded Church at the Springs in 1994.

Sylvia credits business management guru Tom Paterson in particular with helping him apply strategic thinking to the task of establishing new churches.

"Relevance is a moving target, and every corporation in America knows that irrelevance is a slow march toward death for them," Sylvia says. "Everybody—from Coke to Windex to Elmer's Glue—knew that if they didn't change, they would die. Down the road, the church needs to wake up to that."

Alongside his ministry at the Springs, Sylvia directs NEXT Churches and works with Intentional Churches, offering guidance and mentorship in both organizations.

Sylvia is also enthusiastic about keeping up with the latest changes in the church world. He says the Internet allows him to learn from other churches without leaving his desk. Sylvia delights in scouring the web for insights on how to further develop his ministry.

"I tell our church all the time: We signed up to be God's R&D department a long time ago," he says. "We're going to do whatever it takes to reach people far from God, and we're always going to be pushing the envelope." *—Audrey Shi*

CHURCH: JOHN GAIM—LIGHTROCKET/GETTY IMAGES

Workers planting marijuana on June 17, 2016, at Los Sueños Farms, in Pueblo, Colo., the largest outdoor legal grow facility in the U.S.

A BACKLASH IS GROWING IN A STATE WHERE MARIJUANA HAS QUICKLY BECOME A $1 BILLION LEGAL BUSINESS.

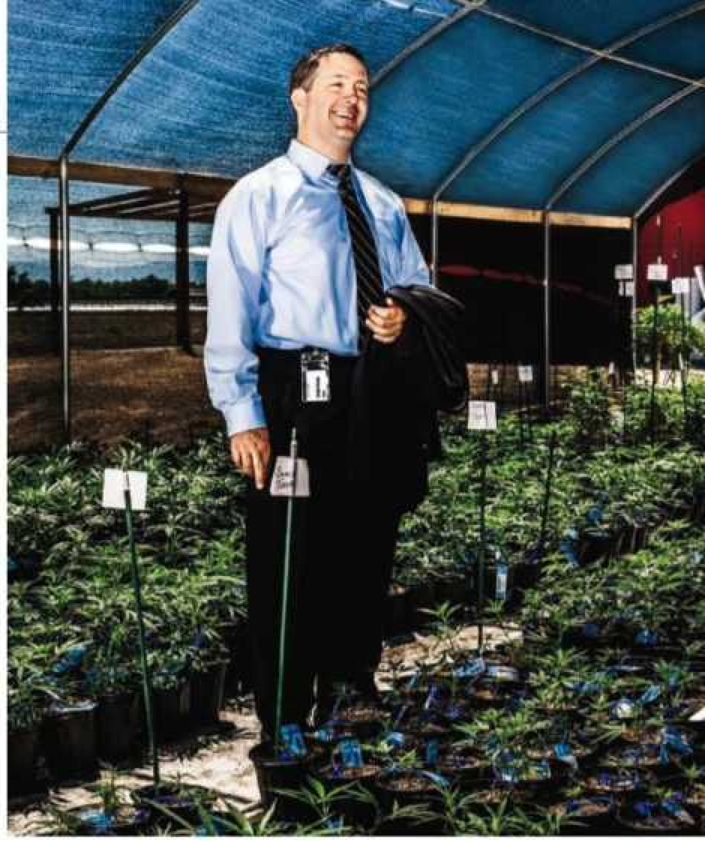
BY JENNIFER ALSEVER

IS POT LOSING ITS BUZZ IN COLORADO?

FOR MONTHS, Paula McPheeters and a handful of like-minded volunteers have spent their weekends in grocery-store parking lots, even in 95° F heat. Sitting around a folding table draped with an American flag, they asked passing shoppers to sign a petition. Inevitably a few sign-wielding young protesters would show up to argue that McPheeters's group was dead wrong. With the two sides often just yards away from each other, shouting matches erupted. "We're peaceful people," one woman yelled. "You're drugged out," countered an angry man. Threats and phone calls to police became the norm.

The wedge dividing the people of this small blue-collar city of Pueblo, Colo.? Legal marijuana.

PHOTOGRAPHS BY RYAN DAVID BROWN



Pueblo County commissioner Sal Pace, visiting a grow facility, likens the region to "the Napa Valley of cannabis."

