

Bloomberg Businessweek

September 11, 2017



AI BABIES ARE COMING

The
Sooner
Than
You Think
Issue

p42



Moments of Unlock

Do We Still Need Financial Advisors?

Using a financial advisor runs counter to our do-it-yourself culture. But a 2016 study by Wells Fargo¹ found that the average performance of portfolios managed by financial advisors exceeded that of investor-managed portfolios, even after fees were taken into account. **Zar Toolan**, head of Advice Quality at Wells Fargo Advisors, recounts how one particular investor arrived at that “moment of Unlock” that changed how he saw his wealth and investment options.

“ **How did one of your financial advisors help a client retire earlier than he otherwise would have?** One of our clients was in his late 50s in 2008

when the Great Recession hit. His portfolio – and just about everybody else’s – lost double digits. He talked with his financial advisor, and even though his advisor recommended against it, he pulled a lot of money out of stocks and put it into cash.

His advisor reviewed the client’s Envison® plan – our proprietary planning process – and showed him that if he kept his portfolio in cash he wouldn’t likely be able

to retire until he was 68, far later than he had planned. The client had an unlock moment, and realized he had to get back into the stock market. They were able to adjust his retirement plan, slowly moving the cash back into stocks. By working closely with the client and being aware of his plans and goals, the advisor helped him overcome his emotional reaction to volatile markets.

Do you think that making such emotional investment decisions is common among investors? Study after study has been done over the last couple of decades that demonstrate this tendency. Investor psyche is a big driver of how people invest. For example, a 2016 Dalbar study² shows that investors tend to get in late to a bull market and they tend to sell when the markets go down, so they tend to chase performance.

The benefit of a financial advisor is that he or she can hold you accountable to the goals and dreams and aspirations you have. Sometimes it is about hand-holding you through difficult markets, so you’re not making the wrong decisions, emotional decisions, at the wrong time.

You have an MBA and a decade of experience in financial services. And yet you yourself have a financial advisor. Why does someone like you need someone else’s help with investment planning? Life is complex. I look at my financial advisor not as just an investment professional, but really as a life coach. Their job is to boil that complexity down into a plan and a score, and keep me on track toward meeting my goals. And when I’m tempted to make an emotional decision about my money, they hold me accountable, providing guidance rooted in experience and facts. **”**



1. Wells Fargo Investment Performance Deep Dive, May 2016
2. 2016 Quantitative Analysis on Investment Behavior, DALBAR, Inc., 2017

Past performance is no guarantee of future results.

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Bringing non-traditional investments into the mix can help energize your portfolio.

We call a realization like this an Unlock.

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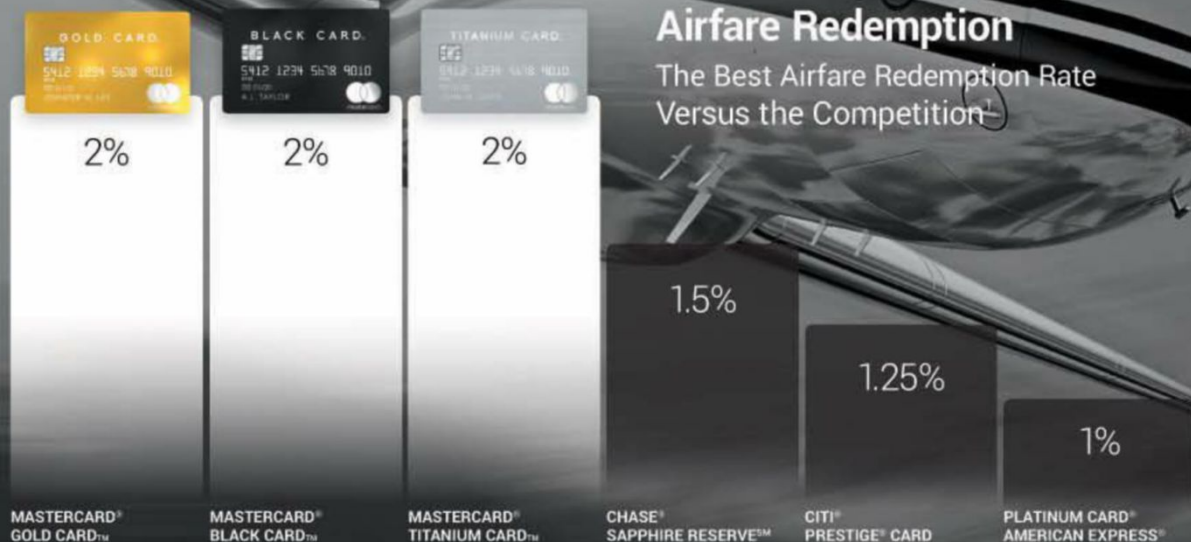
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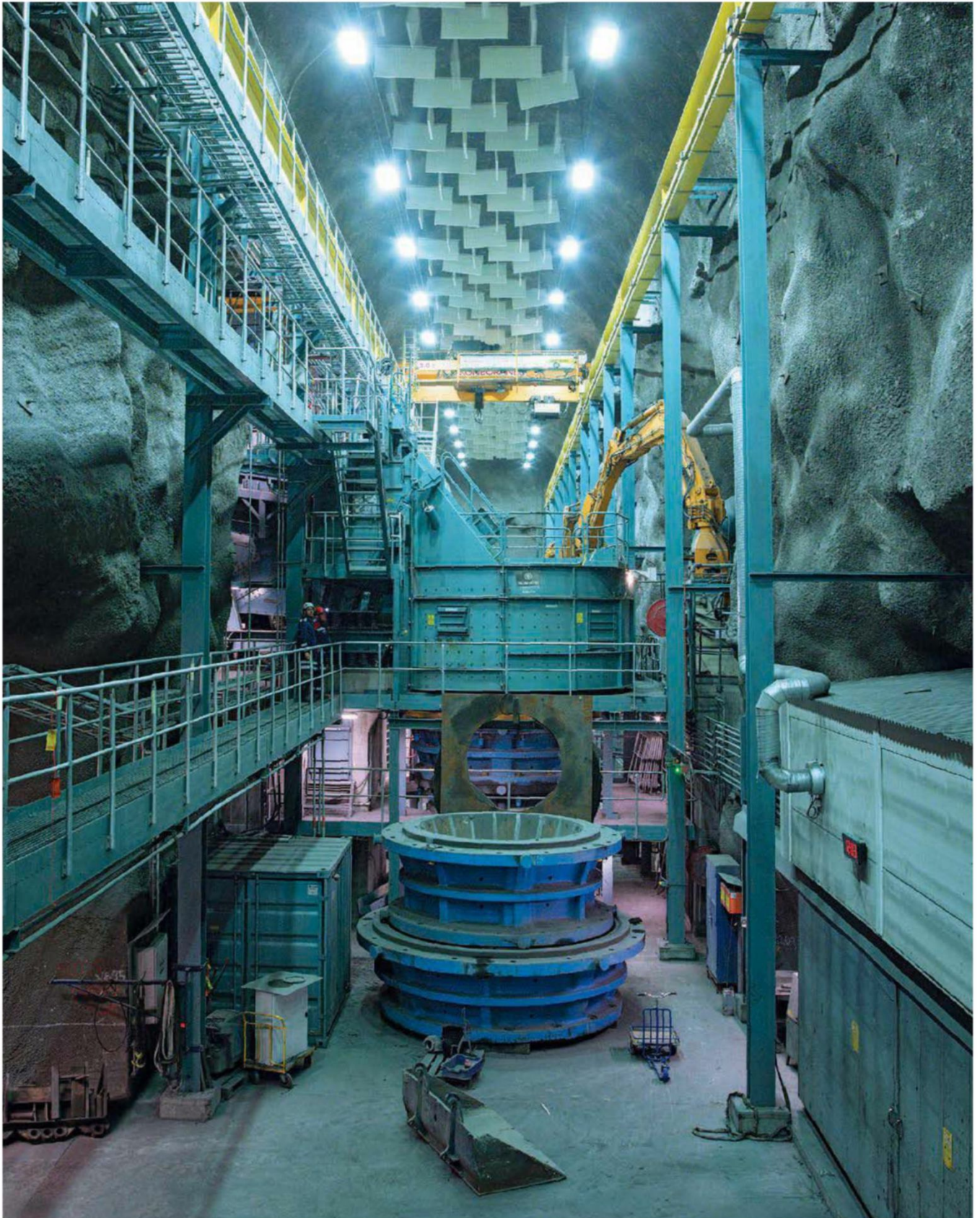
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68 ▲ In Sweden, a mine worth moving a town for

■ IN BRIEF

10 ● China's cryptocurrency crackdown ● Size 0 models get kicked off the catwalk ● Hollywood's summertime blues

■ REMARKS

12 **The calculus behind North Korea's nuclear machinations is simple: Survival**

■ VIEW

14 Don't ask private companies to put limits on public debate

1

BUSINESS

17 AbbVie has built a fortress of patents to defend its best-selling drug

19 L'Oréal, long known for its female-friendly workplace, is looking for a few good men

21 Why plastics could be pricier post-Harvey

2

TECHNOLOGY

22 Waymo has an edge on Uber in court, but it may be losing its lead over self-driving rivals

23 More than 1 million people worldwide have found work putting the I in AI

24 Buzz-building influencers hold no sway at Snapchat

3

FINANCE

26 Diamonds are a disaster for U.K. bank Standard Chartered

28 Private equity investors are searching for the exits at British malls

29 A snapshot of United Technologies' \$23 billion deal for Rockwell Collins

4

ECONOMICS

30 Small towns are a big problem for oil and mining companies in Colombia

31 An immigration crackdown is adding to a worker shortage in Texas—just as Houston begins to rebuild

34 More med school grads are turning away from medicine

5

POLITICS

36 Trump's decision to rescind DACA will stoke the GOP's long civil war over immigration

38 A rising tide of anti-EU sentiment may shape Czech elections this fall

39 How much is 666 Fifth Ave. costing the Kushner Cos.?

42 **"We're also exploring the idea of creating a digital celebrity"**



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The Sooner Than You Think Issue

Soul Machines puts
a human face on AI p42

The Silicon Valley index p48

China's livestreaming
boom vs. Beijing's
censors p50

**Who will be the first
\$100 billionaire?** p53

Voyage to the
Earth's final frontier
in a minibus p54

We are the 10% p59

**The unstoppable
federal budget** p59

East tops West p60

**The return of supersonic
air travel** p60

We'll need a lot of
lithium for all those
Teslas and phones p60

High-efficiency
vertical farming,
everywhere p62

**A 6,000-yard
season** p67

An entire town
is on the move
in Sweden p68

**The clean energy
revolution is here** p73

**A navigable
Northwest Passage** p73

The ultimate
keyboard shortcut p74

Building a
business out of
sucking CO₂ from
the atmosphere p76

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Asia

● Cambodia charged the leader of its main opposition party with treason. Kem Sokha faces as many as 30 years in jail as the ruling party tightens its grip before parliamentary elections next year.



● Digital assets such as bitcoin swooned as China banned fundraising through new cryptocurrencies.

The policy is meant to clamp down on initial coin offerings, which have raised \$2.3 billion so far this year.

● Facebook bid \$610 million for the digital rights to the Indian Premier League cricket tournament—and still came up short. Star India, a unit of 21st Century Fox, won by pledging

\$2.6b

for both broadcast and digital rights.

Americas



● Attorney General Jeff Sessions announced an end to DACA, the five-year-old program that gives children brought to the country illegally the right to work and study without the threat of deportation.

● Over the objections of many prominent Republicans, President Trump reached an agreement with congressional leaders to pass a Hurricane Harvey relief bill alongside legislation to raise the debt ceiling and a continuing resolution that will fund the government through mid-December.

● “They’ll eat grass, but they won’t abandon their program unless they feel secure.”



Russian President Vladimir Putin rejected U.S. calls for new sanctions against North Korea on Sept. 5, two days after Pyongyang carried out its most powerful nuclear test to date.

● An international consortium of journalists accused Azerbaijan of using a

\$3b

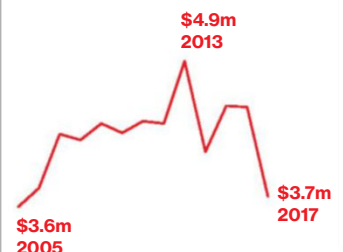
slush fund to bribe European politicians and buy luxury goods. President Ilham Aliyev’s office issued a statement calling the accusations “totally groundless.”

● BRICS countries criticized Pakistan for harboring terror groups in a 43-page declaration. Pakistan quickly rejected the portrayal.



Thousands of Rohingya people fled Myanmar as the country’s military attacked the small Muslim community. About 125,000 refugees have crossed the border into Bangladesh since fighting began in late August.

● *Wonder Woman* could do only so much for Hollywood, which posted its worst U.S. summer box-office haul since 2005. Domestic theaters collected \$3.7 billion over the season, which ended on Labor Day, down 18 percent from the previous year.





Hurricane Irma, one of the most powerful Atlantic storms on record, wreaked havoc on the Caribbean and threatened southern Florida. Insurance stocks plunged and orange juice futures spiked as investors prepared for devastation.

● Federal Reserve Vice Chairman Stanley Fischer resigned, effective Oct. 13, citing “personal reasons.” His departure will leave four of seven seats on the Fed board vacant.

● Brazilian police carried out search and arrest orders on Rio politicians suspected of paying bribes in the country’s successful bid to host the 2016 Olympic Games.

Officers searched the headquarters of Brazil’s Olympic organizing committee, while a lawyer for Carlos Nuzman, the committee’s president, said his client was innocent.

Europe

● LVMH and Kering banned size 0 models from their shows, part of a movement within the fashion industry to promote positive physical standards.

● Lilium, a German maker of flying cars, landed

\$90m

in financing, led by China internet giant Tencent Holdings. The two-year-old startup completed a successful flight of its vertical-takeoff electric jet last year.



● Lego said it would lay off 8 percent of its workforce, about 1,400 employees, after sales fell

5%

in the first half of the year. It’s the company’s first revenue drop in 13 years.

● The European Union’s highest court ordered a lower court to revisit a \$1.3 billion antitrust fine against Intel.



The penalty, levied in 2009, was the largest of its kind at the time.

Africa

● After Kenya’s Supreme Court invalidated the results of the country’s Aug. 8 presidential election, opposition leader Raila Odinga threatened to boycott the rerun slated for Oct. 17. He wants greater transparency from the election commission, whose electronic systems were compromised in the vote.



● Nigeria and South Africa posted modest growth in the quarter ended June 30, as both economies struggle to recover from recession. Nigeria was buoyed by increased oil production, while South Africa surged on a record maize crop.

A close-up photograph of two men, likely Kim Jong-il and Kim Jong-un, with the title text overlaid. The man on the left is wearing glasses and has a serious expression. The man on the right is also serious. The background is dark and out of focus.

How the Kims Came to Love The Bomb

● For Pyongyang, the nukes aren't bargaining chips. They're an insurance policy against regime change

● By Michael J. Schuman

North Korea looks pretty scary at the moment, firing off missile after missile, threatening to target Guam, and, on Sept. 3, testing what the regime claims was its first hydrogen bomb. And the country's dictator, Kim Jong Un—so ruthless he may have had members of his own family murdered—might be just crazy enough to push the button to initiate a catastrophic war.

Or maybe not. Look deeper, and you'll find a North Korea that isn't as much of an immediate danger to the U.S. as the headlines and rhetoric suggest. That's because Pyongyang isn't very likely to use its nukes and missiles against the U.S.—or anyone else.

Don't get me wrong: North Korea still presents a huge security risk to East Asia and the world. Kim's neighbors include three of the world's 11 largest economies and two of America's closest allies, Japan and South Korea. No U.S. president would want to see Pyongyang lob a missile into Tokyo or Seoul, let alone Hawaii.

But climb into the mind of Kim—as terrifying as that may sound—and we can conclude that his aim isn't to destroy Los Angeles but to save his own skin. This is a regime that was never expected to still be around in 2017. When the Berlin Wall came down and the Soviet Union unraveled more than a quarter century ago, North Korea was supposed to vanish with them. The regime has since outlasted economic and political isolation, stiff international sanctions, and famines so severe that they may have claimed hundreds of thousands of lives. But through it all, the Pyongyang government has persisted. That speaks to the cunning of the Kim family, which has lorded over the country since its founding by the current Kim's granddaddy in 1948. They're survivors.

And that's what Kim is striving to do today: survive. He's not out to conquer the world or even expand his influence in his own neighborhood. Kim and the Pyongyang elite must recognize that the odds are against them and their backs are to the wall. We can assume they're at least somewhat aware that the forces opposed to the regime—led by the U.S., the world's superpower—are too overwhelming to fight off on their own. North Korea doesn't possess the military and economic resources to wage a sustained conventional war.

It's true that the economy has been showing signs of life. Seoul's central bank recently figured that North Korea's gross domestic product grew 3.9 percent in 2016, the fastest pace in 17 years. (North Korea doesn't release its own economic statistics.) The country, however, remains quite poor. Per capita national income, at around \$1,300, isn't even 5 percent of South Korea's.

That poverty has taken its toll on North Korea's military. Although the armed forces boast more than 1 million people, ranking as the world's fourth-largest, their conventional weaponry is aging and technologically far behind those of South

Korea and the U.S. A 2015 assessment by the U.S. Department of Defense said North Korea's equipment to a great degree is based on Soviet and Chinese designs dating to the 1970s and earlier and its air force has planes of 1940s vintage. The government's efforts to modernize, the report noted, have been limited.

If a war does break out, Pyongyang could inflict a lot of damage and kill a lot of people, especially in South Korea. Research firm Capital Economics in an August report figured that the Korean War of the 1950s erased 80 percent of South Korea's national output, and even if a 21st century sequel were to prove less catastrophic, wiping out, say, 50 percent, that alone would still shave 1 percent off global GDP. But North Korea's chances of fending off a concerted military effort by the U.S. and South Korea are probably quite low.

Nor can Kim count on his main source of support, China, to save the day. Beijing did just that in the 1950s Korean War, when U.S. forces had North Korea all but wiped from the map. In 2017 the Chinese government may not be so willing. An August editorial in the *Global Times*, a Communist Party newspaper, said that Beijing should stay neutral if Pyongyang were to instigate a conflict with the U.S. That's not necessarily an official declaration of policy, but it could indicate limits to China's appetite to defend its longtime ally.

Kim certainly isn't endearing himself to the Chinese government. His antics are raising tensions between Beijing and Washington, which has upped the pressure on China to control its saber-rattling partner by sanctioning Chinese businesses that allegedly help Pyongyang and has warned more may come. And Kim has displayed a surprising willingness to snub his supposed best friends. The latest nuclear test came on the same day Chinese President Xi Jinping was hosting world leaders at the BRICS Summit in the city of Xiamen and just as Xi is preparing for the all-important National Congress of the Communist Party of China next month, during which he's expected to further consolidate his grip on the country.

Here's where the nukes come into play. Pyongyang believes they're the best, and possibly only, deterrent against evaporation, absorption, or annihilation. That's why the regime has never been truly willing to trade its nuclear program for other benefits—something Washington has tried to do since the 1990s. The nukes aren't a bargaining chip. They're an insurance policy.

Yet the very same weakness that drives Kim's mania for nuclear weapons is why he can never use them, at least not as an aggressor. As President Trump has already warned, any such attack would be met by “fire and fury.” That comment was irresponsible, but the point is true nevertheless. Kim likely isn't delusional enough to think his country could survive an all-out war with the U.S. and its allies. Proactively launching a nuclear-topped ballistic missile against the U.S. would mean his own destruction. That's why it won't happen. The U.S. Defense Department in its 2015 report said that even though the country remains a continuing threat, “North Korea is unlikely to attack on a scale that would risk regime survival.”

If we see Pyongyang's motivations in this light, the policy course the Trump administration is taking is all wrong. Threats of fire and fury will only make Kim more paranoid and more certain that he needs nukes to defend himself or deter an aggressive Washington—paradoxically, persuading Pyongyang ▶

◀ to press ahead even more quickly with its nuclear and missile development. Note that the more bombastic Trump has become and the closer he seems to inch toward the use of force, the more belligerent Kim has become, to the point of testing what could have been a hydrogen bomb.

That unfortunately leaves Washington with few options. Any hint that U.S. policy is heading toward some sort of regime change won't go down well with a Pyongyang desperate to survive. Kim & Co. are equally afraid of being swamped in more peaceful ways. Unification with an economically vibrant South Korea will almost certainly lead to the marginalization of Pyongyang's elite and an end to their influence.

At this stage, with Kim already in possession of nukes and maybe the ability to deliver them, the only viable option for Washington is to accept this reality and deal with Pyongyang as it does with any of the world's other nuclear powers. This may sound terribly distasteful, and the course presents its own

risks—mainly, that North Korea's neighbors, especially Japan and South Korea, will feel the need for nuclear weapons of their own, leading to a regionwide, potentially destabilizing arms race. Washington would also have to work hard to ensure Pyongyang doesn't spread its know-how to other rogue states or terrorist organizations that might be less wary of using it—such as Islamic State.

But the U.S. has successfully dealt with the appearance of other nuclear powers, whether China, India, or Pakistan, and it may have to do so again, this time by containing the North Korean threat instead of attempting to eliminate it. Negotiating a settlement with Pyongyang as a nuclear power may actually bring a sort of stability to the peninsula that the U.S. has been seeking for more than 60 years. Maybe then, a less isolated and fearful North Korea will be more open to giving up its nuclear weapons. The time it takes may not be ideal. But it's a lot better than fire and fury. **B**

VIEW

To read Meghan L. O'Sullivan on Trump's North Korea dealmaking and Leonid Bershidsky on Elon Musk and the Russian AI threat, go to Bloombergview.com

Don't Kick Neo-Nazis Off the Internet

14

● Getting corporations to decide what's appropriate risks setting a dangerous precedent for all Americans

Neo-Nazis are having a hard time doing business these days. After a white-supremacist rally in Virginia ended in violence in August, a pressure campaign has induced a lengthening list of companies to shut down accounts used by the participants and their fellow travelers. From dating apps to ride-sharing services, seemingly every right-thinking company is joining the crackdown.

That may appear to be a triumph for decency. In fact, it risks setting a dangerous precedent.

Consider a vile neo-Nazi website called the Daily Stormer. After the rally, both Google and GoDaddy stopped hosting the site's domain registration, and Cloudflare stopped protecting it from cyberattacks. Such services are the nuts and bolts of online life. And in refusing to deal with the Daily Stormer, they effectively kicked it off the internet.

Good for the internet, you might say. But it's not so simple. Cloudflare, for one, had second thoughts. "It doesn't sit right to have a private company, invisible but ubiquitous, making editorial decisions about what can and cannot be online," wrote Matthew Prince, the company's co-founder.

He's right. Such companies are perfectly entitled to drop odious customers. But expecting them to arbitrate public discourse is fraught with risks. Domain registrars are generally neutral about the content of their users' sites and rightly so: As crucial conduits, they have outsized power over who can express themselves online. "The pre-internet analogy would be if Ma Bell listened in on phone calls and could terminate your line if it didn't like what you were talking about," as Prince put it.


Practical problems also abound. Exactly what content should the companies accept and what should they ban?

Neo-Nazis may seem like an easy call. But with tens of millions of users expressing all manner of views, these companies don't have the capacity—much less the desire—to parse their customers' politics and distinguish what's appropriate and what's offensive.

More to the point, no one should want them to. Neo-Nazis, however repulsive, have the same speech rights as every other American. In demanding that back-end web companies kick them off the internet for legally protected expression, activists are effectively asking them to limit public debate—according to whatever corporate principles the companies might dream up. Do you trust GoDaddy Inc. with that responsibility?

Remember, too, that the pressure won't end with neo-Nazis. Some right-wing groups are already asking whether companies plan to ban Black Lives Matter activists. In polarized times, such calls—however ludicrous—are likely to expand and intensify. As economist Milton Friedman once put it, expecting companies to take a stand on such issues would "extend the scope of the political mechanism to every human activity."

