

The Future Issue

FORTUNE

MAY 01, 2017

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The Doctor Will See You Now

INSIDE THE DIGITAL HEALTH REVOLUTION & HOW IT WILL CHANGE YOUR LIFE

The Future of

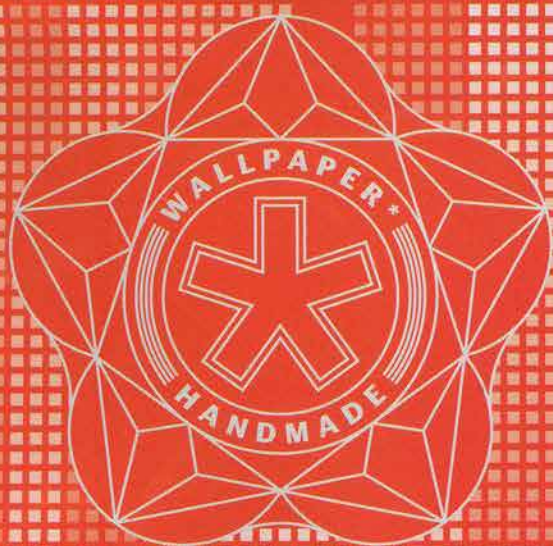
Fashion Robots Food Finance Security

AND THE
32
Companies
THAT ARE
CREATING
TOMORROW
TODAY

+

What Prediction Markets
Can Tell Us About
Trump's Next Move

ASIA PACIFIC
EDITION NUMBER 6



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From June to October, Singapore + Wallpaper* Handmade Classics will be refreshed with new and exclusive pieces arriving hot from Milan's Salone del Mobile 2017.

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MAY 1, 2017

FEATURES



This Is the Future

Optimists crave it. Pessimists fear it. Whatever your outlook, there's a good chance you're fascinated by the future. In this issue we've identified 32 companies devoted to transforming the world around us in the coming years.

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▲ ON THE COVER:
ILLUSTRATION BY MOLISTUDIO

THE FUTURE OF HEALTH

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By SY MUKHERJEE

The business of medicine is ripe for disruption. Here are 21 companies—and 34 bold leaders—using technology to reinvent it.

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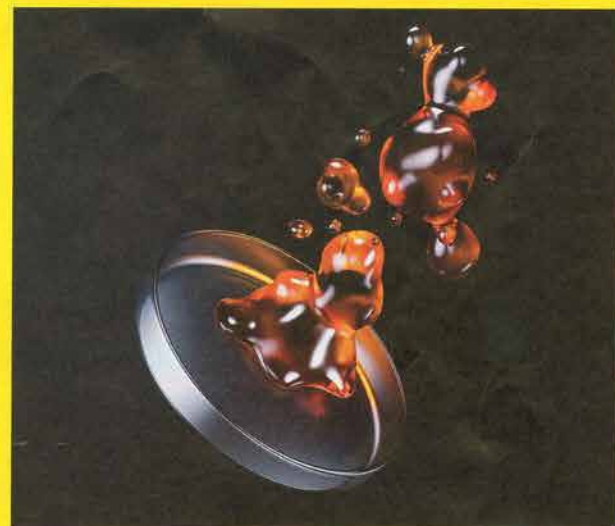
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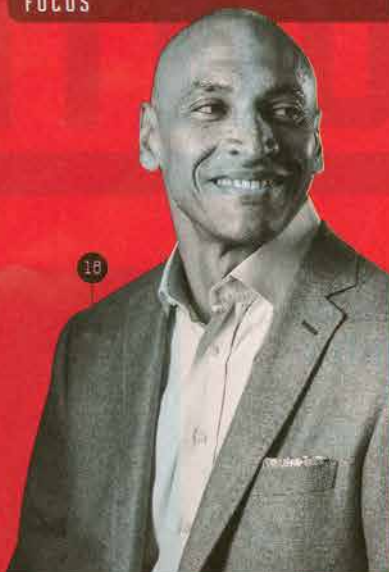
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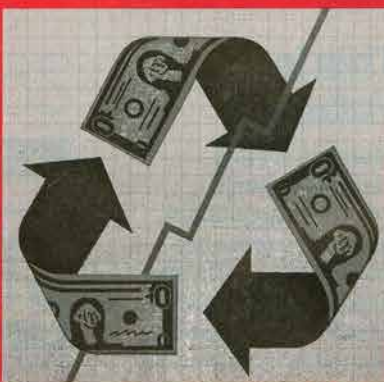
In the wake of sexism allegations at the well-funded transportation company, Silicon Valley rethinks its pursuit of rule-breaking results. By ERIN GRIFFITH

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Critics want to reform the controversial visa program. A visual analysis of the latest stats. Text by BRIAN O'KEEFE; graphics by NICOLAS RAPP



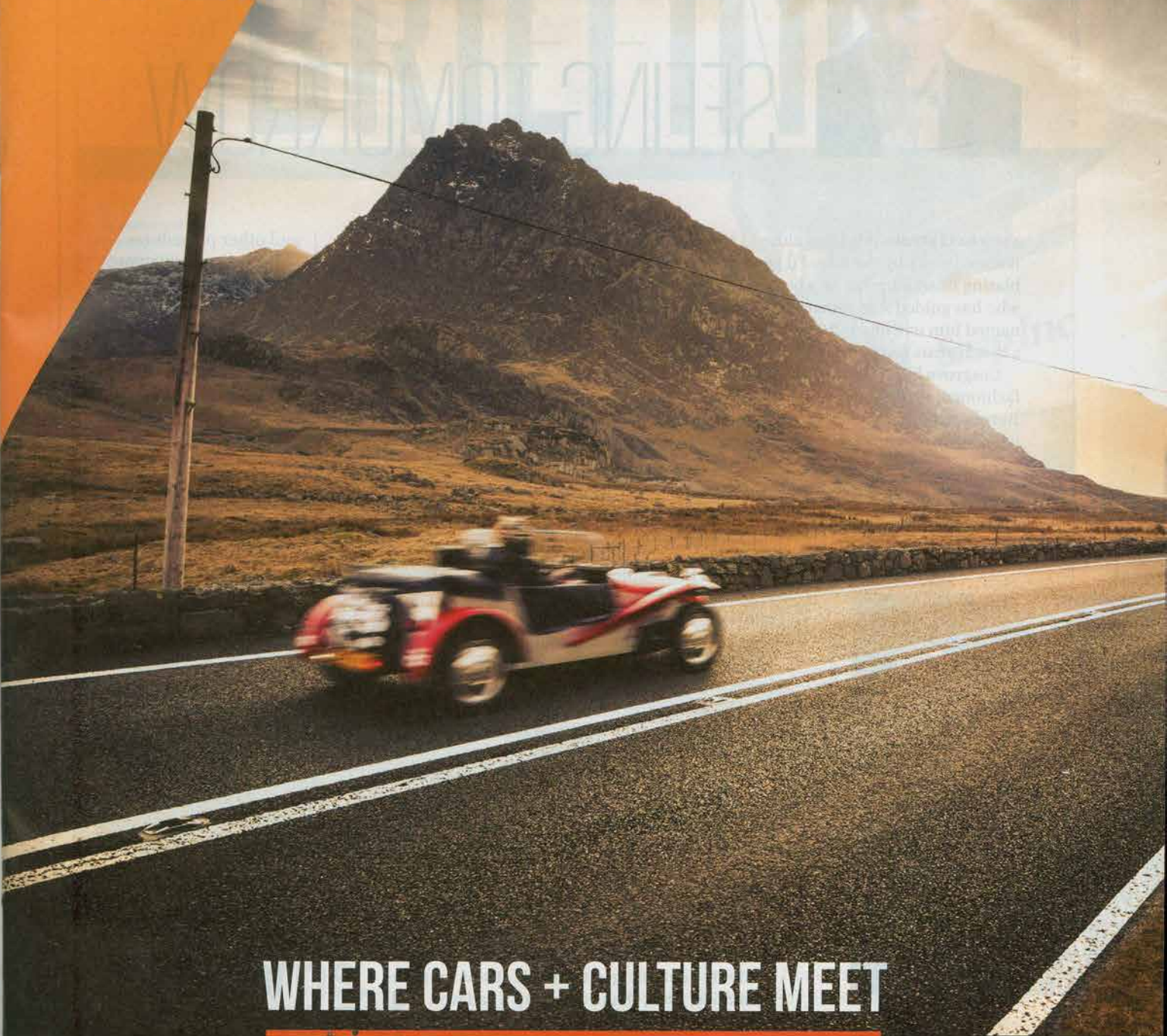
CORRECTIONS

A Boom With a View (April 1) misstated Tala's loan delivery rate—200,000 loans totaling \$8.5 million per month—and founding date: 2011. *Fortune* regrets the errors.

Fortune Asia [ISSN 0738-5587] is published monthly, with extra issues in March, June, September, and December, by Time Asia [Hong Kong] Limited. *Fortune Asia* may also publish occasional extra issues. Customer Service and Subscriptions: For 24/7 service, please use our website: fortune.com/customerserviceasia. You may also contact Customer Services Center at 852-3128-5688, or email to enquiries@timeasia.com or write to Time Asia [Hong Kong] Limited, 37/F Oxford House, Taikoo Place, 979 King's Road, Quarry Bay, Hong Kong. Subscribers: If the postal authorities alert us that your magazine is undeliverable, we have no further obligation unless we receive a corrected address within two years. Mailing List: We make a portion of our mailing list available to reputable firms. If you would prefer that we not include your name, please contact Customer Services Center. Member, Audit Bureau of Circulations. © 2017 Time Asia [Hong Kong] Limited. All rights reserved. *Fortune* is protected through trademark registration in the U.S. and in the countries where *Fortune* magazine circulates. *Fortune Asia* is printed in Singapore. Singapore MCI (P) 061/11/2016. Malaysia KKKON permit no. PPS1162/05/2013 [022950].





THE DRIVE



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SEEING TOMORROW

A FEW DAYS BEFORE this issue closed I traveled to the Cleveland Clinic, in its namesake city by the lake. I'd gone there to see Toby Cosgrove, the path-blazing heart surgeon who became CEO of that hospital system in 2004 and who has guided it to remarkable success ever since. (That's one reason we named him one of our 2016 Businesspersons of the Year—and probably about a dozen years too late at that.)

Cosgrove has a country-doctor sensibility—his manner is genteel and old-fashioned, and his accent is so upstate New York it might as well be Canadian. But there's nothing backward-looking about him. Cosgrove, indeed, is a futurist, a guy who knows that progress moves at light speed. To capture it, you just need to have sharp enough vision to see it—and a willingness to jump after it as it's rushing by.

And that's why he was so excited to show me the towering 3D skeleton

that stood in front of us in an otherwise empty meeting room at the clinic. Every vein and artery on this skinless scaffold—a human figure about six feet tall—could be seen in its precise pathways through the body. The serpentine vessels, in turn, led to a heart, whose proportions were also spot-on. We could walk around that heart, sizing up the organ from any angle—and even poke our noses inside it to examine chambers and valves that were also rendered to their correct shapes and measures.

None of this actually existed. The skeleton, the blood vessels, organs, all of it, were simply augmented-reality images emanating from the Microsoft HoloLens visors we were wearing—and created by an ingenious software model developed by Dr. Mark Griswold, a professor of radiology at Cleveland's Case Western Reserve University, and his team. This was a better way to learn the twists and turns of the body than studying anatomy in a textbook. It was more informative, even, than cutting up a cadaver, said Cosgrove. "If I had gotten to train with virtual anatomy in med school, I'd have been a better surgeon." Or so said the man had who helped pioneer advancements in mitral valve repair

and other procedures.

With virtual anatomy, there's nothing in the body we can't see: a heart beating, nerves signaling in the brain, a cell dividing, an infection raging. "If we can dream it," says Griswold, "we can build it."

And that right there is the theme of this bold edition of *Fortune*: our Future Issue.

On the pages that follow we showcase the dreamers and builders of tomorrow—the entrepreneurs and visionaries who are not just creating the next generation's medical marvels, models, and platforms, but also redefining everything from television to banking to security to the production of food (please see our package of stories that begins on page 25). What's more, we highlight 41 companies that are helping to drive these breakthroughs.

Here, fellow readers, is the future. Now all we have to do is catch it. ■

CLIFTON LEAF
Editor-in-Chief, *Fortune*
@CliftonLeaf



○ From telemedicine to genomic editing, the digital health revolution is here.

THE
WORLD IN
7
PAGES

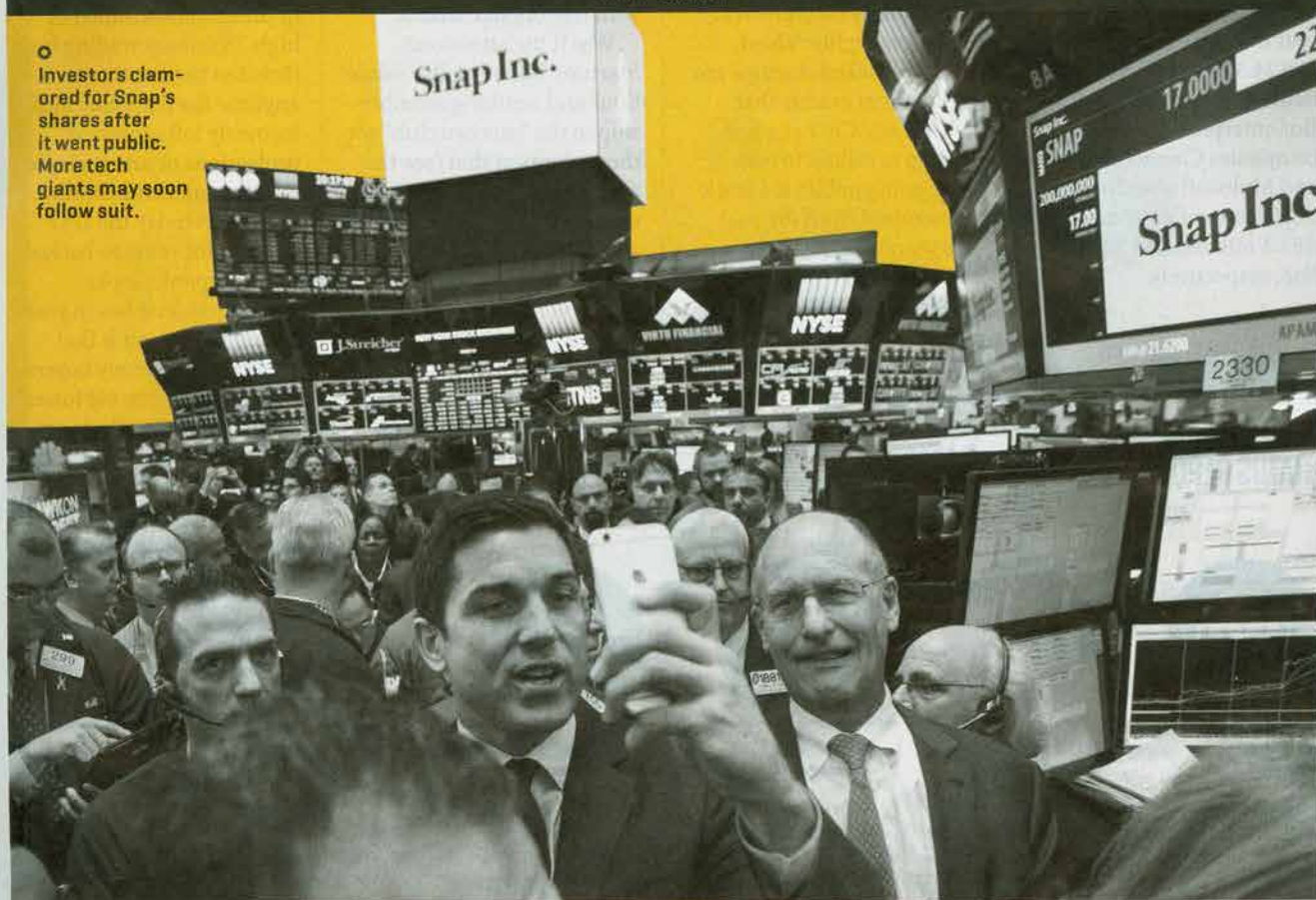
BRIEFING

PAGE

1

MAY 1, 2017

Investors clamored for Snap's shares after it went public. More tech giants may soon follow suit.



Goodbye, Unicorns. Hello, IPOs!

Silicon Valley used to avoid the public markets. Now IPOs are back—because many startup founders desperately need them. BY ERIN GRIFFITH

TECH

AFTER YEARS of avoiding the public markets, Silicon Valley suddenly has IPO fever. Snap's successful debut, paired with solid early performances from MuleSoft and Okta, has investors—both the Wall Street kind and the Sand Hill Road kind—making *squee* sounds of excitement.

They're so exuberant, one VC even declared on CNBC that this year "could be one of the best for the IPO market since the dotcom boom." It may be the first time anyone has referenced the 1999–2000 tech bubble as aspirational. ▷▷

BRIEFING

But pinch-yourself valuations aren't the only thing today's IPO candidates have in common with their dotbomb forebears: They're also losing money. Snap, which lost \$515 million last year but is currently valued at \$24.5 billion, is a particularly egregious offender. But enterprise technology companies Cloudera, Okta, and MuleSoft also disclosed 2016 losses of \$187 million, \$83.5 million, and \$50 million, respectively.

DEBUTANTES

THE IPO STATUS REPORT

And as in 1999, more often than not, no profit is no problem. On its first day of trading, Okta stock surged 38%. Public-market investors are desperate for a growth story (any growth!), and these highly valued, venture-backed startups are giving them exactly that.

That any CEO at a hot startup is willing to consider going public is a stark turnaround from the past five years. On the stages of posh tech conferences, when asked "Will you IPO?" the CEOs of billion-dollar startups would answer, essentially, "Why?"

For the money? They didn't need that. Investors like sovereign wealth funds,

family offices, mutual funds, and hedge funds—relative newbies who didn't dabble in startups before the current boom—were keeping startups flush and well stocked with free organic snacks.

Was it the attention? Startups' billion-dollar valuations and resulting membership in the "unicorn club" got them plenty of that (see the aforementioned posh conference stages, as well as magazine covers and TV hits).

Meanwhile, there were plenty of reasons not to IPO: To startup founders, going public meant jumping through hoops to get a bunch of bean-counting Wall Streeters to see their world-changing vision, di-

luting their ownership, and paying massive banker fees for the privilege. And if it was successful, their reward would be earnings reports, every quarter, for the rest of time, while a bunch of high-frequency trading bots threaten to tank the stock anytime the company misses its overly lofty revenue projections or an employee tweets something dumb.

And yet today the IPO pipeline for venture-backed tech companies looks healthier than it has in years. Part of the reason is that there aren't as many buyers willing to tolerate big losses from unicorns as there are unicorns losing money. Some founders have tried to sell their startups and found no buyers willing to pay their inflated valuations. And some venture investors are losing patience waiting for a return on their investments. Even the "new money" investors are becoming more selective—that's forcing all but the top-tier companies to turn to the public market for cash.

For regular investors, this means they can now get a piece of these rarefied high-growth startups and all the risk and reward that entails. For startups, it means more disclosure, perhaps leading to greater accountability for the Valley's disrupters. And it signals a sea change in the tech world. So far this year, six startups have left the billion-dollar unicorn list, while a paltry 10 have joined it, according to CB Insights. The Age of Unicorns appears to be coming to a close.



RECENT

• **Snap**

With a \$24.5 billion market cap after its March IPO, Snap could pave the way for more tech unicorns to make public debuts.

• **Okta**

Shares of the cloud-software provider were up 38% during its first day of trading, in April.

• **MuleSoft**

The software firm went public in March and is now worth nearly \$3 billion.



LOOMING

• **Tanium**

The cybersecurity unicorn has been stoking IPO speculation for months.

• **Spotify**

The music streaming giant reportedly aims to go public before the end of the year, but may use a direct listing to do so rather than an IPO.

• **Blue Apron**

The meal-kit titan has hired Goldman Sachs to lead it to the public market by year-end.



RUMORED

• **Dropbox**

It's not official, but the company is reportedly meeting with banks in preparation for its IPO filing.

• **Palantir**

CEO Alex Karp has said that he's "philosophically" opposed to an IPO but that it now may be the "simplest" thing to do.

• **Qualtrics**

The enterprise survey company just completed a "pre-IPO" round of funding.