Colorado gave the green light to recreational marijuana back in 2012, when it passed a law to make nonmedical pot sales legal starting Jan. 1, 2014. But now opposition is rising in communities across the state. Colorado has become a great social experiment, the results of which are still not clear. "The jury is still out as to whether this was a good idea," says Colorado attorney general Cynthia Coffman.

What's undeniable is this: Legal marijuana is in high demand in Colorado. Only three other states—Alaska, Washington, and Oregon—plus the District of Columbia currently permit recreational adult use of cannabis. (It's legal for medical use in another 19 states.) Of that group, Colorado led the way in 2015 with $996.5 million in licensed pot sales—a 41.7% jump over 2014 and nearly three times the figure in Washington State. Recreational sales made up nearly two-thirds of the total.

Now, as citizen groups attempt to put the brakes on the growing industry, a heated debate has emerged about the drug's societal impact. Doctors report a spike in pot-related emergency room visits—mostly due to people accidentally consuming too much of potent edible pot products. Police face new cartel-related drug operations. Parents worry about marijuana being sold near their homes and schools. And less affluent communities like Pueblo struggle with the unintended consequences of becoming home to this emerging and controversial industry.

Amendment 64 decriminalized marijuana statewide, but Colorado's cities and counties still decide if the drug can be grown and sold locally. At least 70% of the municipalities in the state have banned commercial operations, either by popular vote or board decisions.

Many other communities have begun pushing back. Last fall, controversy arose in the small western Colorado town of Parachute when an antipot group attempted to recall members of the town council who had welcomed pot shops. (Voters defeated the recall 3 to 1.) Debate has since emerged in Aspen, Carbondale, Glenwood Springs, Grand Junction, Littleton, and Rifle over the number, location, smell, and mere existence of retail and cultivation facilities. Citizens in the San Luis Valley, in the southern part of the state, say their schools and social services have been overwhelmed by a flood of newcomers coming to grow cannabis on cheap land, despite limited water. And just this spring officials in Colorado Springs and Englewood opted to ban pot social clubs, which are akin to lounges in which people can legally smoke weed in public.

"I'm getting calls now from people who voted for legalization thinking it wouldn't affect them," says Kevin Sabet, cofounder of national antimarijuana legalization group Smart Approaches to Marijuana. "They're surprised to see these are sophisticated businesses opening up next to their schools selling things like marijuana gummy bears. And they're angry."

OFFICIALS IN DENVER, which is home to one-third of the state's cannabis market, moved this spring to rein in pot capitalism. The city passed an ordinance capping the number of dispensaries and grow facilities at the present level. But discontent continues to fester in poorer communities, where many of these operations inevitably land. "We were told that legalization would take drugs out of our community," says Candi CdeBaca, a community activist who grew up in the mostly Latino and poor Denver neighborhood of Elyria-Swansea. "The drugs stayed—and the drug dealers changed."

CdeBaca points to, for example, an increase in school suspensions related to marijuana. And unlike the meatpacking plants and refineries that once dotted the area, CdeBaca says, this new industry hasn't brought her neighbors jobs. Instead, the money is flowing to outsiders.

"It's the Wild West, and the well-funded marijuana industry has dominated the regulatory process, and people are finally speaking up," says Frank McNulty, a lawyer for Healthy Colorado, which plans to put a measure on the November state ballot—an easier task in Colorado than in many other states—that would limit the active drug ingredient THC in cannabis candy and concentrates and require health warnings on packaging. The marijuana industry has objected to the proposal, and the issue is now before the Colorado Supreme Court.

Cannabis backers bristle at the pushback, calling it a back-door effort by prohibitionists who simply disagree with the legalization of the drug. Mason Tvert, director of the Marijuana Policy Project, which leads legalization efforts nationwide, cites studies showing minimal impact on society and no harm to Colorado's growing economy. Says Tvert: "Anyone who says it's caused an increase in this or that [problem] is full of shit."

What plays out in Colorado may influence what happens across the nation. Pot remains illegal under federal law. But legalization of recreational marijuana for adult use will be on the November ballot in California, Massachusetts, and Nevada, and likely in Arizona and Maine too. Voters in Arkansas, Florida, and Missouri will be voting on whether to approve it for medical use. The growth of the cannabis industry has begun to attract the interest of big companies. Microsoft announced in mid-June that it has developed a software product to help states track marijuana growth and sales.