Neo-Nazis should face protest, and their hideous beliefs should be denounced. When they harm others, they must be held to account. But corporations—or more precisely their lawyers—are the wrong mediators for such debates. **B**



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LOOK AHEAD

● Caterpillar holds its investor day on Sept. 12

● Altaba, holder of Yahoo!'s remaining assets, reports second-quarter earnings

● Big drugmakers make presentations on new medicine at the European Society for Medical Oncology Congress in Madrid on Sept. 8-11

Guarding Big Pharma's Crown Jewel

To keep rivals from rolling out generics for its biggest moneymaker, drugmaker AbbVie is using patents—lots and lots of patents

Humira, a treatment for inflammatory diseases such as rheumatoid arthritis and psoriasis made by AbbVie Inc., is the planet's best-selling drug. It's also been around almost 15 years. Those two facts alone would normally have rival drugmakers eagerly circling, ready to roll out generic versions that could win a piece of the aging medicine's \$16 billion in annual sales. Yet last year, when the patent on Humira's main ingredient expired, not a single competitor launched a copycat version. Figuring out how to manufacture it wasn't the obstacle. The real challenge was the seemingly impenetrable fortress of patents AbbVie has methodically

constructed around its prized moneymaker.

The more than 100 patents AbbVie has secured over Humira's lifetime make it difficult for another company to replicate the drug without using processes and techniques to which the pharma giant continues to hold rights. Many of those patents were issued over the past few years as the expiration of Humira's main patent grew closer. Typical drugs, made through chemical synthesis, usually have no more than a dozen or so patents, if that. But biologic medicines such as Humira, which accounts for more than 60 percent of AbbVie's revenue and can carry a list price of more than \$50,000 per patient, are ►

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PHOTOGRAPH BY CAROLINE TOMPKINS FOR BLOOMBERG BUSINESSWEEK

◀ typically made in living cells rather than chemically manufactured. That process often involves more steps and a higher level of complexity, which opens the door to more potential steps to patent. What's more, companies can claim any changes to their drugs over the years—say, using a slightly different medium in which to grow cells or adjusting the dosing—warrant new legal protections that can keep generic competitors at bay.

If you have a \$16 billion-a-year drug, “every month is a good month that you’re on market alone,” says Mike Fuller, chair of the biotechnology practice group at law firm Knobbe Martens. “So you’re going to spend whatever it takes to be as aggressive as possible and get as many patents as possible.”

AbbVie’s not the only one relying on patents to protect popular biologic medications. Johnson & Johnson’s Remicade, for instance, is another blockbuster anti-inflammatory biologic drug with more than 100 patents. But AbbVie has been especially outspoken about its strategy. After seeing it laid out in a company presentation, Ronny Gal, a research analyst for Sanford C. Bernstein & Co., said at a conference of makers of biosimilars (generic-like drugs, in biologic drug parlance) last fall: “I’m pretty sure every CEO in biopharma sent that to their head of IP [intellectual property] and said, ‘Can we do that?’”

While most drugmakers have been frightened off, Amgen Inc. has decided that the prize is too rich not to try breaching AbbVie’s patent defenses. Amgen is in the first wave of what’s likely to be a protracted legal battle with AbbVie to launch a biosimilar version of Humira in the U.S. AbbVie has filed suit in federal court in Delaware to block the effort, insisting that Amgen has violated 61 patents. The trial for the first 10 is set for late 2019. “The AbbVie vs. Amgen case is very interesting to a lot of us because it’s the first time the patent thicket strategy has been tried in biologics litigation” in the U.S., says Robert Cerwinski, a partner at law firm Goodwin Procter. “The sheer number of patents does not guarantee success.” German drugmaker Boehringer Ingelheim GmbH has also started to develop its own version of Humira, to which AbbVie has responded by filing suit, arguing that Boehringer infringed on 74 Humira patents.

In a statement in response to questions about this story, AbbVie spokeswoman Adelle Infante said that Humira “represents true innovation in the field of biologics and is protected by a strong portfolio of intellectual property.” When asked about patent challenges on an investor conference call earlier this year, Chief Executive Officer Rick Gonzalez suggested it won’t be easy for a competitor to defeat Humira’s intellectual property. “The strategy that we have in place is not one that hinges on one or two patents,” he said.

In a presentation by AbbVie in October 2015, a slide titled “Broad U.S. Humira Patent Estate”

detailed its strategy: patents covering every aspect of the drug’s life, from its origins to the diseases it’s approved for. The company listed 22 patents for various diseases or methods of treatment, 14 on the drug’s formulation, 24 on its manufacturing practices, and 15 “other” patents. The latest expiration date is 2034—providing more than double the protection span a drug such as Humira might normally expect. “Congress had extensive discussion about how long should biologics get exclusivity before they get competition,” says Jeff Francer, general counsel at the Association for Accessible Medicines, the lobbying group formerly known as the Generic Pharmaceutical Association. “They settled at 12 years, and if you take 12 years from when Humira was approved, that brings you to 2014, so they’re now trying to get that extended to 2034.”

The Humira patents, often with arcane names and descriptions, cover everything from what’s inside the drug to how it’s dosed. For example, a patent called the Fed-Batch Method of Making Anti-TNF-Alpha Antibody protects the way AbbVie produces an antibody used in a cell culture medium with a specific pH, Cerwinski says.

If the science behind the patents appears exotic to the nonscientist, the legal strategy is easy to grasp. In 2014, for instance, AbbVie stepped up its pace of patent filings in advance of last year’s expiration of its main patent. A review of Humira’s patents by the Association for Accessible Medicines shows the drugmaker has been obtaining patents at a feverish clip in recent years: 21 in 2016 and 32 in 2015. “There’s a lot of innovation in biologics and in biologic manufacturing,” says Fiona Scott Morton, professor of economics at Yale. “Of graver concern is that this multistep process of making biologics can be patented. The firm can strategically choose when to file.”

Still, AbbVie isn’t home free. A rival drugmaker can technically launch a biosimilar version of Humira while patents are still outstanding, a practice known as launching “at risk.” Should a court find the biosimilar drugmaker in the wrong in that scenario, the company would end up owing substantial damages. But if courts rule the other way, AbbVie could suffer a breach in its patent armor that likely would invite other companies to challenge its drug’s hegemony—and could lower prices.

Until that happens, though, AbbVie continues to rake in big Humira bucks. U.S. sales in the most recent quarter were up 18 percent, to \$3.2 billion in the three months ended June 30, from a year earlier.

“It is that portfolio of patents that provides us confidence that ultimately we can protect the position which Humira based on all the innovation that we’ve done and the investment we’ve made,” said CEO Gonzalez. —*Cynthia Koons*

THE BOTTOM LINE Humira’s annual sales exceed \$16 billion. But few drugmakers are willing to challenge the more than 100 patents maker AbbVie has constructed around the medicine.

● Top five biologics by 2016 global sales, with date of U.S. FDA approval

Humira
AbbVie
2002
Immunology
\$16.1b

Enbrel
Amgen and Pfizer
1998
Immunology
\$8.9b

Remicade
Johnson & Johnson and Merck
1998
Immunology
\$8.2b

Rituxan
Roche
1997
Cancer
\$7.4b

Avastin
Roche
2004
Cancer
\$6.9b

L'Oréal's Problem With Men

● The cosmetics giant is tops with female applicants. With guys, not so much

In his first assignment for L'Oréal, Rob Imig spent 10 months pitching a shu uemura lipstick to beauty editors across the country. The editors—all women—often reacted with confusion or amusement. “The reaction was a bit startled sometimes,” says Imig, now a 13-year veteran of the company. “The beauty business is dominated by women. They thought it a bit odd that a guy named Rob was coming to show them a new lipstick.”

While big companies around the world are striving to improve the gender balance of their workforces, most are focusing on hiring more women. But for L'Oréal, balance means attracting more men. The €25.8 billion (\$30.6 billion) French beauty products company has been a pioneer in the push for gender equality, regularly earning awards for its efforts. Women manage 58 percent of L'Oréal's brands and hold almost two-thirds of executive positions. In 2017 the company ranked first in Equileap's annual ranking of 3,000 global corporations on their progress toward gender equality.

L'Oréal has been so successful at developing

a reputation as a female-friendly workplace that women job applicants flock there. One result: Last year, 77 percent of new hires were female. Therein lies a problem. “They have a huge gender gap,” says Jonna Sjoval, managing director for the Americas at Universum, which ranks the most desirable employers among business and engineering graduates worldwide. In its most recent tally of U.S. employers, L'Oréal was No. 9 for women business graduates but only No. 150 among men.

The beauty company's managers worry that the gap could put it at a disadvantage in recruiting. “For a big corporation like us, attracting talent for the future will be a huge topic,” says Jean-Claude Le Grand, L'Oréal's head of diversity and inclusion. “We need to attract more male talent.”

Having more men among its 90,000 global employees might also help L'Oréal better understand and win male customers, who are becoming increasingly important in the beauty business. The market for men's grooming products will expand 3.3 percent annually over the next five ▶

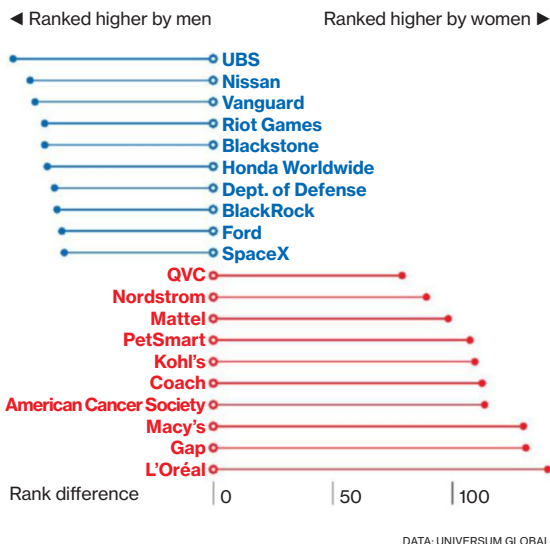
“The definition of leadership is still largely male”



ILLUSTRATION BY INKEE WANG

Where men and women prefer to work

Companies with the largest perception gap between genders



DATA: UNIVERSUM GLOBAL

years, compared with 2.9 percent for beauty and personal-care products in general, according to data from Euromonitor International.

L'Oréal, which doesn't sell razors, ranks third in the \$47.8 billion men's grooming market, with a 5.6 percent share in 2016. No. 1 Procter & Gamble Co., maker of Gillette razors and Old Spice cologne, had 18.7 percent, while Unilever NV, which owns the Axe brand, had 10.9 percent. No L'Oréal brand is in the top 10 for men in market share, though the company's Baxter of California targets men. Several of its other brands, such as Kiehl's and SkinCeuticals, are marketed to both sexes.

L'Oréal's goal is to recruit equal numbers of men and women by 2020. "Our vision is clear: We want a perfect balance between males and females," says Le Grand, who's headed the company's diversity efforts since 2005.

One way L'Oréal is working to attract more men is by tweaking the way the company presents itself to job applicants. On the jobs site for L'Oréal's U.S. unit, shots of the glamorous models and makeup used in the company's consumer advertising are nowhere in sight. Instead, prominently featured are photos of a goggle-wearing female chemist seated at a microscope and a male employee who runs a tech incubator that develops products such as an electronic hairbrush.

L'Oréal today is also more likely to emphasize the entrepreneurial aspects of a job, such as developing a product or having profit-and-loss responsibilities, which often appeal to male applicants. "We're not just a company that sells makeup," says Angela Guy, L'Oréal's U.S. diversity chief. "We develop our own products, we have R&D, manufacturing, engineering, and other jobs in tech fields that may interest men."

Joelle Emerson, chief executive officer of Paradigm, a diversity consulting firm in San Francisco, says that using images of women and men in nontraditional roles is likely to appeal positively to both genders. "Signals and messages," she says, "can have a significant impact on who's going to be attracted to working for you."

Underrepresented groups—including men in the beauty industry—won't apply for jobs that emphasize innate abilities, such as having "a brilliant mind" or "an eye for" something, says Emerson. "They believe, and not incorrectly, that they are more likely to be stereotyped," she says. It's better to emphasize the opportunity to develop skills in a job, she says.

L'Oréal still has work to do to integrate women into its highest ranks. It's not uncommon for women to make up the majority of the workforce at fashion and beauty companies "because of their affinity with the product or service," says Aniela Unguresan, head of EDGE, a Swiss-based organization that certifies organizations and companies, including L'Oréal, on their gender equality programs. "You have a thin layer of male talent at the entry level, but at the top, the pattern is reversed," she says. "The definition of leadership is still largely male."

Just a decade ago, men held 76 percent of the top 1,000 positions at L'Oréal, 83 percent of the strategic positions, and 93 percent of the seats on the executive committee. Today, although women have made gains overall, their ranks thin in the higher posts. They make up 48 percent of the top 1,000 positions, 30 percent of the strategic positions, and 32 percent of the executive committee. Le Grand wants to balance that group by 2020, and the company is providing managers with bias and inclusion training to make sure they can send the message to their staff and develop and promote female leaders. L'Oréal is also encouraging women to take on science, technical, and engineering positions traditionally dominated by men.

Meanwhile, to help make the workplace more welcoming for men, L'Oréal in recent years has sponsored an affinity group for male employees in the U.S., the Men's Think Tank, which hosts speaking and networking events, shares insights with management, and helps with recruitment. The company says the group shares the credit for increasing the number of male hires there by 27 percent in 2016.

Imig, who was part of an otherwise all-female team at Kiehl's from 2007 to 2015, today oversees five women and two men in the Vichy beauty brand's digital communications department in Paris. His boss is a woman. "Communications was predominantly women 10 years ago; that's no longer the case," he says. "There are still not a lot of guys, but I've never felt anything but accepted." —*Laura Colby*

● Share of L'Oréal new hires in 2016 who were female

77%

THE BOTTOM LINE Cosmetics maker L'Oréal has a great track record attracting female employees—so much so that now it's aggressively trying to attract men to gain a better balance.

Artifact

Ethylene



Ethylene is found in plastic bags, antifreeze, bubble gum, PVC piping, polyester, and diapers



Many Americans have probably never heard of ethylene. But this colorless, flammable gas usually made by superheating oil or natural gas is arguably the most important petrochemical on the planet—and much of it comes from the Gulf Coast region savaged by Hurricane Harvey. Ethylene and its derivatives make up about 40 percent of global chemical sales, says Hassan Ahmed, an analyst at Alembic Global Advisors. The U.S. accounts for 1 of every 5 tons on the market, and ethylene plants globally were already running almost full-out before Harvey, Ahmed says. “So any little hiccup—and this is much beyond a hiccup—will dramatically tighten supply-demand balances,” he says.

Texas produces almost three-quarters of the nation’s

ethylene supply. That’s critical because this basic chemical building block is the foundation for making plastics essential to U.S. consumer and industrial goods, from car parts used by Detroit automakers to diapers sold by Wal-Mart Stores Inc. Processing plants turn the chemical into polyethylene, the world’s most common plastic, which is used in garbage bags, food packaging, and even chewing gum. As ethylene glycol, it’s the antifreeze that keeps engines and airplane wings from freezing in winter. It also becomes the polyester used in textiles and water bottles. Because of Harvey’s flooding, Texas plants accounting for 67 percent of U.S. ethylene capacity have closed, say analysts at Jefferies LLC. Production may not return to prestorm levels until fall. —*Jack Kaskey, with Lynn Doan*

LOOK AHEAD

● San Francisco hosts a regional version of the Mobile World Congress trade show

● Marketers converge on Digital Summit Detroit, an annual conference

● Apple's annual iPhone unveiling will mark the company's first serious effort to sell a model priced at about \$1,000



● Waymo has the edge on Uber as the companies go to court, but both have a lot to lose

There's a month to go before the trial starts, but in many ways Waymo can already count its trade-secrets lawsuit against Uber Technologies Inc. as a win. The unusually speedy pretrial discovery process has yielded a steady drip of embarrassing revelations for Uber. It's forced the ride-hailing company to fire the head of its driverless car division. And it's contributed to the ouster of Uber Chief Executive Officer Travis Kalanick, now the most highly anticipated witness in a case that could reshape the nascent market for self-driving car technology.

But Waymo, the company formed from the Google Inc. self-driving car project, hasn't won yet. There are no more fact discovery hearings before the trial begins on Oct. 10, and Waymo is running out of time to locate the 14,000 computer files it claims engineer Anthony Levandowski stole while in its employ and transferred to Uber's driverless program, which he took over last year. Without that smoking gun, Waymo, a unit of Alphabet Inc., may have a tough time directly tying Levandowski's actions to Uber's alleged trade-secret theft, forcing it to try to convince a jury using strong but circumstantial evidence.

"They didn't sue the guy who supposedly committed this great theft," says Arturo González, a lawyer for Uber, which has denied using Waymo's trade secrets. "It's like your neighbor steals your lawn mower, and instead of suing him, you sue the guy who bought it at the auction."

Uber hasn't exactly been upfront about the evidence in this case. U.S. District Judge William Alsup has repeatedly upbraided the company for misleading him about the trail of evidence and its often-clandestine early dealings with Levandowski, including the 2016 acquisition of his self-driving truck company, Otto, for \$680 million in stock. Emails

between Uber executives and lawyers show "they knew good and well what they were getting into with Mr. Levandowski," the judge said during a hearing on July 26. "It's a mess of your own making."

Levandowski has refused to testify, asserting his constitutional right against self-incrimination. His lawyer, Miles Ehrlich, declined to comment for this story. In May, Alsup referred the lawsuit to federal prosecutors for possible investigation. So far, no criminal case has materialized.

Like Uber's lawyer, Alsup has also warned Waymo that while it's made a compelling case that Levandowski took the 14,000 files, it needs to prove more than that to sway a jury. "If you can't prove that Uber got these trade secrets, then, you know, maybe you're in a world of trouble," he said during the July 26 hearing.

Absent an explicit trail of evidence, Waymo is betting it can persuade jurors that a comparison of its designs with Uber's is sufficiently damning. "We have documentary, physical, and testimonial evidence showing the specific use of multiple Waymo trade secrets, specific pieces of technology, that can be found copied in Uber's," says Charles Verhoeven, Waymo's lead trial lawyer. Most important: the laser-radar technology known as lidar, which helps driverless cars navigate obstacles and one another. "This is an intentional scheme to steal technology that goes to the top of the company," Verhoeven says. "All Waymo wants is for its trade secrets not to be used."

Kalanick's testimony may prove pivotal because he and Levandowski were close, going on long walks together as they planned the future of Uber's self-driving car program. The two met before Levandowski left Waymo, raising questions about whether they conspired to bring Waymo's technology to Uber.

Google parent Alphabet doesn't have a reputation for sore-loser litigiousness or even for particularly caring about much of its intellectual property; it paints itself more as a for-profit academy where knowledge is the priority. It's been rare for the company to use its IP, which includes thousands of patents, to attack competitors.



Driverless cars, however, seem to have hit a nerve.

Just before Christmas, Alphabet sued another former employee for allegedly taking trade secrets to driverless-technology company Drive.ai. A former Google employee who's raising money for another autonomous driving startup says he's had to field unusually pointed questions from investors worried about the possibility of a legal threat, even though he didn't work on Google's self-driving project. (He declined to speak publicly for fear of retribution from Alphabet.)

"If Waymo loses the lawsuit against Uber, it's possible that folks will start to question whether Waymo has lost its competitive edge," says Eric Goldman, a professor at Santa Clara University School of Law who focuses on internet and intellectual-property cases. And there's a lot more competition than there used to be.

When Uber first began its self-driving effort in 2015, Google's project "seemed to be the only game in town," says Mike Ramsey, an auto analyst at researcher Gartner Inc. Ramsey estimates that some 50 companies are now working in autonomous driving. "A lot of things have changed since then," he says. In those two years, General Motors Co. and Ford Motor Co. have each paid hundreds of millions of dollars to buy self-driving companies. And since Waymo sued Uber, Fiat Chrysler Automobiles NV, Waymo's initial car partner, has formed a self-driving partnership with BMW AG. Chris Urmson, Waymo's former top executive, is also raising money for his own company, another likely competitor.

Whether or not Waymo wins its lawsuit, it's fair to wonder if Uber will stay in the race. Incoming CEO Dara Khosrowshahi, the former head of travel site Expedia Inc., has a long list of business and cultural problems to resolve. While driverless cars were an obsession for Kalanick, Khosrowshahi may not have the same love for an unproven technology that has hall-of-fame liabilities attached. "It's like Delta owning special jet-engine technology," says Ramsey, who suggests Uber may stop trying to build its own lidar and other components, instead waiting for them to become cheap enough to be interchangeable.

In his first address to new employees, on Aug. 30, Khosrowshahi said he's most interested in making the company a better ride-hailing company. "Especially in times of trouble, you really want to focus on the core," he said, according to comments released by a spokesperson. "The core of this business is what's going to pay the bills."

Now that Kalanick, Waymo's hostile star witness, isn't running Uber, might the companies settle the suit and ignore a bruising trial? Maybe. That would, for example, remove the threat that the case could embarrass Alphabet executives on the witness stand. But Khosrowshahi, after all, was hired by the board of Uber, where Kalanick remains a force bigger than the director's seat he continues to occupy. "I'm a fighter," Khosrowshahi told his staff in that first address. "I am all in, and I'm going to fight for you with everything in my body."

—Joel Rosenblatt, with Mark Bergen

THE BOTTOM LINE While Waymo has put Uber on the defensive during pretrial proceedings, it could fail to win over a jury, and it has a lot of fresh competition in driverless technology.

Will Make AI Smarter For Cash

- The need for humans to train AI software has created a new industry

When Katharine Rubin has a spare moment on the way to school, she helps a big-name tech company smarten up its artificial intelligence. Rubin, a 22-year-old accounting major at New York City's Baruch College, is part of a growing workforce that spends anywhere from 5 minutes to 40 hours a week increasing the I in AI. Specifically, Rubin and others provide training data for machine learning algorithms, a form of AI that can be taught from experience.

For an autonomous car to recognize pedestrians ▶

"If you can't prove that Uber got these trade secrets, then, you know, maybe you're in a world of trouble"

◀ and stop signs, it's typically fed thousands or millions of photos, all hand-labeled. To nail a conversation, a digital assistant needs to be told over and over when it's failed. And so Rubin spends 10 to 30 hours a week on her phone or computer evaluating search results and chat retorts through a site called Clickworker. Her income, generally \$10 to \$14 an hour, pays for part of her college commute from New Jersey and some of her mom's groceries. Each task pays 3¢ to 15¢ apiece, she says, and "they're easy, so it quickly adds up."

As automation and AI eliminate a range of relatively rote jobs, the need to train software is also creating other employment opportunities. People must label massive collections of unsorted data so computers can perform more complex tasks, such as driving cars and carrying on conversations. Clickworker GmbH is one of several companies feeding the need for training data as machine learning spreads into more business processes. All together, more than 1 million people around the world are chipping in, one click at a time.

Many of the startups are being fed by eager venture capitalists. So far this year, Alegion, Scale, CloudFactory, Mighty AI, and CrowdFlower have received about \$50 million in investment funding, and Understand.ai is expecting to raise a few million this month.

Some of these companies have specialties. Mighty AI Inc. and Understand.ai focus on annotating images for autonomous driving. DefinedCrowd tackles natural language processing, so workers record or transcribe speech samples, among other tasks. Microwork photographs and tags brand logos to, say, track exposure on Instagram. Other companies are generalists, tagging vehicle damage, categorizing media, handwriting notes, or assessing product reviews as needed.

Clients range from startups to the likes of Google parent Alphabet, Amazon.com, Apple, Facebook, International Business Machines, Microsoft, and big automakers. (At that level, most also have in-house sorters.) Jacques Bughin, a director of the McKinsey Global Institute, speculates that the nine-figure market could hit \$5 billion in five years. Jonathan Roosevelt, a partner at Industry Ventures who led CrowdFlower's \$20 million round of funding in June, says that's optimistic but possible. "One of the things that got us excited is how valuable this is to some very rich companies," he says.