MAYBE NEXT YEAR

• **Uber**

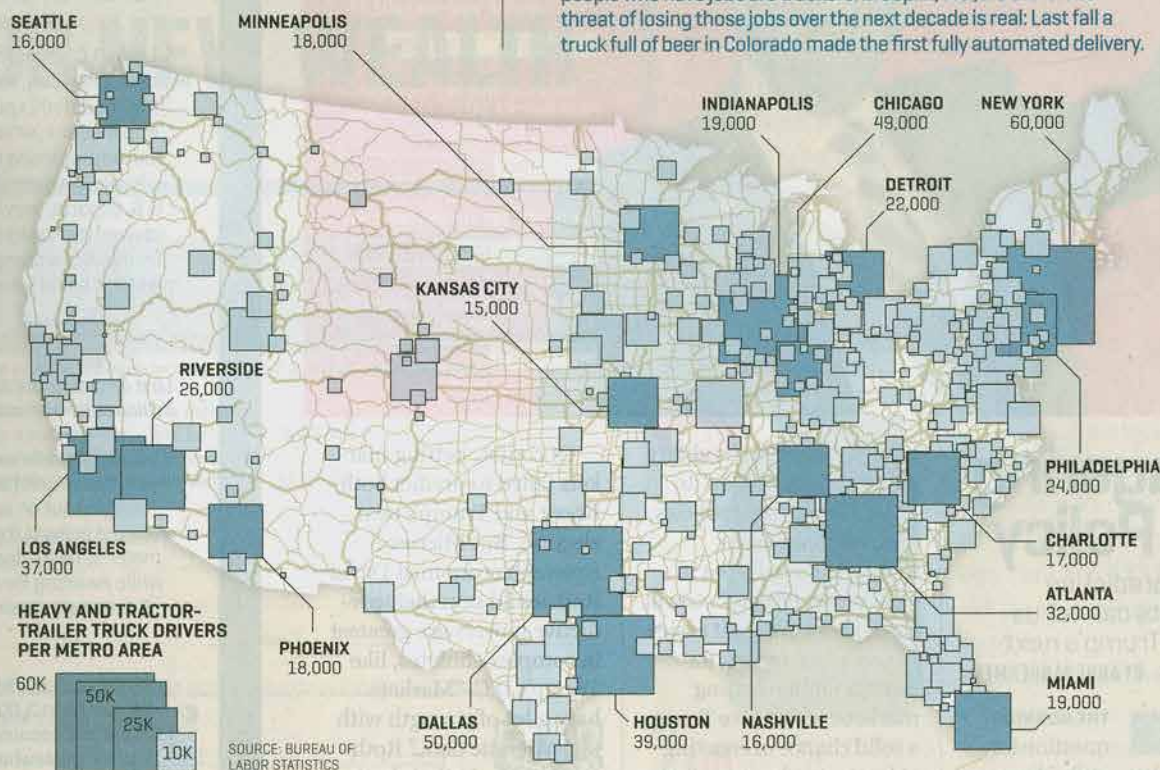
Recent bad press could further delay an IPO at the company, whose CEO has said he wants to stay private for as long as "humanly possible." [See page 24 for more on Uber.]

• **Airbnb**

The company turned its first profit in the second half of 2016. But Airbnb's leadership says it will probably wait at least another year to go public.

LONG-HAUL TRUCKING U.S.A.

When Americans talk about "robots taking our jobs," they're usually referring to factory work. That's because we don't have self-driving trucks yet. Truck driving is one of the occupations most vulnerable to automation, and one of the most common. In Omaha, 2.8% of people who have jobs are truckers. In Joplin, Mo., it's 5.6%. The threat of losing those jobs over the next decade is real: Last fall a truck full of beer in Colorado made the first fully automated delivery.

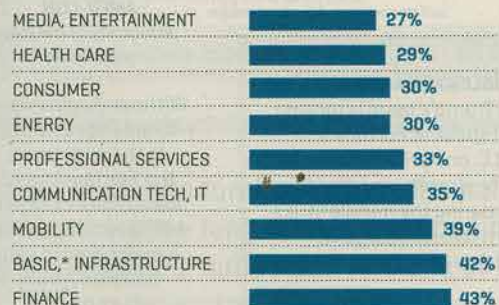


■ THE WAY WE WORK NOW

TRAINING FOR YOUR NEXT JOB, THE ONE THAT MIGHT NOT EXIST YET

Change is tough, and in most workplaces it's inevitable. According to World Economic Forum surveys, over a third of the core skill sets in most jobs will be replaced by new ones by 2020. One industry ripe for a reset? Finance, as new tech takes hold. Media, on the other hand, has processed enough disruption to last for a while.

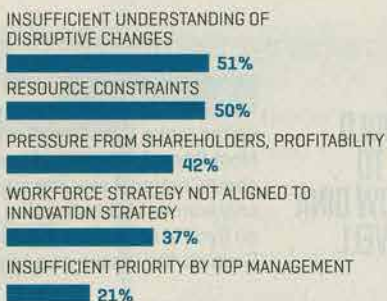
RESPONDENTS SAYING THAT SKILLS NEEDED IN THEIR INDUSTRY ARE CHANGING



SOURCE: WORLD ECONOMIC FORUM

*INCL. CHEMICALS, MINING, AND METALS

BARRIERS TO CHANGE REPORTED BY RESPONDENTS



■ RETAIL

THE SLOW-MOTION RETAIL TRAIN WRECK

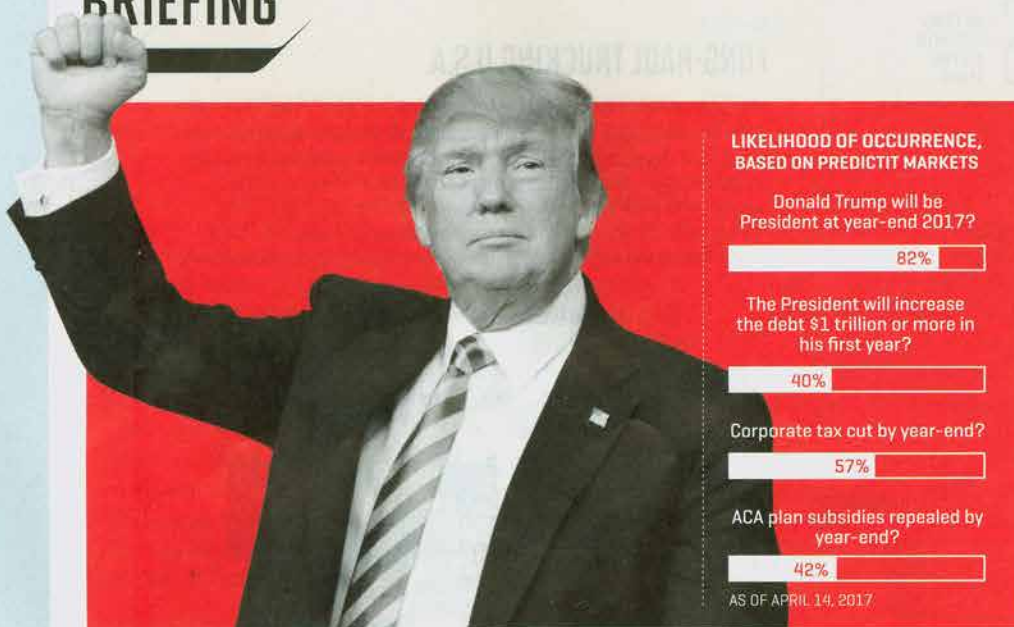
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MILLION SQUARE FEET

Retail closures announced this year as of mid-April, according to CoStar, a tally on par with the entirety of 2015. [The typical department store is about 130,000 square feet.]

BRIEFING

PAGE 4



Wagering on Policy

What prediction markets can tell us about Trump's next moves. BY ANNE VANDERMEY

ODDS

THE BURNING question for

the markets, still riding high on Donald Trump's promises of tax cuts and infrastructure spending, is whether or not he'll be able to follow through on them. Investors worry stocks

have "overpriced the ability of the administration" to push through new policies, as a Goldman Sachs strategist recently put it. Congressional conflicts will certainly not make it easier.

One place to look for clarity? Online betting markets, which give Trump a solid chance of enacting at least some key proposals. For example, wagerers on PredictIt give the President a 57% chance of getting a corporate tax cut by the end of 2017. Less so Obamacare repeal (see chart).

Of course, betting markets failed to predict both Brexit and Trump's own election. But Microsoft Research economist David Rothschild says their predictive powers are greatest in complex climates, like Trump's D.C. "Markets have a lot of strength with idiosyncratic data," Rothschild says. At their best, betting markets are savvy political prognosticators. At their worst, they're one more way for people to lose money if the Trump Bump fizzles.



YOU SHOULD GET TO KNOW DINA POWELL

ONE TO WATCH

ANOTHER GOLDMAN SACHS ALUM on Donald Trump's team is moving up the ranks. Dina Powell, who will speak at *Fortune's* Most Powerful Women dinner in D.C. on April 27, is now deputy national security adviser for strategy and was the only woman in the situation room during the missile strike on Syria in April. The Egyptian-born former George W. Bush staffer is seen as a centrist force in the White House.

WAITING FOR THE EX-IM BANK

Long D.C.'s favorite punching bag, the now-hobbled Export-Import Bank, which backstops loans to foreign buyers of U.S. exports, may be revived by President Trump. A few companies that could benefit:

BOEING

Lost an estimated \$300 million to Ex-Im inaction

Boeing's defense and space unit has missed out on or delayed at least three major satellite deals while awaiting Ex-Im financing support.

GENERAL ELECTRIC

Sent at least 3,000 jobs abroad because of financing elsewhere

One example: GE plans to move 350 gas-engine manufacturing jobs from Wisconsin to Ontario—thanks to Export Development Canada, the Canadian version of Ex-Im.

AMER-CON

About \$500 million on the line

Without government financing restored in the near term, the Florida-based manufacturer says it will have to abandon a major deal in sub-Saharan Africa. —CLAY DILLOW

WHEN GUANGZHOU MEETS FORTUNE

A MAGNET CITY FOR NEW WEALTH



Guangzhou, the forefront city of the nation's nearly four-decade long reform and opening-up, is now positioned to build itself into one of China's important hub cities.

Last September when Time Inc. Chief Content Officer and then *Fortune* Editor-in-Chief Alan Murray and Guangzhou city government announced the 2017 *Fortune Global Forum* was to be held in Guangzhou, the city, also known historically to the outside world as Canton, would inevitably look forward to a rendezvous with *Fortune*.

Speaking of fortune, Guangzhou has a long list to show off, especially after Foxconn Technology Group and city authorities recently laid the foundation stone to kick off a project with an investment of \$8.8 billion (USD). The tech giant will produce the latest 10.5 generation 8-k electronic display here. The entire negotiation, contract signing and ground-breaking were completed in an incredibly quick 100 days, which was widely acclaimed and summarized as the "new Guangzhou speed."

With that same rapid pace, the city is eager to catch up and expand in the new generation of information technology, artificial intelligence and biomedicine (IAB), signing numerous projects worth billions in U.S. dollars. Together with other recently signed projects like Cisco Guangzhou Smart City, GE International Bio-industry Park and IDG Southern Centre, Guangzhou is well poised to see a cluster effect of new development deals.

As a city at the forefront of the nation's nearly four decade long reform and opening-up, Guangzhou is positioned to build itself into one of China's important hub cities. China's southern gateway city has ambitions to become a hub in international shipping, aviation and science and technology innovation.

With a millennia-long history of leading China's business and foreign trade, Guangzhou has established trade relations with more than 200 countries and regions around the world. And 288 of *Fortune Global 500* companies have operations in the city.

That explains why Guangzhou was chosen to host this year's *Fortune Global Forum*. As Murray said at the September press conference, "Guangzhou is both a renowned symbol and a modern manifestation of China's participation in global commerce."

The month of December, when the forum will be held from December 6-8, is the finest season in this sub-tropical and ever-green city. With that in mind, Guangzhou is in the process of readying itself to meet *Fortune*.



BRANDS

TEENS: PHONES OVER FRIES

Google commissioned a study of Gen Z to find out what they thought was cool. Google [surprise?] landed very high on the list. McDonald's, not so much.

MOST COOL ▶



YOUTUBE



NETFLIX



GOOGLE



BEATS BY DRE



AXE



RED BULL



MCDONALD'S

LEAST COOL

SCREEN TIME

Hollywood's Search for a Blockbuster Algorithm

BY TOM HUDDLESTON JR.

AI PREDICTS THIS SUMMER'S OPENING WEEKEND BOX-OFFICE HAULS

BAYWATCH
\$21.58m
on 3,500 screens

DIARY OF A WIMPY KID: THE LONG HAUL
\$17.3m
on 3,400 screens

ROUGH NIGHT
\$15.6m
on 3,000 screens

SNATCHED
\$13.3m
on 3,000 screens

ATOMIC BLONDE
\$9.2m
on 2,000 screens

SOURCE: VANT

◀ Algorithms can use inputs like Amy Schumer's popularity to project ticket sales.

HOLLYWOOD ALLOCATES

considerable brainpower and capital toward crafting the perfect formula for a blockbuster. And now a growing number of tech startups are taking that idea literally.

Take Vault, an Israel-based artificial-intelligence startup that's one of the newest entrants using analytics and algorithms to predict ticket sales. Vault CEO and cofounder David Stiff says his company's platform can analyze the box-office potential of a film based only on the "core story DNA" gleaned from a raw screenplay or a movie trailer. Founded in 2015, Vault spent two years honing a neural-network algorithm that relies on 30 years' worth of box-office revenues, film budgets, audience demographics, and actor information to determine box-office potential.

Vault isn't alone: Other tech players in Hollywood include the U.K.'s Epagogix, Antwerp's Script-Book, and Boston-based

Pilot. Forward-thinking studios like Legendary Pictures (now owned by China's Dalian Wanda) also rely on their own in-house analytics teams to devise data-informed marketing strategies.

Stiff admits his platform whiffed on the recent surprise box-office success of the satirical horror movie *Get Out*, underestimating the film's social media buzz. But he says roughly 75% of Vault's predictions come "pretty close" to the films' actual opening grosses.

Going forward, studios are hoping these tools won't just avoid flops but will also help them compete against platforms like Netflix and Amazon Video. With their troves of user data, online distributors can gauge exactly what audiences want to watch and when. And they don't share their information, while box-office results are mostly public knowledge, suggesting Hollywood's most crucial Big Data battles are still to come.

Uber's Africa Push Hits Roadblocks

BY TOM JACKSON

TRANSIT IT'S BEEN A ROUGH couple of months for Uber in the U.S., after a spate of sexual harassment allegations and a #DeleteUber boycott drive on Twitter. But that's hardly the extent of the ride-sharing giant's woes: Uber's latest struggles in Africa make its stateside squabbles look downright tame.

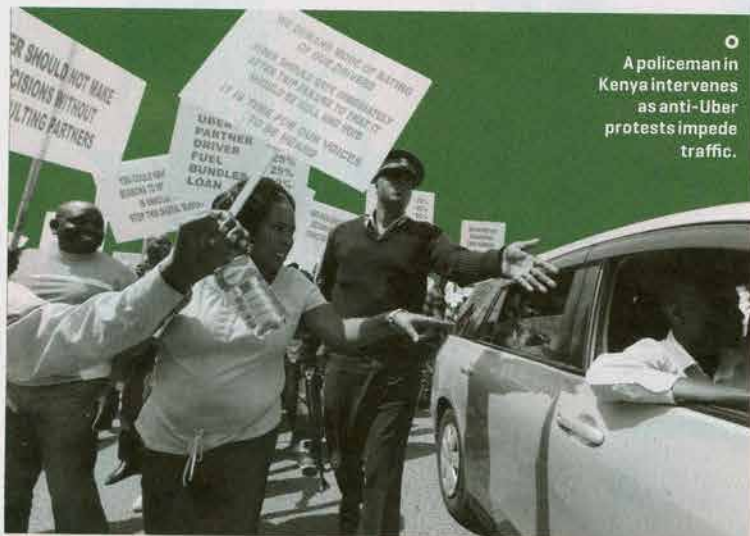
Over the past year, Uber has expanded aggressively on the continent, meeting fierce driver backlash. In South Africa, hundreds of taxi drivers blocked airport roads in March. And in Kenya, they have physically attacked Uber drivers—two cars were set ablaze.

Success could be worth Uber's trouble, though. Tanzania and Ghana are the fastest- and third-fastest-growing car markets in the world,

helping Uber amass more than 60,000 drivers in Africa. Increasing connectivity and mobile penetration there also suggest a huge future customer base.

Uber is not alone in sensing the potential. Ride-sharing competition in Africa is among the fiercest anywhere. Rivals include Taxify (a multinational company that works with existing taxis), Little Cab (backed by mobile giant Safaricom), and Zebra Cabs (which recently raised \$21.5 million to expand in South Africa).

But despite the headwinds, Uber is still the continent's ride-sharing leader, with better prices and amenities than smaller players. In Africa, as in the U.S., it may find that, headlines aside, convenience is still king.



A policeman in Kenya intervenes as anti-Uber protests impede traffic.



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Is Craft Beer All Froth?

Boutique brewers changed the way America drinks, but they could be headed for a hangover. BY JOHN KELL

BINGES

SOME SOBERING
statistics:

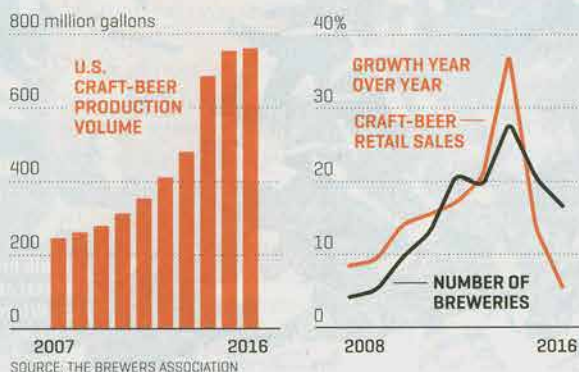
Craft-beer volume grew 6% last year, to 24.6 million barrels, but market share increased just one tenth of a point, to 12.3%. That's bad news for a group of upstarts that had been putting up inebriating numbers for years.

"The era of 18% growth is probably over," says Bart Watson, chief economist of the Brewers Association. "The industry is maturing."

As any beer-loving twentysomething can tell you, maturity is tough.

Like many hot industries before it, craft beer has growing pains. The number of breweries rose 17% in 2016, to a record 5,301—a level that may not be sustainable and can paralyze consumers with choices. "When they can't figure out what craft beer to have, they just say, 'I'll have a Corona,'" says Jim Koch, founder of Sam Adams maker Boston Beer.

Large craft brewers are particularly feeling the squeeze. Four of the five largest craft brands ceded market share in 2016. Part of the dilemma: Giant companies are increasingly buying up buzzy brands, edging in on the shelf space of pure-play craft companies, and eroding their indie cred with consumers. Not all drinkers know (or care) that Ballast Point is now tied to Corona, but small brewers certainly aren't toasting those unions.



Oscar Munoz,
CEO of United
Airlines

OUR BAD!

CORPORATE CONTRITION: WHO GROVELED BEST?

SOMETIMES THE APOLOGY IS NEARLY AS BAD AS THE MISTAKE. HERE, THREE RECENT CORPORATE MEA CULPAS THAT MADE THEIR OWN HEADLINES.

MADDENING

"I apologize for having to reaccommodate these customers."

United Airlines CEO Oscar Munoz after the airline forcibly removed a man from a full flight. Munoz later apologized for the botched apology.

PASSABLE

"I must fundamentally change as a leader and grow up."

Uber CEO Travis Kalanick after a season of scandals including a leaked video of his argument with a driver. In case you're wondering, Kalanick is 40 years old.

ALMOST EFFECTIVE

"Clearly we missed the mark and we apologize."

Pepsi corporate PR released a remarkably straightforward response after its ad featuring soda-loving protesters was savaged on social media.

FOCUS

PRACTICAL
EXPERTISE

VENTURE



Sinelli enjoys the confetti cannon at Which Wich's Dallas headquarters.

FOR WHICH WICH, SUCCESS IS IN THE BAG

Ordering on brown paper bags is a gimmick at Jeff Sinelli's sandwich chain—just one idea from a dynamo with hard work in his DNA. **INTERVIEW BY DINAH ENG**

HOW I GOT STARTED

Jeff Sinelli, 48, jokes that he emerged from the womb “naked and broke, sold the umbilical cord to the doctor, and hasn’t stopped since.” In truth, his hustle manifested itself at age 10, when he eked out cash by picking up cigarette butts at his dad’s nightclub. He later began opening clubs and restaurant chains, including Which Wich Superior Sandwiches. It’s known for its customizable offerings and ordering process: Customers mark up a bag with a menu on it; the food is delivered in that bag. Which Wich now has 438 stores, and 2016 revenue was \$217 million. Sinelli’s story:

I GREW UP in a two-story house in Hamtramck, Mich. We lived on the first floor, and my grandparents lived on the second. My grandparents were on a government assisted food program, and both of them worked three jobs to make ends meet. My father graduated from law school, then got into the nightclub business.

When I was 10, he would take me to work with him on Saturdays and put me in the parking lot to pick up the cigarette butts and bottle caps. I would negotiate my pay—enough to cover my candy. That experience taught me that no job is too small.

I went to Michigan State and got a degree in communications in 1990. My senior year, I played professional lacrosse for the Detroit Turbos while going to school. After finishing an MBA at City University of Seattle, I worked for my father, playing bartender, managing his clubs, and playing lacrosse.

Then I went to Dallas to visit my brother. I could smell the entrepreneurial spirit and decided that was the town for me. At 28, I started a nightclub called the Main Street Asylum. The building didn't have a roof because of a fire. So I got a great lease and turned it into an outdoor patio bar. It was 1996, and it cost about \$100,000 to open. I had about \$20,000 in savings and borrowed several thousand from friends and family. I had \$80,000 in debt spread over 20 credit cards.

I lived in a friend's back house, and for a year I sold TV airtime to ad agencies during the day. At night, I'd change in my car to jeans and my nightclub clothes and work at the club.

Since we didn't have a roof, we had to close the bar in the winter and reopen in the spring. But when we reopened, there was an art festival outside our front door over a four-day weekend, and we made more than \$100,000 in beer sales. That cleared the debt, and the business took off.

I opened 10 nightclubs and restaurants over the next few years. Every time I'd make a little, I'd start something else, from martini bars to a hamburger restaurant. I was having fun creating concepts. Then I decided I wanted to find one thing that I could expand and replicate in other cities.

I saw a friend doing Mongolian barbecue. I thought I could do it better by modernizing the concept and branding it. So I sold off everything and started Genghis Grill in 1998. I spent \$150,000 on the first restaurant, then more and more to make each one bigger and better. The cash flow was good, and I got an SBA loan.