In a recent appearance on CNBC, Colorado Gov. John Hickenlooper offered this advice to other states considering legalization: "I would suggest wait a year or two and see how it goes."

NOWHERE HAS THE IMPACT of legalization in Colorado been felt more powerfully than in the small community of Pueblo, located 114 miles south of Denver. At least 20 dispensaries and 100 growing facilities with 4 million square feet of cultivation now dot the highways near this town of 160,000, which has aggressively embraced the budding industry, making it the top cultivation spot in the state. "We're sort of like the Napa Valley of cannabis," says Pueblo County commissioner Sal Pace.

Pueblo has struggled for decades, ever since the 1983 recession, when most of the jobs at the local CF&I steel mill disappeared. Today the community is dealing with failing schools, rising gang activity, and increased crime. With a total of 26 homicides in 2014 and 2015, Pueblo earned the highest per capita murder rate in the state.

When the county's three commissioners approved licenses for marijuana operations in 2014, Pueblo's problems got worse, argues McPheeters, a Pueblo mom and community-college budget manager who is the driving force behind a group called Citizens for a Healthy Pueblo. "The promises of marijuana have not come true," she argues. After weeks of contentious petition drives, McPheeters's group believes it has gathered enough signatures to put a measure on the November ballot to revoke all the recreational marijuana licenses in the county. Marijuana industry groups, however, have sued, arguing that the number of signatures falls short under a new state law. A judge is set to decide in July.

Groups serving the poor in Pueblo report a flood of homeless people arriving from other states. Local homeless shelter Posada, for instance, has witnessed a 47% jump in demand since 2014, including 1,200 people who reported to shelter workers that they came to smoke pot or get jobs in the industry, says Posada's director, Anne Stattelman. She says her funding is tapped out. "It's changed the culture of our community," she says.

The city's three hospitals officially threw their support behind the antipot ballot measure after reporting a 50% spike in marijuana-related ER visits among youth under age 18 and more newborns with marijuana in their system. A number of local businesses are also backing the ban after struggling to find sober employees.

Commissioner Pace, in particular, has emerged as a target of criticism for citizens hoping to rid Pueblo of legal marijuana. As a state legislator he drafted early pot regulations and then as commissioner led local efforts to launch the industry in Pueblo County after 56% of voters in the city approved Amendment 64. "It will take time to change some people's opinions that pot is bad," he says.

The pro-marijuana contingent in Pueblo say critics are misplacing blame for the area's problems. They argue that the pot business has generated jobs and taxes as well as a college scholarship and a local playground. Revoking the licenses of cannabis shops, they say, will only fuel the black market. Says Chris Jones, an employee at a local dispensary clad in a Bob Marley T-shirt: "We already voted on this one time. Let it stand."

BOTH ANTIPOT GROUPS and marijuana advocates tend to cherry-pick data to support their claims. However, Larry Wolk, chief medical officer for the state department of health, says it's too early to draw conclusions about the true social and health impacts on Colorado.

Marijuana-related hospitalizations have tripled in Colorado since legalization, and emergency room visits have climbed 30%, according to a state report released this spring. And pot-related calls to poison control have jumped from 20 to 100 a year, says Wolk. Drug-related school suspensions have also climbed. Yet teen usage hasn't shot up dramatically, and crime has remained fairly stable. Marijuana-related DUIs increased 3%, and traffic fatalities involving THC increased 44%—but the absolute numbers were small in comparison to those that involved alcohol, according to the report.

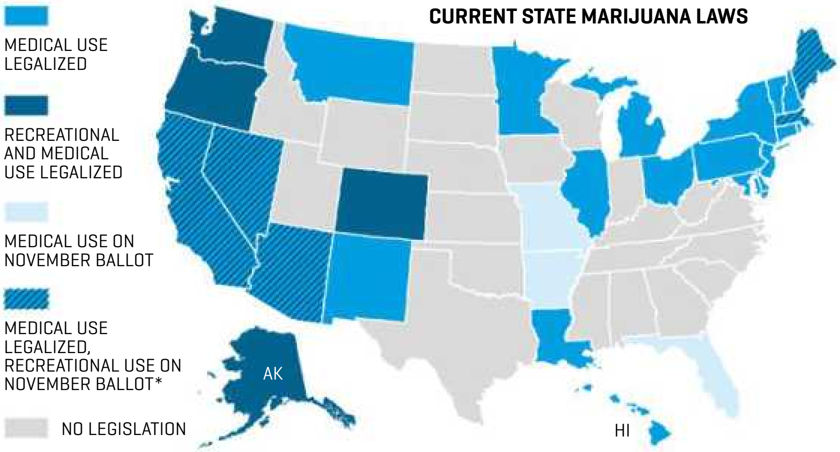
The data is tricky, Wolk says, because Colorado didn't track these numbers the same way prior to legalization. Are there more suspensions, he asks, because teachers are more aware? Are doctors now asking about marijuana at hospitals when they didn't previously? "It may be a year or two before we'll really have good answers," says Wolk.