Beyond recruiting workers and sorting data, AI training companies typically create the software interfaces for workers to label data, as well as the quality-control methods. Some of them hire people one task at a time. Alegion Inc. and Clickworker each have about 1 million data sorters, with most of the tasks aimed at machine learning. Daryn Nakhuda, the chief executive officer of Mighty AI, says his company tries to add gamelike elements (experience points, badges, online discussion forums) to make the jobs

more fun and less fatiguing. These services pay anywhere from a penny a task to \$2,000 a pop for a radiologist to tag a medical image.

Other companies offer full-time work. IndiVillage Tech Solutions LLP hosts about 100 women and youth at its office in the Indian town of Yemmiganur and spends profits on education and drinking water for the community. "We think it's pretty cool that a tiny community in a rural Indian village today is helping with providing data for artificial intelligence," says Chirasmita Amin, the company's business development manager. In Serbia, Microwork pays an hourly wage of at least \$3 an hour, more than twice the local minimum, to 100 people in an area where jobs are scarce, and it says it aims to expand its ranks to 1,000 this year. Samasource trains and employs people in Africa, India, and Haiti.

"I can imagine an AI that is connected to all of humanity," says Andy Gough, the CEO of Microwork, "and whenever it needs to learn something, it simply employs humans to generate the data it needs." Rubin, the Baruch student, doesn't worry about possibly training her AI replacement someday. "No matter what the profession," she says, "we will be working alongside AI in our everyday lives." —*Matthew Hutson*

THE BOTTOM LINE The nine-figure market for AI trainers has attracted about \$50 million in venture funding this year to a cadre of startups dependent on armies of workers to sort data.

● There are well over **1m** people helping to train AI software (for a fee)

Snapchat vs. the 'Influencers'

● The disappearing-message service kept it tough for users to measure their audience, and Instagram swooped in

Was "Wuz Good" Armstrong has almost 700,000 followers on Instagram, enough to get paid six figures a year to promote Lexus cars and Axe body spray there. It's easy, he says, to put products in his comedy and stunt videos for an audience that will still like and comment on the posts as long as they're entertained.

Snapchat makes things a lot tougher. Armstrong has followers there, too, but he doesn't know exactly how many. And because of the way the service works, it's hard for him to track how many people watch the

sponsored messages he sprinkles into his posts. To capture the audience for a recent video for Toyota Motor Co., he had to set an alarm on his iPhone for 23 hours and 59 minutes after the post to remind him to take a screen shot of the number of viewers. He was cutting it close: Like most Snapchat posts, the video disappeared at the 24-hour mark, taking his proof with it. He makes a lot less money on Snapchat—maybe \$10,000 a year, he says, if he’s lucky.

This is by design. Snapchat’s parent company, newly public Snap Inc., says the app is mostly meant to be used for communication among close friends. The implication: It’s not designed for the so-called influencers who use carefully edited Instagram photos to get internet-famous enough to hawk Axe. Influencer types use Snapchat anyway, and people follow them anyway, but Snap makes little effort to cater to them. And they’re getting annoyed. The number of influencers posting Snapchat stories in the second quarter fell 20 percent from the first quarter, while Instagram saw an 11 percent jump, according to data-analysis company Captiv8.

The company doesn’t send executives to VidCon, the influencer conference in Anaheim, Calif., where Instagram and its corporate parent, Facebook Inc., have a heavy presence. There’s no special Snapchat team catering to the pitchmen and no easy way for the influencers to tell how many views they’re getting, making it less obvious why the Lexuses of the world should pay them. And since Instagram copied Snapchat’s “stories” feature, letting users string together videos that disappear after a certain amount of time, “Instagram has taken a lot of Snapchat’s swag, for sure,” Armstrong says. Snap declined to comment for this story.

Instagram’s clone (also called “stories”) has made it easier for advertisers to cut Snapchat out of their plans. At last year’s New York Fashion Week, marketing agency United Entertainment Group used other services to pay teen girls and college-age women to pitch a large hair-care brand to their peers. “It would have fit right into the Snapchat demographic, but right now there is just so much available on Instagram and on YouTube and on Facebook,” says Josh Kaplan, senior director at UEG’s influencer-focused division. “It makes it very difficult for us to justify pushing content to Snapchat.”

Instagram has catered to this kind of advertising only in the past year or so. Since 2016, the company has made it easier for brands to track the popularity of posts by the influencers they pay and let the brands pay to promote those posts as they would regular ads. (It’s also started to indicate more clearly which posts are paid ads.) Facebook and Twitter Inc., like YouTube, allow some influencers to get a cut of ad revenue from videos they produce.

Snap would be wise to catch up, says Erin Dorr, vice president for digital and social strategy at MSL Group, a PR conglomerate. “Agencies everywhere are just waiting for Snapchat to come out with more



1 Armstrong hails a Lyft to class and nods to the *Fresh Prince of Bel-Air* theme, after oversleeping 2 The freedom of the internet, the former Vine star says, helped deliver him a Toyota Corolla 3 He credits Axe body spray with getting him out of the “friend zone”

functionality and capabilities and transparency for influencer campaigns,” says Dorr, whose company represents Procter & Gamble Co. and General Motors Co., two of the biggest advertisers in the world.

But Snap isn’t interested, say people familiar with its executives’ thinking. As a compromise, the company has started providing viewership data to a handful of popular users who produce posts Snap considers broad or interesting enough to be tagged as “official” stories. Michelle Obama made the cut; most latte-foam artists didn’t.

This break with self-promotional social media types is one of the many ways Snap has deliberately eschewed the examples of Facebook and Instagram, despite outside pressure for it to start making more money. Without mentioning the company by name, Snap executives aren’t shy about criticizing Facebook’s obsession with growth during investor presentations and earnings calls, arguing that the service’s value has been diluted by meaningless connections and notifications about acquaintances users haven’t seen in years. Snap maintains it’s focused on holding the interest of a much smaller group of higher-value eyeballs.

However big or small the audience, brands want to know exactly who they’re reaching, says UEG’s Kaplan, whose clients include Microsoft, Samsung, and Unilever. “It’s very important to us to have an apples-to-apples comparison with how we’re spending our dollars.” If clients choose Snap, he says, “we get a lot of screen shots.” —Sarah Frier

THE BOTTOM LINE Snapchat’s lack of public user data has made it less hospitable for buzz-building types. Its parent company doesn’t seem to mind.

LOOK AHEAD

● The CEO of Wells Fargo will speak to investors in New York. The bank recently said it will refund customers it pushed into unneeded car insurance

● The Senate Banking Committee holds a hearing on fintech

● The Bank of England's Monetary Policy Committee meets. Markets don't expect an interest rate hike

Diamonds Aren't A Bank's Best Friend

Standard Chartered thought it would be great to expand a unit making loans secured by the jewels. Now it wants out



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Dimitra Kessenides,
and Pat Regnier

Businessweek.com

Standard Chartered Plc's plunge into the risky business of diamond lending began a little more than eight years ago with a cocktail party at its London headquarters. Maurice Tempelman, longtime companion of the late Jackie Onassis and head of one of the biggest U.S. diamond companies, was there. So were diamond trader Dilip Mehta, who'd been made a baron by the king of Belgium, and other luminaries from the industry of middlemen who buy rough stones, polish them, and sell them to jewelers and retailers.

Flitting among the guests was Kishore Lall, who'd recently been hired to run the bank's business of issuing loans secured by diamonds and receivables. The party marked the announcement that Standard Chartered had money to lend. Among the crowd, many of the diamond traders, known as diamantaires, were potential clients.

The cost of that ill-fated venture is still being tallied. Since about 2013, the bank has accumulated roughly \$400 million in actual and likely losses on a portfolio of loans that once reached \$3 billion, according to a bank official familiar with the matter. Chief Executive Officer Bill Winters, who took over the bank two years ago, is still trying to clean up the mess.

Standard Chartered would become the world's dominant diamond financier—lending to mining companies but mostly to diamond cutters, dealers, and traders in need of financing to purchase the gems. It would also serve as a cautionary tale: a bank that thought it knew better than rivals, according to interviews with more than 20 people, including executives who worked at the bank. Some of the people said the bank ignored risk warnings from its own employees. All of them asked not to be identified for fear of harming their careers.

While diamond loans never accounted for more than 2 percent of Standard Chartered's assets, they were part of a wider pattern of what Winters has called "looseness" under previous management. Some of those practices resulted in the bank having to pay almost \$1 billion to settle U.S. investigations into sanctions and money laundering violations—fines unrelated to the diamond loans. But fraud was an ever-present danger in a business where parcels of gems are moved from company to company and country to country, borrowed against each step of the way.

"The diamond industry has deliberately wrapped itself in a cloak of obfuscation, and it should be treated with extreme caution by any outsider," says Charles Wyndham, a former sales director at mining giant De Beers Group of Cos. and founder of WWW International Diamond Consultants Ltd. "The parallels between what's happening now in the diamond industry and what happened in the subprime crisis are so painfully obvious." A spokesman for Standard Chartered declined to comment. Lall, who left the bank in 2015, said in an email to Bloomberg that

fraud wasn't rampant in the diamond industry and the bank had a "strong, independent risk culture." Standard Chartered, Lall wrote, "was not an organization where it was prudent—or even possible—to violate bank policy and ignore risk."

The February 2009 cocktail party came five months into the global financial crisis, when other banks, including Bank of America, HSBC Holdings, and JPMorgan Chase, were getting out of the diamond-financing business. Prices of rough stones had tumbled, sending shock waves through an industry that spanned mines in Botswana, traders in Belgium, polishers in India, and jewelry stores in the U.S.

Lall, who once served as the chief financial officer of New York's Gristedes supermarket chain, is the son of a former Indian diplomat and a graduate of MIT's Sloan School of Management. He remade himself as a diamond financier at ABN Amro Bank NV, the world's leading diamond lender. Crushed by the financial crisis, the Dutch bank was vulnerable to new competition. Mike Rees, Standard Chartered's head of wholesale banking, had been looking for a way into the diamond-lending business and went after Lall in the fall of 2008. Rees charged him with replicating ABN Amro's business, according to people with knowledge of the plan. Rees declined to comment for this article.

Over the next four years, Standard Chartered opened its wallet to diamantaires, undercutting other lenders and offering flexibility on credit deals that rivals couldn't match. Companies such as Eurostar Diamond Traders NV and Arjav Diamonds NV borrowed hundreds of millions of dollars from the bank.

There was one snag: Compliance, credit, and risk officers, as well as some members of Lall's own team, were raising red flags, according to people familiar with the communications. The credit team had strict rules and had to check that buyers were real and credible; that the diamonds were actually being shipped; that the IOUs, known as receivables, were being paid; that those payments were servicing the loan; and that the bank's share of debt to any company didn't exceed 25 percent. Because traders borrowed against sales, it was in their interest to inflate those numbers, according to people familiar with the industrywide practice. And unlike gold or silver, diamonds are difficult to value.

Lall said in his email that his team worked with the bank's risk officers and external auditors to make sure each company pursuing a loan was authentic. It "simply didn't happen" that his team ignored warnings. He said they could only propose loans, while it was up to the risk officers to approve them.

By early 2014 rough diamond prices, which had recovered after the financial crisis, were tumbling again. Consumer demand was stagnant, and traders were struggling to make a profit. At the same time, the leading supplier of the raw gems, De Beers, which had sold rough diamonds at a discount to handpicked ►

"The diamond industry has deliberately wrapped itself in a cloak of obfuscation"

◀ customers, became more aggressive with pricing, cutting traders' margins.

In May 2013, Lall's boss, Sanjeev Paul, flashed 20 charts on a screen at Mumbai's Trident Hotel, where Standard Chartered's diamond team was having its annual get-together. Each slide represented the debt of a top client, according to two people who attended the meeting. And each showed the bank held more than half the company's debt. In two cases, it was more than 70 percent. Paul, who declined to comment for this story, told the team to start cutting back, the people say. If they had any issues, they should come to him.

That summer, Standard Chartered's diamond business had its first major default. Winsome Diamonds & Jewellery Ltd., a jewelry manufacturer based in Surat, India, that had been borrowing from the bank long before Lall joined, was unable to make payments on \$1 billion of loans. About 15 percent of them were from Standard Chartered, people familiar with the matter say. When Indian authorities investigated, they found that \$700 million of all the loans to Winsome Diamonds had been diverted to 13 companies registered in the United Arab Emirates. Winsome Director Harshad Udani says the company is trying to recover what it's owed and settle the debt.

Losses continued to mount. Lall moved back to

New York and left the bank in September 2015, when the team was disbanded. He said his departure was the result of global cost-cutting and he left in good standing. Rees, who earned \$72 million over a six-year period, according to company filings, and was promoted to deputy CEO in 2014, left in 2016.

Standard Chartered still is owed about \$1.7 billion in outstanding diamond debt, part of \$100 billion in risky assets that Winters has said he wants to restructure, according to two people familiar with the matter. While the bank has been trying to sell its remaining loan book, it hasn't found a buyer at a recovery rate it's willing to accept. Meanwhile, rough diamond prices have fallen more than 20 percent over the past three years. Banks in Dubai and India have started financing diamond cutters, polishers, and traders, but many companies face a credit crunch.

Arjav, one of the diamond-trading companies that owes Standard Chartered money, is feeling the pain. "They were very aggressive, they really wanted to lend money," Arjav President Ashit Mehta says of the bank. "The terms and conditions were lenient from each and every point." —*Franz Wild, Thomas Biesheuvel, and Stephen Morris*

THE BOTTOM LINE Standard Chartered once proudly ran a \$3 billion portfolio of loans to diamond traders, making it the world's most dominant financier. There would be few jewels in that crown.

Something Else To Blame on Brexit



● Slow sales of U.K. malls have left private equity holding the shopping bags

In the English town of King's Lynn, the carcass of a shuttered department store lies next to betting shops, discount retailers, and a cash-for-gold kiosk. It's a typical sight in a country where online shopping has taken root more deeply than just about anywhere else. The boarded-up facades show something else: just how much unloved property U.K. private investors are saddled with.

The Vancouver Quarter in King's Lynn, the kind of mall ubiquitous in the region since the 1960s, is one of dozens acquired by private equity fund managers on the cheap in the wake of the financial crisis. All told, there are about £2 billion (\$2.6 billion) of shopping centers that funds would

like to sell, says David Lockhart, chief executive officer of NewRiver REIT Plc, which invests in malls and stores.

A roster of investors, including Lone Star Funds and Cerberus Capital Management LP, bought U.K. malls from troubled banks, betting values would recover. Yes, the internet had been killing off traditional shopping centers for years, but borrowing costs were at a record low and consumer spending remained a key driver of the economy. Purchases by private equity real estate funds account for about a fifth of all mall sales in the country since 2010.

But now, households are curbing spending as the pound weakens and inflation outpaces wage

increases. Prices have fallen for nonprime malls by more than any other type of commercial property since Britain's June 2016 vote to leave the European Union, according to research by broker CBRE Group Inc. Says Lockhart of the private equity funds looking to get out: "We are not entirely comfortable with their price expectations, which relate back to a time before the Brexit referendum."

Managers who sold malls before the Brexit referendum did well. In a joint venture with Catalyst Capital Group Inc., Blackstone Group LP's third European real estate fund bought several malls, including the Houndshill Shopping Centre in the northern English seaside town of Blackpool. The funds paid about £85 million for Houndshill in 2011 and eventually sold it for £105 million in 2015.

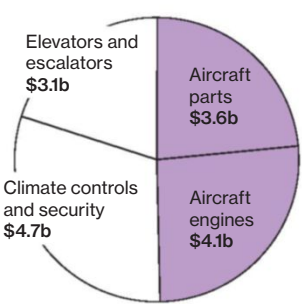
In the first quarter of this year, the number of malls bought and sold slumped to 2008 levels, data compiled by broker Cushman & Wakefield Inc. show. U.K. malls such as the one in King's Lynn, purchased five years ago by Oaktree Capital Management LP, were bought along with other properties in portfolios of soured loans sold by banks, sometimes for as little as 20 percent of their value. Oaktree has spent most of 2017 trying to find a buyer for the King's Lynn mall, which is in eastern England. A spokeswoman for Oaktree declined to comment on the firm's investments.

Potential investors such as insurers and pension funds meanwhile have generally shied away from all but the best U.K. malls and shifted their money into new areas such as rental homes, medical buildings, and retirement housing. Real estate investment trusts have also balked. Hammerson Plc, the U.K.'s largest REIT specializing in retail, is focused on malls where brands can "showcase their full range, where we can offer an experience beyond retail, with catering and leisure," CEO David Atkins says.

Money managers who hold major retail properties either have to bide their time or look at alternatives for sites they can't sell, such as changing the mix of use to include less retail and more housing and leisure properties such as restaurants and cinemas. Blackstone, for instance, halted a plan to sell the St. Enoch Centre in downtown Glasgow, Scotland, in 2015 after bids fell short of expectations. The firm is now replacing a store that was vacated by defunct retailer BHS Ltd. with a movie theater and more restaurant space.

"The real problem is the midrange centers, which are in smaller towns or those that are the second-best in a larger city," says Tom Sharman, head of research and strategy for real estate finance at Royal Bank of Scotland Group Plc. Unless you can sell it to the local government, "then I think you are going to struggle to find a buyer," he says. —*Jack Sidders*

THE BOTTOM LINE After the recession, private equity funds viewed malls as cheap assets they could flip fast. The properties have been a drag on balance sheets ever since.

| Deal Snapshot | | Rockwell Collins Inc. | | | | | | | | | | | |
|--|--------|--|-------|----------------|--------|------------------|--------|-------------------------------|--------|--------------------------|--------|--|--|
| BUYER United Technologies Corp. | | PRICE \$23b | | | | | | | | | | | |
| United Technologies, whose businesses include jet engine maker Pratt & Whitney, has agreed to buy the manufacturer of touchscreen cockpit displays and other avionics. | | | | | | | | | | | | | |
| What It Does | | The deal, one of the biggest in aviation history, will create an aircraft-parts giant that can outfit jetliners and warplanes from nose to tail. That could help United Technologies as it faces pressure for pricing discounts and increased output from big customers such as Boeing Co. and Airbus SE. | | | | | | | | | | | |
| United Technologies 2Q Sales | | A Bigger Bet | | | | | | | | | | | |
|  <table border="1"> <caption>United Technologies 2Q Sales</caption> <thead> <tr> <th>Category</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Aircraft parts</td> <td>\$3.6b</td> </tr> <tr> <td>Aircraft engines</td> <td>\$4.1b</td> </tr> <tr> <td>Climate controls and security</td> <td>\$4.7b</td> </tr> <tr> <td>Elevators and escalators</td> <td>\$3.1b</td> </tr> </tbody> </table> | | Category | Value | Aircraft parts | \$3.6b | Aircraft engines | \$4.1b | Climate controls and security | \$4.7b | Elevators and escalators | \$3.1b | Aerospace is already about half of United Technologies' sales. But the company has stumbled in the business recently: A line of engines has been dogged by technical glitches, slowing deliveries of some new Airbus planes. | |
| Category | Value | | | | | | | | | | | | |
| Aircraft parts | \$3.6b | | | | | | | | | | | | |
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| Elevators and escalators | \$3.1b | | | | | | | | | | | | |
| United Technologies "becomes a critically important supplier to Boeing and will have a strong negotiating position." — <i>Hans Weber, president of consultancy Tecop International Inc.</i> | | | | | | | | | | | | | |
| What's Next | | Analysts think regulators will OK the deal. But Boeing has said it's "skeptical that it would be in the best interest of—or add value to—our customers and industry." It could flex some muscle, because of terms in its contracts. Gregory Hayes, United Technologies' chief executive officer, has said the bigger company will be more efficient and innovative. — <i>Ed Hammond, Richard Clough, Julie Johnsson, and Dinesh Nair</i> | | | | | | | | | | | |

LOOK AHEAD

● India's prime minister hosts his Japanese counterpart for a three-day visit starting on Sept. 13

● The U.S. inflation reading for August comes out on Sept. 14

● EU finance and economy ministers gather in Tallinn on Sept. 15-16 for talks on how to deepen monetary union



Colombians Yank The Welcome Mat

● Small towns are exercising their constitutional right to block oil and mining projects

Coffee and fruit growers in the mountains around Arbeláez, a small farming town 35 miles from Bogotá, may have a significant amount of oil wealth under their feet. In July they defied the government and foreign investors and voted to leave it there. Local referendums, known as “popular consultations” in Colombia, are increasingly being used to block oil and mining projects, causing alarm among companies in those industries. More than 40 such votes are planned, according to the National Hydrocarbons

Agency, threatening to paralyze exploration across the Andean nation.

Canacol Energy Ltd., a Toronto-listed company, paid \$7.5 million in 2014 for a 190,000-acre block in Arbeláez, but following the July 9 vote it can't carry out seismic testing or drill exploratory wells to ascertain how much crude may be underground. South Africa's AngloGold Ashanti Ltd. invested \$360 million to mine gold in western Colombia but shelved the project after local residents voted 6,165 to 76 on March 26 to ban mining in the area.

Community referendums have become the greatest obstacle to operating in Colombia, says Charle Gamba, chief executive officer of Canacol. “The worst investment signal for a foreign investor is to invest in a country where there's no contractual stability.” The plebiscites threaten the industry that's powered Colombia's growth over the last decade

and a half and provides its biggest source of export revenue. With oil production dropping and untapped reserves down to less than six years of output, the nation urgently needs new discoveries if it wishes to remain an energy exporter. (Colombia's neighbors, Ecuador and Venezuela, have approximately 40 years and 340 years of reserves, respectively.)

Finance Minister Mauricio Cárdenas has said the rules need to change to keep small communities from vetoing projects that are in the national interest. But since Colombia's constitution grants citizens the right to hold these types of referendums, the government can't simply send a bill to Congress. "To change this, a law wouldn't be sufficient," says José Gregorio Hernández, a former head of Colombia's Constitutional Court. "It's necessary to change the constitution."

Colombia's mining code had previously prevented local authorities from barring projects in their territory. But the Constitutional Court struck down the provision as unconstitutional last year, helping to trigger the wave of popular consultations, according to Rodrigo Negrete, a lawyer who's advised Arbeláez and other communities on environmental questions. The plebiscites can be convened by either the local authorities or residents who've collected a requisite number of signatures. The high court ruled last year that the votes are binding. An oil field or mine that was already licensed to produce wouldn't be affected, says Negrete.

In all five of the popular consultations held this year, locals voted overwhelmingly against letting oil and mining companies into their communities. They've been cheered on by environmentalists and national politicians, including former Bogotá Mayor Gustavo Petro, who leads in polling for the 2018 presidential election. In Arbeláez, the split was 4,312 to 38 in opposition. Farmers feared the presence of oil wells would threaten their water supply, according to Mayor Jorge Godoy, a member of the Conservative Party.

"We don't have that much water. There isn't enough for the oil company," says Luis Jaime Ortiz, who runs a coffee shop in the town and campaigned for the no vote. "The government's attitude is that we are left-wing subversives, when in fact this is a town that's completely conservative and Catholic." The area, which supplies Bogotá with tomatoes, peas, and blackberries, largely escaped the civil conflict and drug violence that plagued other regions in recent decades.

A change in 2011 to the way Colombia apportioned oil and mining royalties has inadvertently stoked opposition to projects in communities such as Arbeláez, according to Leonardo Villar, director of Fedesarrollo, a Bogotá-based economics research group. Many municipalities experienced a windfall during the recent era of high oil prices, but much of the money was stolen or squandered by local politicians, Villar says. To address the problem

and to distribute the oil wealth more evenly across the country, the central government cut the share of royalties flowing into town coffers. Juan Carlos Echeverry, the finance minister at the time and now CEO of Ecopetrol, the state-controlled oil producer, said the goal was to "spread the jam across the whole slice of toast."