People started calling, wanting franchises. It wasn't my intent to franchise, but when you have that many inquiries, you know you're onto something special. But I found out there are people waving checks who don't necessarily hold your values. Some guys wanted to do things their way, rather

MY BEST ADVICE

JEFF SINELLI

Founder, CEO, and Chief Vibe Officer, Which Wich

HAVE A SENSE OF URGENCY.

As soon as a sandwich bag hits the line, we start making it because we value the customer's time. We don't hold people up. We show up.

NEVER RUN OUT ...

of energy, of your supplies, of anything. We keep our shelves full. It sends the message that the business is well capitalized. You never want to run out of the product that a customer comes in for.

DEVELOP AND TRUST YOUR GUT.

My three decision makers are my gut, my heart, and my head. You know when you're making the right decision because your body will tell you. I'm the Chief Vibe Officer because success is all about energy.

than keep to our franchising system, which ensured that customers had the same experience everywhere. One time I walked into a Genghis Grill and there were unapproved products in the food line. I had to throw them in the trash. You always encounter situations like this with franchisees. I'm always respectful and explain why we operate the way we do, which has been successful.

In 2002, Consilient Restaurants bought Genghis Grill, giving me enough money to start something new. The lightbulb went off after I studied the legacy of sandwich founders like Blimpie's Tony Conza, Subway's Fred DeLuca, and Jimmy John Liautaud at Jimmy John's. I wanted a long-term story like that.

So I started Which Wich and made it franchise-friendly. I designed a logo and passed out business cards at the National Restaurant Association convention. Industry magazines wrote about the concept before we made our first sandwich. My mom used to put my lunch in a brown sack and put my name on it. That inspired our ordering system. Customers would come in, write their orders on a brown paper bag, and the sandwich would be made to order. People read about the idea and wanted to be a part of it.

There were a lot of Subways and Quiznos then, but I thought I could do better. Our first store, in 2003,

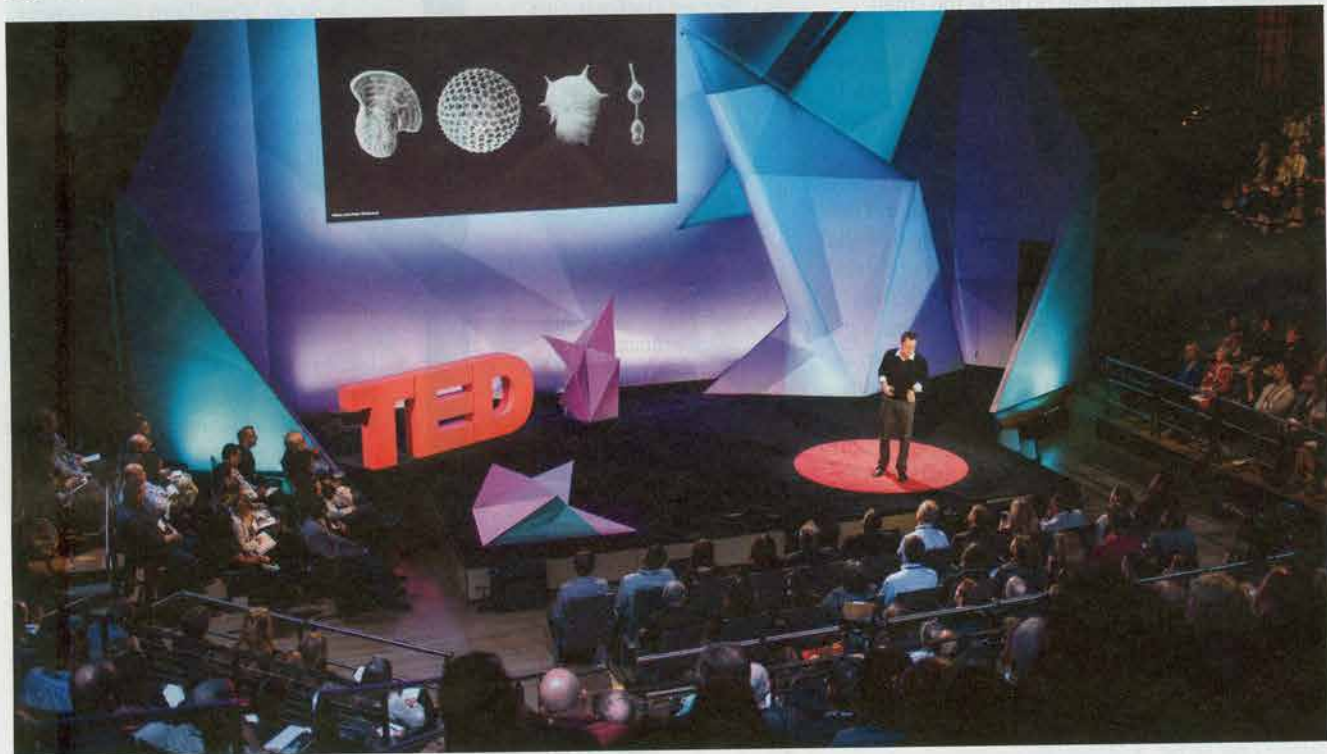
was in Dallas. I convinced the landlord not to renew his lease with Subway. He knew our history with Genghis Grill and asked what we'd do to be different. I said, "Milk shakes," and he said, "Let's do it."

We expanded across the country, then started going international. Five years ago, I went to India on an exploratory trip but decided the time wasn't right to open there. Still, I used what I learned and created a system for nontraditional locations. Now we have everything from kiosk-size Which Wiches to 1,700-square-foot locations. Target asked us to build into some of their stores, so we're currently in nine California Targets.

I learned early on that you need to keep an eye on everything. So I visit our mail room daily to look at what comes in, and I like signing every check. There are so many tangents, from marketing to real estate to operations. You have to have a full understanding of them all. ■

TED GOES CORPORATE

The conference host and purveyor of ideas is providing more and more services to big companies. Clients crave TED's elixir of innovation—but the strategy poses risks to the nonprofit's brand. BY LAURA ENTIS



TECH

IT'S HARD TO ESCAPE TED these days.

What began as an annual conference of ideas about technology, entertainment, and design (hence the acronym) is now the intellectual equivalent of kale: nutritious, oddly addictive, and part of the shared consciousness among a certain set. TED Talks have been viewed online 6.1 billion times—okay, that's way more beloved than kale—and they've popularized ideas relating to everything from body language to the power of introverts.

Lately, though, the nonprofit has been expanding in a different realm: providing services to *Fortune* 500 companies. TED began creating co-branded conferences for the likes of IBM, Intel, Unilever, and UPS a few years ago. More recently, its corporate services have broadened to include on-demand talks, in which TED brings in several of its

O IBM materials scientist George Tulevski speaks at his company's customized private TED conference in San Francisco in November.

speakers to address employees at company events, public-speaking classes taught by TED coaches, and residencies that allow companies to rent space at TED's sleek New York City headquarters to get an up-close view of its creativity and vigor.

Mainstream corporations crave the aura of innovation that a TED Talk can impart. Some want to learn how to apply TED's distinctive style to internal and external communications. For its part, TED is looking to boost its revenues to fund CEO Chris Anderson's ambitious goals: to spread ideas around the globe. Still, the strategy presents risks. If TED comes to be seen as a marketing firm, it could erode the credibility that makes its brand valuable.

Anderson, an Oxford-educated media entrepreneur, has steadily expanded TED since he bought what was then a single conference in 2001. Today it's

a global brand with two annual conferences, a library of educational videos (TED-Ed), free online TED Talks, a network of independent TED-like events (TEDx), and a Fellows program.

But Anderson doesn't want to speak only to the educated elite. As billions more people in the developing world connect to the Internet, he says, the definition of what a TED Talk is and who it's for needs to expand. When a "teenage boy in the slums of Nairobi" picks up a \$25 mobile device, for example, Anderson wants TED to be ready to engage. This means hosting talks in multiple languages (there's already a robust translation service in place) and expanding the format beyond its trademark Talk. Recently the organization hired a three-person team to develop new ways of spreading ideas online.

All of this costs money, and TED's revenue growth from conference sponsorships and ticket sales has flattened. In 2015, the most recent year for which it has filed a tax return, TED generated \$66.2 million in revenues (and eked out a few hundred thousand dollars in "profits"). Donations accounted for 35% of the revenues. Ticket sales made up another slice (attendance costs between \$8,500 and \$17,000 per person). The largest piece of revenues, some 40%, came from corporate sponsorships, according to Anderson.

If TED wants to continue growing, it needs to find additional funding sources. That job falls to Lisa Choi Owens, who was hired in late 2015 as chief revenue officer. She hopes to expand the TED Institute, which was founded in 2013. For \$1.5 million or more, it will prepare a one-day conference for a corporation. TED's team starts by identifying developments or ideas at the company worthy of a talk. "It's the same curatorial process we do for any of our events," says Anderson. TED selects the venue, coaches the speakers, helps plan the event and strategy, and then hosts, produces, and videotapes it. (It posts the resulting videos on a branded portion of TED's website; the best ones are featured on the site's main page.) In 2015 the Institute generated some \$5 million in revenues, a figure expected to rise to \$7 million this year.

"WE'RE ON A QUEST FOR IDEAS, AND IF IT'S A CHOICE BETWEEN TAKING THE MONEY OR MAINTAINING THAT PRINCIPLE," ANDERSON SAYS, "WE WOULDN'T TAKE THE MONEY."



○ TED CEO Chris Anderson has expanded corporate services as his ambitions have grown.

The corporate conferences look and feel like the originals. At IBM's event in San Francisco last year, for example, TED's logo was ubiquitous. An IBM materials scientist named George Tulevski talked about how the next computing breakthrough will come from compelling carbon nanotubes to form themselves into useful structures. (The presentation employed a TED-style metaphor. Statues are built from stone, Tulevski began, "but what if you worked in the opposite direction, not from a block of stone, but from a pile of dust?")

Employees loved it. "There were people lined up around the block before the doors opened," says Michela Stribling, a creative director at IBM. "The positive reviews were unanimous."

Owens is experimenting with new ideas, including a less expensive digital-only version of its private conferences. TED has set up an in-house advertising agency to create small-batch video campaigns for brands. It has also selected customized assortments of existing talks on topics such as curiosity and innovation, primarily for Marriott hotel guests to watch in their rooms. The chain has also incorporated TED Talks into internal operations; at some hotels, staffers are shown a "quick TED video" before their shift to consider what it means to "think more creatively, more laterally, and problem-solve," says Matthew Carroll, vice president of global brand management.

TED is also partnering with Marriott on a series of salon-style events in Seattle, London, Dubai, Bangkok, and Santiago, Chile, in which TED Fellows speak to guests and employees. And brands can hire the organization to throw a 90-minute session at TED's headquarters. Public-speaking courses, taught on occasion by Anderson himself, are also available. These offerings are so new that it's too early to gauge their success.

TED acknowledges that its corporate services seem at odds with its educational mission. "We talk about that a lot," says Anderson. If TED becomes a platform to hawk products or fluffy ideas, that could tarnish its reputation. And what of the clients? Would TED create videos for, say, tobacco companies? "We're on a quest for ideas, and if it's a choice between taking the money or maintaining that principle," the CEO responds, "we wouldn't take the money." Anderson says TED is upholding its standards on content too. Client executives can suggest topics and speakers for Institute events, but TED has the final word. The initiative's future success may resemble that of a new tourist destination. Having customers is great—but having too many spoils the very treasure they're trying to celebrate. ■

TECH

McAfee is three decades old in an industry where age can be a liability.

How will you change this perception?

The prior McAfee had a little bit of a supermarket strategy: You come and you buy one of anything "cyber" from us. In my view that wasn't what the industry needed from us. It needed us to be more of a player that could deliver them an architecture. So we shrank the product portfolio, and we're investing more in some areas. One of the newest areas is machine learning—this is the big buzz right now in the industry.

Since resigning from the company, founder John McAfee made headlines for his political views and clashes with law enforcement. Does it impact the brand?

First of all, John McAfee hasn't been involved in this company for over 20 years. In fact I did a Google [search] on McAfee, and half the time I get Pat McAfee, the punter for the Colts.

But in all seriousness, we did a lot of research to really understand what the brand means to people. And here's where we came out: We're already doing something that's hard, which is to spin a company out of another company. We happen to have a brand that because we've been around, it's got positives and it's got negatives.

Under Intel, McAfee was a division of a large semiconductor company. Now it's independent. What are the opportunities? Challenges?

Being private is a path to independence. And as far as getting access to capital, we no longer have to compete with other parts of the Intel business for investment—whether that investment is about M&A or investments we want to make internally. Intel is a 100,000-person company with nearly \$60 billion in revenue. And it's mostly building semiconductors. Now we'll just have a little bit more freedom and flexibility.

What keeps me up at night or gets me up early in the morning is worrying about how I make this a place that is good for our people and good for our customers. Because if we don't do that right, nothing else is going to matter. ■

Q&A

SECURING MCAFEE

The computer security company has worked to distance itself from its controversial founder and resist irrelevance under Intel. CEO Chris Young shares his plan to patch up the newly independent company. BY MICHAEL LEV-RAM

CHRIS YOUNG has a long to-do list. As CEO of McAfee, which popularized antivirus software in the 1980s and 1990s, he has to prove to investors that his company can operate on its own following a \$4.2 billion spinout from Intel in April.

He needs to show peers that McAfee can succeed in a new era. And he must teach customers that the company can once more be on the cutting edge. Here's what Young had to say ahead of his company's spinoff.

PURSUIITS

DOING BUSINESS IN: BUENOS AIRES

EXECUTIVE TRAVEL

Come to the capital of South America's second-largest economy for the strong U.S. dollar, a globally minded reformist President, and visa-free travel. Stay for the café society, boutique hotels, and sensational arts scene. BY ADAM ERACE

Getting around

Flights from the U.S. land at Ministro Pistarini International Airport, 14 miles southwest of central Buenos Aires. Taxis are plentiful (more than three times New York City's fleet), and pickups can be arranged inside the arrivals hall. Once in the city, you can get around on Latin America's first subway system (established 1913) and via more than 180 numbered bus lines, called *colectivos* or *bondis*, that run 24/7.

Best business hotels

Philippe Starck's Gothic-inspired interiors, nightly tango shows, and a see-and-be-seen pool have made **Faena** the city's design standard setter since it opened in 2004.

Need something more conservative? The historic **Alvear Palace** just renovated its luxurious suites, while **Algodon Mansion** provides a townhouse experience in Recoleta, with a wine cellar stacked with bottles from its sister winery in Mendoza.

Where to take clients

Do dinner in Palermo Hollywood at the city's best new restaurant, **Lusitano**. The *pulpa a feira* [octopus with olive oil and paprika] is fantastic, and the art-filled space looks like the residence of some well-to-do fictional adventurer. Afterward, have cocktails at **Floreria Atlántico**, a cozy speakeasy in the basement of a flower shop, or experi-



ence one of Argentina's cultural institutions, the tango, at **La Catedral**, a trapped-in-time club in Almagro.

Local gifts

Argentina is known for gutsy Malbecs, and the smart staff at **Pain et Vin**, a tasting room and sourdough bakery in Palermo Soho, can help you pick a knockout—or something more offbeat,

like a high-altitude Uco Valley Semillon—from its shelves. The other thing everyone brings home from Buenos Aires? Shoes. **Calzados Correa** in Almagro has been making men's bespoke leather boots, Oxfords, and moccasins since 1955, while the famous **Comme il Faut** is the place for killer heels in tutti-frutti colors and animal prints.

1
[1] El Mercado restaurant: Argentine cuisine at Faena. [2] Aire de Lyon exhibition at Fundación Proa.

Between meetings

Experience Buenos Aires' vibrant arts scene, from outstanding contemporary installations at **Fundación Proa** to **Pasaje Lanín**, a street of houses decorated with colorful tile mosaics in the emerging arts district of Barracas. If you have the time, don't miss the sculpture gardens at **Isla El Descanso**, a storybook landscape an hour north of the city on the delta of the Paraná River.

Extending your stay

Multiple daily flights make the 55-minute trip to Punta del Este in neighboring Uruguay. **Jose Ignacio** is a trendy town with wide, wind-swept beaches, horse ranches, and chic hotels. You can also go by car. From Buenos Aires, it's a scenic half-day drive. 2

EVERY LAST CHILD DESERVES A FUTURE



Save the Children.



Meet 5-year-old Amena.* Seeing her safe inside a hospital, you wouldn't know that she's a child refugee from Syria, recently rescued at sea from certain death.

At Save the Children, we do whatever it takes – every day and in times of crisis – to ensure children like Amena grow up healthy, learning and safe. No matter who they are or where they're born.

Because every child deserves a future. **Every last child.**

[SavetheChildren.org/Amena](https://www.savethechildren.org/Amena)
Watch Amena's dramatic rescue and recovery.

*Child's name changed for protection. ©2017, Save the Children. All rights reserved. Photo: Louis Leeson.

SHARE REPURCHASES

STOCKS THAT DODGE THE BUYBACK BLUES

The President's tax reforms could set off a stampede of share repurchases. But such deals don't always pay off for investors. Here's how to tell good buybacks from bad. BY RYAN DEROUSSEAU

INVEST

IN THEIR PITCH for tax reform, President

Trump and congressional Republicans have made promises that evoke Oprah Winfrey's talk-show days. ("You get a tax cut! *You* get a tax cut!! *YOU* get a tax cut!!!") But for investors, the biggest windfall may come from a deal that would require corporations to, at least briefly, pay *more* taxes.

That deal involves the repatriation of \$2.5 trillion of profits that American businesses have parked overseas in order to avoid paying the 35% U.S. corporate tax rate. The details are far from settled, but if an agreement coalesces, companies will bring much of that money back to the States, paying a one-time lower tax rate—whereupon investors expect they'll return hundreds of billions of dollars to shareholders in the form of stock buybacks. Goldman Sachs analyst David Kostin estimates that the dollar amount of share repurchases could reach \$700 billion this year, a 20% increase over 2016, if a tax deal gets done.

Investors, needless to say, are salivating. Anticipation of a buyback bonanza was one factor behind this past winter's Trump Bump rally. For money pros, repurchases are familiar territory: Big companies routinely use them to mop up excess shares that they've issued to raise new capital or as part of executives' compensation. And under the right circumstances, a buyback can lower a company's long-term costs and make its stock more desirable.

But before they get giddy about any specific company's buyback, investors should dig deeper—because lately a buyback has more often than not meant "buyer beware." Fortuna Advisors, a financial consulting firm that compiles a buyback scorecard, has a particularly sobering assessment of the strategy's effectiveness. In recent years 71% of the companies in the S&P 500 launched at least one major repurchase program—and on average, by Fortuna's measure, their returns lagged behind the stock market after the buyback >>



▷▷ began. "They don't really help shareholders much," Fortuna CEO Gregory Milano says of buybacks, and typically "their timing is terrible."

That's the opposite of what investors are primed to expect. When a company repurchases stock, investors who sell get an influx of cash. And in theory, as those shares are taken off the market, each remaining share becomes more valuable because future profits will be divided among fewer shares. That's why companies typically enjoy a stock-price bump after announcing a repurchase: Short-term players rush in to get the payout, while longer-term investors anticipate owning a bigger piece of tomorrow's earnings pie.

That virtuous cycle plays out, however, only if the stock keeps rising and earnings keep growing—results no company can guarantee, of course. What's more, while the pace of buy-

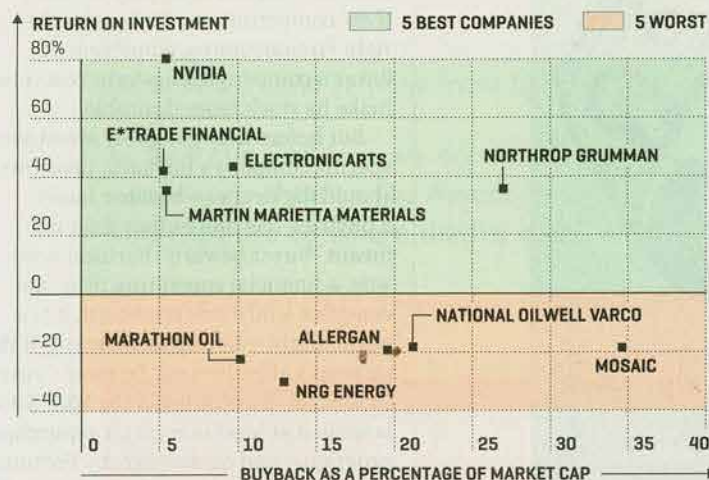
backs has accelerated since 2010, the reasons for the increase aren't all investor-friendly. Richard Fields of Tapestry Networks has studied buybacks for the Investor Responsibility Research Center Institute: He says many corporate boards prefer repurchases to dividends because a buyback is easier to suspend or alter if a company hits a rough patch. Unlike a dividend cut, a change in the timing of a buyback doesn't have to be publicly announced and is less likely to spook investors.

Some critics argue that repurchases represent squandered opportunities for growth, since \$1 billion spent on buybacks is \$1 billion *not* spent on R&D, acquisitions, or capital investments—or on job creation. University of Massachusetts at Lowell economist William Lazonick argues that some companies' buybacks are "funding the stock market" through financial engineering to boost the pay of executives who hold stock.