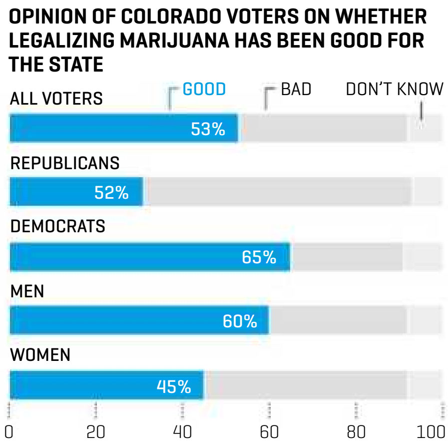
Marijuana legalization has delivered some surprises statewide to regulators, police, and citizens alike. For instance, many people thought legalization would quash the black market for the drug. "That's been a fallacy," says Coffman, Colorado's attorney general. Legalization of cannabis stores and grow operations has drawn more drug-related crime, she says, including cartels that grow the plant in Colorado and then illegally move it and sell it out of state. "They use the law," she says, "to break the law."

Since 2013, law officials say, they have busted 88 drug

THE POT THICKENS

MARIJUANA REMAINS ILLEGAL UNDER FEDERAL LAW, BUT A GROWING NUMBER OF STATES ARE DECRIMINALIZING IT. VOTERS IN COLORADO ARE DIVIDED.





*EXPECTED TO BE ON THE BALLOT. THERE'S ALSO A POSSIBILITY IN MICHIGAN, BUT IT'S UNCLEAR WHETHER IT WILL BE ABLE TO QUALIFY FOR THE BALLOT

SOURCE: MARIJUANA POLICY PROJECT

cartel operations across the state, and just last year law-enforcement made a bust that recovered $12 million in illegal marijuana. Adds Coffman: "That's crime we hadn't previously had in Colorado."

The state legislature is trying to play catch-up. Last year it passed 81 bills enacting changes to drug laws, prompting state law-enforcement groups to request a two-year moratorium on new laws so that they could have time to adjust. Lawsuits are also flying—including one from Colorado's neighbors. Nebraska and Oklahoma have sued Colorado, claiming that it is violating federal drug statutes and contributing to the illegal drug trade in their states.

Another surprise to many Coloradans is that a promised huge tax windfall to benefit schools hasn't materialized. Of the $135 million generated in 2015, for example, $20 million goes to regulatory and public-safety efforts related to cannabis, $40 million funds small rural school construction projects, and the rest goes to youth drug prevention and abuse programs. That's a drop in the bucket for a $6.2 billion education budget.

A third revelation to parents in particular is the potency of today's pot, says Diane Carlson, a mother of five who started Smart Colorado to protect teens from the drug. The weed, edibles, and concentrates sold in stores have THC levels that average 62% and sometimes as high as 95%, according to a 2015 state report. That compares with levels of 2% to 8% in the 1990s. "We passed this thinking it was benign, that it was the stuff from college," says Carlson. "The industry is just moving too fast, and we're playing catch-up while the industry is innovating."

Sitting in a Denver café, Carlson compares marketing by the marijuana industry to that of Big Tobacco in the 1950s, portraying the product as a harmless cure-all for everything from ADHD to anxiety. Yet research shows that marijuana is harmful to the developing brain. She supports Healthy Colorado's ballot initiative to limit the active drug ingredient in THC in marijuana edibles, candy, and concentrates to 17%.