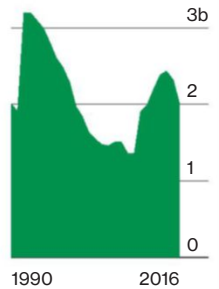
The upshot is that local governments have less incentive to incur the political cost of supporting oil projects, particularly when the price of Colombia's benchmark crude is trading at about \$45 per barrel, less than half its value five years ago.

Canacol CEO Gamba says that these types of referendums have no equivalent in the rest of the region and that, without a change in the rules, a single community can "hold hostage" the rest of Colombia, depriving it of royalties and taxes. The government's inability, or unwillingness, to get on top of the issue is "increasingly worrisome," he says.

Things might have turned out differently for the company had local residents believed they could benefit from its presence in their backyard. "The majority of people in Arbeláez aren't petroleum engineers, who are the ones who earn the big salaries," says Oscar Javier Velásquez, a local farmer. "We are cheap labor, unqualified. So what can they offer us? Practically nothing." —*Matthew Bristow*

THE BOTTOM LINE A wave of local referendums threatens to paralyze oil exploration in Colombia, jeopardizing the country's future as a petroleum exporter.

● Colombia crude oil reserves, in barrels, at yearend



◀ Graffiti in Arbeláez, Colombia, encourages locals to vote against an oil project to protect the environment

Houston and the Politics of Immigration

● Trump and a new Texas law are discouraging workers the city needs

José Zamudio, who does day labor in a Dallas suburb for as much as \$15 an hour, is considering moving to Houston to help the city rebuild after Hurricane Harvey. There's just one caveat. "If I'm seeing police are picking up a lot of people or there are a lot of immigration raids, I'd leave for another state," says Zamudio, an undocumented immigrant whose wife and three children stayed in the Mexican city of Celaya when he came north seeking work 15 months ago.

Hurricane Harvey is about to put the effects of President Trump's anti-immigration rhetoric and actions to the test. Twelve years ago, after Hurricane Katrina ravaged New Orleans, President George W. Bush's administration decided to ignore the legal status of workers helping to rebuild the city. Ads seeking a rapid reaction force of framers, ►

◀ bricklayers, and roofers for the Houston area, where an estimated 1.7 million homes were damaged by the flooding, are already popping up on Craigslist. One specifies that applicants should be willing to work 12 hours a day, six days a week.

But the political and the economic climate is a lot different than it was in 2005. For months, the U.S. labor market has been tightening as the economy picks up speed and Trump—along with allies in Texas and other states—cracks down on undocumented workers. Nationally, arrests of undocumented immigrants rose 40 percent in the first half of 2017 from the same period last year, according to Immigration and Customs Enforcement. There’s also a deterrent effect, with fewer migrants trying to enter the U.S. without the necessary paperwork: From Feb. 1 through the end of July, officials apprehended 56 percent fewer people at the Mexican border than in the same period last year, 122,542 compared with 279,058.

Trump’s immigration crackdown has aggravated an already serious shortage of construction workers. In a July survey by the National Association of Home Builders, more than 60 percent of contractors said they couldn’t find enough carpenters, framing crews, or masons.

Houston, which faces one of the biggest reconstruction projects in American history, stands at the crossroads of these trends. Two-thirds of contractors in the state have reported a shortage of concrete workers, compared with 51 percent nationwide, according to a survey by construction industry group Associated General Contractors. Builders in Texas also said they had a hard time finding electricians and wallboard installers. And that was before the state approved the nation’s toughest immigration enforcement measure this spring.

The law, which was set to go into effect on Sept. 1 until a federal judge blocked it just two days earlier, threatens local officials with firing or a year in jail, and municipalities with fines of up to \$25,500 a day, for failing to step up immigration enforcement. That would, for instance, require police officers to arrest a driver pulled over for a routine traffic violation, if the person isn’t able to provide documentation proving they’re in the U.S. legally. The state’s biggest cities, including Houston, oppose the measure, and legal battles over it may last years.

In the wake of Harvey, Bill Beardall, executive director of the Equal Justice Center in Austin expects workers and contractors to pour in from out of state and create a “Wild West” of unsafe working conditions and wage theft. This hastily assembled labor pool will “do the urgent cleanup work in pretty dirty, nasty, contaminated kinds of places in the immediate post-rescue environment. And that will phase into the reconstruction effort, which will also need low-wage workers,” says Beardall, whose center will represent poor and undocumented workers in the rebuilding.

In southeast Texas, the already fierce competition

for people handy with hammers will be intensified by the dwindling number of foreigners. Wages for construction laborers rose 10 percent to 16 percent annually for six years in New Orleans after Hurricane Katrina, and they’ll likely rise even faster now in Houston, says David Jarvis, a Houston-based senior vice president of John Burns Real Estate Consulting.

The undocumented face the decision of whether to risk their tenuous livelihoods for a rich payday. Ismael Sánchez, who moved to Texas from California about a decade ago, hasn’t returned to Guatemala to see his wife and two children in four years.

▼ A cleanup crew deals with the aftermath of Harvey in Houston



Instead, he sends home about \$500 a month. He’s torn between moving to Houston for Harvey work and fleeing. “Because of this law, I’ve been thinking of leaving Texas,” he says.

Zamudio comes early to a day-labor station in Plano, near Dallas, waiting for work pouring concrete or doing landscaping in heat that can top 100F. “We came here to work, nothing more,” he says. “We’re not here stealing or fighting. We’re doing the work that nobody from here wants to do and, even so, they want to run us off.”

Gathering a workforce to repair the flooded city will have repercussions throughout the nation. David Orlando, Houston division president for Red Bank, N.J.-based homebuilder Hovnanian Enterprises Inc., expects to lose contractors to the rebuilding effort because he can’t pay as much as the insurance industry. “We have a fairly large base of trade labor, and I will remind them of where their loyalty is,” he says. “When the remodeling work dries up, we’re still here.” —Margaret Newkirk, Thomas Black, and Prashant Gopal

“If I’m seeing police are picking up a lot of people... I’d leave for another state”

THE BOTTOM LINE Wages for construction laborers rose 10 percent to 16 percent annually in New Orleans after Katrina and will likely rise even faster in Houston.



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Doctors Without Patients



● More med school grads are going into business rather than practicing

Matthew Alkaitis, a third-year student at Harvard Medical School, is calm, friendly, and a good listener—the kind of qualities you’d want in a doctor. But though he spends 14 hours a day studying for his board exams, the 29-year-old isn’t certain how long he’ll be wearing a white coat. In September, Alkaitis, who also has a Ph.D. in biomedical sciences, will begin a two-year fellowship at McKinsey & Co., where he’ll be advising clients in the health-care field. “I really hope that my career involves a period of dedicated time taking care of patients,” he says. “But I also have this competing goal to one day start or help build out a company that really adds something new and interesting and innovative to the medical system.”

Like Alkaitis, more people are coming out of medical school and choosing not to practice medicine. Instead, they’re going into business—starting biotech and medical-device companies, working at hedge funds, or doing consulting. In a 2016 survey of more than 17,000 med school grads by the Physicians Foundation and the recruitment firm Merritt Hawkins, 13.5 percent said they planned to seek a non-clinical job within three years. That’s up from 9.9 percent in 2012. A separate Merritt Hawkins survey asks final-year residents: “If you were to begin your education again, would you study medicine or would you select another field?” In 2015, 25 percent answered “another field,” compared with 8 percent in 2006. Among reasons they cited: a lack of free time, educational debt, and the hassle of dealing with insurance companies and other third-party payers.

The trend is worrying, since the U.S. already suffers a shortage of doctors, especially in rural areas. “If you have a large number of people out

training to see patients and taking care of people in our communities, then all of a sudden deciding not to, that’s a concern,” says Atul Grover, executive vice president of the Association of American Medical Colleges. The AAMC projects a nationwide deficit of up to 100,000 doctors by 2030.

Medical students have more career options nowadays, in part because medical and business schools are teaming up to offer joint degrees. There were 148 students enrolled in M.D.-MBA programs in 2016, up from 61 in 2003, according to the AAMC. At Harvard Medical School, in a class of about 160 students, about 14 will pursue the joint degree, and another 25 or 30 plan to get a master’s degree in other areas—such as law and public policy. “We have some students who want to go back to the Midwest and practice in a community setting,” says Dr. Anthony D’Amico, a professor of radiation oncology at Harvard Medical School and an advisory dean. And then there are those “who want to implement skill sets they’ve been blessed with and apply them on a broader scale.”

Dr. Rodney Altman of San Francisco says the time he spends treating patients in the emergency room informs his work as a managing director at Spindletop Capital, a private equity firm that invests in health-care companies. “For me the one-on-one interaction with patients, while important and rewarding, wouldn’t have been as rewarding as being able to impact a larger number of patients,” says Altman.

Some consulting companies are stepping up hiring of doctors. Steffi Langner, a spokeswoman for McKinsey, says her firm is actively recruiting doctors because the analytical skills necessary to be an M.D. are similar to the problem-solving skills a consultant needs.

Dr. Jon Bloom trained as an anesthesiologist and practiced for three months, then enrolled at Massachusetts Institute of Technology’s Sloan School of Management. He says he was inspired by other doctors he knew who were inventors and entrepreneurs. One reason more are choosing that path is that investors are willing to fund them. Figures compiled by the National Venture Capital Association show that investments in medical-related startups climbed from \$9.4 billion in 2007 to \$11.9 billion in 2016. Bloom is co-founder and CEO of Podimetrics, a startup in Somerville, Mass., that has developed a mat device that predicts and prevents diabetic foot ulcers. Bloom says that even though his invention is now on the market after receiving approval from the U.S. Food and Drug Administration in 2015, he’s still living the startup life. “I definitely don’t make nearly as much as what a doctor makes. That wasn’t really important to me,” he says. “My friends who graduated residency many years ago, they have multiple cars, fabulous houses. They did OK. I still occasionally eat ramen noodles.” —*Anne Mostue*

THE BOTTOM LINE A U.S. deficit of doctors may worsen as a growing minority of U.S. medical school grads are choosing other professions.

● According to one projection, the shortage of doctors in the U.S. by 2030 will reach

100k



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LOOK AHEAD

● The U.S. has told the United Nations Security Council that it wants tougher sanctions against North Korea adopted by Sept. 11

● Norway holds parliamentary elections on Sept. 11

● Hillary Clinton's book on the 2016 election, *What Happened*, will be released on Sept. 12

The Unmaking n

Of American Dreams

By pushing DACA to Congress, Trump exposes the deep divisions over immigration inside the GOP and likely makes bridging the gap harder

September 11, 2017

Edited by
Matthew Phillips
and David Rocks

Businessweek.com

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For months, Donald Trump seemed genuinely torn over what to do about the Deferred Action for Childhood Arrivals (DACA) program, the Obama-era initiative that shields immigrants from deportation if they were brought to the U.S. illegally as kids. On the campaign trail, Trump vowed to end DACA, but he's since softened his tone, saying the decision was one of the most difficult he faced and that he would show "great heart" toward the roughly 800,000 so-called Dreamers protected by DACA.

In June a group of Republican state attorneys general, led by Ken Paxton of Texas, decided to force the president's hand and threatened to sue if he didn't end DACA by Sept. 5. Heading into the Labor Day weekend, as reports circulated that Trump would soon rescind the program, the president still struck a supportive tone. "We love the Dreamers!" he told reporters on Sept. 1. Four days later the White House finally said it would rescind DACA and give Congress six months to come up with a solution to the Dreamers' plight. Trump also had Attorney General Jeff Sessions take the stage. In a 10-minute statement, Sessions leveled a blistering critique of DACA, condemning it not only as an illegal overreach by President Obama but as bad policy, saying it denied jobs to hundreds of thousands of Americans, contributed to a surge of unaccompanied minors to the border, and created "terrible humanitarian consequences."

By making the attorney general, a hard-liner on immigration, the face of the administration's position on DACA, Trump exacerbated a major divide within the Republican Party and, intentionally or not, probably made it harder for anti-immigrant conservatives to find middle ground with the pro-business wing of the party, which would prefer to extend DACA's protections through legislation. "I was a lot more optimistic about Congress doing a deal before Sessions started talking," says David Bier, an immigration policy analyst at the Cato Institute. "Sessions totally boxed in Congress by condemning it as he did."

Trump made his decision to rescind DACA against the advice of senior Republican leaders such as Senator Orrin Hatch of Utah, who says he called the president during the week before Labor Day to urge him to preserve the program. Nor did Trump consult much with business leaders or allies outside the White House, according to five people familiar with the matter. He instead focused on recommendations from officials inside the Homeland Security and Justice departments, one of the people said.

DACA threatens to lay bare the civil war over immigration that's been raging inside the GOP for well over a decade. In 2007 a comprehensive immigration bill failed to make it to a vote in the Senate largely because of opposition from Republicans, including Sessions. In 2010, Republicans in Congress overwhelmingly voted against the Dream Act that would have granted citizenship to the same category of immigrants. After the 2012

presidential campaign, an "autopsy" conducted by the Republican National Committee concluded that the GOP needed to do much more to improve its standing among Latinos and immigrants. Trump's victory last year—with his anti-immigrant appeal to the nativist wing of the party—ended any notion that the party had softened its approach.

The divide over immigration was captured in the hours after Sessions' speech by the comments of two Republican members of Congress. Urging passage of a bill protecting Dreamers, South Carolina Senator Lindsey Graham called the issue a "defining moment" for his party at a news conference alongside the Senate's No. 2 Democrat, Dick Durbin of Illinois. By contrast, Representative Steve King of Iowa, a leader of the anti-immigration flank, said any delay to ending DACA that allowed the GOP to codify its protections would be tantamount to "Republican suicide."

A number of vulnerable Republican senators and House members could see their 2018 reelection campaigns threatened by a protracted debate over the program. Jeff Flake of Arizona and Dean Heller of Nevada, the two GOP senators most at risk of losing their seats, have sizable Latino populations in their states and support preserving the protections. Republican House members with similar demographics in their districts have taken the same pro-DACA position, including Mike Coffman of Colorado, Carlos Curbelo of Florida, and Jeff Denham of California. Flake and Heller face Republican primary opponents who're sticking close to Trump on immigration issues.

DACA will likely drop to the bottom of GOP leaders' list of priorities as they face a jam-packed fall schedule of legislative debates. That schedule got a bit lighter on Sept. 6, as Trump sided with congressional Democrats on a tentative agreement to fund the government and lift the debt ceiling for three months as part of a Hurricane Harvey relief bill. That pushes further budget and debt-ceiling decisions to the end of the year, when Republicans also want to rewrite the U.S. tax code. Giving priority to DACA would likely anger their base.

"If they pass a straight-up Dream amnesty, they will go into the elections having failed to repeal Obamacare but having passed amnesty," says Mark Krikorian, who runs the Center for Immigration Studies, a group that favors restricting immigration. Krikorian says he's come away from conversations with administration officials with the impression that the White House has "no legislative strategy" to fix the immigration system and instead has tossed the ball in Congress's court without guidance. "It's the same mistake they made on Obamacare."

Texas Republican Congressman Lamar Smith, the former chairman of the House Judiciary Committee, which oversees immigration policy, insists there will be no discussion about helping DACA recipients without first addressing the wall that Trump wants to build. "They can certainly be part of the discussion, but not until we secure the border." ▶

"If they pass a straight-up Dream amnesty, they will go into the elections having failed to repeal Obamacare but having passed amnesty"

● Percentage of Dreamers living in the nine states that threatened to sue the Trump administration if it didn't begin to phase out DACA by Sept. 5.

| | Share | Rank |
|-------|--------|------|
| Texas | 14.77% | 2 |
| Kan. | 0.78 | 25 |
| S.C. | 0.74 | 27 |
| Ark. | 0.59 | 31 |
| Ala. | 0.50 | 32 |
| Neb. | 0.40 | 34 |
| Idaho | 0.37 | 35 |
| La. | 0.03 | 37 |
| W.Va. | 0.02 | 51 |

◀ Lawsuits to try to save DACA are coming. Democratic attorneys general for New York, Massachusetts, and 14 other states filed a joint suit on Sept. 6. And California is ready to sue on behalf of its 425,000 Dreamers. DACA litigation could win in federal court if plaintiffs land a favorable judge who temporarily reinstates the program. They may even win an appeal if the case is filed in a similarly supportive district such as the Ninth Circuit, which has repeatedly reinforced lower-court rulings in the Trump travel-ban litigation. But any chance of DACA winning permanent legal protection would likely end if it wound up in front of the Supreme Court, where conservatives hold a 5-4 majority.

Trump still doesn't appear to have made up his mind. On the evening of Sept. 5, after a day of debate, he added more confusion to the situation by tweeting that if Congress doesn't "legalize DACA," he would "revisit this issue." No one is sure what he means.

—Sahil Kapur and Kartikay Mehrotra, with Laura Litvan, Shannon Pettypiece, and Jennifer Jacobs

THE BOTTOM LINE Trump's decision to rescind DACA is an omen of intense political and legal bickering in the months to come—even as 800,000 young people are in limbo.

Gaining From the EU But Hating It Anyway

● An isolationist streak threatens to shape Czech elections this fall

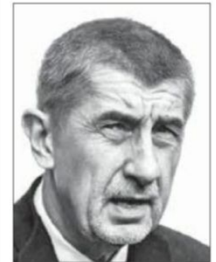
Since joining the European Union 13 years ago, the Czech Republic has become the richest country in the formerly communist east, with a higher living standard than older members Portugal and Greece and the lowest unemployment in the 28-member bloc. Families travel freely, students study abroad, and businesses thrive by exporting to other EU countries. And yet Czechs are less excited than any other European nation about being part of the club: Only a third say that being an EU member is "a good thing"—lower than the crisis-stricken Greeks and the Brexiting Brits—and just a quarter or so want to adopt the euro, according to recent Eurobarometer surveys. "The EU doesn't bring me anything," says Pavel Ricka, a 38-year-old lawyer from Prague. "It's

headed by politicians with very socialist thinking. They want to regulate everything."

That euroskepticism will shape general elections in October and threatens to nudge the Czech Republic toward the kind of isolationism sweeping neighbors Poland and Hungary. Opinion polls give a wide lead to Andrej Babis, a Slovak-born billionaire who crashed the Czech political scene in 2011 and has gained popularity by painting traditional parties as corrupt and incompetent. Like Donald Trump in the U.S., Babis has argued that his business acumen qualifies him to run the country, and he portrays himself as a doer: During his three years as finance minister, he rammed through a bill forcing businesses to link cash registers to the tax office via the internet, significantly improving tax compliance.

Babis remains popular despite the potential for conflicts of interest with a business empire that includes farms, chemical plants, two leading Czech newspapers, and a restaurant in the French city of Mougins that boasts two Michelin stars. A brewing corruption scandal—police say one of his farms illegally received EU subsidies, an allegation he denies—has done little to hurt his appeal to voters.

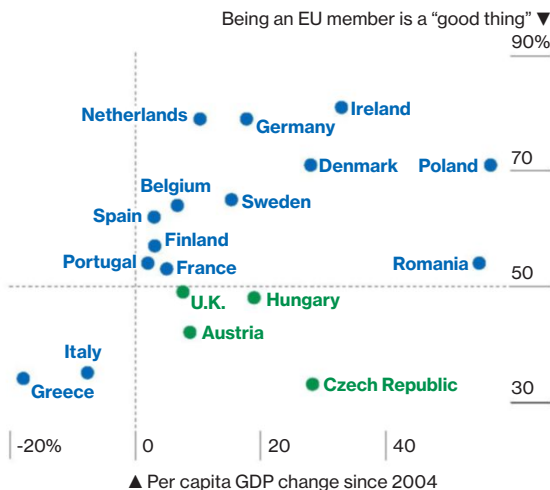
His party, ANO (Czech for "yes," but also an acronym for Action of Dissatisfied Citizens), has attracted voters from both right and left, draining support from traditional parties. Babis, 63, doesn't have quite the authoritarian streak of Hungarian Premier Viktor Orban or Poland's Jaroslaw Kaczynski, but he mirrors their euroskepticism. He's said the EU should set up Ellis Island-style immigrant detention centers in Tunisia and Turkey. He wants NATO to seal the bloc's borders to keep out immigrants. And he's voiced strong support for maintaining the



● Babis

To the Polls in Prague

Czechs dislike the EU despite strong GDP growth since joining



koruna as the Czech currency. “We don’t want the euro here,” Babis says. The common currency “gives Brussels another area for meddling.”

Babis taps into a long-standing wariness of outsiders among Czechs, honed by traumatic histories with the Austro-Hungarian empire, Nazi aggression, and Soviet domination. “Czechs have always been suspicious of anything that seems to control them from the outside,” says Jiri Pehe, the director of New York University in Prague, who served as an adviser to President Vaclav Havel in the 1990s. “There’s a gaping historical wound in the Czech psyche.”

With the exception of Havel, the dissident playwright who became the country’s first post-communist president, Czech leaders have been at best lukewarm toward Brussels. Milos Zeman, the current president, has shown a greater affinity for Russia’s Vladimir Putin and China’s Xi Jinping than for fellow EU leaders. In July 2016, Zeman floated the idea of a referendum on membership, and he’s criticized German Chancellor Angela Merkel as being soft on immigration. Havel’s immediate successor, Vaclav Klaus—arguably the most influential Czech politician of the past three decades—has over the years shifted from grudging acceptance of EU rules to comparing the bloc to the Soviet Union. “We’ve prospered not because of EU membership but in spite of it,” the 76-year-old former head of state says. “The EU has become a dominant centralized power with very little autonomy for its members.”

Even the ostensibly pro-European ruling Social Democrats have opposed EU policies on refugees and adoption of the euro as they seek to shore up support. Foreign Minister Lubomir Zoralek, who’s leading the party into the election, says the next government should focus on narrowing the gap with richer neighbors such as Germany before a shift to the euro. And he says the Czechs shouldn’t be required to accept refugees from border nations such as Italy and Greece. Still, he says, “the EU is our only chance. We won’t find anything better.”

The latest survey by polling agency Median shows the Social Democrats getting only 14.5 percent of the vote, trailing ANO’s 26.5 percent and just ahead of the pro-Russian Communist Party, with 13 percent. A decisive ANO victory could cement the Czechs’ anti-EU views at a time when bigger countries such as Germany and France are discussing a multispeed Europe, with core members pursuing greater integration. Its economic success notwithstanding, the Czech Republic risks finding itself on the bloc’s periphery, says Petr Just, a politics professor at Metropolitan University in Prague. “Lots of people think that since we’re doing so well already we don’t need the EU anymore,” he says. “They point to examples like Norway or Switzerland. But that’s an illusion.” —*Ladka Bauerova and David Rocks*

THE BOTTOM LINE Rising euroskepticism threatens to turn Czechs away from the ruling Social Democrats, benefiting billionaire businessman Babis on October’s ballot.

Cost of

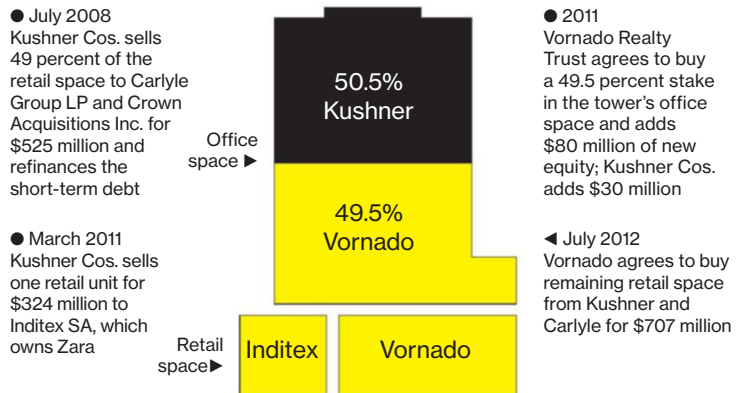
666 Fifth Avenue

Jared Kushner’s family business, Kushner Cos., owes hundreds of millions of dollars on a money-losing 41-story office building in New York City. The mortgage is due in 18 months, and the company has failed to secure foreign investors despite an extensive search.