Amid this simmering discontent, Milano and Fortuna have built a mini-franchise around figuring out which companies get the most bang for their buyback buck. Since 2011, they have calculated "buyback ROI," a company's annualized rate of return based on a formula that accounts for the cash spent on buybacks, the money it saves by "avoided dividends" on the repurchased shares, and the change in its stock price since the buyback. A strong ROI is a sign of savvy manage-

THE BEST AND WORST AT BUYBACKS

When companies repurchase their shares at a prudent time, shareholders benefit too. The buyback ROI metric, calculated by Fortuna Advisors, is based in part on the performance of a company's stock post-buyback. This chart shows the companies that got the most and least bang for their buyback buck in the five years through 2016.



SOURCES: FORTUNA ADVISORS; S&P GLOBAL, BLOOMBERG

NOTES: ROI DATA IS ANNUALIZED; MARKET CAP AS OF 12/31/16; EPS CHANGE IS Q4 2011 VS. Q4 2016.

EARNINGS GROWTH ISN'T EVERYTHING

Theoretically, the more shares a company buys back, the more its earnings per share should grow. But a bigger buyback is no guarantee of soaring earnings or a rising stock price, as the ROI scores of the stocks here reflect.

	BUYBACK (SHARE OF MARKET CAP)	CHANGE IN EPS	BUY- BACK ROI
NORDSTROM	40%	6%	0%
DISCOVERY COMM.	37%	18%	-7%
NORTHROP GRUMMAN	27%	39%	36%
IBM	26%	1%	-1.5%
MCDONALD'S	25%	8%	10%

ment: It suggests that the company bought stock when it was undervalued and put subsequent savings to good use. A low ROI suggests that the company bought high—something no investor likes to hear—and that the money would have been better spent elsewhere.

Fortuna evaluated repurchases in the S&P 500 over the five years through the end of 2016, tracking 353 companies in all. The median buyback ROI for those companies was 11.2% a year. That sounds good—until you realize that the annualized return for the broader market, including dividends, was 14.6% over the same stretch. In other words, investing in a company after a buyback was more likely than not to disappoint you.

Among companies with low ROI, it's often true that bad timing is everything. Three of the five worst recent performers (see graphic) are energy companies whose shares tanked after the buybacks began, as oil and natural-gas prices plunged. Another case in point: clothing company Hanesbrands. Since the spring of 2015, the company has bought back \$731 million in stock. But since then its U.S. sales have fallen amid a general wipeout in clothing retail, and its stock has dropped 40%. Hanesbrands' buyback ROI: a dismal -18%.

Fortuna has also found that companies that buy back an unusually large percentage of their shares often deliver low ROI. Of the five companies that reduced share count the most via buybacks since 2011, four (Nordstrom, McDonald's, IBM, and media company Discovery Communications) subsequently generated subpar returns. The exception was defense contractor Northrop Grumman. It bought back some \$11 billion of stock over the past five years, reducing share count by about 30%. But those moves accompanied a strategic streamlining in response to reduced defense spending. Northrop maintained double-digit profit margins over that span, even as its revenues fell—pleasing investors, who have doubled its stock price over the past three years.

THE COMMONSENSICAL TAKEAWAYS: A buyback is no guarantee of long-term happiness, and a really big one might even be a red flag. But when a company has promising prospects for growth and its stock is reasonably priced, a buyback can be a nice booster shot to the returns of a long-term investor. With that in mind, we looked at other companies whose recent buybacks have paid off nicely, and spotlighted a few that look likely to continue their recent good runs.

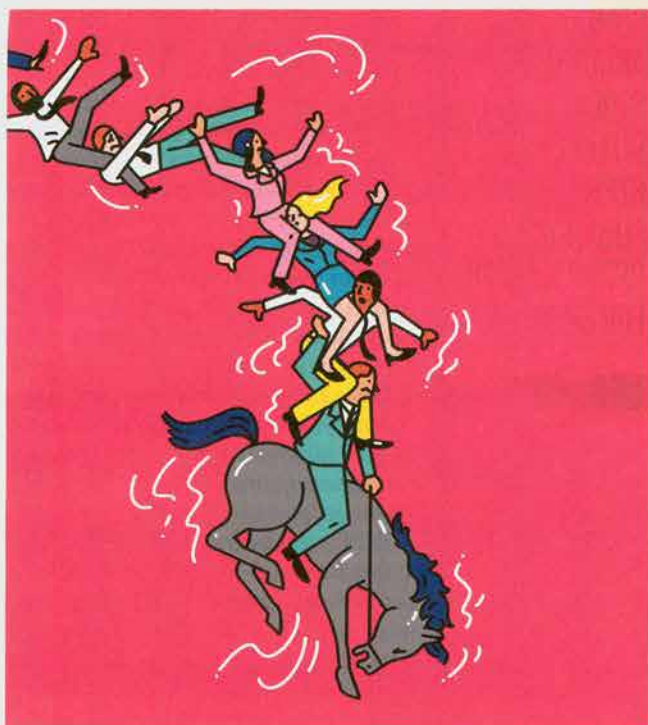
Chipmaker **Nvidia** topped Fortuna's ranking, with an ROI of 81%: Not coincidentally, it was the best-performing stock in the S&P 500 in 2016, rising 224%. Nvidia benefited from a 44% increase in its gaming-chip business and also became a darling in the autonomous-vehicle space—you can find its chips in Tesla's autopilot feature. These technologies are in very early stages, says Craig A. Ellis, an analyst at B. Riley, giving Nvidia room to grow. As part of an ongoing buyback program, the company plans to return \$1.25 billion to shareholders this year.

SOME CRITICS ARGUE THAT STOCK BUYBACKS REPRESENT SQUANDERED OPPORTUNITIES FOR GROWTH.

A bet on **Martin Marietta Materials** (ROI: 35%) is a contrarian bet on bipartisanship. Martin Marietta sells materials used to build highways, including "aggregates" like asphalt. A rare moment of unity in Washington in 2015 led to the \$300 billion FAST Act infrastructure bill, and money from FAST projects is now flowing in, says SunTrust Robinson Humphrey analyst Rohit Seth. A Trump infrastructure bill, which could also garner bipartisan support, would offer more of the same. Even if not, sales should be steady: Martin Marietta gets 35% of its \$3.6 billion in revenue from Texas, which has among the biggest transportation budgets of any state.

Earlier this year, medical-product-maker **Boston Scientific** (ROI: 33%) had to recall its promising Lotus aortic-valve device from the European market after discovering a flaw. Its market capitalization fell by about \$2 billion on the news, according to Needham analyst Mike Matson. But that may have created a buying opportunity. The flaw is fixable, and Lotus should return to market this year. Meanwhile, the company's acquisition of Symetis, a maker of aortic-valve replacement devices, should help spur the already strong growth of Boston Scientific's cardiovascular division.

The transition of credit cards from "swipe stripe" to chip-and-PIN security systems began in October 2015, but only about 30% of small businesses own machines that accept the up-graded plastic, according to Wedbush's Moshe Katri. That's good news for **Global Payments** (ROI: 34%), which sells such gear and has the industry's largest exposure to the small-business market. Its shares lagged last year amid fears that Brexit would disrupt cross-border transactions in Europe. (Europe accounts for 22% of the company's \$3 billion in revenues.) But those worries have receded, and today, Katri notes, Global Payments' stock is priced below competitor Vantiv's even though it's growing faster. ■



A BOOM WITH A VIEW

LESSONS IN UBER'S ROUGH RIDE

In the wake of rampant sexism at the well-funded transportation company, Silicon Valley rethinks its pursuit of rule-breaking results. **BY ERIN GRIFFITH**

WHEN A COMPANY as successful as Uber stumbles as dramatically as the startup did this year, the blame game begins. Uber's leaders should have earlier addressed allegations of sexism and workplace harassment. Investors should have pressured management to fire HR policy violators. Certainly the board of directors should be held accountable for something.

"It's been a tough 24 hours. I know the company is hurting," CEO Travis Kalanick wrote to



FOR MORE

Follow Erin Griffith
on Twitter
@eringriffith or at
fortune.com/boom.

staff before announcing an independent review of the company's workplace environment.

For years, Uber's toxic culture was a poorly kept secret in Silicon Valley. A recent string of exposés only served to tell the rest of the world what techies already knew.

Some people tried to push for changes. "We have hit a dead end in trying to influence the company quietly from the inside," wrote investors Mitch Kapor and Freeda Kapor Klein in an open letter published in February. But many more said nothing, believing themselves powerless to make a difference at a company with a "super-voting" stock structure. (Kalanick and his cofounders essentially control Uber's board with shares worth 10 votes to every one regular shareholder vote; he can't easily be fired.)

Talk to anyone in the tech industry about Uber and your conversation will go something like this: "What a mess! Glad it's not mine." (Pause.) "But also, uh, we can do better!"

Preventing another Uber-like situation is not just the right thing to do, ethically speaking. It's also in everyone's best business interest. One company's toxic culture reflects badly on an entire industry ecosystem.

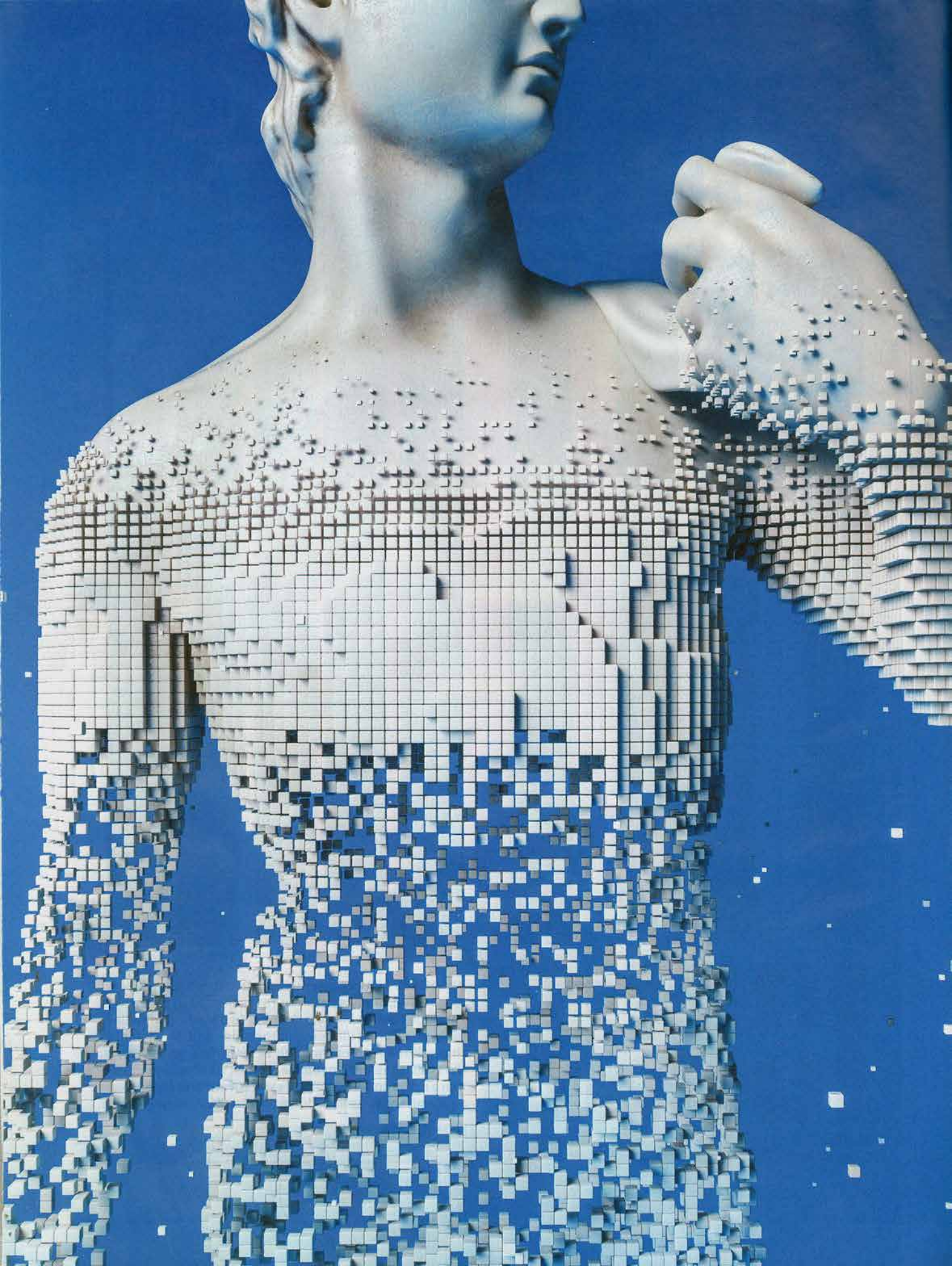
The uncomfortable reality is that no single aspect of Uber's culture—what critics call a strategy of growth at any cost, a view of human resources as a mere recruiting arm, a celebration of vague mantras including "Always be hustling" and "Be yourself"—is unique to the company. Until Uber's recent public-relations crisis, many people in Silicon Valley equated the company's aggressive tactics with its success. (Worth \$68 billion, it is the most valuable venture-backed company in the world.) Young founders admired Kalanick for his temerity.

They should heed the lessons of Uber's plight. Many investors believe that a company's beliefs and behaviors are set by the time it hires its 20th employee. A "cultural retrofit," I'm told, is nearly impossible. That's why venture capitalists increasingly prize clearly stated values, ethical decision-making, transparency among staff, and recruiters who can find diverse candidates for leadership roles.

These considerations can be an afterthought to entrepreneurs rushing to turn ideas into businesses. But facing them early is better than the alternative: building a wildly successful business that's rotten to the core. ■

THE FUTURE IS NOW

OPTIMISTS CRAVE IT. Pessimists fear it. Whatever your disposition, chances are you're fascinated by the future. The pages that follow are devoted to decoding what lies in store, offering glimpses of the ideas and technologies that will shape tomorrow. We've identified **32 COMPANIES** that will transform medicine, media, food, and much more in the coming years. If even a fraction of them succeed, the future will have been well worth waiting for.



■ THE FUTURE OF

HEALTH

PREPARE FOR THE DIGITAL HEALTH REVOLUTION

The business of medicine is inefficient, expensive, and ripe for disruption. Here are 21 companies that are using technology to reinvent it—and to change our lives in the process.

By Sy Mukherjee

THERE ARE MANY CHOICES we make over the course of our lives. Some are fairly insignificant, like the clothes we put on in the morning; others, such as the vocations we settle on, have life-changing consequences. But there's one critical decision we don't get to make: the choice of being born into a human body—and all the arbitrary ailments and inevitable biological breakdowns that follow.

This is what sets health care apart from other industries. The business of medicine is quite literally one of life and death. And throughout much of the world, it remains a messy, inefficient, expensive sector in need of radical reform.

Just consider some of the heart-wrenching numbers. Nearly one in four non-elderly American adults had past-due medical debt in 2015. That's actually an improvement from 2012, when the figure was closer to 30% (insurance coverage gains under the Affordable Care Act are one likely reason for

the decline). In Mississippi, more than 37% of the population owed money to care providers in 2015. Medical expenses are the top driver of personal bankruptcies. And last year the federal government projected that the nation's health care bill would top \$10,000 per person for the first time in history.

So what do we get for these extravagant private and public costs? A system where it takes weeks to see a doctor face-to-face, where more than 6,500 locales are officially deemed to have too few medical professionals to meet patients' needs, and where U.S. health outcomes are consistently mediocre compared with those of many of our developed-nation peers (and even some of the less developed ones).

This status quo is ripe for disruption. And while true reform will require all the relevant parties—government, industry, and health care consumers themselves—to make major adjustments, an insurgent group of digital health companies is doing its best to drag American medicine into the 21st century kicking and screaming.

That means superseding physical constraints like having an actual hospital by harnessing the power of mobile technology, making the act of taking your medicine less of a hassle, and peering into our very biological building blocks to wage war on the most intractable maladies.

To offer a preview of what this tech-optimized future might look like, we identified 21 innovative companies in five categories—each of which is challenging the conventional approach to medicine.

Welcome to the digital health revolution.



TELEMEDICINE

How Health Care Is Transcending Physical Walls

AT THE TURN OF THE 20TH CENTURY, getting a checkup in America frequently meant your doctor came to you. Armed with a modest black bag of tools and old-fashioned medical know-how, physicians of yore would often take care of you right at your bedside.

As quaint as that image may seem today, it's in some ways a vision of the future. New technologies are bringing back the house call—or a digital version of it, anyway.

THE COMPANIES

A slew of telehealth companies, from the Boston-based **AMERICAN**

WELL to San Francisco startup **DOCTOR ON DEMAND**, are again bringing health care to your doorstep—or more commonly, to your workplace. The National Business Group on Health last year surveyed 133 large companies employing 15 million Americans about their benefit practices: An astounding 90% said they expect to make at least some telemedicine services available to their workers this year. By 2019, nearly all of them will.

So what does that brave new world look like? Say you've been working after hours and suddenly feel feverish and woozy. You would walk down the hall to your company's on-site digital health station—that's a fancy word for "kiosk" (which, in turn, is a fancy word for "booth")—where you would consult with a physician immediately by phone or video. That same doctor can take your vital signs—temperature, pulse, blood pressure—and if needed, send a prescription to the nearest pharmacy. Or maybe just tell you to go home and get some rest.

In December, American Well

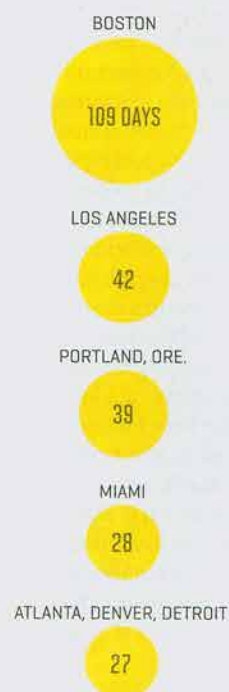
partnered with **CONCENTRA**, which has more than 300 medical centers in 40 states, to provide some of those on-call physicians.

One obvious advantage of telemedicine is that the doctor can be anywhere—which is not the case for our traditional health care system. At hospitals across the country, in fact, there is an entrenched doctor shortage, which has grown only more acute as millions of Americans have gained health coverage in recent years.

New digital platforms are helping to solve that problem too. One New York startup, **NOMAD HEALTH**, pairs doctors with hospitals in need of physicians in three specialties—internal medicine, emergency medicine, and psychiatry. Nomad cofounder and CEO Dr. Alexi Nazem, in an interview with *Fortune*, likens the system to an Airbnb model for medical staffing. The professional matchmaking process lets health systems find doctors with specific credentials (say, an internal medicine specialist with five years' experience who is free to work at a New York-area hospital in July) and vice-versa. The platform then automatically takes care of tasks like providing malpractice insurance if the hospital and doctor strike a contract.

This isn't just convenient from a medical resource perspective; it also plays into a nascent "gig economy" in health care that's become increasingly popular among younger, tech-savvy physicians. "With very little effort we've been able to tap into a huge flow of doctors who want to do short-term, freelance, flexible work," says Nazem. "And I think that trend will continue [among millennials] not only because of the attitudinal shift [on freelance medical work] but also because the existence of technology actually makes it possible to do this kind of work." Last summer the company raised \$4 million in an early funding round led by First

AVERAGE WAIT TIMES FOR A FAMILY MEDICINE DOCTOR APPOINTMENT, 2017



SOURCE: MERRITT HAWKINS

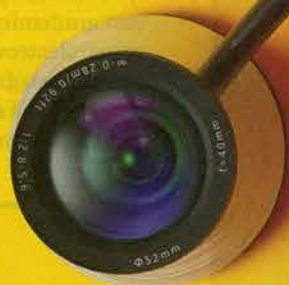
Round Capital and RRE Ventures.

And it's not just medical startups driving this mobile health surge. Ride-sharing giants **UBER** and **LYFT** have started new programs to provide non-emergency medical transport for patients who struggle to get to a hospital. One platform that launched last fall, called Circulation, integrates medical records into Uber's API so that nurses, caregivers, and hospital transportation coordinators can more easily schedule rides for patients and accommodate their needs (such as if they have a wheelchair or trouble seeing).

THE FUTURE

These technologies may one day fundamentally shift the way that health care is delivered and consumed. But before that transformation takes hold, some other changes will have to happen—including new reimbursement rules from insurance companies and policy shifts that make it easier for physicians to practice across state lines without gaining extra licenses or accreditation. There's also the matter of whether mobile medical care will ultimately reduce national health spending: At least one recent report suggests that the technology may well cause people to pursue care they don't need precisely because it makes it so convenient to get.

Still, don't bet against the trend. For consumers, after all, convenience has always been king—and convenient *and* cheap? Well, there's no beating that.





ALGORITHMIC MEDICINE

Big Data and AI Push Learning

THE TERM "BIG DATA" gets tossed around so casually that it's easy to forget just how big "big" really is. Consider that 2.5 quintillion bytes of data are created every day, according to **IBM**. In health care, this amounts to an hourly avalanche of new research papers, clinical trials, scientific studies, and patient health information. And it's impossible for doctors and medical researchers to keep up with even a tiny fraction of it.

Enter machine learning and artificial intelligence. Shorn of human weaknesses like the need to eat or sleep, computers are now speed-reading through not only the vast academic literature but also CT scans, electronic medical records, and mountains of data from clinical trials and genomic studies. AI is also giving drugmakers critical insights into who

benefits most from their treatments and changing the way hospitals manage their administrative operations.