The backlash worries Mike Stettler, the founder of Marisol, one of Pueblo County's largest dispensaries, which has been endorsed by comedian and weed smokers' icon Tommy Chong. The onetime construction worker fears that Pueblo's pushback against pot will shut down his entire recreational dispensary and its 10-acre grow operation, which generated $4.5 million in revenue last year. "I'm hoping and praying this thing doesn't go through, but you don't know," he says.

He says he has invested millions in his business and has more plans for growth. In May he flew to Las Vegas to discuss a partnership with famed guitarist Carlos Santana to create a Santana brand of weed called Smooth, named after the artist's hit song.

Inside, Marisol is a veritable wonderland for cannabis enthusiasts. Customers can consult a "budtender" for advice on the right weed for energy, sleep, or relaxation. They can also choose from a seemingly boundless variety of marijuana merchandise—from vegan "dabbing" concentrates for water pipes to pot-infused bottled beverages to peanut-butter-and-jelly-flavored THC candies. There are even liquid products designed to alleviate marijuana overdoses.

Giving a tour of the store, employee Santana O'Dell, clad in green tights with tiny marijuana leaves on them, sighs as a beatific smile appears on her face. "This is freedom," she says.

For a growing number of her neighbors, however, legalized marijuana is starting to feel like a really bad high.

FEEDBACK *letters@fortune.com*

HOT JOBS FOR 2020 AND BEYOND

RAPIDLY EVOLVING TECHNOLOGY WILL ENRICH YOUR LIFE. CAREERS WILL ARISE TO MAKE IT LESS CONFUSING.

By Stanley Bing

THE WORLD AROUND us is changing so quickly that only those who don't even try to understand it have any chance of dealing with it. Jobs that used to pay the bills will soon fade into the murk along with such former occupations as stevedore, elevator operator, and the guy who separates editorial content from advertising. The good news is that as old careers disappear, new ones are arising to take their place. Here are just a few.

Fitbit walker: Face it. Sometimes you just don't have the time or inclination to do your steps. This employee will don your wearable tech and do your 10,000 for you, making sure you stay in shape.

Identity broker: Increasingly, our "real" selves are simply too quotidian to make it where it counts in the virtual space. These entrepreneurs will provide personae that are much more engaging and marketable. I plan to be a pugnacious, idealistic mountaineer looking for fun, but still capable of deep commitment if the right person comes along.

Online shaming consultant: Along with an **Internet rage manager,** these professionals will work with you to make sure that you're properly gang-bullying the right people on Twitter and Facebook and not being attacked by the angry mob yourself for a random joke, comment, or honest opinion.

Self-driving-car driver: Silicon Valley will have its way, and at some point pretty soon none of us will have the right or ability to drive ourselves. Instead, vehicles powered by AI almost as stupid as we are will be in control. When they get into trouble, individuals capable of running a yellow light in order to avoid an accident will be needed.

Genuine friend locator: I have many "friends" who are unknown to me. When they wish me happy birthday, it's about as meaningful as when a talking elevator tells me to have a nice day. Somewhere buried in all those contacts, I must have some real friends who mean something to me. This person will help me find them.

Disrupter disrupter: I'm sick of these buttheads and their enablers in the media and would pay big money to see somebody with some mad skills mess them up.

Emoji exterminator: There are simply too many. Some must die.

Geriatric navigator: Egotistical billionaire moguls are working hard to live forever. It appears they'll be around for 10, 20, even 40 years longer than prior generations. By the time they hit 120, they'll be physically fine but unable to tell which end is up or how many third homes they own.

Cyber-pet euthanizer: What do you do with a 60-year-old cyborg Shih Tzu who won't stop its high, strobed-out barking? Someone will be needed to take Fluffy out and gently remove its tiny little silicon brain center.

Brain rebooter: Drugs will appear soon that make us smarter, faster, and more fun at parties. In addition, they'll tend to separate our cerebellums from our corpora callosa. Enter this specialist to get our heads back together—until we choose to scramble them again.

Dirt farmer: What's old is new again. Experts tell us we're only about 30% through the whole climate change thing. When the entire world is covered with nothing but dust, we're still going to need broccoli.

Funeral director on Mars: Elon Musk wants to die there. He's been right about a lot of things so far. A clear opportunity for the right mortician awaits. F

Follow Stanley Bing at stanleybing.com and on Twitter at @thebingblog.

ILLUSTRATION BY GIOVANNA GIULIANO

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