The Purchase

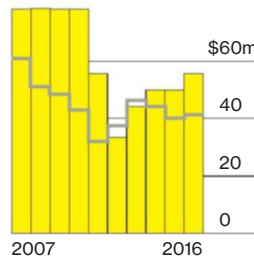
Kushner Cos. paid **\$1.8b** in 2007 putting up only **\$50m** and borrowing the rest

The Kushners have sold all the building’s retail space and half of its office space



Losing Money

Debt service tops profit

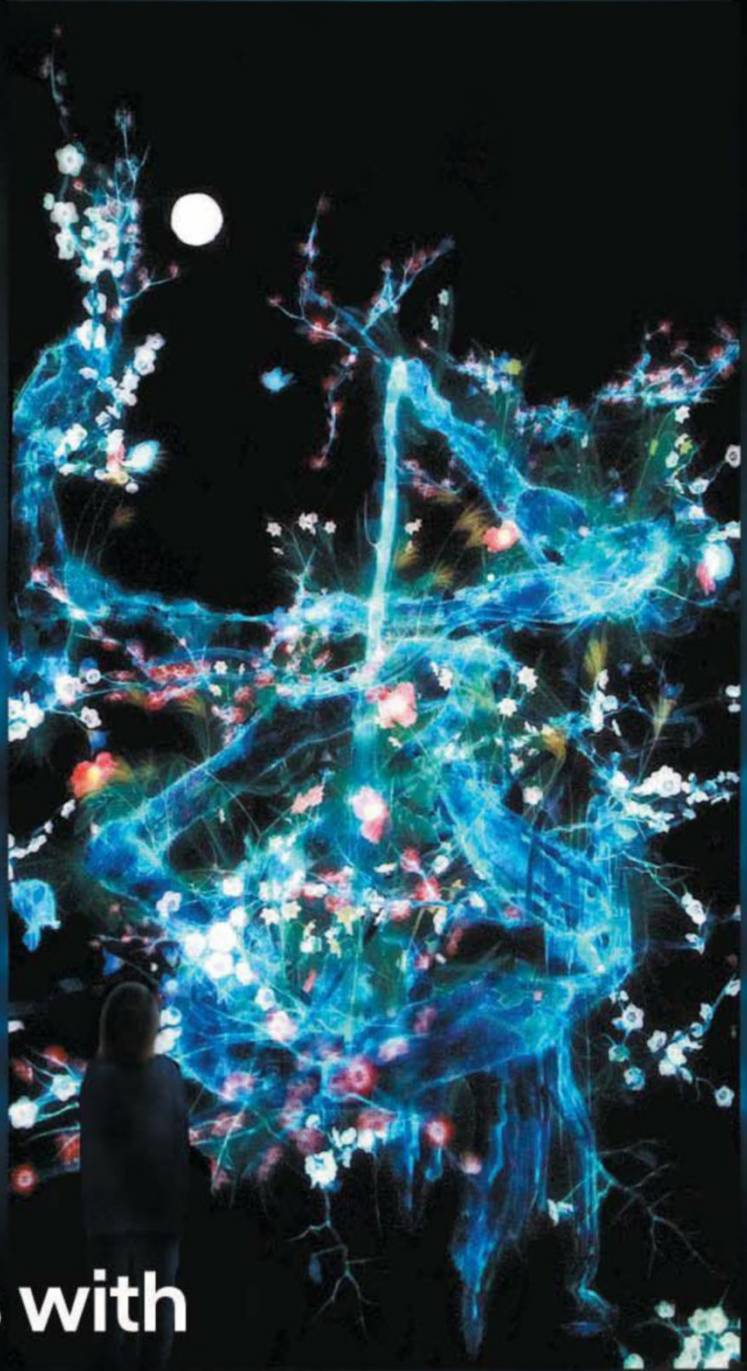


Loan payments have surpassed net income in all but two years the Kushners have owned the building

The company says it will prevail. “Reports that portray it as a distressed situation are just not accurate for the building or for the company,” says Kushner Cos. President Laurent Morali.

—*David Kocieniewski and Caleb Melby*





Feel closer to artists' minds with their own voices



Your full access to today's world of art.

Photo credit: Team Lab

Team Lab, Cold Life, 2014

Brilliant IDEAS

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**Bloomberg
Media**

The here and now feel more urgent than ever, but occasionally it's worth taking a slightly longer view. While it's easy to sigh at the distant promises

of Martian colonies or holodecks, the stuff in these pages isn't all that far off. A decade from now, lifelike virtual assistants and brain-controlled

exoskeletons may seem as obvious and quotidian as, say, having the sum of all human knowledge on the phone in your pocket.

Contents

2017

2017

2018

2019

2020

2022

2023

2030

2035

2038

2040

2060

The Silicon Valley Index p48

Streaming Away From The Censors p50

Founding the \$100 Billion Club p53

Life, or Something Like It p42

Now Boarding for The Titanic Tour p54

We Are The 10% p59

The Unstoppable Budget p59

East Tops West p60

Supersonic Commercial Air Travel Returns p60

Things Are Looking Up For Farming p62

We're Going to Need More Lithium p60

A 6,000-Yard Season p67

The Clean Energy Revolution Is Here p73

How to Move a Town p68

Better Typing Through Mind Control p74

The Navigable Northwest Passage p73

The Sooner Than You Think Issue

Plus: Two pals trying to de-warm the planet p76

**Sooner Than
You Think**

Industries
Artificial Intelligence
Customer Service

2017

A virtual baby capable of learning





Life,

First, Mark Sagar mastered the art of creating super-lifelike faces. Now, he's working to build people from the inside out

Or Something Like It

P people get up to weird things in New Zealand. At the University of Auckland, if you want to run hours upon hours of experiments on a baby trapped in a high chair, that's cool. You can even have a conversation with her surprisingly chatty disembodied head.

BabyX, the virtual creation of Mark Sagar and his researchers, looks impossibly real. The child, a 3D digital rendering based on images of Sagar's daughter at 18 months, has rosy cheeks, warm eyes, a full head of blond hair, and a soft, sweet voice. When I visited the computer scientist's lab last year, BabyX was stuck inside a computer but could still see me sitting in front of the screen with her "father." To get her attention, we'd call out, "Hi, baby. Look at me, baby," and wave our hands. When her gaze locked onto our faces, we'd hold up a book filled with words (such as "apple" or "ball") and pictures (sheep, clocks), then ask BabyX to read the words and identify the objects. When she got an answer right, we praised her, and she smiled with confidence. When she got one wrong, chiding her would turn her teary and sullen.

If it sounds odd to encounter a virtual child that can read words from a book, it's much more disorienting to feel a sense of fatherly pride after she nails a bunch in a row and lights up with what appears to be authentic joy. BabyX and I seemed to be having a moment, learning from each other while trading expressions and subtle cues so familiar to the human experience. That's the feeling Sagar is after with his research and his new company Soul Machines Ltd.

The term "artificial intelligence" has become a catchall for impersonal, mysterious calculations performed behind closed doors. Huge farms of computers crank away at piles of data, using statistics to analyze our internet history, driving habits, and speech to produce targeted ads, better maps, and Apple Inc.'s Siri. This sense of AI as an amorphous shadow falling over more and more of our lives has left people from Stephen Hawking to Elon Musk skeptical of the technology, which tends to feel unnatural, somehow less than real.

Sagar is a leading figure in the camp trying to humanize AI, which he says has the potential to yield a more symbiotic relationship between humans and machines. While he wasn't the first to this idea, his approach is unique, a synthesis of his early years as a computer scientist and later ones in the world of Hollywood special effects. The face, he's concluded, is the key to barreling through the uncanny valley and making virtual beings feel truly lifelike. Soul Machines' creations are unparalleled in this respect, able to wince and grin with musculature and features that move shockingly like ours. They have human voices, too, and are already contracted for use as online helpers for companies ranging from insurance providers to airlines. Soul Machines wants to produce the first wave of likable, believable virtual assistants that work as customer service agents and breathe life into hunks of plastic such as Amazon.com's Echo and Google Inc.'s Home.

Companies with similar aspirations throughout Japan and the U.S. have produced a wide array of virtual avatars, assistants, and holograms. Many of the people behind these projects say AI systems and robots can achieve their full potential only if they become more humanlike. They need to have memories, the thinking goes, plus something resembling emotions, to propel them to seek out their own experiences.

Sagar's approach on this front may be his most radical

contribution to the field. Behind the exquisite faces he builds are unprecedented biological models and simulations. When BabyX smiles, it's because her simulated brain has responded to stimuli by releasing a cocktail of virtual dopamine, endorphins, and serotonin into her system. This is part of Sagar's larger quest, using AI to reverse-engineer how humans work. He wants to get to the roots of emotion, desire, and thought and impart the lessons to computers and robots, making them more like us.

"Since my 20s, I've had these thoughts of can a computer become intelligent, can it have consciousness, burning in my mind," he says. "We want to build a system that not only learns for itself but that is motivated to learn and motivated to interact with the world. And so I set out with this crazy goal of trying to build a computational model of human consciousness."

Here's what should really freak you out: He's getting there a lot quicker than anybody would have thought. Since last year, BabyX has, among other things, sprouted a body and learned to play the piano. They grow up so fast.

Unlike most of those working in Silicon Valley, Sagar doesn't reflexively defer to engineering. "When scientists see the world and artists see the world, they are looking at the same thing," he says, "using a different language and viewpoint to describe it. But it's all true. Everything is interconnected."

He got that idea early. When he was born in Nairobi in 1966, his father was working for the East African Railways and Harbours Corp. as a systems analyst, programming punch-card computers to run the train infrastructure. His mother, a painter, took him to game reserves every Thursday to practice drawing animals. A few years later, the family moved to New Zealand, where Sagar started helping his dad DIY around the house—fixing the TV, monkeying with the plumbing, tuning up the cars. He kept honing his drawing skills, too, paying particular attention to his mom's portrait work. "She was able to almost capture somebody's likeness with about three lines, getting someone's curves just right," he says. "It made me really conscious of the importance of the exact curves of people's eyes and mouths and things like that."

Sagar made use of those observations as a young man abroad, when he sketched portraits for cash on the street and in restaurants. Like many youngsters from his part of the world, he took an extended break between high school and college. For four years he crisscrossed the globe, drawing, bartending, selling door to door, even filling sandbags for the Australian army to pay his way. After returning to New Zealand, he earned a Ph.D. in engineering from the University of Auckland, then pursued post-doctoral work at MIT. In Massachusetts, he and some colleagues built digital models of the human eye that were detailed and lifelike enough for surgeons to use for practice. By 1998, Hollywood had called on Sagar to try to make computer-generated imagery, or CGI, look less CG.

His first project was a remake of *The Incredible Mr. Limpet*, which called for Sagar's team to morph Jim Carrey into a talking fish capable of hunting Nazi U-boats. (Yes, really. The original starred Don Knotts.) Warner Bros. Entertainment Inc. abandoned the project after paying for \$10 million in digital Carrey-fish expressions, deeming it too costly for a full-length film. Sagar, however, wasn't ready to stop working on digital faces. For a couple of years he used the creatures as the basis of a virtual assistant startup called Life F/X and had his faces read emails



aloud. The company died with the dot-com bubble, so Sagar took a job doing special effects for Sony Pictures Imageworks Inc. (*Spider-Man 2*). That made him well-known in the movie business and led him back to New Zealand in 2004.

At Weta Digital, the effects shop run by *Lord of the Rings* director and fellow Kiwi Peter Jackson, Sagar won two Academy Awards in seven years, overseeing the digital character creation for Jackson's *King Kong* remake and James Cameron's *Avatar*. His synthesis of engineering and artistry had provided him with an advantage in making Kong and the alien Na'vi seem real. Years of drawing portraits and crafting virtual eyeballs had given him insights into the nuances of the face that are uncommon among CGI specialists, while his effects software has made it relatively easy to film an actor going through a range of emotions and to automatically fuse the expressions into, say, a giant gorilla. "It's these almost imperceptible movements in the eye and face that we pick up on as something having a soul behind it," he says.

Feeling he'd solved the riddles of the face, Sagar dreamed bigger. He'd kept an eye on advancements in AI technology and saw an opportunity to marry it with his art. In 2011 he left the film business and returned to academia to see if he could go beyond replicating emotions and expressions. He wanted to get to the heart of what caused them. He wanted to start modeling humans from the inside out.

At the University of Auckland, Sagar created the Laboratory for Animate Technologies and recruited about a dozen researchers. Far from Weta—or his Life F/X office on Hollywood

Boulevard, with Bob Marley's star out front—the Animate team worked in a cramped room kept permanently hot and sticky by the heat from their powerful computers. When I saw the space last year, the engineers were surrounded by giant animated faces projected onto the walls, every pore and eyebrow hair distinctly rendered. Far from being lifeless, the faces appeared eager to strike up conversations, their muscles contracting and relaxing with each breath.

At the back corner of the lab, Sagar sat amid a clutter of notes and books such as *The Archaeology of Mind* and *Principles of Computational Modelling in Neuroscience*. It was there, on his pair of massive computer monitors, that he put BabyX through her virtual paces. The baby represented the culmination of much of the lab's efforts, combining Sagar's facial artistry with the latest in AI learning and speech software. Underneath that cherubic face, there was also some pioneering, and borderline horrifying, technology.

With a click of his mouse, Sagar stripped away BabyX's skin, leaving a floating pair of eyes—bloody veins and all—attached to a finely detailed brain with a brain stem running down the back. This version of BabyX could still see out into the world and interact with us. When we showed her words, the part of the brain that deals with language glowed purple. When we praised her, the pleasure center lit up yellow. "Researchers have built lots of computational models of cognition and pieces of this, but no one has stuck them together," he said. "This is what we're trying to do: wire them together and put them in an animated body. We are trying to make a central ►

◀ nervous system for human computing.”

Sagar clicked again, and the tissue of the brain and eyes vanished to reveal an intricate picture of the neurons and synapses within BabyX’s brain—a supercomplex highway of fine lines and nodules that glowed with varying degrees of intensity as BabyX did her thing. This layer of engineering owes its existence to the years Sagar’s team spent studying and synthesizing the latest research into how the brain works. The basal ganglia connect to the amygdala, which connects to the thalamus, and so on, with their respective functions (tactile processing, reward processing, memory formation) likewise laid out. In other words, the Auckland team has built what may be the most detailed map of the human brain in existence and has used it to run a remarkable set of simulations.

BabyX isn’t just an intimate picture; she’s more like a live circuit board. Virtual hits of serotonin, oxytocin, and other chemicals can be pumped into the simulation, activating virtual neuroreceptors. You can watch in real time as BabyX’s virtual brain releases virtual dopamine, lighting up certain regions and producing a smile on her facial layer. All the parts work together through an operating system called Brain Language, which Sagar and his team invented. Since we first spoke last year, his goals haven’t gotten any more modest. “We want to know what makes us tick, what drives social learning, what is the nature of free will, what gives rise to curiosity and how does it manifest itself in the world,” he says. “There are these fantastic questions about the nature of human beings that we can try and answer now because the technology has improved so much.”

Not long after my first play date with BabyX, Sagar packed up his lab and researchers and moved them to the top floor of Auckland’s iconic Ferry Building, where he started Soul Machines to commercialize his team’s breakthroughs. By his standards, the near-term commercial applications are pretty straightforward. About 45 staffers, including artists, AI experts, language experts, and coders, are building a cast of virtual assistants. For the most part, these are refined versions of Sagar’s Hollywood work, only they’re smart enough to understand spoken language and respond to queries, with less of the creep factor characteristic of virtual people.

The first face Soul Machines revealed to the world, in February, is Nadia, a pretty white woman with pulled-back brown hair, greenish eyes, pink lipstick, and Cate Blanchett’s voice. Sagar’s team developed her for Australia’s National Disability Insurance Agency, which plans to employ her as an online aid for the country’s 500,000 people with disabilities. The hope is that those interacting with Nadia on the agency’s website will find her more personable and usable than text-based chatbots or the menu trees on its automated phone line.

The interactivity goes both ways, according to Sagar. Nadia gives a subtle nod to signal understanding and appears quizzical when confused, but she also interprets viewers’ expressions through the cameras on their PCs or mobile devices. “If you look confused, it can see that and proactively guide you,” Sagar says. “You can also still yell at these

things, but they will respond in the most gracious way. People are good at dealing with irate customers and adjust their body language for the situation. We can do the same thing.”

Sagar had some help with Nadia, using International Business Machines Corp.’s Watson technology as the basis for her speech recognition. His company hired Blanchett to spend 15 hours recording phrases that the software can turn into a much wider variety of responses to questions. Nadia has already been tested on 10,000 people, who taught her to refine her answers and the emotions she displays at certain times. The Australian government expects her to start full-time work early next year.

Soul Machines has 10 trials under way with airlines, health-care providers, and financial-services firms. In the early going, the company’s biggest test will be whether users find its software realistic enough to be as satisfying as human conversation. Even successful customer-relations experiences with chatbots, ones where the bot gives the right answer, tend to leave people dissatisfied because they feel like they’ve been pawed off on an inferior being.

For now, Sagar’s team has been developing each of its first few virtual assistants in a one-off fashion, a bit like a consulting company. “Most of our clients today see their first digital employee as an extension of their brand,” says Chief Business Officer Greg Cross. “They are going through a design process that is similar to selecting a spokesperson for your TV advertising campaign.”

To make its process easier to repeat, Soul Machines is writing character creation software that reduces development to a series of simple menus. By sliding a few dials, Sagar can transform a young, thin avatar into an older, chubbier one and alter complexion and other features. Each menu-built result looks as lifelike as a character that a film production or video game developer might spend millions of dollars and many months to create. The company has paid actors to record hundreds of hours of monologue, assembling an audio library it can use to give voice to characters such as a troll meant for a client in Scandinavia or an animated, anthropomorphic strawberry that’ll be used on an educational site for children.

As the technology matures, Cross expects it to travel further from the PC screen. Automakers are already thinking about the characters fielding questions and answers from riders on screens in their self-driving cars. Similarly, Amazon, Apple, and Google parent Alphabet will likely want faces to go with their voice-activated virtual assistants. “We’re also exploring the idea of creating a digital celebrity,” Cross says. “What if you could take one of the top recording artists or sports people and build a digital version that fans could interact with in a very emotionally intelligent way?”

Like Cross, Sagar often appears oblivious that his pitch might sound creepy. In August, when I pay a visit to Soul Machines to see Sagar’s latest creations, he’s wearing a T-shirt that depicts two fetuses sharing a womb, arranged head-to-toe in a kind of yin-yang pose. One

| |
|---------------------------|
| “We want to |
| know what |
| makes us tick, |
| what drives |
| social learning, |
| what is the nature |
| of free will” |

of the fetuses is human; the other has a distinctly artificial brain filled with circuitry. He wanted to make this design the company logo. The investors who gave him \$7.5 million last November said no.

Sagar comes off like a visionary academic, at times almost possessed. Ask a basic question, and you're likely to get an impassioned 30-minute response that weaves in AI, art, psychology, and Plato. It's hard to imagine this man holding court with a car insurer, trying to sell a suit-wearing executive on a virtual avatar, without things getting weird. But Sagar says he relishes the commercial part of the business, because it's helping him better understand what people like and don't like about his avatars and zero in on the finer details of interpersonal interactions.

Version 5.0 of BabyX has gone far beyond the original floating head. She now has a full body that sits in a high chair, legs bobbing back and forth while her hands look for something to do. For the next part, you'll want to sit down and grab a pacifier, too.

Sagar's software allows him to place a virtual pane of glass in front of BabyX. Onto this glass, he can project anything, including an internet browser. This means Sagar can present a piano keyboard from a site such as Virtual Piano or a drawing pad from Sketch.IO in front of BabyX to see what happens. It turns out she does what any other child would: She tries to smack her hands against the keyboard or scratch out a shabby drawing.

What compels BabyX to hit the keys? Well, when one of her hands nudges against a piano key, it produces a sound that the software turns into a waveform and feeds into her biological simulation. The software then triggers a signal within her auditory system, mimicking the hairs that would vibrate in a real baby's cochlea. Separately, the system sets off virtual touch receptors in her fingers and releases a dose of digital dopamine in her simulated brain. "The first time this happens, it's a huge novelty because the baby has not had this reaction before when it touched something," Sagar says. "We are simulating the feeling of discovery. That changes the plasticity of the sensory motor neurons, which allows for learning to happen at that moment."

Does the baby get bored of the piano like your non-Mozart baby? Yes, indeed. As she bangs away at the keys, the amount of dopamine being simulated within the brain receptors decreases, and BabyX starts to ignore the keyboard.

Sagar has teamed up with Annette Henderson, a psychologist who runs a baby research lab in Auckland, to advance the technology. Henderson has filmed hundreds of hours of interactions between babies and caregivers while performing different experiments, such as teaching a baby a new word or ignoring him for a few minutes. The children's response data—laughs, cries, hand movements, shifts in posture—are being digitized to create a better-informed behavioral model. "We know the exact movements, microexpressions, and responses," Sagar says. "When we build our next models for BabyX, we should be able to generate this same behavior."

In about 18 months, Henderson plans to use an upgraded version of BabyX to run experiments with caregivers and other children. She sees the virtual baby as a way to test new theories in previously unimaginable ways, by altering thousands of variables at will—what if a baby doesn't smile, what if she

won't hold your gaze, and so on. Studying a virtual child's response to stimuli, Henderson says, may help researchers understand how to better engage with flesh-and-blood children who aren't particularly social.

In return, Sagar gets to advance his quest to understand human nature. "We can record the mother interacting with a virtual baby and keep adding features to BabyX until she is so lifelike that we get a natural interaction," he says. "At that point, we have achieved our goal."

And then what?

Many of the world's leading brain researchers have come away impressed by the types of simulations Sagar and other AI optimists are building. "I spend more and more time with these guys," says Gary Lynch, a professor of neurobiology at the University of California at Irvine. "This is all real. It's not an academic enterprise any longer." The problem with work like Sagar's, as Lynch sees it, is that the end result—a truly conscious virtual baby—is so complex and unique that it's not a useful mirror of human behavior. "It will do something that nobody ever dreamed of," he says. "It will head out the door and say, 'Goodbye. I have stuff I want to do.'"

Other researchers caution that Sagar could be misleading people about the state of the technology through his cute, intricate faces. "Westerners tend to want to anthropomorphize these things, and we can get very enchanted by them," says Ken Goldberg, a professor of industrial engineering and operations research at University of California at Berkeley. "If you make it look human and act human, you almost have a double responsibility to be clear about its limitations." He applauds Sagar for doing this type of research but doesn't want people to get false hope about the near-term benefits of such technology. Sagar has a tendency to talk as though BabyX can already do all the things he's dreaming.

While it seems reasonable to assume Sagar's endgame is a world that ties humans inextricably with machines, he often spends weekends in the wilderness to get away from computers, and he won't let his kids use the internet at night. This isn't exactly the type of behavior one might expect from someone pushing AI as fast as he can into the unknown and hoping for the best. During one of our conversations, I point out that tales such as *Frankenstein* don't usually end up well for the humans. "We're not digging up dead bodies," he says, neatly dodging the real moral of the playing-God story.

You don't have to be paranoid to believe the rise of AI could turn out quite badly for humans. The computers might start making decisions for themselves, and those decisions could include things detrimental to mankind. One minute, BabyX is eating a virtual pudding cup off a website; the next, she's sold your house for personal amusement, or decided she should be in charge.

Sagar remains sanguine about the lessons AI can learn from us and vice versa. "We're searching for the basis of things like cooperation, which is the most powerful force in human nature," he says. As he sees it, an intelligent robot that he's taught cooperation will be easier for humans to work with and relate to and less likely to enslave us or harvest our bodies for energy. "If we are really going to take advantage of AI, we're going to need to learn to cooperate with the machines," he says. "The future is a movie. We can make it dystopian or utopian." Let's all pray for a heartwarming comedy. **B**

Sooner Than You Think

Industries

Electronics

Software

Biotech

2017 2017

While much of the U.S. strives to be more like Silicon Valley, the Valley will become more like itself.