THE COMPANIES

With IBM, the metamorphosis seems to have happened overnight:

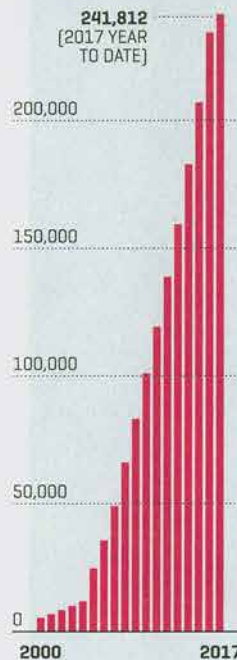
The starched-shirt centenarian went from a stolid mainframe and consulting giant to an upstart digital health pioneer—all in the blink of an AI. Big Blue can thank Watson—its *Jeopardy!*-winning, cognitive computing superstar—for that. And the company's ravenous dealmaking business unit, IBM Watson Health, seems to be redefining daily what AI applications can be used for.

In the two years since Watson Health launched, it has struck partnerships with an impressive array of academic institutions, such as the Memorial Sloan Kettering Cancer Center and prominent biopharma companies like **PFIZER**, **MEDTRONIC**, and **JOHNSON & JOHNSON**. In each case, Watson is given roughly the same task: Feast on reams of data and find hidden patterns—and hopefully new knowledge—within them. Watson can do this with electronic medical records as well as with so-called unstructured data (like that found in the image of an X-ray or brain scan).

And as with telemedicine, its insights can be made mobile. Earlier this year, for instance, Watson's oncology-focused unit struck its first deal with a community hospital, a 327-bed outfit in Jupiter, Fla., that can now harness the supercomputer's power to match cancer patients with the treatments most likely to help them (thanks to a clinical data set expertly reviewed by Memorial Sloan Kettering).

But what if AI and deep learning could help doctors figure out a patient's disease simply by analyzing a face—no scans or testing required? That's precisely what Boston-based startup **FDNA**

NUMBER OF REGISTERED CLINICAL STUDIES



SOURCE: NATIONAL LIBRARY OF MEDICINE DATABASE

is trying to achieve with its Face2Gene platform. The firm has put together a photo database of people with more than 2,000 rare genetic diseases. Doctors can snap pictures of their patients and upload them to FDNA's mobile app, which then spits out a list of disorders they might have by analyzing telltale facial features associated with those conditions (the tech is not a diagnostic tool, but rather a way to narrow down the list of possible genetic suspects). And the company hopes the system can drastically improve the "diagnostic journeys" that those with rare diseases typically face: Such patients, on average, are seen by seven doctors before the correct diagnosis is made.

Cutting costs and catching on to illnesses as early as possible are major goals for this type of tech. But it can also be used to combat administrative headaches like long hospital wait times. Last October, **GE HEALTHCARE** and the **JOHNS HOPKINS HOSPITAL** launched a fully digital hub to better manage everyday operations. The Judy Reitz Capacity Command Center gets a constant influx of data about important events at the

hospital; it receives about 500 messages every minute from more than a dozen different Hopkins IT systems and with the help of predictive analytics turns this swamp of data into suggestions for action that prevent bottlenecks and get patients both into and out of the hospital faster.

And, according to Johns Hopkins at least, it's showing impressive early results. The hospital says the command center has shaved more than an hour off the time it takes to dispatch an ambulance to another facility and that emergency room patients are assigned a bed 30% faster than before.

THE FUTURE

Now for a sobering fact: All the whiz-bang computing power in the world can't find knowledge in the data if the data isn't shared to begin with. And surprising as it may seem, says Greg Simon, former executive director of the White House Cancer Moonshot, we "still live in an information-scarce medical world."

The federal government and private organizations have tried to encourage sharing in recent years through initiatives like the Genomic Data Commons, a "unified data repository" intended to hasten cancer cures by making research public. But real progress on this front will take more than a handful of public-private initiatives: It will require a change in mind-set—a radical new willingness to share and share alike.



NEXT-GENERATION CAPSULES

The Evolution of Drug Delivery

THE HYPODERMIC NEEDLE made a splash on the medical stage in the 1850s by combining two key inventions: the conventional syringe (eventually converted from metal to glass so that users could better measure doses) and sharp, hollow needles. While the innovation was initially used for purposes such as injecting pain sufferers with powerful opioids, it became a true game changer once insulin came on the scene in 1921. Unlike painkillers, insulin can't be ingested—it has to be administered via an in-

jection or a pump in order for the body to absorb it and control blood sugar.

The way that we take our drugs has continued to evolve in the decades since then—syringes became disposable, for example—and the progress is far from over.

THE COMPANIES

In the past few years companies like **BRAEBURN PHARMACEUTICALS**, **INTARCIA THERAPEUTICS**, and **PROTEUS DIGITAL HEALTH** have set out to create better medical mousetraps through devices that make existing drugs more effective. That means peace of mind for diabetes patients, who no longer have to constantly prick their fingers to measure blood sugar and manually adjust insulin doses, and hope for recovering opioid addicts, who might face a relapse if they don't adhere to a strict treatment protocol.

Last May, Braeburn and partner **TITAN PHARMACEUTICALS** became the first companies to win Food and Drug Administration (FDA) approval for an implant to treat opioid addiction. Their product, Probuphine, is made up of matchstick-size implants placed into patients' upper arms in a simple outpatient procedure. These devices dispense a drug called buprenorphine—itsself an opioid, but one that doesn't produce the sort of euphoric and addictive high that more powerful painkillers such as OxyContin and morphine do.

But rather than have patients take buprenorphine manually, Probuphine dispenses small amounts of the drug continually into the bloodstream, ensuring that people actually stick to their prescribed regimen. The device can be used for up to six months.

This type of automated, long-term delivery system could make it easier to treat everything from brain diseases to diabetes. Indeed, diabetes is one affliction that Intarcia has in its crosshairs.



GENOMIC REVOLUTION

Precision-Editing the Code of Life

The Boston company is seeking FDA approval for an under-the-skin pump system that it says can dispense a steady stream of diabetes drugs for a period of six months or longer. But notably—even before it has won marketing approval—some think the technology could be an effective weapon against another deadly scourge: HIV. The Bill & Melinda Gates Foundation said it will invest up to \$140 million in Intarcia, in the hopes that its device can deliver prophylactic medicine—and help shield patients at high risk of infection from HIV.

The common theme of these innovations is that medicine itself is necessary but not sufficient: Patients actually have to take it as directed for it to work. Nonadherence to prescribed regimens is also costly, resulting in nearly \$300 billion a year in wasted spending, according to some studies.

Automating the process is one way to tackle this problem; Proteus Digital Health, however, is taking a different approach. The Silicon Valley startup's "smart pill" platform, Discover, helps doctors track patients' biometrics—and whether or not they're sticking to a drug protocol—with the help of ingestible (and on-the-body) sensors that communicate with a smartphone app. This way, patients with chronic diseases like hypertension and diabetes (and their physicians) can figure out the most effective dosing regimens.

THE FUTURE

Improving the way we take drugs could save those in the developed world many billions of dollars in annual health care expenses. It could also transform how the world's poorest nations prevent and treat disease—whether through patches that administer vaccines or through long-acting implants that dispense HIV/AIDS drugs. Even in medicine, it seems, the delivery business is in the throes of revolution.

ADENINE. THYMINE. GUANINE. CYTOSINE. These four tiny compounds provide the basis of life. They are the "letters" that make up DNA's code, and their various permutations can determine everything from our physical appearances to our risk of being born with a devastating disease.

So it's not surprising that being able to manipulate these chemical building blocks is one of the most exciting prospects in medicine. And thanks to a gene-editing technology known as Crispr-Cas9, it's become a whole lot easier to do just that.

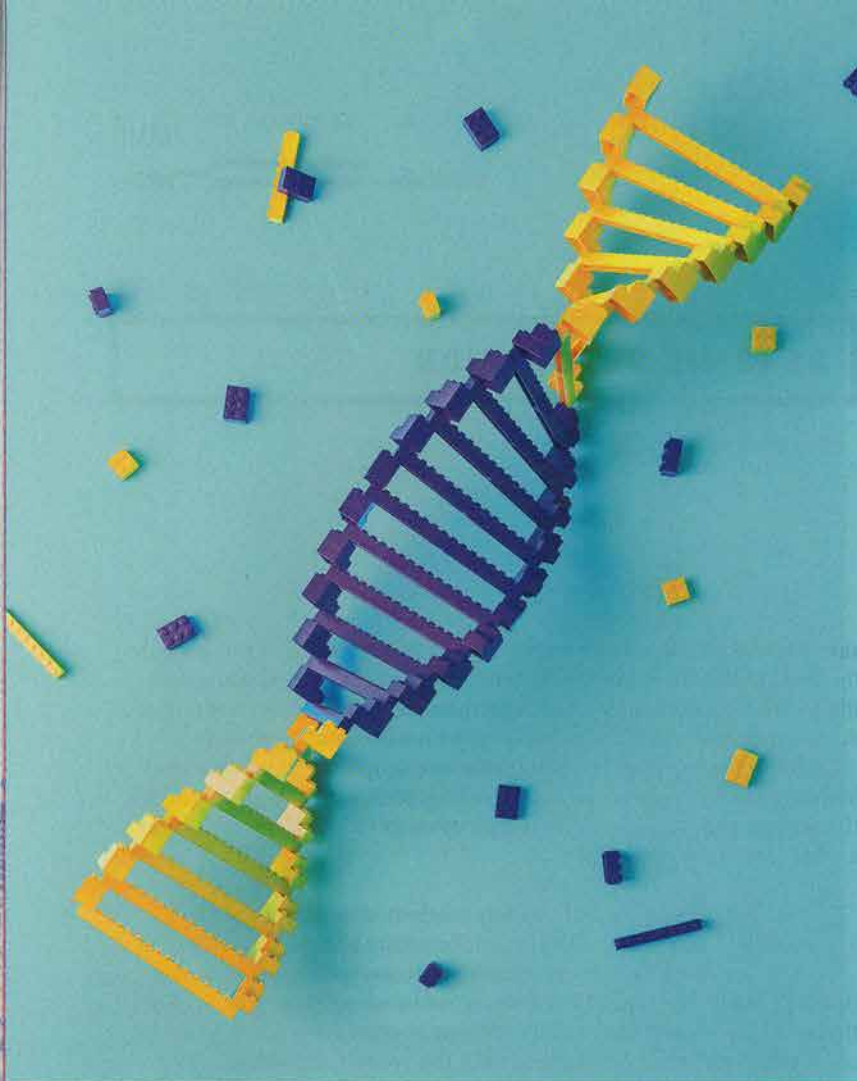
THE COMPANIES

Crispr has been widely celebrated as one of the most (if not the most) groundbreaking biotech discoveries of the 21st century. That's not to say gene editing is new (it isn't), but Crispr simplifies the process by using molecular scissors that can be precisely targeted to snip out aberrant regions of genetic code, which can then be replaced with the correct sequences.

The technology's possibilities are staggering—in theory, allowing medical scientists to do everything from cure genetic disorders like sickle cell disease to identify gene targets for combating HIV. Silicon Valley billionaire and cancer immunotherapy patron Sean Parker is funding the first U.S. Crispr trials in humans, which are expected to begin this year at the University of Pennsylvania and allied institutions; in March, pharma giant **ALLERGAN** struck a \$90 million deal with Crispr specialist **EDITAS MEDICINE** for access to the biotech's experimental therapies to treat rare and serious eye diseases.

And Crispr-Cas9 isn't even the only type of Crispr out there: On April 12, researchers at the University of Texas Southwestern Medical Center announced they had successfully paired the gene-editing tool with a different kind of enzyme, called Cpf1, to correct mutations associated with the devastating muscle-wasting disorder Duchenne muscular dystrophy. Crispr-Cpf1 could potentially prove even more promising than the Cas9 variety because the Cpf1 enzyme is smaller and can target certain genomic regions that Cas9 can't reach.

What makes Crispr so exciting is that, thanks to its precision, the tool has opened up a world of innovation to research facilities that previously wouldn't have been able to handle the expenses or complexities of genome editing. The possibility that different Crispr-associated enzymes may be more effective than others is fueling the scientific competition. So is the fact that Chinese scientists at Sichuan University in Chengdu launched the first-ever human Crispr trial, in a



lung cancer patient last October—a milestone that American scientist Dr. Carl June predicted would “trigger Sputnik 2.0” and a “biomedical duel” in the field between China and the U.S.

The genomic revolution isn’t just a scientific one, though. It’s also regulatory. Gene-related tech has a way of putting the fear of God—or the fear of man playing God—in people. And regulators have been cautious when it comes to the field.

That’s partly what makes **23ANDME’S** landmark FDA victory in early April so notable. The Alphabet-backed Silicon Valley startup, valued at \$1.1 billion, became the first company allowed to sell genetic tests (and accompanying health-risk reports) for 10 different diseases directly to consumers without a prescription. That includes conditions like Parkinson’s, Alzheimer’s, and celiac disease.

Victory wasn’t always assured. In November 2013, the FDA sent 23andMe cofounder and CEO Anne Wojcicki a stern warning saying that the company’s tests and health reports, which it was already selling straight to customers, were unapproved medical devices that hadn’t been cleared by the agency. The firm had to shelve many of its services as it worked to convince regulators that its genetic tests were accurate and the accompanying medical risk reports clear enough

that they wouldn’t confuse or harm customers.

Now 23andMe has pulled off the kind of comeback that’s rare to see in biopharma. “The FDA has embraced innovation and has empowered people by authorizing direct access to this information,” said Wojcicki in a statement following the clearance.

THE FUTURE

Genomic technology has evolved from the stuff of science fiction to a tangible reality, with massive medical and financial implications. Just how high are the stakes? Enough that the brilliant minds behind Crispr-Cas9—University of California at Berkeley’s Jennifer Doudna, her academic partner Emmanuelle Charpentier of the Max Planck Institute for Infection Biology in Germany, and rival Broad Institute of MIT and Harvard scientist Feng Zhang—and the various biotechs affiliated with them are embroiled in an ugly, global patent spat over the rights to the tech. (Zhang and the Broad won a key intellectual-property ruling in the U.S. earlier this year, but the matter is far from settled in markets like Europe and Asia.)

And ethical concerns will continue to dog this space. The technology isn’t quite advanced enough to birth a world of “designer babies.” But even in the case of 23andMe’s home DNA kits, some question the morality of telling a customer he is at high risk for Alzheimer’s when there’s little the person can currently do about it.

No one said revolution was easy.

PHARMA'S NEW FRONTIER

The Radical New Models
for Drug Discovery

THE LINES BETWEEN Big Pharma and small biotech are eroding. Traditional drug giants have caught on to the not-so-dirty little secret that outsourcing drug research (and in-licensing) may be a more effective strategy than trying to create groundbreaking new molecules within the confines of a single lab.

"No one company can corner in or create a monopoly on the best thinking that's out there. And so if we've built the lab and we invested a billion dollars in

discovering medicines, we can only do what we could in the four walls of our village," as Allergan CEO Brent Saunders, a licensing-and-acquisition maven, put it during an interview with *Fortune* earlier this year. "But if we walk outside of that, we're fishing in an ocean vs. a pond for innovation."

But shifting collaborative models aren't the only forces changing the face of drug development. Some companies are thinking not just outside the box but outside the planet when it comes to improving medicine.

THE COMPANIES

Elon Musk's groundbreaking private space outfit, SpaceX, flew its 10th mission under a NASA commercial resupply contract in February. The Dragon spacecraft delivered payloads to the International Space Station (ISS), including some high-profile biopharma cargo from **MERCK** and others.

Merck has been collaborating with the Center for the Advancement of Science in Space (CASIS), which has been tasked by NASA to oversee the ISS's U.S. National Lab since 2012. CASIS's mission is to encourage "use of this unparalleled platform for innovation"—and Merck is taking this to heart by experimenting with drug development in the realm of microgravity.

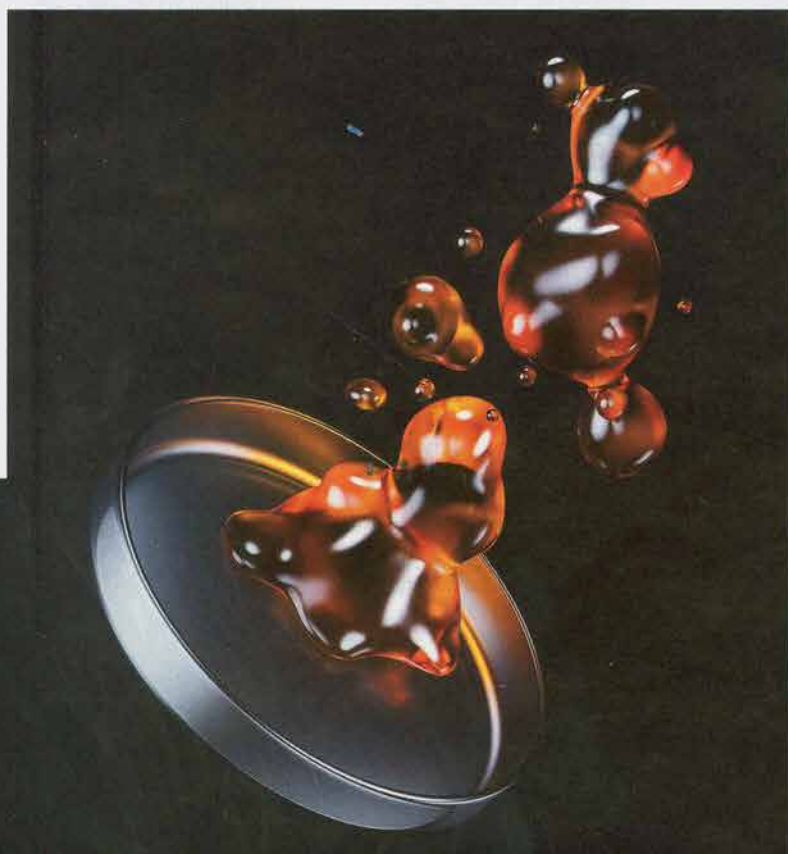
Such an environment, it turns out, presents all sorts of opportunities that aren't available down here on Earth, as Merck structural chemistry scientist Paul Reichert explained to *Fortune* in an interview.

For instance, you don't get the kind of gravity-driven diffusion that makes molecules scatter to a specific destination based on their density (think of excess sugar falling to the bottom of an oversaturated glass). One of Merck's main interests involves growing protein crystals, which form as larger and more organized structures in microgravity.

On the ISS, Merck has been doing experiments on its next-gen cancer medicine Keytruda. The mission, says Reichert, is "to understand the impact of the microgravity environment on the structure, delivery method, and purification" of these types of compounds. The lack of gravity-induced molecular changes on the U.S. National Lab could help Merck researchers improve drug delivery and manufacturing methods on Earth.

THE FUTURE

From tech incubators to world-class research facilities, from tweaks to biological machinery to computers that can unlock its secrets, and from research conducted on our pale blue dot to the cosmos themselves, the health care revolution is within our grasp. But ultimately realizing it will require collective changes in policy and scientific culture—and recognizing that technology, like humans, has its own limits.



34 Leaders Who Are Changing Health Care

From bold investors to company builders, from research scientists to patient advocates, here are nearly three dozen women and men who are driving progress in medicine and the business of keeping us healthy.
By *Fortune* Staff

THE RISK-TAKERS

MICHAEL GILMAN

CEO, Arrakis Therapeutics

The former Biogen executive and serial entrepreneur has chased some of biotech's most interesting experimental spaces. His latest quest? Creating medicines that target RNA.

KATHERINE KUZMESKAS

CEO, SimplyVital Health

Kuzmeskas's mission is to harness blockchain, the digital ledger technology at the heart of Bitcoin, to combat inefficiencies in medical record-keeping and payment systems.

VIVEK RAMASWAMY

CEO, Roivant Sciences

The 31-year-old wunderkind and former hedge funder has pulled off some of biotech's biggest IPOs in recent years. His companies are working to treat everything from Alzheimer's to cancer.

BRYAN ROBERTS

Partner, Venrock

A natural communicator and a buoyant supporter of digital health innovation, Roberts also has a hot hand when it comes to investing. He has backed one winner after another.

▼ ANNE WOJCICKI

CEO, 23andMe

With the recent nod of the FDA, Wojcicki's battle-tested startup is now the only company in the U.S. that can sell genetic tests and health-risk reports directly to consumers, no prescription necessary.



THE VISIONARIES

▲ JOE BIDEN

Former Vice President, Leader of the White House Cancer Moonshot

The 47th Vice President of the U.S. has always been one to roll up his sleeves and get to work. The nation saw that with his tireless effort to boost progress against cancer by changing the culture of research. And he's still at it.

BILL AND MELINDA GATES/SUE DESMOND-HELLMANN

Cochairs/CEO, Bill & Melinda Gates Foundation

For years, this global health triumvirate has tackled—and edged closer to eradicating—the world's most intractable (and yet long-neglected) diseases, from polio to malaria.

ATUL GAWANDE

Surgeon, Writer

The celebrated *New Yorker* writer, who also happens to be a surgeon, has eloquently exposed many of the flaws of American health care—and offered some smart ways to address them, too.

NORA VOLKOW

Director, National Institute on Drug Abuse

As the nation grapples with an epidemic of substance abuse, Volkow's groundbreaking work, showing that addiction is a disease of the brain rather than a moral failing, is especially important.



THE DISRUPTERS

JONATHAN BUSH

CEO, Athenahealth

Few are more persuasive—and outspoken—about the need to repair our health care system. The fix, says Bush: advanced technology, better care coordination, and data-based prevention.

SEAN DUFFY

CEO, Omada Health

The Google alum's startup aims to prevent diabetes in people on the cusp of developing it by using a digital scale, a smartphone app, and an online support community.

ARIANNA HUFFINGTON

CEO, Thrive Global

The queen of new media has brought "wellness" onto the health agenda as never before—a welcome development for the sleep-deprived masses.