Lots of places in America want to become technology hubs. We ranked about 300 metro areas based on 12 equally weighted criteria, some positive and some negative, to determine their similarity to the Valley.

San Francisco

-based companies received \$23 billion in venture capital in 2016, the most per resident of any metropolitan area

San Jose

is home to 26 of the 100 largest technology companies on Nasdaq

Both the good and the bad

Boulder, Colo.

has the highest rate of broadband access, some 89 percent of households

◀ The good stuff

The closer a metro area is to the left side of the page, the more like Silicon Valley it is in nine positive ways: rates of college education, science and engineering majors, top universities, headquarters of big tech companies, venture capital investment, share of jobs in computer-systems design and related services, broadband subscription rates, independent coffee shops, and commutes by bike, public transportation, or on foot.

Ithaca, N.Y.

home values are 26 percent of San Jose's

Tech without the

2060

Story

Dorothy Gambrell and Peter Coy

So You Want to Be Like Silicon Valley?

Boston

is home to 7 of the 100 top-ranked universities in the U.S.

■ Washington, D.C.

End of Silicon Valley

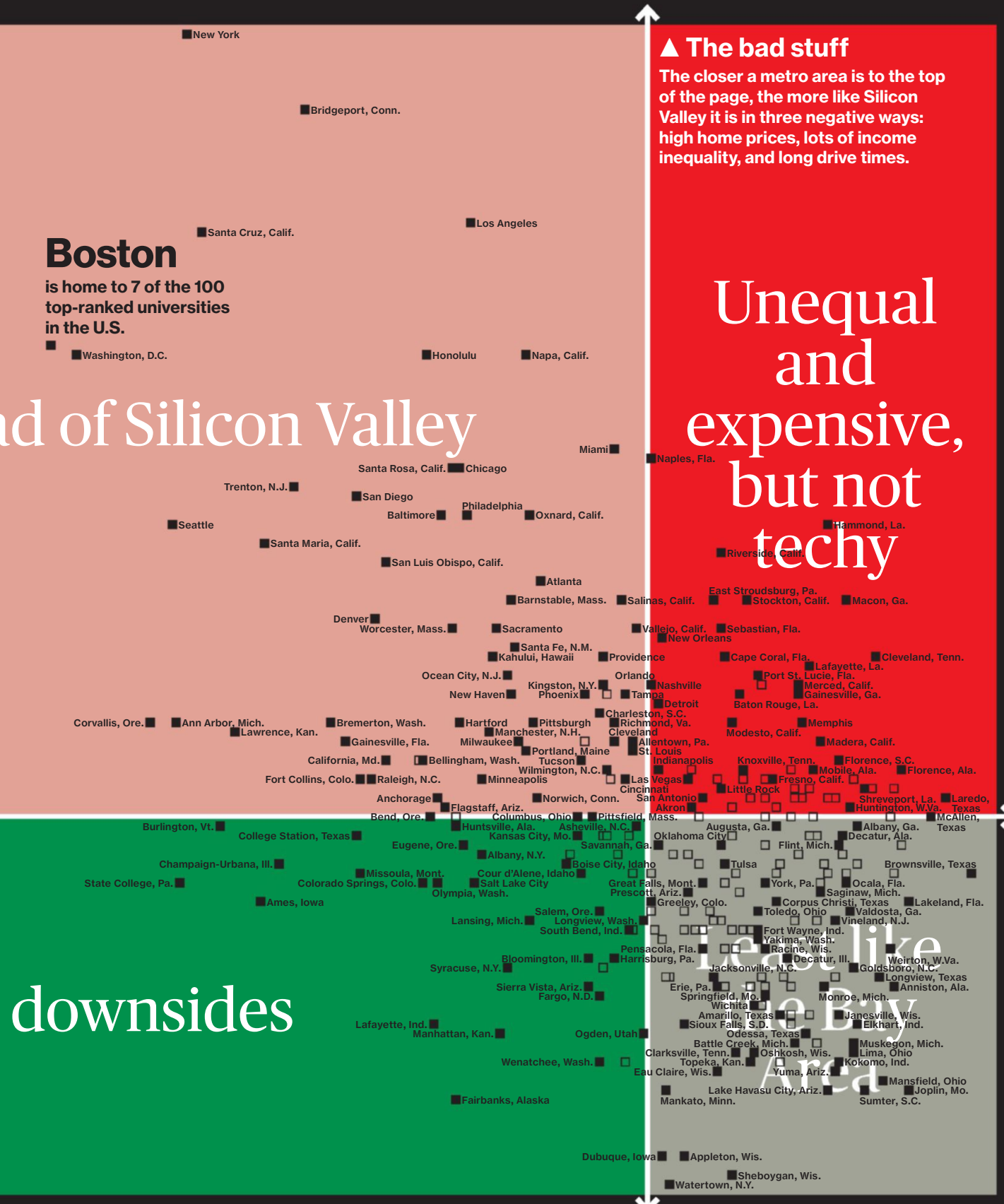
▲ The bad stuff

The closer a metro area is to the top of the page, the more like Silicon Valley it is in three negative ways: high home prices, lots of income inequality, and long drive times.

Unequal and expensive, but not techy

downsides

Area like the Bay



Sooner Than
You Think

Industries

Marketing

Entertainment

2017

More than 200 million people in China watch livestreams

Streaming

Sara Jane Ho (red dress)

50

In China, young people are making money—and waves—by finding their voices online, in real time. It's either the future of social change or the future of government crackdowns





Kyle (left) and Klaus with Coal Black, their dog



Fan "Troy" Hongyi

Away From The Censors

This spring, Jin transformed a corner of his three-person Beijing dorm room into a makeshift live-streaming studio. For privacy, the skinny 24-year-old grad student pressed sticky hooks to the ceiling in a semicircle and hung a pale-green shower curtain around his wooden desk. He bought a lamp for backlighting and a plastic stand to hold his iPhone roughly at eye level. He even persuaded his roommates, both fellow biology Ph.D. candidates, to stay away most evenings from 7 p.m. until midnight. That's when he pulls the curtain to hide the dingy concrete

walls, takes out his bags of makeup, and streams live video of himself on the internet.

One typical night, Jin glances between his small lavender mirror and the iPhone while he draws a blush-tipped brush languidly along his cheekbones and pencils in arched eyebrows. As a mellow playlist cycles in the background, he chats with a few dozen viewers—he talks, they type—occasionally turning his head from side to side to show off his profile. He dons a long black wig, then laughs, flipping the locks over his shoulder. “This wig doesn’t suit my outfit,” he says. “I’ll ▶

◀ change it.” The next one is red; a fan writes, “So beautiful.”

Jin recognizes some of these regulars, who’ve subscribed to his channel and are notified when he logs on. “I haven’t seen you for a while,” he says when a longtime viewer greets him. “What are you doing?” The response: “I’m missing you.” Unending affirmation is hard not to love, which explains why Jin is reluctant to pause and be interviewed. “I started livestreaming because my school life is boring,” he says, “and I wanted something more exciting.”

The grad student has known since middle school that he’s gay, but he isn’t out to family or most friends. In China homosexuality was a crime until 1997 and was labeled a psychiatric disorder until 2001. Public acceptance is fragile; there are no antidiscrimination employment protections, same-sex marriage is illegal, and some parents still push LGBT children into electroshock “conversion” therapy.

Jin says he feels freer to be himself alone in his dorm. A few months ago he decided to try the new livestreaming function on Blued, China’s largest gay-dating app. Some 15,000 fans now send him a steady supply of “beans,” a virtual currency that converts to as much as 1,800 yuan (\$274) a week after the app takes its 70 percent cut. (Certain stars negotiate a 50-50 split.) That means he makes more than the average salary in large Chinese cities.

China didn’t invent livestreaming, but the country has taken to it with fervor. In the past couple of years, the broadcasts have gone from nerd fringe to mainstream, with more than 200 million of China’s 730 million internet users watching on at least 1 of 200 Chinese apps, according to PwC. Viewers are transforming the economy with beans, hearts, and red envelopes; Credit Suisse Group AG estimates that all of the virtual thumbs-up, plus product sales spurred by promos, will total almost \$5 billion this year, up from about \$750 million in 2014. By comparison, the nation’s movie theaters expect to collect about \$6.6 billion in box-office revenue.

The broadcasts aren’t just kids behind shower curtains. “Livestreaming is being adopted by a whole slew of industries, whether it’s education or news or boutique grocery shopping,” says Shaun Rein, founder and managing director of China Market Research Group in Shanghai. Now there are livestreaming functions on leading online services including Alibaba’s shopping site, Taobao China, and Sina’s Weibo, China’s equivalent to Twitter.

With the public’s embrace, streaming has become a bigger target for government censors. As China’s regime tightens its grip on the internet—a stark and aggressive trend since the beginning of the year—it’s unclear if the quirky and chaotic livestreaming space will survive. Much of its allure depends on the perceived intimacy and authenticity that comes with somebody talking to you from his bedroom, a contrast to scripted state media broadcasts. “There’s not much trust of any establishment in China,” says Sara Jane Ho, a Beijing lifestyle guru who streams. “People want to see something real and unexpected.”



From Day One, China’s livestreaming platforms have included systems for micropayments so content providers didn’t need to rely on advertisers. Early audiences were mostly guys under 25 living in third-tier cities without a lot of entertainment options; the first hit sites, such as YY, featured geisha-style entertainers. Livestreaming’s influence widened as dating apps such as Blued and Momo, as well as Taobao and Weibo, added the function.

Ho doesn’t need to appeal to young men in provincial backwaters. She uses Weibo’s partner app, Yizhibo, to raise her profile among potential nouveau riche clients seeking lessons in etiquette, fashion, and social graces. She styles her hair and makeup neatly to talk on camera with friends about how to pick the most flattering bikini. But she says fans respond most enthusiastically when things go awry. Occasionally, a shop owner refuses to be filmed, or she shows up to a building that’s locked. Spontaneous connection is “the quickest way to grow your fan base,” says Ho, who was raised in Hong Kong and attended Harvard Business School.

Her approach is becoming more common among the young and business-minded in China, who see livestreaming as an intimate branding opportunity. On a Friday night in early June, Fan “Troy” Hongyi and Zhou Zhou are sitting on a black sofa in their Beijing office, clad in T-shirts and cargo shorts and clasping pillows that read “I Love London” and “Keep Calm and Carry On.” The teachers at New Oriental Education & Technology Group Inc., one of the country’s most successful education companies, are about to begin a 90-minute livestream on Yizhibo doling out “language tips for surviving overseas,” as the message to Fan’s 141,000 followers reads.

The men, in their early 20s, mix jokey banter with practical advice. An off-camera colleague operates a desktop speaker, adding exaggerated electronic sounds such as studio applause. First they cover lost-in-translation basics, such as how to answer the question “Where are you from?” The correct answer should be a country, not the last place you were. “Don’t say you’re from the toilet!” Fan says.

Next they review cultural touchstones that an overseas Chinese student could use to bond with English or American peers, including *The Vampire Diaries*, Backstreet Boys, and Jack Daniel’s. (Zhou pantomimes gulping from a bottle.) By now they have about 2,700 people watching. They close by offering cheesy pickup lines to a viewer asking for dating advice. Responding

to questions is crucial, Fan says after the broadcast, because interaction is what makes livestreaming better than TV.

Which might explain why, “instead of 600 cable channels, you have millions of livestreams,” says William Bao Bean, a partner at venture firm SOSV and managing director of Chinaccelerator in Shanghai. This spring, Bao Bean’s accelerator attracted 1.3 million viewers to a Yizhibo stream of startup founders sharing business advice.

Livestreaming might also translate into off-screen fame. In June the app Momo rented a soundstage in Beijing’s Chaoyang Park, equipped it with strobe lights, and brought 10 of its most-followed livestreamers onstage in sparkling formal wear to belt out Chinese pop anthems. The performances, mostly duets and trios, resembled *American Idol*, and executives from BMG, the music label and talent agency, were there to announce a partnership aimed at selecting starlets to pack off to Hollywood. “I didn’t understand the lyrics,” BMG Executive Vice President Thomas Scherer told two stiletto-clad singers after they finished their song, but “you both have amazing voices.”

Even China’s government is experimenting with streaming official propaganda, such as Premier Li Keqiang’s annual work report. More attention from Beijing, however, may also threaten the medium’s range of possibilities. As education companies and Hollywood powerhouses have turned to livestreams to hunt for customers and talent, the government has started to impose new restrictions. “Politically sensitive” material and porn have always been off-limits, but some of the latest decrees are laughably precise, including a ban on women suggestively eating bananas, while others are intentionally vague so that officials can enforce them as they please.

Earlier this summer, the Ministry of Culture cracked down on 30 livestreaming apps without defining what the services had done wrong. Overnight, a dozen were shuttered. The government says it’s also banned more than 2,000 hosts for behavior that “offended socialist core values and brought negative impacts to the healthy growth of youth and teenagers,” according to a statement from the Cyberspace Administration of China, which oversees internet content.

Streaming companies have responded by employing armies of in-house censors. About a quarter of Blued’s 230-employee Beijing office is dedicated to real-time monitoring of user accounts. One Beijing-based nonprofit says a planned livestream raising awareness about young people’s options for mental health care was abruptly canceled by its app partner shortly after the latest crackdown. On the streaming app Inke, a standard disclaimer scrolls across every broadcast: “If you see livestreams about protests, please report such behavior—the platform will handle it immediately. The Internet police is patrolling 24 hours a day.”




Jin ran afoul of the Blued censors once this spring when he uncrossed his legs and—accidentally, he says—his dress tugged up to partially reveal his underwear. Instantly, his feed was cut off. A professional livestreamers group (Jin is one of a few hundred members) negotiated with Blued to get him reinstated.

Some livestreamers are full-time, but Jin says he’s not planning to give up his studies. His biology research focuses on genetically modified organisms, which he says is a promising line of work. It just doesn’t offer the rush he feels in front of his iPhone.

As more streamers win followings, optimists see the enormous market and cultural value boding broader changes. “I hope we can help people feel less pressure, less discrimination because of their differences—no one should feel inferior,” says Blued founder Geng Le, a 40-year-old former cop.

Livestreamers Kyle and Klaus might foster the kind of tolerance that Geng is after. The young couple bought their first apartment a year ago in northern Beijing, a rite of passage for middle-class Chinese. Unlike Jin, these young men have painstakingly won the acceptance of their close family and friends. On their Blued stream, they typically putter around the house, bantering about Klaus’s work as a research scientist or Kyle’s neglected dancing talents. Sometimes they play with their rescue mutt, Coal Black. It’s all fairly mundane, says Kyle, wondering aloud why they have 15,000 fans. He hoists Coal Black into his arms, then answers his own question.

“Many people must watch us to imagine what it would be like to be an out gay couple, to live together in China, not as a secret,” Kyle says. “What we show on our livestream, it is daily life for us, but it is someone else’s fantasy.”

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| Industry | 2019 | Story |
| Wealth | | Andre Tartar |
| <h2>The \$100 Billion Brotherhood</h2> <p>As long as their net worths continue to grow at the rates they have for the past five years, as tracked by the Bloomberg Billionaires Index, three people will pass the 12-figure mark within the next two years.</p> | | |
|  3/7/2018 Jeff Bezos Amazon founder and CEO |  7/20/2018 Mark Zuckerberg Facebook co-founder and CEO |  4/24/2019 Amancio Ortega Inditex majority owner and CEO |
| <p>What about Microsoft co-founder Bill Gates and investor Warren Buffett, currently ranked first and fourth among the world’s richest? Both are held back by their philanthropy, which has included a \$4.6 billion gift of Microsoft stock from Gates in June and Buffett’s plan to give away 4 percent of his Berkshire Hathaway stock annually.</p> | | |

Sooner Than
You Think

Industries

Tourism

Research

2017

2018

Booking trips to the ocean's deepest point

54 Titanic
visits



Rush in *Cyclops 1* at OceanGate's headquarters in Everett, Wash.



Now Boarding For the *Titanic* Tour

Stockton Rush is building the most advanced privately owned minisub in the world. Where would you like to go?

For years upon years, Stockton Rush dreamed of leaving this earthly plane. “I wanted to be an astronaut,” says the man with the satin pilot’s jacket and the lustrous silvery mane, speaking at New York City’s Explorers Club, one of the few places where a guest might really encounter someone who’s exited our planet’s atmosphere. Rush learned to fly as a teenager specifically for that purpose, but he became disillusioned with the narrow scope of manned space exploration. He wanted to go far and find new worlds. “I eventually realized I wasn’t going to get to Jupiter or Mars,” he says. Which was OK, because Rush found a new and even more mysterious universe to explore. “I realized that all the cool stuff I thought was out there is actually underwater,” he says, then begins clicking through slides of creatures from the extreme deep. These are the fish of nightmares and sci-fi films: They have huge eyes or no eyes, spiny protuberances, enormous teeth, exoskeletons. “Here’s the creature from *Alien*,” he says, showing a slide from the film, and then, click—something in our oceans that looks a heckuva lot like the creature from *Alien*. Click. “Here’s the goblin shark.” Click. “And the barrel-eyed fish, one of my favorites. It was brought up in nets ▶

◀ over the years, but until someone saw it underwater, we didn't know that its eyes rotate up inside its gelatinous skull."

There's no better place to pitch audacity than the Explorers Club, and Rush has come to New York to raise awareness of his quest to reignite curiosity about the abyss. The 55-year-old Seattle native has spent much of the past decade drumming up support for deep-sea exploration, and he's found people mostly uninterested—or at least wary. Rush longs to shine lights into the dark realms of the ocean, to 3D-map ancient wrecks, to study the bizarre ecosystem of hydrothermal vents, and to see the barrel-eyed fish in its element, but he keeps running into the same problem: There's no good way to get down there and do any of that.

Small, robust, deep-diving submarines known as submersibles are the spaceships of the deep, and they're in preciously short supply. "I didn't understand why there were only a few submersibles in the world that could go to the average depth of the ocean," Rush says. That's about 3,800 meters (12,500 feet)—or so we think. The ocean floor is only crudely mapped. We know it less well than we know the surface of the moon.

Approximately half of the ocean is at least 3,000 meters deep, and there are four active vessels capable of getting there, each owned and operated by a national government and not available to the private sector: France's *Nautile* (which can dive to 6,000 meters), Japan's *Shinkai* (6,500 meters), China's *Jiaolong* (the newest and deepest diving, capable of 7,500 meters), and the U.S.'s *Alvin* (4,500 meters and best known for helping to find the wreck of the *RMS Titanic*). "A couple of years ago, *Alvin* celebrated his 50th birthday," Rush says with a smirk, as an image of the rotund, almost cartoonish little sub pops up among the slides. "There are not many pieces of high-tech equipment that celebrate 50th birthdays." *Alvin* has been "massively upgraded," he says, "but it is an interesting statement on how much money has been invested, or not invested, in submersibles."

Rush earned his money "the old-fashioned way," he says. "I was born into it and then grew it." His grandfather was an oil and gas magnate who made a fortune in Indonesia. Rush has been investing in startup companies most of his adult life while also working in aviation. He was a commercial jet transport pilot at 19 and later a flight-test engineer for McDonnell Douglas Corp. When he has time, he still flies the Glasair III experimental airplane he built from a kit, but since he acquired his first submarine in 2003, his focus has been on exploring underwater. That sub, a crude, two-person tube based on plans once sold in the back of *Popular Science*, looks like a steampunk sculpture that pattered out of Burning Man or a giant propane tank that fell on its side. ("I hate when people say that," Rush says.)

He bought the sub partially assembled out of a dusty hangar in California and finished the job himself. He loved that little sub, even though it could dive to only 100 meters and required him to lie face down staring out a window in the floor—and terrified anyone he took for a ride. These faults were superfluous; what mattered was that the sub gave Rush a chance to begin exploring the vast realm beyond the capability of scuba equipment.

And that sealed it. He decided this would be his calling, to reignite man's fire for the deep.

In 2009, Rush founded OceanGate Inc., a company promising "manned submersible solutions" for the deep ocean, and began a crash course in submarine design. He and a partner, Guillermo Söhnlein (who's since left the operation and is now only a small shareholder), bought and modified two larger subs as steps toward the real goal—a multiperson submersible that can dive to 4,000 meters and beyond.

That sub, *Cyclops 2*, should be ready for sea testing by yearend, leaving just enough time to complete safety certification for the thing Rush is most eager to promote in New York: a 2018 trip to the wreck of the *Titanic*, which lies 3,800 meters beneath the surface of the North Atlantic, nearly 400 miles off the coast of Newfoundland. In April, OceanGate sold the last of the 54 spots available for the first year, at \$105,129 per person. That's the inflation-adjusted price of a first-class ticket in the Vanderbilt suite on the *Titanic*'s first and only voyage.

Rush assumes that once the sub is out in the wild and ferrying billionaires into the deep, commercial clients of all sorts will beat a path to his door. But—at least now—he cares far more about what it will mean as a symbol for the forgotten ocean. "It didn't take off like space did. It doesn't have the visuals," he tells the Explorers. "Had I known what was there and had it been popularized by movies like *Star Trek*. ... Humans are naturally terrified of going underwater, but that's where the coolest stuff is."

Rush didn't set out to take people to the *Titanic*. It had already been done. Starting in 2005, Deep Ocean Expeditions LLC, owned by an eccentric Australian adventurer and entrepreneur named Mike McDowell, shuttled 197 tourists to the famous luxury liner using two Soviet-era Mir submersibles chartered from the Russian Academy of Sciences during a difficult economic period in which Russia was also selling seats on rockets. The last of those trips took place in 2012, the 100th anniversary of the *Titanic*'s sinking. Rush assumed that meant the market was exhausted. Then he talked to Rob McCallum, the British-born adventurer who led the trips. McCallum told Rush that the only reason the trips had stopped was that the Russians quit renting out the Mirs, which have since been mothballed. "There was never an end in sight to our market," McCallum says. "We just didn't have the machines."

Up to that point, Rush had been thinking about unexplored wrecks, hydrothermal vents, and bizarre sea creatures, not to mention the many ways a capable sub could be leased out to an oil and gas company to service undersea wells and oil platforms, or to a research institution to do surveys of sea cucumbers, or to the CIA/NSA/DIA to do whatever it is that spooks do on the floor of the ocean. He still thinks that's where the company's future lies. But what the market wanted then and there, Rush finally recognized, was more *Titanic*.

"Even I didn't appreciate how big the *Titanic* was until we offered it," he says over a plate of pasta a few weeks after the Explorers Club lecture. He's a cheerful, charismatic man whose boyish enthusiasm for adventure makes for easy comparisons

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| "Humans are naturally terrified of going underwater, but that's where the coolest stuff is" |
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to adventure-chasing bon vivants such as Richard Branson and Elon Musk. “For a number of people, it’s the most important thing they’re ever going to do.”

Rush won’t disclose the cost of developing the *Cyclops 2*, beyond saying it’s “in the tens of millions.” So far, he’s been able to fund OceanGate with his own money, plus seed capital from friends and family. At various points, especially in the early days, Rush solicited venture capital money, but he got only polite rejections. He received similar treatment from oil and gas companies. Everyone, he says, just wanted to wait and see.

None of which slowed his progress or damped his enthusiasm. “People used to ask me, ‘How do you think you can do this if nobody else can?’ I like to point out that the two deepest-diving subs on the planet are the Chinese *Jiaolong* and James Cameron’s sub”—the *DSV Deepsea Challenger*, which in 2012 carried the *Titanic* director to Challenger Deep, the ocean’s deepest point, and is now retired. “They were both built by amateurs who had never built subs before. The sub is not the challenge. The challenge is the business model and the logistics.”

Rush is certain he’ll have the *Cyclops 2* ready to dive to the *Titanic* next May, or he’s at least good at acting certain. He hasn’t made it easy on himself. Since the American naturalist William Beebe first closed the hatch on his so-called bathysphere and plummeted 845 feet under the Atlantic in 1930, every deep-diving submersible has had a hull made of metal—typically steel and occasionally titanium. Rush told his engineers he wanted to save weight by using carbon fiber and also that the hull had to be safe to 6,000 meters. He’s still waiting for the arrival of the hull, which is curing in an oven at a composites company in central California, as we walk through a large garage bay and into the hangar that serves as OceanGate’s base in the port of Everett, Wash., 45 minutes north of Seattle.