REBECCA ONIE

CEO, Health Leads

Onie is pushing for a more expansive medical system; her organization, Health Leads, asks what patients need to be healthy—food, electricity, safe housing—and makes it happen.

▼ SEAN PARKER

President, Parker Institute for Cancer Immunotherapy

His revolutionary institute is a model for academic collaboration, data sharing, and the challenges of managing IP in science. And it's also taking some of the boldest bets yet in cancer research.



THE ADVOCATES

▲ KATHY GIUSTI

Founder, Multiple Myeloma Research Foundation

Giusti created what is without question the most successful patient advocacy model on the planet—one that, importantly, gets patients, researchers, and industry to sit at the same table.

PETER HOTEZ

Dean, National School of Tropical Medicine at Baylor College of Medicine

A self-described “scientist, researcher, advocate,” Hotez, who focuses on deadly infectious diseases around the world, was one of the first to sound the alarm on Zika in the U.S.

NGOZI OKONJO-IWEALA/ SETH BERKLEY

Board Chair/CEO, GAVI

Former Nigerian Finance Minister Okonjo-Iweala and GAVI CEO Berkley oversee a public health alliance that has boosted access to vaccines in 73 of the world’s poorest countries, tackling scourges like cholera and cervical cancer.

MICHAEL T. OSTERHOLM

Director, Center for Infectious Disease Research and Policy, University of Minnesota

When it comes to emerging disease threats, Osterholm has long been the world’s sentinel—and a persuasive exponent of the need to do more to prevent the next global pandemic.

RAJ PANJABI

CEO, Last Mile Health

The Liberian-born physician returned to his native country after its brutal civil war only to face a bigger threat: Ebola. His work to contain that disease—and train local residents to serve as community health care workers—may have saved thousands.

GREG SIMON

Director, Biden Cancer Initiative

The man who ran the impressive ground game for the White House Cancer Moonshot is a behind-the-scenes visionary who makes progress happen.



THE DISCOVERERS

JIM ALLISON

Chair, Department of Immunology, the University of Texas MD Anderson Cancer Center

His pioneering, decades-long work in immunology—which led to the discovery of immune checkpoint inhibitors—has changed the way we fight cancer and offered hope to millions.

LUIS A. DIAZ JR.

Head of the Division of Solid Tumor Oncology, Memorial Sloan Kettering Cancer Center

With a team-focused and collaborative mind-set, Diaz has brought the notion of a “liquid biopsy”—a blood test that can reveal genetic markers that shed fresh light on cancer and other diseases—much closer to reality.

▲ JENNIFER DOUDNA/ EMMANUELLE CHARPENTIER

UC Berkeley/Max Planck Institute

They borrowed a bacterial defense mechanism called Crispr and transformed it into a tool that may one day “edit” many diseases right out of our genomes.

GERALDINE HAMILTON

President and Chief Scientific Officer, Emulate

Emulate’s “organs on chips” technology could revolutionize how food and drugs are tested for safety.

LAURA NIKLASON

Founder, Humacyte

Her efforts to engineer vascular and lung tissue have put her in the vanguard of regenerative medicine.

THE CORPORATE INNOVATORS

MARK BERTOLINI

CEO, Aetna

The forward-looking and outspoken insurance CEO is focused on population wellness; his employees are rewarded for getting a good night’s sleep and other healthy behaviors.

JOE JIMENEZ

CEO, Novartis

Jimenez has championed the need to build health care infrastructure in the developing world—and to use ready-made tech when possible. One example: using SMS messaging via mobile phones to ensure essential medicines like vaccines are where they’re needed.

SANDI PETERSON

Group Worldwide Chair, Johnson & Johnson

J&J’s first-ever group worldwide chairman is leading the charge to transform the \$72 billion, 131-year-old giant into a cutting-edge health technology company.

SUE SIEGEL

CEO, GE Ventures and Healthymagination

CEO Jeff Immelt lured the well-respected Silicon Valley VC to GE in 2012; she now leads innovation and growth initiatives at the 125-year-old company, partnering with its \$18 billion med-tech division.



▲ BERNARD TYSON

CEO, Kaiser Permanente

Tyson leads one of the few organizations in America that seem to get health care right; nonprofit Kaiser—a health plan, hospital system and physicians group all in one—offers high-quality, [relatively] affordable care. **E**

■ THE FUTURE OF



DIGITAL SOCIETIES



WELCOME TO TOMORROW LAND

In the tiny European nation of Estonia (pop. 1.3 million) virtually every process is digitized—and the startup scene is thriving. What can the world's largest economies learn from one of its smallest?

By Vivienne Walt





Starship Technologies CEO Ahti Heinla shows off one of his company's delivery robots. Heinla was part of the team that created Skype, founded in Estonia in 2003.



IN A SPRING AFTERNOON, I'm gazing out the window of an office building on the outskirts of Estonia's capital, Tallinn, watching people stroll below, when a cream-colored plastic container mounted on black wheels rounds the corner and begins maneuvering its way among the pedestrians. The device looks like a kid's toy. But in reality it's a high-tech delivery robot called Starship and potentially the next mega-profitable invention to spring from this snowy, miniature country on the northern edge of Europe—one of the more unexpected launching pads on the planet. "If you look at sci-fi movies set 20 years from now, you don't see people carrying their groceries. Robots just arrive at their homes," says Ahti Heinla, cofounder and CEO of Starship Technologies. Reality, he says, has caught up to sci-fi. "About two years ago we realized it was possible to create this part of the future right now."

For a snapshot of how we might all be living tomorrow, there are few better places to visit than this picturesque city of 400,000, whose winding medieval alleyways offer an elegant contrast to its digital present. Creating the future now, as Heinla puts it, is Estonia's driving project, and increasingly it is its core business too.

Most Americans or even Europeans would be unable to find this pinprick on a map, squeezed between its small Baltic Sea neighbor Latvia and mammoth Russia. Its population, just 1.3 million, is about the same as Dallas or the Bronx borough of New York City. But its modest size and remoteness belies its clout. It is here that a group of friends, including Heinla, invented the hugely popular Internet calling platform Skype.

Given Estonia's history, the invention of Skype in this country was ironic. While Americans were buying their first cell phones, about a quarter-century ago, Estonians were shut off from the world as an outpost of the Soviet Union. You could easily wait 10 years to be assigned a landline phone. By the time the Soviet Union imploded in 1991, the country was in a time warp. "We did not have anything," says Gen. Riho Terras, the commander of Estonia's armed forces, who had been a student activist at the time. The country had to reboot from zero. Terras says each citizen was given the equivalent of 10 euros, or \$10.60. "That was it," he says, laughing. "We started from 10 euros each."

One generation on, Estonia is a time warp of another kind: a fast-forward example of extreme digital living. For the rest of us, Estonia

offers a glimpse into what happens when a country abandons old analog systems and opts to run completely online instead. That notion is not fanciful. In various forms, governments across the world, including those in Singapore, Japan, and India, are trying to determine how dramatically they can transform themselves into digital entities in order to cut budgets and streamline services (and for some, keep closer tabs on citizens). Estonia claims its online systems add 2% a year to its GDP.

The moment I land in Tallinn, my phone pings with the city's free Wi-Fi network, which rolled out more than 15 years ago. But the extreme-digital life of regular Estonians is far less visible. At birth, every person is assigned a unique string of 11 digits, a digital identifier that from then on is key to operating almost every aspect of that person's life—the 21st-century version of a Social Security number. The all-digital habits begin young: Estonian children learn computer programming at school, many beginning in kindergarten.

In 2000, Estonia became the first country in the world to declare Internet access a basic human right—much like food and shelter. That same year it passed a law giving digital signatures equal weight to handwritten ones. That single move created an entire paperless system. Since no one was required to sign with a pen, there was no need for paper documents to pay taxes, open a bank account, obtain a mortgage, pick up a prescription, or perform most of life's other tasks, other than marrying and divorcing. "I established my company in about 20 minutes, without going anywhere," says Kaidi Ruusalepp, 41, CEO of Funderbeam, an investment trading platform for early-stage, non-IPO startups, which she founded in 2013. "We never visited the tax board, the Social Security agency, anything," she says. "Everything is online."

So, too, are Estonians' taxes. Almost all Estonians file taxes online—within minutes. Since public registries are all linked in one system, Estonians can log in to prefilled tax declarations showing their income, property, number of children, and so on. They make necessary tweaks and hit the send button. (Out-



○
Kaidi Ruusalepp, founder and CEO of startup Funderbeam, at her company's offices in Tallinn.

Three Estonian Startups on the Rise

The thriving tech scene in the capital city of Tallinn has attracted the attention of venture capitalists worldwide. Here are a handful of companies to watch.

STARSHIP TECHNOLOGIES

Cofounded in 2014 by Janus Friis and Ahti Heinla, two of the Estonians who helped create Skype, the company is now testing its food-delivery robots in markets like London, Hamburg, and Redwood City, Calif. Auto giant Daimler is an investor.

JOBBATICAL

Founder Karoli Hindriks believes that "if everyone could do a year abroad, the world would be a better place." Her company, founded in 2014, places skilled job seekers around the world for medium-term stints at overseas companies. Early investors include Union Square Ventures.

FUNDERBEAM

Possibly the world's only online trading platform for early, non-IPO startups, it's built on blockchain technology and was founded in 2013 by Kaidi Ruusalepp, who once served as the Estonian government's first IT lawyer. Famed VC Tim Draper was an early backer.



o Street art on an office building in a Soviet-era industrial section of Tallinn.

side the U.S., this type of approach is increasingly common.) Last year then-Prime Minister Taavi Rõivas earned loud cheers on *The Daily Show* when he described to host Trevor Noah how he had filed his taxes on his iPad during a few idle minutes in the Luxembourg Airport.

When I visit Rõivas, 37, in his office in the Estonian Parliament, it's weirdly devoid of paper. He says during nearly three years as Prime Minister the only time he signed his name in ink was in ceremonial guest books. Theoretically, he says, the government could issue an online order to send troops into battle. "I never signed any law physically," he says. "Never."

Estonians were also first to be able to vote online in elections, back in 2005. When I ask Estonian President Kersti Kaljulaid where she voted in last November's elections, which brought her to power, she responds as if my question is dumb: "From my computer at home." Kaljulaid was speaking to me while we were on a boat to Tallinn from Helsinki, in neighboring Finland, where she had just signed a deal allowing the countries to recognize each other's digital ID cards. Now, for example, Finns and Estonians can visit doctors in the other country and automatically call up their medical records—all stored online. "We have been using digital identifiers for 17 years," she says. "People have learned to trust the system."

ESTONIANS MIGHT TAKE ALL THIS TECH WIZARDRY for granted now, but the country was on its knees economically after the Soviet collapse. It had one huge advantage: It was starting from scratch. "People were paid in cash," says

Tiny, but Mighty

Bordering Russia, Estonia is the smallest of the former Soviet states on the Baltic.



Martin Ruubel, 41, president of Guardtime, a 10-year-old software security company that developed the country's blockchain system (more on that in a moment), sitting in his Tallinn office on the grounds of a converted former military barrack. Since no Estonian had ever had a checkbook, once the Soviets were gone the country simply skipped past pen and paper and issued bank cards. It was a money saver, but had another benefit: It pushed Estonians to get online fast.

Scrambling to piece together a country, the new leaders, young and inexperienced, also rapidly privatized the telecom industry. "It was highly successful," says Mart Laar, 57, who became the first post-Soviet Prime Minister, at age 32, and is now chairman of the board of supervisors for the Bank of Estonia. Since so few people had even landline phones, many simply bought mobile handsets instead. Laar, a historian, says he knew nothing about computers but believed they needed to start with the latest technology. When Finland offered to donate its analog telephone exchange to its poorer neighbor for free, Estonia turned it down.

The government recruited Ruusalepp, now Funderbeam's CEO, as the new country's first IT lawyer when she was just 20 and still a student. "I had no law degree and no understanding of technology," she says. Her first task was to create a law for digital signatures, years ahead of many countries. "We wanted to change the country. We had brains, and we just had to shoot," she says.

Those early decisions set the stage for today's thriving tech scene in Estonia. Skype, founded in Tallinn in 2003, spawned a generation of techies and would-be entrepreneurs. "People thought, If Estonian guys could do something like Skype, I can do it also," says Andrus Oks of Terra Venture Partners, an investment fund in Tallinn. And when Microsoft bought Skype in 2011 for \$8.5 billion, ex-Skypers plowed money into new startups in Tallinn, further attracting U.S. investments. Skype's founding developers, including Starship's Heinla, also launched a venture capital fund, called Ambient Sound. "The Skype effect has been enormous,"

says Heinla, who started Starship with Skype cofounder Janus Friis; major investors include Daimler A.G., as well as Silicon Valley firms Shasta Ventures and Matrix Partners.

Now, if you order Chinese takeout through platforms DoorDash or Postmates in Redwood City, Calif., or Washington, D.C., your food might arrive as a Starship test run, with a ping on your mobile phone letting you know your delivery robot is at the door. Starship is also doing test deliveries in Bern, Switzerland, and London, and Domino's Pizza plans to test some deliveries by Starship soon in Hamburg.

The Skype effect does not end there. In 2011, Skype's first employee, Taavet Hinrikus, cofounded TransferWise, an online money-transfer company, which now occupies four floors of a Tallinn building and handles about \$1 billion a month in exchanges around the world. Investors include Andreessen Horowitz and Peter Thiel's Valar Ventures.

WITH HINDSIGHT, it seems inevitable that Russia would sooner or later collide with its pint-size former territory, which, aside from becoming a major tech hub, had rushed to join both NATO and the EU after the Soviet collapse.

Russia's payback finally came in 2007—and it would markedly change Estonia. It happened when Estonia's government decided to move a World War II memorial statue of a Soviet soldier from central Tallinn to a nearby war cemetery. Pro-Russian demonstrators burned barricades and looted stores in days of rioting. Then Estonia's banks, its Parliament, and several public services suddenly went off-line, in one of the biggest-ever distributed denial-of-service attacks to hit a country. The 2007 cyberattack still haunts Estonia. "We were already really, really dependent on online. We had no paper originals for a lot of things," says



Martin Ruubel, president of blockchain services company Guardtime, in his company's offices in Tallinn.



Children in a coding class in an elementary school in Tallinn.

Guardtime's Ruubel. Estonia believes Russia was behind the attack.

Shortly after, the only NATO-accredited cyberdefense center opened in Tallinn. And this year Estonia will open the world's first "data embassy" in Luxembourg—a storage building to house an entire backup of Estonia's data that will enjoy the same sovereign rights as a regular embassy but be able to reboot the country remotely, in case of another attack. "It was quite clear after 2007 that we knew how to fight against external attacks," Ruubel says. "The worry was, What if there was an attack from inside the system, with someone tampering with the data?"

The answer to that concern came in the form of the technology that now underpins crucial parts of Estonia's system, as well as some of its most successful startups, and that, in the years ahead, could help power the country's future growth: the blockchain.

Essentially a distributed database, a blockchain—the system that also underpins the cryptocurrency Bitcoin—serves as a public ledger that can never be erased or rewritten. The technology allows Estonia's engineers to strengthen its encrypted data and lets Estonians verify at any time that their information has not been tampered with. Estonians are also required to use two-step verification for many online tasks. These and other security measures, say Estonians, make their system as close to unbreakable as possible. (The U.S. State Department said last year that cybercrime "does not represent a major threat" in Estonia.) They contrast it, for example, to Edward Snowden's hacking into the NSA, which he continued over 18 months. "No Snowden can crack this system," boasts President Kaljulaid.

Outside the country, however, there are some doubts as to whether the Estonians' technology is as secure as they claim. In 2014—seven years after the suspected Russian hack—engineers at the University of Michigan studied Estonia's online-voting system and concluded that determined hackers—such as Russian operatives—could feasibly penetrate it, creating fake votes or altering the totals in order to rig elections "quite possibly

without a trace," they wrote in their report. "Estonia's system places extreme trust in election servers and voters' computers—all easy targets for a foreign power," they said. Estonia disputed the claims, saying that it had worked flawlessly in six elections and that it had "a level of security greater than was possible with paper ballots."

To Estonians, the potential of extreme-digital systems for both governments and businesses is dizzying—and with the blockchain, it has only just begun. Guardtime, which has 150 employees and estimates about \$23 million in revenues in 2015, is now among the world's biggest blockchain companies, with clients around the world, including Lockheed Martin and the U.S. Department of Defense. Funderbeam uses so-called colored coin technology, based on the public Bitcoin blockchain, to keep track of transactions and investments. That eliminates the need for brokers and clearing agents.

Ruusalepp, whose early backers at Funderbeam included the Silicon Valley venture capital investor Tim Draper, says she regularly hears Americans argue that paper records are more secure. Estonians, by contrast, would be aghast to have their medical records in paper folders in doctors' offices, she says. "You can never see who has looked at your data," she says. "Blockchain solves the issue of trust."

Those who created Estonia's system say they believe the arguments raging in the U.S. over data privacy are largely misplaced. The focus should instead be to give people control over who accesses their data, by using blockchain technology. "The real issue is data integrity," says Toomas Hendrik Ilves, an Estonian-American from Leonia, N.J., who served as Estonia's President from 2006 until last November, and is now a senior fellow at Stanford University's Center for International Security and Cooperation and sits on the World Economic Council's Future of Blockchain group. He says it could take many years for the U.S.'s sprawling agencies to create an Estonian-type blockchain architecture. "I'm smack in the middle of Silicon Valley, at Stanford, and the amount of creativity

Fast-Forward in "E-stonia"

The Estonian government has been investing aggressively in the country's digital infrastructure. Here are four ways it's ahead of the curve.

E-RESIDENCY

Since 2014 the country has offered electronic residency cards for foreigners living elsewhere that allow people to run their companies out of Estonia no matter where they live and sign documents digitally just as the Estonians do.

DIGITAL DIPLOMACY

This year Estonia will open the world's first "data embassy" in Luxembourg, with a data-storage facility for backing up its citizens' information, and with the same sovereign status as a physical embassy.

WICKED FAST WI-FI

Starting in 2018, Estonia plans to become one of the first countries with 5G network capability, vastly boosting connectivity for devices like driverless cars and robots.

BLOCKCHAIN BUILD-OUT

Estonia is employing the digital ledger system in novel ways. For example, it's harnessing its genome bank to develop "precision medicine" with personalized drugs and treatments, using the blockchain to ensure the data is traceable.

is amazing," Ilves says. "But the public sector is lagging way, way, way behind."

HAVING BUILT perhaps the world's most seamless digital system, Estonia still faces a major limitation: its size. With just 1.3 million Estonians, it runs like a well-oiled machine. But engineers claim there is vast spare capacity. Built right, the system could work with huge numbers. (The U.S. could in theory reengineer its databases from scratch,

say Estonian technologists, and serve 300 million Americans just as well.) To more fully leverage its technological advantage and boost economic growth, Estonia needs more market participants.

Since Estonia had little means for attracting masses of immigrants to its icy Northern European landscape, it came up with a quirky idea—another of its firsts in the world: offering people virtual residency. Taavi Kotka, 38, a software engineer and entrepreneur, dreamed up the concept after becoming the government's chief information officer in 2013. Kotka wrote a policy paper arguing that the population needed to grow fast, and proposed a target of 10 million people by 2025. Since Estonian women were not about to have 10 babies each, the alternative was to figure out what kind of product the country could offer to the rest of the world. Somewhat like Delaware-based corporations in the U.S., e-residents of Estonia can now run their European operations remotely and do business in euros. "We want to be the office for micro and small companies, because that is basically what our country is," say Kotka, who now works as a consultant to Estonian startups. "You cannot grow without customers."

Estonia's first e-residency cards rolled out in December 2014. The microchips inside them are identical to Estonians' digital ID cards but come without citizens' rights, like voting or public pensions, and there is no obligation to pay taxes in Estonia. This is no tax haven: Estonia requires that e-residents pay their taxes to whatever country they owe them. But for a fee of 145 euros (about \$154) e-residents can register companies in Estonia, no matter where they live, gaining automatic access to the EU's giant common market—about 440 million once Britain leaves the union. Of about 18,000 e-residents so far, about 1,400 have formed companies in Estonia. On average, each of those companies spends roughly 55 euros (about \$58) a month on accounting and office administration in Estonia.

This year the government doubled its budget for the program and intends on doubling it again in 2018, saying it's determined to ramp up e-residency numbers quickly. As numbers grow, so too will the business services Estonia offers. Officials have traveled to Tallinn from around the world to examine how to start their own e-residency programs. Kaspar Korjus, managing director of the e-residency program, says his office hosts about 500 delegations a year. "So far the only revenue model for countries is taxes," he says. "But if we get 10 million e-residents paying \$100 a month each, maybe we would not need taxes."

The possibilities do not end there. With its government running on the blockchain, Estonia could in theory begin marketing other inventions as they unfold—creating huge new business. Rõivas, the former Prime Minister, says Estonia is working on developing "precision medicine" that would tap into the genome data of its 1.3 million citizens in order to better diagnose illnesses, treat people, and design personalized drugs. "We can use blockchain to make sure that the data exchanged is able to be traced," he says.

It's possible to imagine Estonia's idea becoming a multibillion-dollar business in the years ahead—turning the whole view of government as a bureaucracy offering public services into an entity generating profits.

Perhaps only a place that started over from scratch in 1991 could reimagine the idea of a country. As I watch the Starship robots maneuver across the company's office in Tallinn, CEO Heinla says he believes Estonians, after decades of living under Soviet rule, were uniquely suited to creating new ways of doing things, including how to run a government. "People grow up and see an establishment they cannot break into," he says, so Estonians simply built something new, and more efficient. Older, more set in its ways—and more skeptical—the rest of the world has yet to catch up. Just don't expect Estonia to wait for us. ■

■ THE FUTURE OF



STARTUP INNOVATION



WANTED: FRESH SOLUTIONS FOR AGE-OLD PROBLEMS

How you eat, dress, log in, save, and interact with others—it all could change. We found seven small companies challenging the status quo and giving us a look into the future. Read on to find out how.

Tidal Vision's
Tidal Scrub
sponge is
antimicrobial,
biodegradable,
and made from
a material
extracted from
discarded
crab shells.





THE FUTURE OF FASHION

PROBLEM: Fast fashion is polluting the planet.

SOLUTION: Garments made from natural waste.

◀ **CRAIG KASBERG** IS an unlikely choice to shake up the fashion industry. The 25-year-old spent years working on an Alaskan fishing boat and is a rare sight at the shopping mall. But as CEO of **TIDAL VISION**, the startup he cofounded, Kasberg is pushing sustainable products made from ocean waste like salmon skin and discarded crab shells.

The approach favors the environment as well as the \$2.5 trillion apparel industry, which is fraught with waste, pollution, chemicals, and human rights abuses. The rise of “fast fashion” has allowed consumers to treat cheap garments as nearly disposable, discarding them after just seven or eight wears. They then end up in landfills, despite the substantial amount of water and chemicals needed to produce them.

Kasberg couldn't believe how much waste the fishing industry dumped back in the ocean. So he negotiated with seafood processors to buy their scraps and launched Tidal Vision to transform those raw materials into products, among them chitosan, which textile companies can use in fabric for garments, and salmon leather, which Tidal Vision sells in sheets to fashion designers. It also sells wallets and belts in 130 specialty stores.

Changing consumer behavior to resist the allure of fast fashion's ultralow prices could take a while. That's fine with Kasberg. Tidal Vision, which has 12 employees and is backed by more than \$1 million from investors, has diversification in mind. The company has deals to coproduce eco-friendly pool clarifiers and has developed an array of other products: preservatives, fertilizers, athletic fabrics, car seat cushions, even antimicrobial sponges. Tidal Vision will cast a big net to stay afloat—until fashion designers get hooked on fish-leather coats, that is.

—JENNIFER ELSEVER

INDUSTRY STATS

100 BILLION+

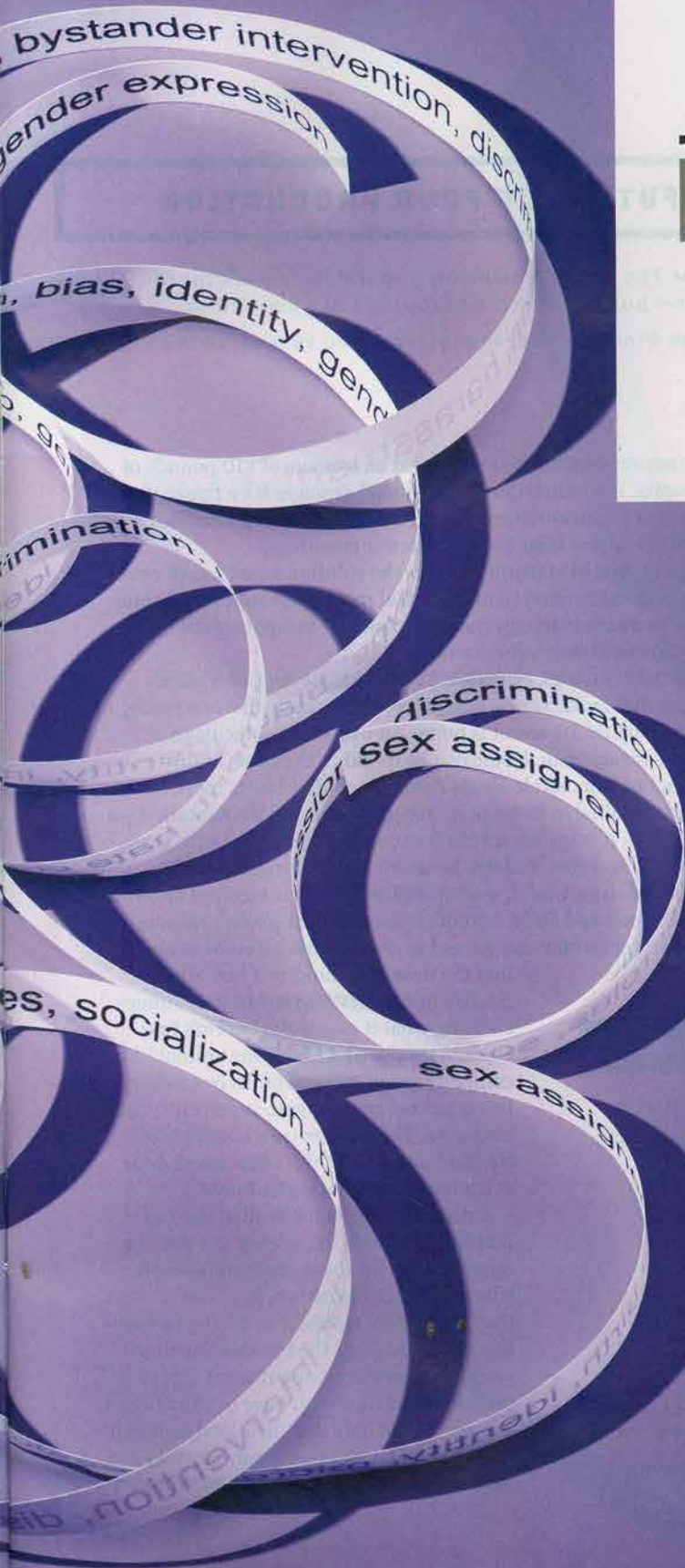
The number of **clothing items produced** in 2014. That's nearly 14 items of clothing for every person on earth.

15.2%

Percent of textile waste that was **recycled** in 2013, of the total 15.1 million tons discarded.

SOURCES: MCKINSEY & CO.; EPA

◉ PROP STYLING BY JOJO LI



THE FUTURE OF COLLABORATION

PROBLEM: Corporate America's empathy gap is hurting its bottom line.

SOLUTION: Virtual reality that offers a different point of view.

IF YOU HAD MET Nathan Egan in 2014, you would have thought he had it all. He was married to his best friend. He had three healthy children. He was the CEO of PeopleLinx, a successful software business that had just raised millions of dollars in funding.

But then things fell apart. His marriage hit a rough patch, and his company veered from explosive growth to near implosion. "That was a low, low point," Egan recalls. "Everything good was gone."

Egan soon realized that it was not the life he wanted. The problem was neither his company nor his wife—it was that he didn't want to be a "he" at all.

Egan came out as Natalie, a transgender woman. For the first time, she understood how minority groups experienced the world. She also realized how little she had considered different perspectives back when she identified as a heterosexual white male. But where Egan saw a problem, she also saw a business opportunity.

Her new venture, **TRANSLATOR**, is a mobile app designed to help companies train their employees' "empathy muscle." The company is building a platform that will enable people to virtually walk in others' shoes.

Each Translator user's experience begins with learning what identity is and what it means to him or her. Depending on an employer's >>

INDUSTRY STATS

\$720 MILLION

Approximate amount businesses invest each year to improve employee engagement.

32%

Percentage of U.S. employees who report being engaged at work.

SOURCES: BERSIN & ASSOCIATES; GALLUP

▷▷ specific needs, the user then learns about other identities—based on race, gender, or sexual preference—that are different from the trainee's own experience. Some lessons are audio exercises, others are games, and some are fully immersive virtual reality experiences.

For example, a male employee might (virtually) find himself in the mind and body of a woman of color as she sits in a business meeting. He may be called "honey" or be asked to fetch coffee for the men in the room. He might hear a monologue of her hopes and fears, including the dreaded, "What if they think I'm the secretary?"

An empathetic workplace isn't just a nice-to-have. In a study of 200 global corporations, psychologist Daniel Goleman found that high levels of emotional intelligence—of which empathy is a key part—was found in 90% of high-performing workers. Moreover, empathetic employees are more engaged, less likely to leave, and better at serving customers. All of that contributes to a company's bottom line. According to a 2013 Gallup study, companies with engaged employees outperform those without them by up to 202%.

Translator's app is still in development, so in the meantime the company is providing in-person workshops to clients, which include *Fortune* 500 companies, banks, health care systems, government organizations, and schools. A little more perspective can't hurt.

—VALENTINA ZARYA

THE FUTURE OF FOOD PRODUCTION

PROBLEM: The world's growing population wants more protein—but the earth's resources are dwindling.

SOLUTION: Plant-based, lab-grown, and fast-growing meat.

AMERICANS LOVE PROTEIN. Each year they eat an average of 210 pounds of meat per capita, more than double the global average. It's a figure that many believe is unsustainable if the agricultural industry is to feed a growing planet on less land and using fewer resources.

A promising class of startups believes the solution is not to ask eaters to give up meat but instead to make actual meat more sustainable and alternatives more convincingly meatlike. And the companies are turning to cutting-edge food technology to do it.

To satisfy beef cravings, **IMPOSSIBLE FOODS** has developed a plant-based burger that looks, tastes, and behaves uncannily like one made from the real McCoy. Its secret is heme, an iron-rich molecule that gives meat its meaty taste. Heme can be found in the roots of nitrogen-fixing plants, but Impossible Foods determined that it was more economical and sustainable to make it through industrial fermentation—a process by which it transfers a gene from the soybean plant into yeast, grows the yeast, and then isolates heme in the resulting broth.

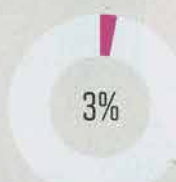
In the seafood department, startup **AQUABOUNTY** has received approval from the U.S. Food and Drug Administration for fast-growth salmon that have been genetically engineered to get to market weight in about half the time as unmodified fish. And for poultry needs, **MEMPHIS MEATS** is commercializing what it says is the "world's first chicken produced without the animal." The company grows meat in tanks by feeding living animal cells oxygen, sugar, and other nutrients. The process uses about 1% of the land and 10% of the water needed for conventional animal agriculture.

A complicating factor in all of this has nothing to do with the science. It's that the target market for these products—people who care about the carbon footprint of what they eat—is also resistant to mixing technology with food (e.g., the backlash against genetically modified organisms). These promising startups will have to convince consumers not only that their food tech isn't scary, but that it may be the only way they can have their meat and eat it too. —BETH KOWITT

INDUSTRY STATS

210 POUNDS

Meat consumed per capita in the U.S. each year.



Percentage of Americans who are vegetarians.

SOURCES: DECO; HARRIS POLL





THE FUTURE OF FINANCIAL STABILITY

PROBLEM: Americans are terrible at saving money.

SOLUTION: Automate the process through expenses.

NOAH KERNER understood the value of a dollar early in life. As a child, he sold baseball cards for quick profits. While he worked in an early job as a bank teller, he moonlighted as a tennis coach and a DJ.

Kerner is now the CEO of **ACORNS**, a company dedicated to helping Americans do what research proves they cannot: save money. The National Institute on Retirement Security estimates the U.S. retirement savings deficit—the gap between how much should be saved to maintain living standards and how much actually is—to be as much as \$14 trillion. Meanwhile, 28% of people between ages 30 and 44 have no retirement savings at all, according to the Federal Reserve. Acorns wants to turn these people into involuntary savers.

Here's how it works. First, you link your debit or credit card to the Acorns mobile app. Then you go about your usual spending routine: Buy a coffee, hail a cab, see a movie. With every purchase, Acorns rounds its cost up to the nearest dollar—then takes the difference and invests it into index funds. Over time, spare change adds up.

Acorns “practically removes” the need “to think about savings,” says Marina Dimova, an executive at Ideas42, a behavioral design firm.

Today Acorns touts 1.7 million users averaging savings of \$750 a year. In return the company charges \$1 per month for accounts under \$5,000 and 0.25% per year for accounts above that. Last year Acorns secured \$35 million in funding from investors. It also partnered with Airbnb and Blue Apron.

There are limits to the impact that Acorns (and rivals Digit and Qapital) can make. Someone with the median U.S. income of \$47,000 needs more than \$400,000 to safely retire at 65.

But the premise is sound. Kerner says Acorns “nudges” customers to boost their withdrawals. For Americans to successfully retire, and Acorns to survive, a nudge must eventually become a norm. —**RYAN DEROUSSEAU**

INDUSTRY STATS

\$3,000

The median **retirement account balance** for all working-age households in the U.S.

28%

Approximate percentage of 30- to 44-year-olds who have **no retirement savings** at all.

SOURCES: NATIONAL INSTITUTE ON RETIREMENT SECURITY; FEDERAL RESERVE

THE FUTURE OF ONLINE SECURITY

PROBLEM: Hackers are after your digital identity—and their tactics are more effective than ever.

SOLUTION: Simplify security.

HACKERS TALK A LOT of smack about their “leet”—that is, elite—skills, but no method of digital burglary is more tried and true than phishing. Tricking people into revealing a password is one of the easiest ways to access sensitive personal information. (Just ask former Clinton campaign chairman John Podesta.) In just over a year, email scammers fleeced \$3.1 billion from U.S. companies, according to the FBI. In a recent report, email security firm Agari found that phishing attacks were either on the rise or keeping pace at 89% of more than 200 surveyed firms.

YUBICO aims to eradicate the threat by fortifying passwords with a physical object—“one key for all the Internet,” says Stina Ehrensward, the company's Swedish-American CEO. Founded in 2007 and backed by Salesforce chief Marc Benioff, Yubico develops a set of hardware devices that add an extra layer of security to online accounts. >>



▷▷ Dubbed YubiKeys, these tokens look like small USB sticks, fit easily on a key chain, and cost \$40 (although simpler models sell for as little as \$18). Individuals can use them to lock down their own Facebook and Google accounts, while businesses are able to safeguard entire fleets of laptops. Corporate customers range from Novartis, the Swiss pharma giant, to CERN, the European nuclear research organization, to the U.S. Department of Defense.

Here's how YubiKeys work: When users try to log in to a secure email or social media account from an unfamiliar computer, a message asks them to insert the key into the computer and tap it. Since only the real account owner possesses the key, scammers working from afar can't get into the account—even if they have the password.

Security pros regard Yubico's crypto-processing as the best form of two-factor authentication available on the market. But there are limitations. Yubico's technology doesn't work with Apple mobile devices and only works in Chrome, Firefox, and Opera web browsers. Yubico also faces competition from companies including Nitrokey, Vasco, and Feitian.

Still, the embrace of two-factor tech is making life more difficult for scammers. Google, Facebook, Dropbox, and Salesforce, as well as parts of the U.K. and U.S. governments, have adopted the standard that Yubico helped pioneer. Expect to see more companies and countries roll out compatibility in the coming months. —ROBERT HACKETT AND JEFF JOHN ROBERTS

INDUSTRY STATS

Phishing

One of the most common forms of cybercrime.

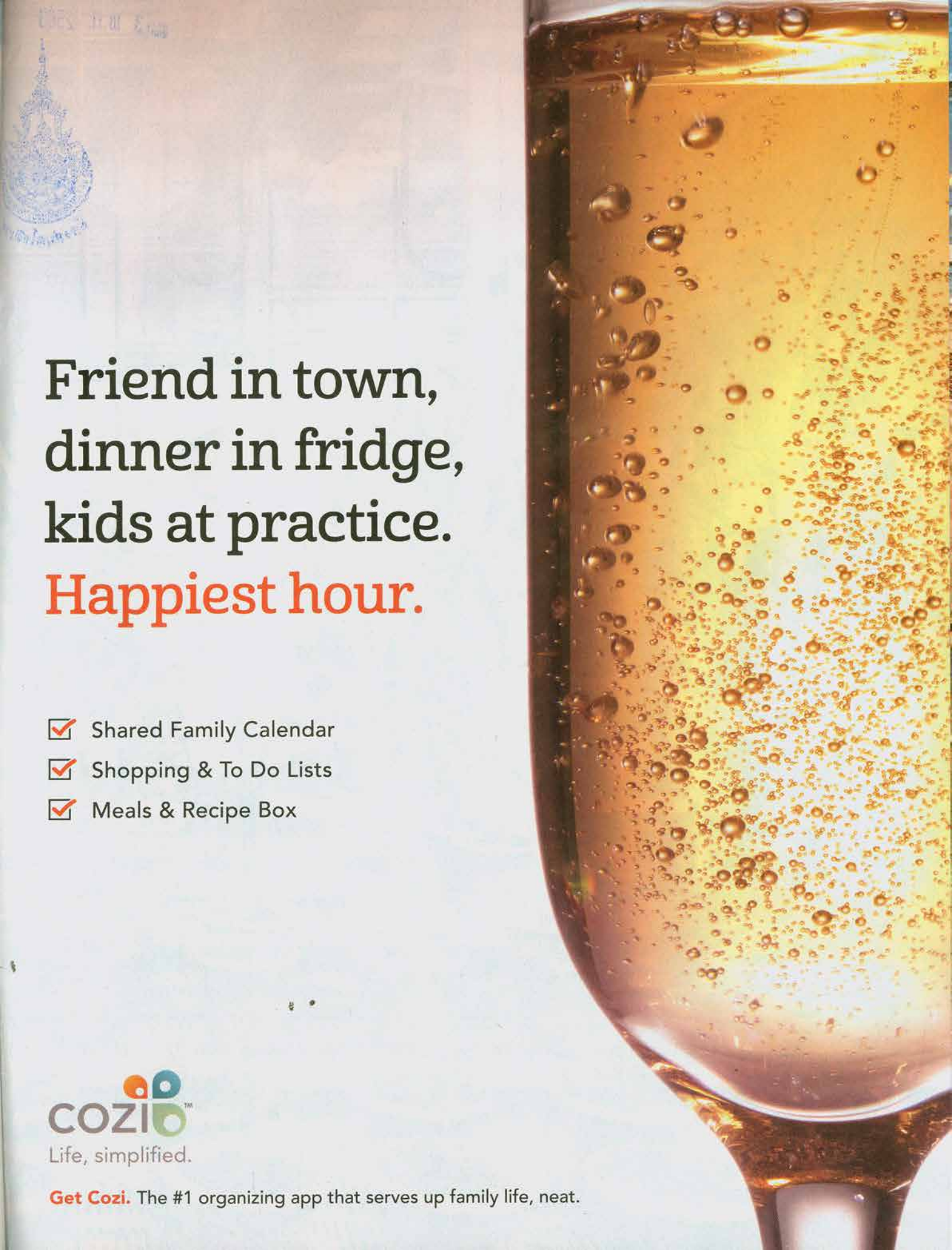
123456

The most common password in 2016.

32%

Increase in the number of hacked sites in 2016 compared with 2015.

SOURCES: INFOSEC INSTITUTE, KEEPER SECURITY, WEBMASTER CENTRAL BLOG



Friend in town,
dinner in fridge,
kids at practice.
Happiest hour.

- ☒ Shared Family Calendar
- ☒ Shopping & To Do Lists
- ☒ Meals & Recipe Box



Life, simplified.

Get Cozi. The #1 organizing app that serves up family life, neat.



■ THE FUTURE OF

AGRICULTURE

CHINA'S \$43 BILLION BID FOR FOOD SECURITY

○ Corn being grown in a greenhouse inside Syngenta's biotech research center in Beijing, the first such foreign-funded facility in China.

ChemChina's acquisition of ag-tech giant Syngenta is part of a broader strategy that could change food supplies and costs worldwide.

By Geoff Colvin

▲ PHOTOGRAPHS BY
STEFEN CHOW

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THE WORST FAMINE IN HUMAN HISTORY occurred in China from 1959 to 1961. An estimated 34 million people starved to death. The horrors were beyond imagining—the elderly and disabled left to perish because they couldn’t work; murder and cannibalism within families. Hundreds of millions of Chinese people today, including most of China’s top leaders, survived that famine.

The legacy of that searing experience—the most recent of China’s many famines throughout history—continues to influence the country’s strategic thinking. It’s a major factor behind China’s biggest-ever foreign corporate acquisition: ChemChina’s planned takeover, for \$43 billion in cash, of Syngenta, the Swiss-based world leader in advanced insecticides, herbicides, and other crop-protection products and the No. 3 producer of seeds.

Why should we care about a Chinese chemical company buying a Swiss agricultural business, however mammoth the deal might be? For starters, it’s part of a wave of global consolidation in agriculture that will put an increasingly large portion of the world’s commercial seed market—roughly 50%—under the control of a few giant multinationals. In addition to the ChemChina/Syngenta union, Dow Chemical is buying DuPont, and Germany’s Bayer is in the process of swallowing

up Monsanto, perhaps the most controversial producer of genetically modified seed species. This combined \$170 billion deal binge promises to have a profound impact on the future of global agriculture.

Beyond that, ChemChina’s purchase of Syngenta provides valuable insight about China’s broader view of its future. The deal signals important trends in the country’s policy on innovation, biotechnology, intellectual property, and globalization. “This acquisition is very probative of what’s happening in China,” says Robert Kuhn, a longtime China expert. “It really defines the frontier.” It’s also the latest step in a national strategy that could change food supplies and costs worldwide.

Approved by all relevant government authorities globally, the deal looks likely to close in May or June. It’s a massive transaction by Chinese standards, dwarfing the previous record, set by oil giant CNOOC’s acquisition of a Canadian energy company, Nexen, for \$15 billion in 2013. ChemChina CEO Ren Jianxin has made his company the most aggressive global acquirer among China’s state-owned enterprises, buying Italy’s Pirelli tire company and Germany’s Krauss-Maffei machinery manufacturer in 2015, for example. But the Syngenta acquisition is vastly larger, and it wouldn’t have happened without the Chinese government’s blessing. To understand how it advances many of the country’s interests and why it’s so important beyond China, one must begin at China’s unique relationship with food.