He’s also waiting for the titanium dome that will be attached to the hull’s end, which is being milled in Pennsylvania.

One reason Rush is so confident of meeting the *Titanic* deadline is that about 80 percent of *Cyclops 2* will be identical to *Cyclops 1*, one of the submersibles he bought when he founded OceanGate. (It’s been modified so thoroughly that it looks like a new design.) *Cyclops 1*, a “working prototype” rated to 500 meters, has been in use for the past few years, including last summer, when Rush took a small group of clients to the wreck of the *Andrea Doria*, the Italian ocean liner that sank in 1956 off the coast of Nantucket in Massachusetts.

The two subs will share an exterior frame, thrusters, sonar, life support (96 hours’ worth), and control systems, including the modified Sony PlayStation controller that pilots use to “fly” the subs. Rush is proud of this detail. He wanted the operation to be familiar and simple, so a pilot can pick it up easily, and asked engineers at the University of Washington’s Applied Physics Laboratory, who also contributed to the hull design, to match the controls on the submersibles—forward, backward, sideways, pivot, hold—to the buttons of an actual toy.

Cyclops 2 will have numerous differences, too. A major focus is what Rush calls the “user experience.” He wants ambient LEDs inside the cockpit and tablets displaying feeds from the external cameras. Both will help make up for the fact that, unlike *Cyclops 1*, which has an enormous clear dome at one end, *Cyclops 2* will have only a single small window at the front. It’s an unfortunate requirement of the extreme pressures found below 5,000 meters.

There’s a full-size model of the *Cyclops 2* interior in the shop, where OceanGate’s engineers can practice the arrangement and installation of components. “What I’d like is for it to be like a holodeck, so the whole inside is a screen,” Rush says, running a hand along the perforated aluminum that currently serves ►

◀ as an interior surface. “We can put images on it, and if somebody gets nervous, we give them a beach scene.”

Rush has talked to the Scripps Institution of Oceanography about a program in development that’s like Shazam, the song-naming app, for sea life. It’s probably a few years away, but the concept is compelling. The program takes an image, scans the contents, compares whatever is there to known life forms, and then returns species names in real time. Imagine looking at a live feed of the sea outside as identifying names and information pop up alongside every plant or animal that appears. And then there’s the possibility of virtual-reality headsets to make a passenger feel as if she’s outside the sub, in the water—a concept in development at the Advanced Visualization Lab at Woods Hole, the famous oceanographic institute in Massachusetts.

“But none of that’s really relevant right now,” Rush says. “The most important thing is building something that actually gets there and back.”

He still can’t believe he has to sell the ocean so hard. “I started the business thinking that it’s all about proving I can do it,” Rush says, sitting at a conference table in the small warren of offices where OceanGate’s non-engineers work. And certainly that’s been part of it. But the bigger challenge has been proving to people—especially investors—that the ocean matters. “I thought they’d look at it the way I did,” he says. Meaning, with slack-jawed, wide-eyed wonder.

Rush continues to be a major investor and has stepped in to write emergency checks when funds have run low. Finally, over the past year, capital has gotten “substantially easier” to raise, he says—deposits for the *Titanic* trip gave him both money and

credibility. “I mean, I’m not quite where SpaceX is,” he says, “but it’s nice to have some income as opposed to running around just trying to get meetings.”

There are other intriguing elements beyond the sub. Rush spent years studying the world of submersibles in search of inefficiencies and realized that the biggest limitation wasn’t the submarine; it was the ship required for launch and recovery. All of the world’s deep-diving manned submersibles have to be paired with a large ship that can carry them to a site, then lift them up and over the side into the water for launch. The process of moving a heavy sub overboard and then getting humans into its small hatch is precarious even in calm conditions. When the sea gets agitated, boarding is almost impossible.

Rush realized that if he could simplify the launch and recovery, he could significantly cut logistics costs and make his sub that much more marketable, because it would in theory be easier to move around the world and be useful on more days. There’s an old saying in naval operations that he likes to quote: “Your ship is always in the wrong ocean.”

Having a carbon-fiber sub will help. It will be lighter and easier to transport. But Rush’s secret weapon is the 35-foot-long flat metal barge on which *Cyclops 1* sits. *Ms. Lars* (an acronym for mobile subsea launch and recovery system) is in her third iteration, with a fourth and hopefully final version on the way. Last summer, for the *Andrea Doria* excursion, OceanGate just put *Cyclops 1* and its barge on a truck to Boston. The barge was pulled to the wreck site behind a run-of-the-mill harbor craft.

OceanGate planned to go back to the *Andrea Doria* this summer to work on a 3D scan with the sub’s newer, better sonar, but Rush decided in early June to scrap that and “conserve manpower to ensure that *Cyclops 2* remains on track.” Instead, *Cyclops 1* stayed in Everett to serve as a test mule for its deeper-diving successor until October, when it will be moved to the Bahamas to participate in research at the Cape Eleuthera Institute. “We’re going to explore the band between what’s scuba-dive-able and the real deep,” Rush says. Little is known about that zone—from 200 feet to 1,500 feet, more or less—and the Cape Eleuthera scientists are keen to study how surface sharks interact with sharks that operate primarily in the deep.

What if the *Cyclops 2* isn’t ready in time or fails a sea test and requires a significant redesign? OceanGate is both a submersible manufacturer and a tour operator, so it’s a question that does come up. In the case of a major delay that would cause Rush to miss the May 2018 window for reaching the *Titanic*, he’d probably push everything back a year. “I mean, we can do it,” he says. “Virgin Galactic’s been doing that for, what, seven years?” And people are still putting down deposits for space.

Rush’s hope—really, his expectation—is that none of this matters in the end—that the experience of spending a day zooming around a realm very few humans have seen will be so transformative that the product will sell itself and some significant percentage of his clients will become regulars. He even considered a membership model, such as NetJets Inc.’s.

Rush fantasizes about so many dives: a Roman trireme lying several thousand meters under the Mediterranean, World War II fighter planes rusting away in the relatively shallow waters off of Croatia, and the spectacular ecosystems around hydrothermal



The sub's controls are based on a PlayStation controller

vents, which support life forms that have evolved without needing sunlight. “There are tons of targets,” he says. “The question is, can I get 20 people who say, ‘I want to go see this.’”

Rush is an unabashed optimist. It’s one of his best qualities as a person and an entrepreneur. And he’s also not alone in feeling bullish about the deep ocean in 2017.

Maybe no one has more experience in the deep ocean than Alfred McLaren, a former U.S. Navy nuclear submarine captain, electrical engineer, and president emeritus of the Explorers Club. He says he’s spent “close to five and three-quarters” of his years “completely submerged.” McLaren led U.S. nuclear submarines in some of the first missions under the Arctic ice, and as an expedition leader for McCallum aboard the Mir subs, he’s one of the few people to have visited both the *Titanic* and the *Bismarck*, which is 1,000 meters deeper.

McLaren rolls off a half-dozen sites he’d like to visit. A mobile, deep-diving manned sub could go to the Black Sea to look for 10,000-plus-year-old ships preserved in its hypoxic waters, into the mysterious depths of the Great Lakes, or under Arctic and Antarctic sea ice. A nimble sub could even take people into Loch Ness to look for its monster.

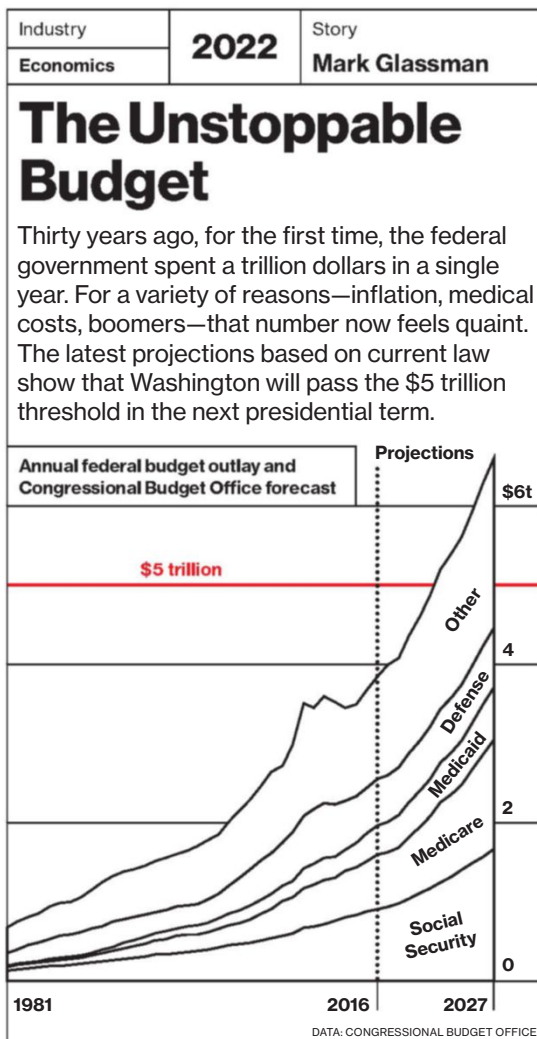
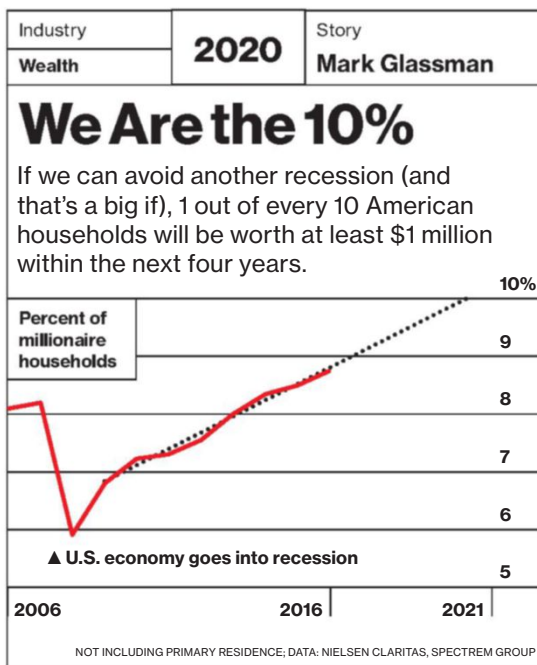
The memory that most stands out from McLaren’s many dives is a “barracuda-shaped” fish that he and a BBC producer saw while descending through 4,500 meters on the way to the *Bismarck*. It was more than 20 feet long and had big eyes, huge scales, and a long jaw with jagged teeth. “There are two of us alive who have seen this,” he says. “There’s big stuff out there.”

Only three humans have been to Challenger Deep, more than 10,900 meters down in the Pacific Ocean. The first two, French inventor Jacques Piccard and Navy Lieutenant Don Walsh, did it in 1960, inside the Italian-built, U.S. Navy-operated *Trieste*. The third was James Cameron, who commissioned the one-man *DSV Deepsea Challenger* for the sole purpose of making the trip. The *Challenger* was plagued with problems, forcing Cameron to cut his time in the trench from six hours to two, but it completed the one job that mattered; it got its pilot to the bottom of the sea and back to the surface safely. Later damaged in a truck accident, it’s now retired.

Rush is skeptical of the idea that anyone would want to endure that trip, which would require many hours of ascent and descent in tight surroundings doing basically nothing. (“You’re just Spam in a can,” he says.) McCallum, who consults for two other deep-sea submersible projects, both in stealth mode, disagrees. He’s certain he could sell it: “I imagine there are people in the world who might spend \$1 million to get there—to be among the first 10 people to do that is a big deal.”

McCallum consulted for OceanGate in the early days, before departing the project for various reasons, including some concern with the way Rush was doing things. He worries that Rush is moving too fast and promising too much. “I know Stockton well and think the world needs more Stocktons prepared to take a chance,” he says. “But he’s a full-speed-ahead, damn-the-torpedoes kind of guy, and in the submersible industry, extreme depth is all about precision and control. Nothing can be left to chance.”

On the other hand, that worry is the same thing that makes McCallum root for Rush and OceanGate. “In Stockton’s view, all things are achievable,” he says. “If we don’t have the technology to develop this, let’s develop it. I love that.”





We're Going

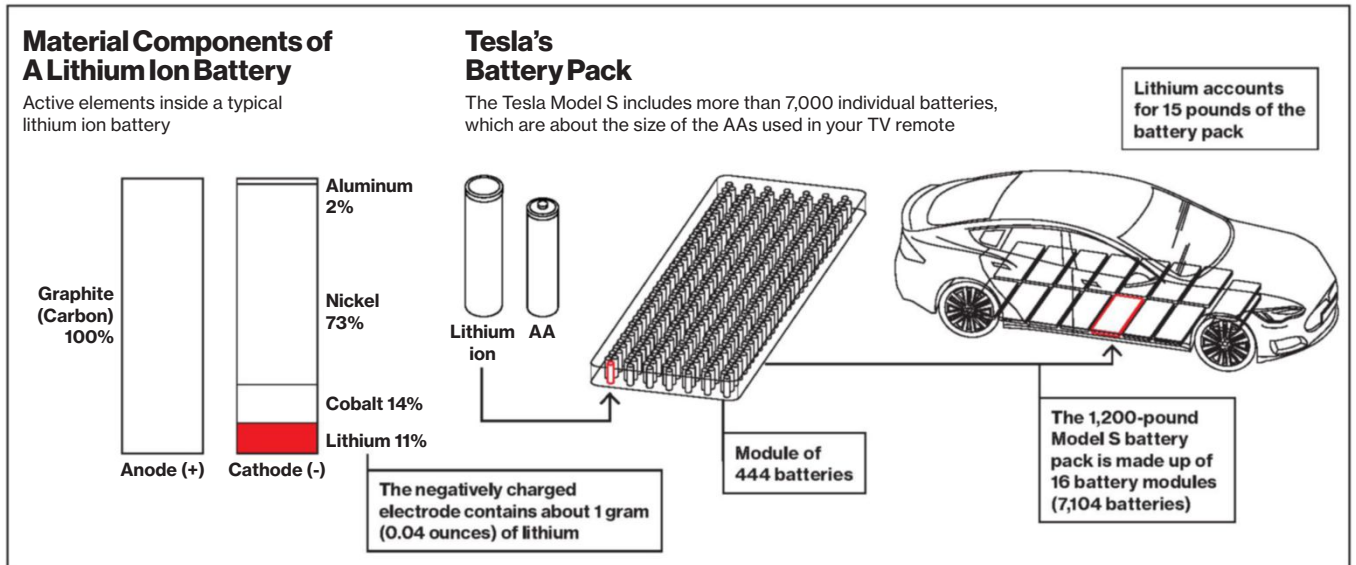
There's plenty in the ground to meet the needs of an electric car future, but not enough mines

Starting about two years ago, fears of a lithium shortage almost tripled prices for the metal, to more than \$20,000 a ton, in just 10 months. The cause was a spike in the market for electric vehicles, which were suddenly competing with laptops and smartphones for lithium ion batteries. Demand for the metal won't slacken anytime soon—on the contrary, electric car production is expected to increase more than thirty-fold by 2030, according to Bloomberg New Energy Finance.

Rest assured, Earth has the lithium. The next dozen years will drain less than 1 percent of the reserves in the ground, BNEF says. But battery makers are going to need more mines to support their production, and they'll have to build them much more quickly than anyone thought. By 2030, Tianqi Lithium, SQM, Albemarle, and FMC, the companies that dominate the business, will have to supply enough lithium to feed the equivalent of 35 plants the size of the Tesla Gigafactory now being built in Nevada, according to BNEF. The total investment in new mines, including some for other elements used in lithium ion batteries, will likely range from \$350 billion to \$750 billion, according to analysts at researcher Sanford C. Bernstein & Co.

Miners must tread into sensitive areas, some with government caps on the amount of lithium that can be dug up. About half the world's reserves are in Chile, predominantly in the arid Atacama Plateau, which straddles the border with Argentina and is home to herders worried about the pollution and water shortages

To Need More Lithium



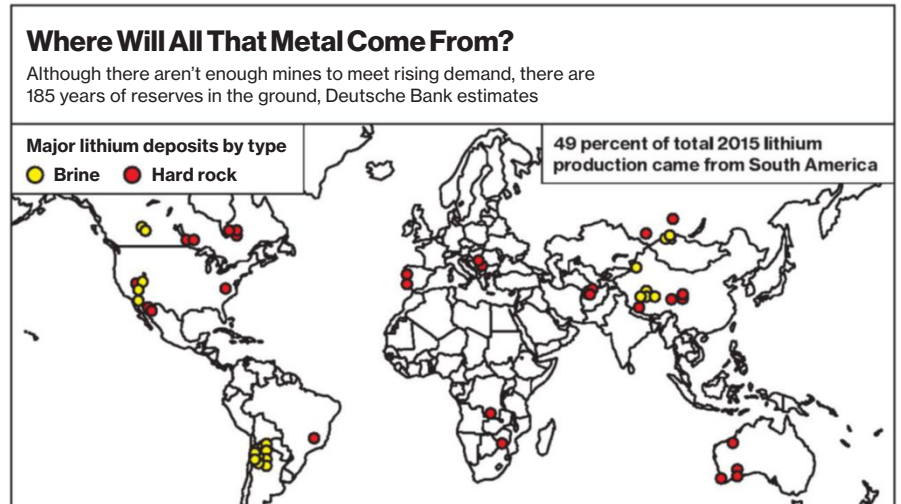
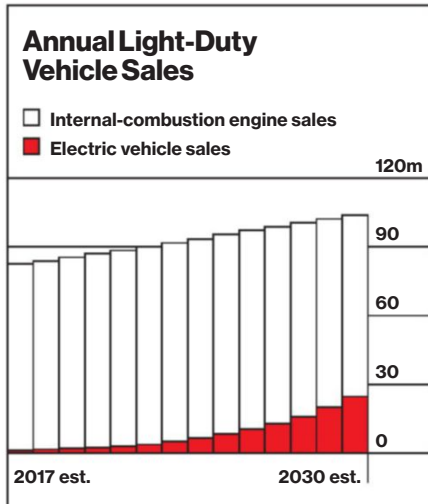
that tend to accompany the mining process, as well as the potential damage to sites they consider sacred. Another deposit is in the picturesque English county of Cornwall, famed for its clotted cream and pirate cove beaches.

Mining companies have promised to add 20 lithium production sites to the 16 currently operating, but the concern remains that they won't be finished in time

to satisfy rising demand. (The first new mine is scheduled to open in 2019.) Mark Cutifani, chief executive officer of mining company Anglo American Plc, sees the opposite problem as more likely. "There are a lot of projects out there, and they'll end up oversupplying the market," he says.

And even if the companies struggle a bit to keep pace with demand, the global scramble may never be reflected in the

sticker price of a Tesla or a MacBook Pro, says Edward Spencer, a senior consultant at London-based researcher CRU International Ltd. "The cost of lithium is absolutely nothing compared to the overall price of the vehicle," Spencer says. Lithium is, as Tesla Inc. co-founder Elon Musk has called it, "the salt on the salad." He'll just need to make sure he's got a steady supply. **B**



BATTERY; TESLA; DUNDEE SECURITIES CORP.; BLOOMBERG RESEARCH; VEHICLE SALES; BLOOMBERG NEW ENERGY FINANCE; MAP; DEUTSCHE BANK; USGS; BLOOMBERG NEW ENERGY FINANCE

**Sooner Than
You Think**

Industry

Agriculture

2017

2018

Start
shipping
produce to
retailers

2030

Have a farm
in every
major metro
area

2060

Story

Selina Wang

Photographs

Justin Kaneps

The Future Of



September 11, 2017

Plenty says its vegetable warehouse has the technology and cash to pump out Whole Foods-quality produce at Walmart prices. Now it just has to deliver

Farming IS Looking UP



Before stepping into Plenty Inc.'s indoor farm on the banks of San Francisco Bay, make sure you're wearing pants and closed-toe shoes. Heels aren't allowed. If you have long hair, you should probably tie it back.

Your first stop is the cleaning room. Open the door and air will whoosh behind you, removing stray dust and contaminants as the door slams shut. Slide into a white bodysuit, pull on disposable shoe covers, and don a pair of glasses with colored lenses. Wash your hands in the sink before slipping on food-safety gloves. Step into a shallow pool of clear, sterilized liquid, then open the door to what the company calls its indoor growing room, where another air bath eliminates any stray particles that collected in the cleaning room.

The growing room looks like a strange forest, with pink and purple LEDs illuminating 20-foot-tall towers of leafy vegetables that stretch as far as you can see. It smells like a forest, too, but there's no damp earth or moss. The plants are growing sideways out of the columns, which bloom with Celtic crunch lettuce, red oak kale, sweet summer basil, and 15 other heirloom munchables. The 50,000-square-foot room, a little more than an acre, can produce some 2 million pounds of lettuce a year.

Step closer to the veggie columns, and you'll spot one of the roughly 7,500 infrared cameras or 35,000 sensors hidden among the leaves. The sensors monitor the room's temperature, humidity, and level of carbon dioxide, while the cameras record the plants' growing phases. The data stream to Plenty's botanists and artificial intelligence experts, who regularly tweak the environment to increase the farm's productivity and enhance the food's taste. Step even closer to the produce, and you may see a ladybug or two. They're there to eat any pests that somehow make it past the cleaning room. "They work for free so we don't have to eat pesticides," says Matt Barnard, Plenty's chief executive officer.

Barnard, 44, grew up on a 160-acre apple and cherry orchard in bucolic Door County, Wis., a place that attracts a steady stream of fruit-picking tourists. Now he and his four-year-old startup aim to radically change how we grow and eat produce. The world's supply of fruits and vegetables falls 22 percent short of global nutritional needs, according to public-health researchers at Emory University, and that shortfall is expected to worsen. While the field is littered with the remains of companies that tried to narrow the gap over the past few years, Plenty seems the most promising of any so far, for two reasons. First is its technology, which vastly increases its farming efficiency—and, early tasters say, the quality of its food—relative to traditional farms and its venture-backed rivals. Second, but not least, is the \$200 million it collected in July from Japanese telecom giant SoftBank Group, the largest agriculture technology investment in history.

With the backing of SoftBank CEO Masayoshi Son, Plenty has the capital and connections to accelerate its endgame: building massive indoor farms on the outskirts of every major city on Earth, some 500 in all. In that world, food could go from farm to table in hours rather than days

| |
|-------------------------|
| Food could go |
| from farm to |
| table in hours |
| rather than days |
| or weeks |

Visitors enter Plenty's South San Francisco farm as if they're heading into a secured chip lab



or weeks. Barnard says he's been meeting with officials from some 15 governments on four continents, as well as executives from Wal-Mart Stores Inc. and Amazon .com Inc., while he plans his expansion. (Bezos Expeditions, the Amazon CEO's personal venture fund, has also invested.) He intends to open farms abroad next year; this first one, in the Bay Area, is on track to begin making deliveries to San Francisco grocers by the end of 2017. "We're giving people food that tastes better and is better for them," Barnard says. He says that a lot.

Plenty acknowledges that its model is only part of the solution to the global nutrition gap, that other novel methods and conventional farming will still be needed. Barnard is careful not to frame his crusade in opposition to anyone, including the industrial farms and complex supply chain he's trying to circumvent. He's focused on proving that growing rooms such as the one in South San Francisco can reliably deliver Whole Foods quality at Walmart prices. Even with \$200 million in hand, it won't be easy. "You're talking about seriously scaling," says Sonny Ramaswamy, director of the National

The company's rainbow chard and other crops grow sideways out of poles

Anthony Secviar is basing his next restaurant's menu around the indoor farm's heirloom vegetables



Institute of Food and Agriculture, the investment arm of the U.S. Department of Agriculture. “The question then becomes, are things going to fall apart? Are you going to be able to maintain quality control?”