THE FOOD STRATEGY of the world’s most populous country is built on a “history of innumerable famines,” as a government planning document for China’s agricultural sector put it. President Xi Jinping acknowledged in 2013 that food security is “an eternal issue for us.” Emperors were stockpiling grain against the threat of famine more than 2,000 years ago, and the country’s leaders have been doing the same ever since.

China today maintains massive stockpiles of corn, rice, and wheat—the world’s largest reserves, the government claims, though it doesn’t release

figures. The UN has recommended 17% of annual grain consumption as a reasonable global safety reserve. The U.S., which produces so much food that it's the world's top food exporter, holds no government stockpiles at all. Consultants believe China keeps reserves equaling a huge 45% to 60% of annual consumption, just in case.

That policy no longer makes sense. "It's a myopic view going back millennia," says Fred Gale, an economist and China specialist at the U.S. Department of Agriculture. "The Chinese diet is changing so much. Few people eat just rice and noodles every day." Policy-makers are beginning to face that new reality. Food security is still an obsession, but its nature is changing. For the first time, the country overall is decently fed. "If the issue is that no one goes hungry, there really isn't an issue," says a China-based consultant who requested anonymity because he's critical of government policy. "The real issue is the move to more protein."

Like people everywhere, the Chinese want more protein as their incomes rise above subsistence levels. Their protein of choice is pork; they consume half of all the world's pork, a proportion that's rising along with incomes. Feeding people meat requires three to four times as much grain in the form of livestock feed as does feeding people grain directly.

Thus China's new reality: Food security no longer means just having enough food. It also means being able to feed people the higher-protein food they increasingly demand. The danger is no longer that millions will starve, but rather that millions may rise up in anger if they can't get, or can't afford, the diet to which they're growing accustomed. China must somehow meet the demands of this new normal by feeding 19% of the world's people—and feeding them better every day—with just 7% of the world's arable land.

That's where Syngenta comes in. The acquisition is part of a recently unveiled, two-pronged strategy for Chinese food security that's far more sophisticated than just filling bigger granaries. "The reason for this deal was food security for China," says Syngenta CEO Erik Fyrwald, an American who



O Syngenta CEO Erik Fyrwald (top) and ChemChina CEO Ren Jianxin (bottom) discussed Syngenta's earnings in February.

ran DuPont's seed and agrochemicals business from 2003 to 2008. That security is to be achieved in two ways. One is obvious: "To improve technology and farm practices in China, where farm productivity is low," says Fyrwald. The second is unexpected: "To make sure we're developing leading-edge technology for agriculture around the world. Even if there's a big drought or a big flood in

China, they want to make sure there's enough food available around the world to import."

That is, China is remapping the path to food security for the first time in its long history. The government would love to produce all the food it needs within its borders, but it's acknowledging that it can't. So while it tries to increase domestic production dramatically, it also aims to ensure that the rest of the world always has plenty of food and that

China can get what it needs, either by buying it or by controlling foreign sources directly through ownership or other deals.

NONE OF THIS WILL BE EASY, and the challenges begin at home with the first prong of the strategy: higher domestic production. China's poor crop yields must be increased not just to meet rising demand, but also so that Chinese farmers, the nation's poorest people, can make more money. So far China has raised yields mainly by using commodity agricultural chemicals and fertilizers—far too many of them. They've polluted the soil and water even worse than industrial activity. The most effective way to raise yields now is to use genetically modified seeds. And the Chinese public, traumatized by 30 years of deadly food-safety scandals, is extremely wary of GMOs.

Never mind that 123 Nobel Prize winners have signed a letter endorsing the safety of GMO foods. The Chinese tend to suspect evil behind any food development billed as innovation, and they don't trust the government to keep their food safe. Many in China believe GMOs are a Western plot to harm them. That theory fits well with China's lack of domestically developed GMO seeds, though the country actually spent years in the 1990s trying to develop them.

Since then the government has banned virtually all GMO seeds in

China because of public fear. "China has major agricultural issues that GMO seeds could address—drought, insects. These are big concerns in China," says the USDA's Gale. "But resistance among consumers has grown over the past 10 years. Those two interests are really clashing at this point. The authorities have never approved [foreign-developed] GMO rice and corn, after 10 years of study."

Chinese leaders know that has to change. China must "boldly research and innovate, [and] dominate the high points of GMO techniques," President Xi said in a 2013 speech. "[We] cannot let foreign companies dominate the GMO market." The best and perhaps only way to meet that challenge was to buy a foreign company—Syngenta.

The GMO promise of dramatically higher crop yields was unavailable to China so long as the country didn't have a player in the game. If it grew Western GMO crops, the country would become reliant on foreign sources of necessary seeds—the opposite of food security. But now that a state-owned enterprise will own a leading seed company, the country's incentives reverse. Wide adoption of GMO seeds becomes a big commercial win for ChemChina and a policy win for the government.

The deal helps meet other national priorities too. Long an imitator, China wants to become the world's top innovator, especially in technology and even more especially in biotech. Syngenta established a Beijing research center in 2008 and is doing biotech science there now; it will be doing much more after the deal closes. As China moves gradually toward public acceptance of GMOs, Syngenta may help smooth the transition by developing, in China, non-GMO seeds that are nonetheless more productive. For example, it's making crops more fungus- and drought-resistant through new techniques of traditional hybridizing. It's also working in Beijing on new technology in genome editing; unlike GMO technology, it doesn't involve inserting a gene from another species, such as a bacterium, into a plant. "To make a corn plant more drought tolerant, you can modify

China's Biggest Non-Chinese Investments

When it closes, ChemChina's purchase of Syngenta will easily count as the largest overseas acquisition by a Chinese company. Here are the top five foreign investments by China, with debt excluded.



SOURCE: DEALOGIC

○
A researcher
at work inside
Syngenta's R&D
center in Beijing.
China wants to
become an innova-
tion leader, espe-
cially in biotech.
Buying Syngenta
can help it achieve
that goal.



genes in the plant without having to put a different gene in," Fyrwald explains. "That's very exciting science." All of that, plus leading-edge GMO research, is what policymakers want more of in China.

Another of Syngenta's attractions is its global reach. The company does significant business in North America, Latin America, and EMEA (Europe, the Middle East, and Africa), with slightly less presence in Asia, where ChemChina can help. ChemChina's own presence in global agriculture is wide but paper-thin; it mostly sells low-profit commodity agrochemicals. Syngenta's more advanced products make it more important wherever it operates. "Syngenta is a truly worldwide company, and China has a strategic objective of engaging with the world," says Kuhn. "There's a sense that China must take leadership in globalization. It's more dependent on globalization than any other major country."

That's especially true when it comes to food security. Having accepted that it can't satisfy its prospering population alone, China must find

a way to feel secure while importing growing quantities of food—the second prong of its strategy. Most countries that must import food, such as Japan, count on a deep, competitive world market to supply their needs. But that's not secure enough for China.

Thus China's new strategy for food security includes controlling its global supply chain from beginning to end, and the chain begins with seeds. A later link, also supplied by Syngenta, is advanced crop protection products to help plants produce more food with minimum damage to the environment. Separately, China is also buying trading companies and combining some of its own to counter big Western firms.

SNAGGING SYNGENTA is crucially important for China in one other way: The country had to secure a major Western partner as the global chemical and seed industry suddenly consolidated over the past 18 months. When Dow and DuPont announced their merger in 2015, Monsanto was trying to buy Syngenta, which wanted a higher price than Monsanto was

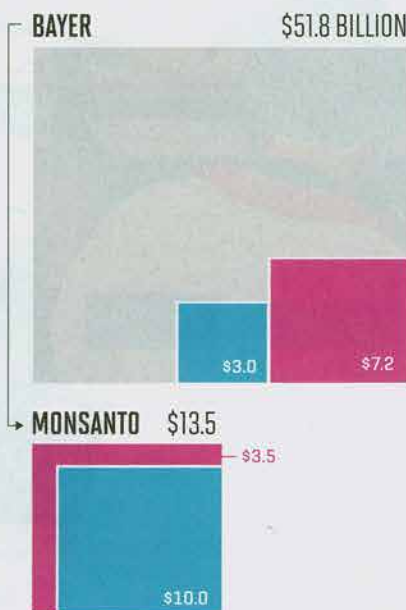
A Buying Binge Reshapes Big Ag

This trio of mega-mergers, totaling some \$170 billion in value, will put an increasingly large portion of the global commercial seed and agrochemical market under the control of a few multinational chemical companies.

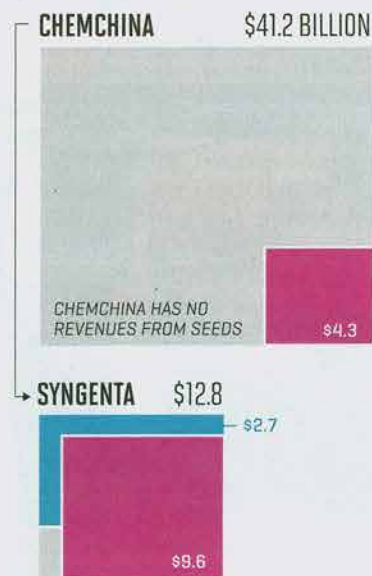
\$60 BILLION MERGER



\$66 BILLION MERGER



\$43 BILLION MERGER



SOURCES: COMPANY FILINGS, BLOOMBERG, ANALYST ESTIMATES

REVENUES BREAKDOWN: SEED REVENUES AGROCHEMICAL REVENUES OTHER

offering. That's when ChemChina stepped in and paid what Syngenta wanted. Soon thereafter, Bayer announced it was buying Monsanto. When those deals close, the result will be three global giants in seeds and agrochemicals: one American, one European, and one Chinese.

The ChemChina/Syngenta deal raises important questions. How will its newly merged competitors be treated in China, the world's largest food market? "That's the elephant in the room: Is China interested in reform only, or interested in reform and opening up?" wonders a U.S. business luminary and China expert. "Once China owns Syngenta, there will be an opportunity to open to other companies with competing products. Will the authorities block imports or recognize that competition is good?"

The answer seems to be that China likes competition up to a point. "The Chinese government is fully open in providing access to foreign players, including Syngenta, Dow, Bayer, DuPont, and Monsanto," says ChemChina's Ren in a phone interview from his Beijing office. "But in spite of this fact, I believe that with ChemChina as a domestic player in a unique and good position, Syngenta enjoys a special position." He notes that besides access to its owner, the government, ChemChina can offer Syngenta 100 production facilities, relationships with hundreds of thousands of farmers, and a financing operation to help farmers buy Syngenta products.

The CEO of a major competitor is resigned to the new industry order in China. "There's no such thing as free markets," he says. "We'll be very watchful of bias to the local. But I'm a realist. We don't have fair market access to some things."

Another big question: Will China's growing appetite imperil food security for the rest of the world? Agricultural economists have worried for years that Chinese demand could overwhelm world food markets, and the country's food imports have increased sharply since 2008. Yet global prices haven't spiked. On the contrary, they've declined. If the Syngenta deal raises



○ **A corn plant growing in Syngenta's research center in Beijing. Chinese officials have yet to approve foreign GMO corn for use in China's fields.**

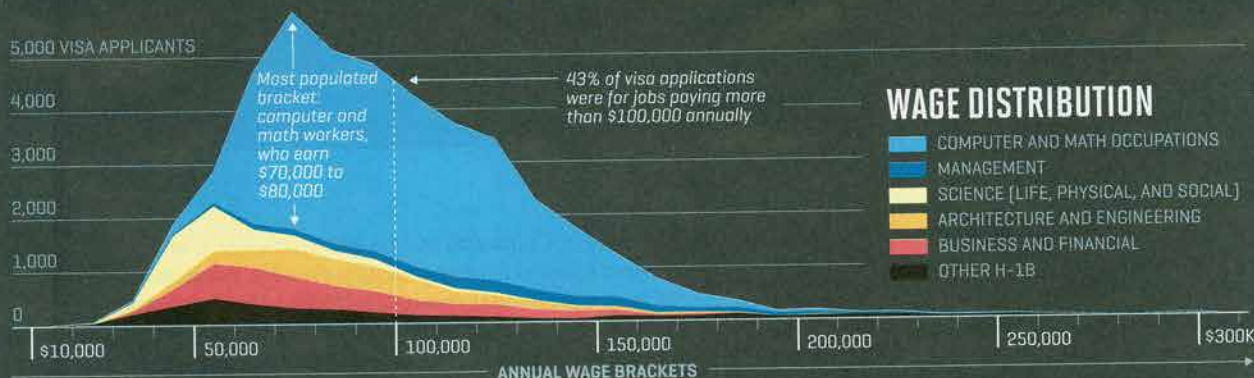
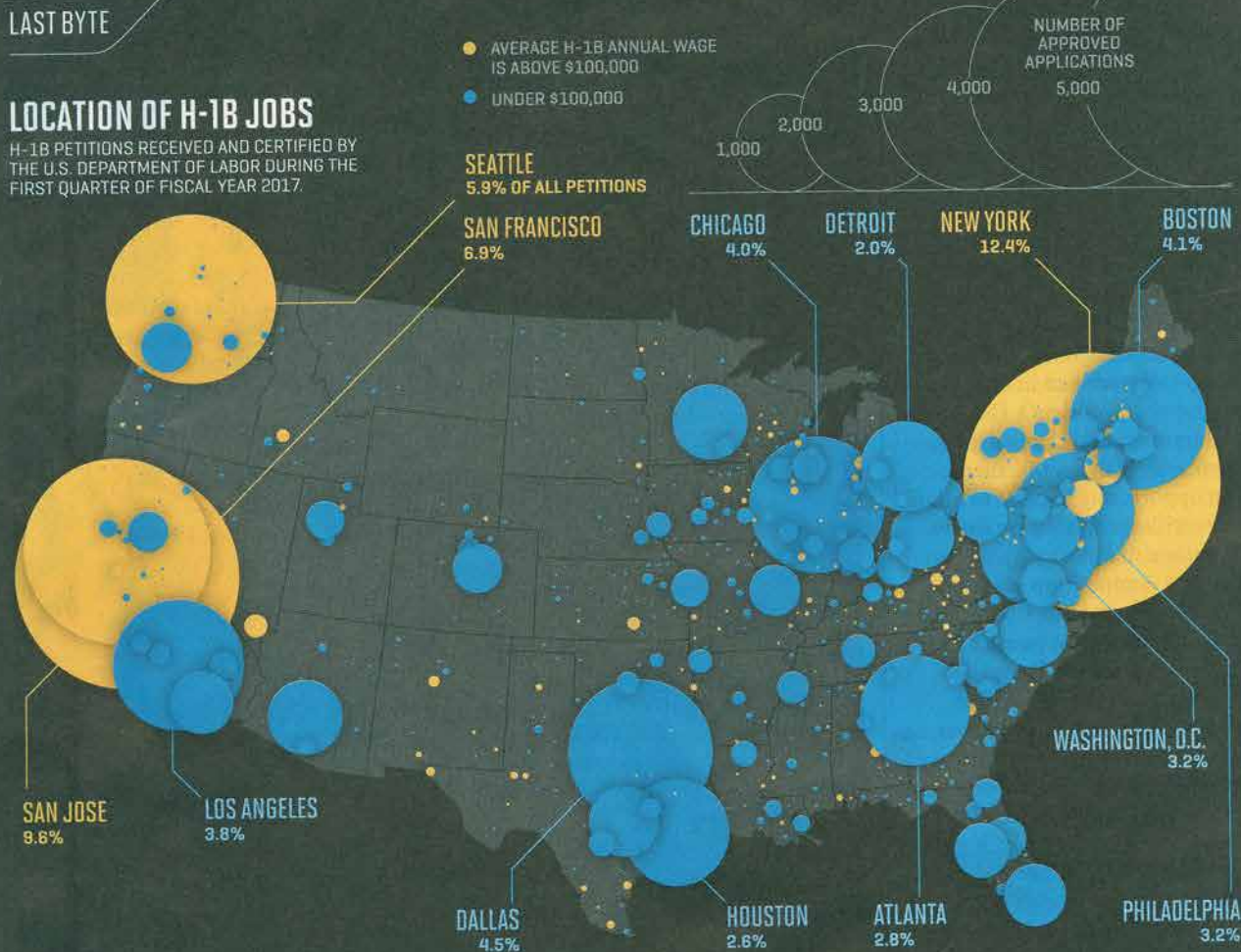
yields in China and maybe elsewhere too, it will ease upward pricing pressure globally. Farmers may not like that result, but it will reduce chances of food-based crises or geopolitical conflicts.

At least it will for a while. One more big question about the Syngenta deal is: What comes next? China will almost certainly increase domestic food production, but the more that its

swelling middle class demands meat, the more grain and soybeans it will need. And even with higher yields, the country can't produce enough on its own. The eternal challenge of fending off starvation has been met. After thousands of years, China has likely suffered its last famine. How well it can meet its next challenge, feeding its people a rich-country diet, is a big question the Syngenta deal addresses but doesn't answer. ■

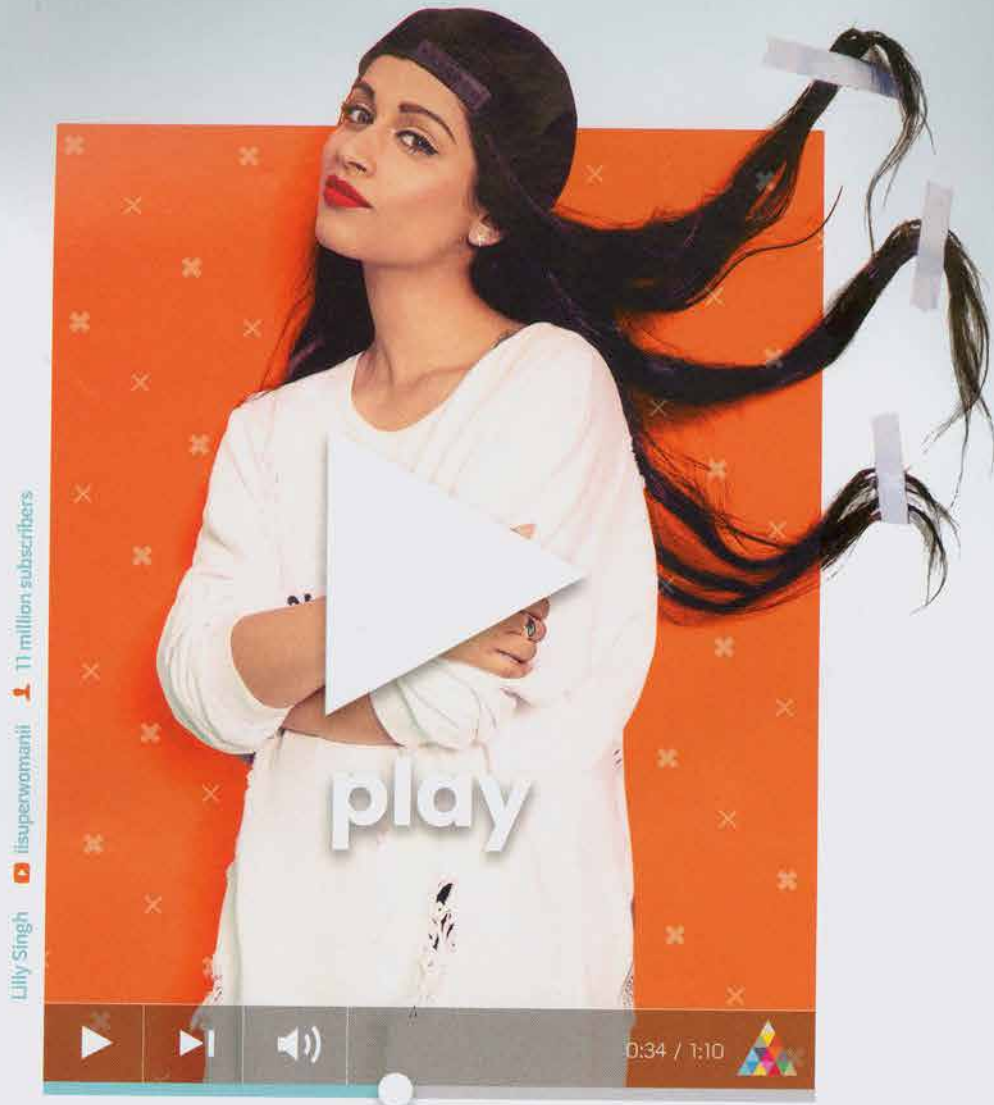
LOCATION OF H-1B JOBS

H-1B PETITIONS RECEIVED AND CERTIFIED BY THE U.S. DEPARTMENT OF LABOR DURING THE FIRST QUARTER OF FISCAL YEAR 2017.



PICTURING AN H-1B OVERHAUL

FEW DEBATES in the world of tech are more heated right now than H-1B visa reform. Fans of the program, which grants 65,000 U.S. visas annually to foreign workers and another 20,000 to candidates with master's degrees, say it brings in needed talent. Critics argue that companies abuse it to replace U.S. employees with cheaper foreign workers. In April, President Trump signed an executive order calling for a review of the system. One proposal, in a bill introduced by Rep. Darrell Issa (R-Calif.), would raise the minimum salary for H-1B workers to \$100,000. To assess the potential impact, here's a snapshot of the 46,081 applications processed in the most recent quarter. —BRIAN O'KEEFE



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GENEVE

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