The idea of growing food indoors in unlikely places such as warehouses and rooftops has been hyped for decades. It presents a compelling solution to a series of intractable problems, including water shortages, the scarcity of arable land, and a farming population that’s graying as young people eschew the agriculture industry in greater numbers. It also promises to reduce the absurd waste built into international grocery routes. The U.S. imports some 35 percent of fruits and vegetables, according to Bain & Co., and even leafy greens, most of which are produced in California or Arizona, travel an average of 2,000 miles before reaching a retailer. In other words, vegetables that are going to be appealing and edible for two weeks or less spend an awful lot of that time in transit.

So far, though, vertical farms haven’t been able to break through. Over the past few years, early leaders in the field, including PodPonics in Atlanta, FarmedHere in Chicago, and Local Garden in Vancouver, have shut down. Some had design issues, while others started too early, when hardware costs were much higher. Gotham Greens in Brooklyn, N.Y., and AeroFarms

in Newark, N.J., look promising, but they haven’t raised comparable cash hoards or outlined similarly ambitious plans.

While more than one of these companies was felled by a lack of expertise in either farming or finance, Barnard’s unusual path to his Bay Area warehouse makes him especially suited for the project. He chose a different life than the orchard, frustrated with the degree to which his life could be upended by an unexpected freeze or a broken-down tractor-trailer. Eventually he became a telecommunications executive, then a partner at a private equity firm. In 2007, two decades into his white-collar life, he started his own company, one that concentrated on investing in technologies to treat and conserve water. After an investor suggested he consider putting money into vertical farming, Barnard began to research the subject and quickly found himself obsessed with shortages of food and arable land. “The length of the supply chain, the time and distance it takes,” he says, meant “we were throwing away half of the calories we grow.” He spent months chatting with farmers, distributors, grocers, and, eventually, Nate Storey.

The grandson of Montana ranchers, 36-year-old Storey spent much of his childhood planting and tending gardens with his six siblings. Their Air Force dad, who eventually retired as a lieutenant colonel, moved them to another base every few years, and the family gardened to save money on groceries. “I was ▶

◀ always interested in ranching and family legacy but frustrated on how to do it,” Storey says. “If you’re an 18-year-old kid and you want to farm or ranch, most can’t raise \$3 million to buy a farm or a ranch.”

A decade ago, as a student at the University of Wyoming, he learned about the same industry-level inefficiencies Barnard observed. He began experimenting with vertical farming for his doctoral dissertation in agronomy and crop science, and in 2009 patented a growing tower that would pack the plants more densely than other designs. He spent \$13,000, then a sizable chunk of his life savings, to buy materials for the towers and started building them in a nearby garage. By the time he met Barnard in 2013, he’d sold a few thousand to hobbyist farmers and the odd commercial grower.

Storey became Barnard’s co-founder and Plenty’s chief science officer, splitting his time between Wyoming and San Francisco. Together they made Storey’s designs bigger, more efficient, and more readily automated. By 2014 they were ready to start building the farm.

Most vertical farms grow plants on horizontal shelves stacked like a tall dresser. Plenty uses tall poles from which the plants jut out horizontally. The poles are lined up about 4 inches from one another, allowing crops to grow so densely they look like a solid wall. Plenty’s setups don’t use any soil. Instead, nutrients and water are fed into the top of the poles, and gravity does much of the rest of the work. Without horizontal shelves, excess heat from the grow lights rises naturally to vents in the ceiling. “Because we work with physics, not against it, we save a lot of money,” Barnard says.

Water, too. Excess drips to the bottom of the plant towers and collects in a recyclable indoor stream, and a dehumidifier

system captures the condensation produced from the cooling hardware, along with moisture released into the air by plants as they grow. All that accumulated H₂O is filtered and fed back into the farm. All told, Plenty says, its technology can yield as much as 350 times more produce in a given area as conventional farms, with 1 percent of the water. (The next-highest claim, from AeroFarms, is as much as 130 times the land efficiency of traditional models.)

Based on readings from the tens of thousands of wireless cameras and sensors, and depending on which crop it’s dealing with, Plenty’s system adjusts the LED lights, air composition, humidity, and nutrition. Along with that hardware, the company is using software to predict when plants should get certain resources. If a plant is wilting or dehydrated, for example, the software should be able to alter its lighting or water regimen to help.

Barnard, tall and lanky with a smile that crinkles his entire face, becomes giddy when he recounts the first time Plenty built an entire growing room. “It had gone from pretty sparse to a forest in about a week,” he says. “I had never seen anything like that before.”

When he and Storey started collaborating, their plan was to sell their equipment to small growers across the country. But to make a dent in the produce gap, they realized they’d need to reproduce their model farm with consistency and speed. “If it takes you two or three years to build a facility, forget about it,” Storey says. “That’s just not a pace that’s going to have any impact.” That meant they’d have to engineer the farms themselves. And that meant two things: They’d need more than their 40 staffers, and they’d need way more money.

It wasn’t easy for Barnard to get his first meeting with Son, in March. One of Plenty’s early investors had to beg the SoftBank CEO, who allotted Barnard 15 minutes. He and the investor, David Chao of DCM Ventures, jammed one of the 20-foot grow towers into Chao’s Mercedes sedan and took off for Son’s mansion in Woodside, Calif., some 30 miles from San Francisco. Son looked bewildered as they unloaded the tower, but the meeting stretched to 45 minutes, and two weeks later they flew to Tokyo for a more official discussion in SoftBank’s boardroom. The \$200 million investment, announced in late July, will help Plenty put a farm in every major metro area with more than 1 million residents, according to Barnard. He says each will have a grow room of about 100,000 square feet, twice the size of the



Storey (left) had sold a few thousand grow towers, mostly to hobbyists, before he met Barnard (right)

Bay Area model, and can be constructed in under 30 days.

Chao says SoftBank wants “to help Plenty expand very quickly, particularly in China, Japan, and the Middle East,” which all struggle with a lack of arable land. Other places on the near-term list include Canada, Denmark, and Ireland. Plenty is also in talks with insurers and institutional investors such as pension funds to bankroll its farm-building with debt. Barnard says the farms would be able to pay off investors in three to five years, vs. 20 to 40 years for traditional farms. Think of it more like a utility, he says.

Plenty, of course, isn’t as sure a bet as Consolidated Edison Inc. or Italy’s Enel SpA. The higher costs of urban real estate, and the electricity needed to run all of the company’s equipment, cut into its efficiency gains. While it’s adapting its technology for foods including strawberries and cucumbers, the complications of tree-borne fruits and root crops likewise neutralize the value of its technology. And Plenty has to contend with commercial farms that have spent decades building their relationships with grocers and suppliers and a system that already offers many people extremely low prices for a much wider variety of goods. “What I haven’t seen so far in vertical farm technologies is these entities getting very far beyond greens,” says Michael Hamm, a professor of sustainable agriculture at Michigan State University. “People only eat so many greens.”

Barnard says he’s saving way more on truck fuel and other logistical costs, which account for more than one-third of the retail price of produce, than he’s spending on warehousing or power. He’s also promising that the company’s farms will require long-term labor from skilled, full-time workers with benefits. About 30 people can run the South San Francisco

The \$200 million investment will help Plenty put a farm in every major metro area with more than 1 million residents

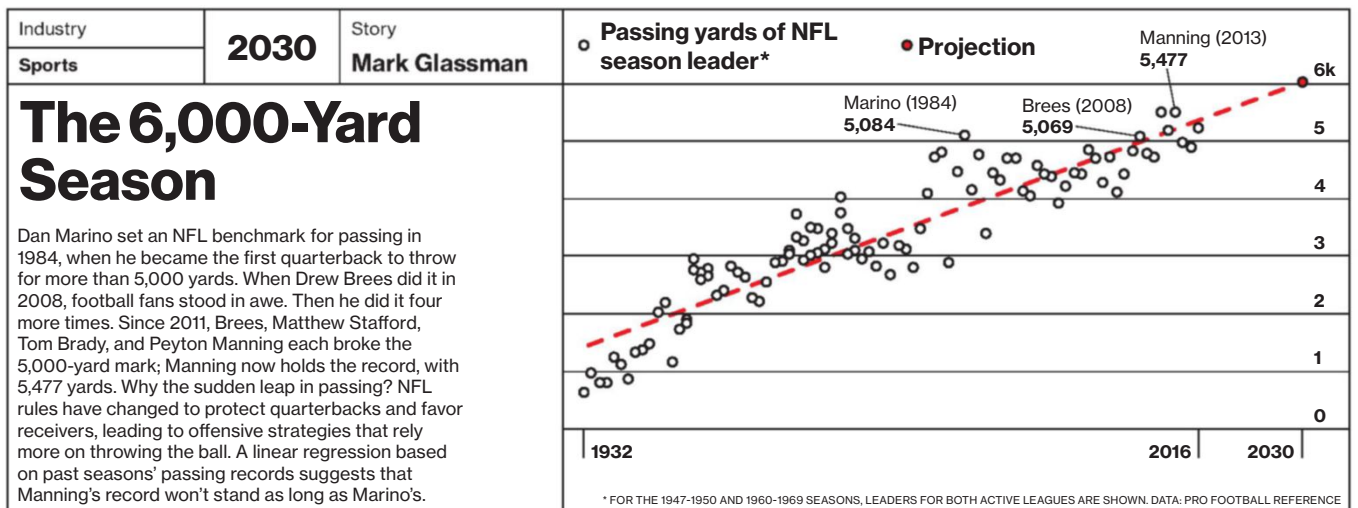
warehouse; future models, which will be about two to five times its size, may require several hundred apiece, he says. While robots can handle some of the harvesting, planting, and logistics, experts will oversee the crop development and grocer relationships on-site.

Retailers shouldn’t need much convincing, says Mikey Vu, a partner at Bain who studies the grocery business. “Grocers would love to get another four to five days of shelf life for leafy greens,” he says. “I think it’s an attractive proposition.”

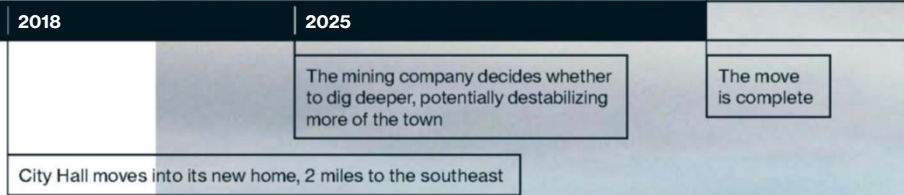
Gourmets like Plenty’s results, too. Anthony Secviar, a former sous-chef at the French Laundry, a Michelin-starred restaurant in the Napa town of

Yountville, says he wasn’t expecting much when he received a box of Plenty’s produce at his home in Mountain View, Calif. The deep green of the basil and chives hit him first. Each was equally lush, crisp, flavorful, and blemish-free. “I’ve never had anything of this quality,” says Secviar, who while at the French Laundry cooked with vegetables grown across the street from the restaurant. He’s now on Plenty’s culinary council and is basing his next restaurant’s menu around the startup’s heirloom vegetables. “It checks every box from a chef’s perspective: quality, appearance, texture, flavor, sustainability, price,” he says.

At the South San Francisco farm, the greens are fragrant and sweet, the kale is free of store-bought bitterness, and the purple rose lettuce carries a strong kick. There’s enough spice and crunch that the veggies won’t need a ton of dressing. Although Plenty bears little resemblance to a quaint family farm, the tastes bring me back to the tiny vegetable patch my grandparents planted in my childhood backyard. It’s tough to believe these spicy mustard greens and fragrant chives have been re-created in a sterile room, without soil or sun. **B**



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| Sooner Than You Think | Industries | 2017 |
| | Mining | |
| | Urban planning | |



68 **How to**



A view of the old Kiruna from the new Kiruna





The citizens of Kiruna, Sweden, always knew they'd have to move to accommodate the local iron-ore mine. They didn't expect it to happen so soon, or so all at once

A

ppropriately, it was the dog musher who broke trail. Sune Stralberg, 66, is a national champion musher, a maker of dogsleds, and owner of Bjorkis Hundprodukter, a one-stop shop for organic kibble, spare sled parts, and dog leads and harnesses. All of this makes him a local celebrity in his hometown of Kiruna, Sweden's northernmost city. He has the white beard and jovial affect of a skinny Swedish Santa and speaks in lovely, lilting sentences, even when he's recounting painful memories, such as one from three years ago, when he was forced to move his shop out of its longtime home and into a strip mall 2 miles down the road. He had little

Move a

choice—the ground beneath the old shop was on the verge of collapse, like much of the rest of the town. “I already knew that I would move because of the iron,” Stralberg says with a shrug. “Everyone knew.”

Kiruna sits on top of Kirunavaara, the world's largest underground iron-ore mine and the source of a rare, high-quality magnetite processed into blueberry-size pellets and used in BMWs and iPhones. The mine is the reason Kiruna exists, employing 12 percent of its 18,000 residents, including, at various times, Stralberg's grandfather, father, and six uncles. Stralberg himself worked in the mine's machine shop for 16 years before quitting, in 1985, to turn his dogsled-making hobby into a business.

Kiruna's magnetite seam is “shaped like a piece of toast,” says Fredrik Bjorkenwall, spokesman for LKAB, a state-owned mining company founded in 1890 to harvest the rich iron deposits of Swedish Lapland. At nearly 2,000 feet wide, it's the largest known iron-ore body in the world, descending at least 6,500 feet on a slant that begins outside the town and angles underneath. It may actually continue far deeper than that—perhaps up to a mile more, Bjorkenwall says. To find out, he'd have to keep digging.

When LKAB started the mine in the late 19th century, it was an open pit. Eventually, ore near the surface was exhausted, and the company shifted to underground mining. The longer it continues, the farther down the miners must go. Every time LKAB cuts deeper, another section of Kiruna becomes unstable. Stralberg isn't the last who'll have to move.

For years the “deformation,” as it's known, affected only

LKAB territory. Vast tracts of the old mining camps are already gone. Kiruna's Luossajarvi lake would be gone by now, too, if the company hadn't built a dam and reduced its size many years ago to make room for the mine's sprawling headquarters. From now on, though, when the mine grows, more of civilian Kiruna must vacate, or sink. A few blocks from downtown, the beautiful historic train station, which disgorged thousands of tourists a week during peak hiking season, has shut. It waits to be razed.

Every resident of Kiruna has been aware of the possibility that he or she might, at some point, have to move to accommodate the mine's gradual expansion. But in 2004, LKAB told the municipal government that to reach the next level of the ore body, the mine would need to be dug a couple thousand feet deeper, rendering an enormous section of the town unstable, including the city center. Thus began an audacious, complicated, still very much in-progress attempt to move the heart of Kiruna, including 5,000 homes and a quarter-mile square of residential and commercial space, about 2 miles southeast. Most structures will be bulldozed and rebuilt, but in some cases—with the most historically significant homes, for instance, or the town's famous wooden church, once voted Sweden's most beautiful building—they'll be taken apart and reassembled or trucked, whole, to Kiruna 2.0.

Stralberg has had to move because of the mine every so

Town

often throughout his life, including three times in his childhood. Having to relocate his shop, though, came as more of a shock. It had been the company store into the 1970s and was the only business in a residential area right on the edge of the deformation zone. As such, LKAB was also his landlord, and in 2011, the company wrote to tell him he had two years to leave. By then, the town was holding open meetings about the future relocation, so Stralberg stood up and faced the LKAB representative. "I'm the first store in history that has to move," he said. Where should he go? What if he was alone in an area with no traffic? "I'll be the only store. Who's gonna come to me and buy something?"

LKAB had no answers at that point, so Stralberg, his wife, and two daughters were left to go their own way. They searched for more than a year. Kiruna has boomed over the past decade, thanks to the mine and adventure tourists seeking a gateway to Lapland's national parks and ski slopes. There's little commercial or residential space available, and growth is constrained by the peculiar laws of Lapland, which protect reindeer herding routes for the indigenous Sami people. Finally, Stralberg found a large space in a speculative new commercial park. His shop is now topped with the world's largest dogsled, at roughly 43 feet long and 375 pounds, so as to be visible from the nearby E10 highway—at least until that road, too, is moved, routed around the area where the new Kiruna is finally beginning to rise.

Stralberg almost went broke building out the space, for which he pays five times the monthly rent of the old one to his new

landlord. After LKAB said it was unable to help him pay for finishing work or supplement the rent, he cashed in his pension. (The company eventually supplied some carpenters to build shelves and offered a truck and a local youth soccer team to help him move.) He's the most publicly disgruntled person in all of Kiruna, a man who was featured on the front page of the local paper under a headline declaring LKAB "liars" in a giant red font. And yet, six years later, Stralberg is happy. The store is making money in a better space and a better location. "I know we have to move the town," he says. "We need the mine. Without the mine, there is no Kiruna."

Kiruna sprawls from northwest to southeast along the base of a mountain that was once another LKAB mine but is now a ski slope with three lifts. Its quaint center is home to City Hall, a culture and tourism center, a six-story Scandic hotel, and a winding commercial district, where shops that have been open since the early 20th century still occupy their original spaces. The highest point in town, visible from almost every home, is a pile of filtered soil from the early open-pit days.

Beneath that is an underground city with 260 miles of roads and the world's deepest restaurant. Workers enter the mine in cars or buses and descend to the active level, more than three-quarters of a mile below the surface. It takes 20 minutes at "rush hour," according to Björkenwall, and life at that depth is clean and comfortable. The main tunnel is so large, the company held a circus there when it opened.

Other towns around the world have been relocated—including Hibbing, Minn., a small community that moved in 1919 to accommodate what was then the world's largest open-pit iron mine. The alternative is to erase a place from the Earth, and that's happened, too, of course—typically because of intentional floods to expand reservoirs. Iowa, Michigan, and New York all had communities that are now at the bottom of lakes. In 2008, China abandoned 150 cities and 1,300 villages, home to 1.3 million people, to make way for the Three Gorges Dam.

Hibbing's move succeeded. The town is home to 16,000 people, many of whom still work in its iron mine. Tallangatta, Australia, survived, too, after moving 5 miles in the 1950s so that Lake Hume, a source of drinking water, could expand. Because of the menace of climate change and rising sea levels, the world is watching Kiruna closely. Already, several small Alaskan fishing villages endangered by sea-level rise have announced plans to relocate, and last year tiny Isle de Jean Charles, La., became the first American town to receive federal funding to move (\$48 million, for a town of 40 residents). These are likely just the baby steps of urban relocation. A study published this year in the scientific journal *Nature* stated that, according to some projections, most of Miami could be underwater in the next century, turning 2.5 million residents into refugees. An average of 21.5 million people are displaced by weather-related events each year, according to the office of the United Nations High Commissioner for Refugees. This year, that number will include more than 72,000 people who fled Hurricane Harvey.

Kiruna's move is unique in the short annals of city relocation. None have been attempted on this scale, at this pace, with this ambitious a vision. Part of this is because Swedish law in particular protects its citizens from man-made disruptions to their livelihood via the Swedish Minerals Act, which obliges mining companies to "pay for the effects and costs that arise when the ►

◀ company's mining activities lead to urban transformations.”

In 2013, LKAB and Kiruna's town government selected the Stockholm firm White Arkitekter AS to develop the “transformation” plans. White's blueprint, titled “Kiruna 4-ever,” was more than a simple move from point A to point B. It was a reimagination of what the city could be, taking advantage of the opportunity to correct the mistakes of organic municipal growth. The new city would be more walkable, with better transportation and greater urban density. It would also have a more direct connection to the vast, unspoiled nature of Lapland, which attracts the tourists driving Kiruna's second-largest industry. Residential blocks will be built as “fingers” divided by raw land, ensuring that every new home is within three blocks of a forest or trail.

LKAB now has 30 full-time employees devoted to the effort, including project managers, communications officers, economists, and real estate managers. So far, every step has taken more time and money than anticipated. The company has already spent \$500 million of the \$1.6 billion reserved for the move just to clear and lay out the town, and a company website set up to explain the work admits that “we can't say how much the urban transformations will ultimately cost.” Dan Lundstrom, a former mine worker who now conducts guided tours of the area, says he's heard informed estimates as high as \$10 billion. LKAB declined to comment on projections.

Stralberg may have been a guinea pig—or “trial rabbit,” as he puts it—for the move, but he's got company now. A multi-building apartment complex was demolished last fall, and residents were moved to new homes on the site of an old military base, leaving behind only foundations, which have been preserved as public art. In June contractors detached seven large wooden homes from the sites where they've sat since the early 1900s, and on July 31, a crew began the delicate process of cutting away the town's iconic steel clock tower, in six segments, for relocation to the new city center. There it will stand in a huge square, next to a new City Hall being built from a spectacular design by Danish architect Henning Larsen. The town government expects to move in by May.

Last year, LKAB bought out all the real estate in the center of Kiruna to smooth the process of closing the old town. While a few people took the opportunity to retire, leaving vacant stores, most took the money and stayed. Now they await some official decision on when to relocate. That date was once 2020 but could now be as late as 2023—it will be a while before they know for sure. The uncertainty is hard on shops, says Johanna Ringholt, who with her father co-owns Centrum House, an 84-year-old clothing store in the current city center. Her grandfather founded Centrum, and she hopes her children will take it over someday.

For now, though, it's hard to plan. While Ringholt and her father selected a prime corner in the new city, just a block from the square, there isn't even a start date for construction on those blocks. Instead of waiting, a few business owners have packed up and left Kiruna altogether. By yearend, the grocery chain ICA AB plans to vacate a large parcel right across the street, leaving an ugly hole in the middle of town. “It's a challenge to survive these years,” Ringholt says.

Considered all together, what's happening in Kiruna is unprecedented. A railroad has moved. Next is the highway. The church will be photographed in great detail, disassembled, and then rebuilt, board by board. LKAB has agreed to pay for 20 structures to be relocated intact, but a U.S. contractor who

visited recently told the town it may ultimately be cheaper for residents to move a house than let LKAB buy them out—at market rate plus 25 percent—and wait to pay retail price for newly built homes.

Another possibility is that private developers could see value in saving structures, buy them from LKAB, and carry out the moves. That's something the architects would like to see, says Krister Lindstedt, the co-leader of the project for White Arkitekter, because a greater mix of old and new will create a more diverse city that doesn't look like a sparkling new suburb. Figuring out how all this gets done takes both time and money, says Lars Backstrom, executive director of Kiruna's department of society and environmental planning. “These organizations”—meaning the town government, the mining company, and the contractors—“aren't set up to move cities.”

About a third of a mile below Stralberg's old shop, in the mine's visitors center, there's a diorama showing Kiruna and the mine with a bright red line encircling the areas that have to be cleared. “By 2035, we will reach that line,” says Lennart Stalnacke, Kiruna's mining manager. Within the next 5 to 10 years, LKAB's board will meet to decide if the company should move deeper into the Earth, to about a mile. (The mine is now on its fifth transportation level—each move takes 8 to 10 years to prepare and costs \$1.5 billion.) That will push the red line even further, forcing the relocation of even more neighborhoods.

How safe is the new site then? Would Kiruna have to move again? Stalnacke stares at the map for a moment, then looks up, smiling ruefully. “If we're still mining 100 years from now, maybe,” he says.

Everyone in Kiruna today will be dead and gone, and whoever is in charge will have had decades to plan for the change. By then, this type of epic scale urban transformation could well be standard practice. And going through another move would be better than the alternative—that is, if mining at depths below 1¼ miles becomes too expensive. In that scenario, the mine closes, and Kiruna would have to stand without it.

Lindstad and the architects at White have considered this. A big focus of the Kiruna 4-ever plan was to make the new city efficient and attractive enough to draw other industries. It already benefits from being a tourism gateway to Sweden's largest national park, which includes ski areas and its highest mountain. And one of the European Space Agency's main launch sites is just 30 minutes away in a remote pine forest.

“It's tricky to foresee how this will play in the future,” says Backstrom. “This transformation attracts so much attention to Kiruna. It's important for us to figure out how we get this attention to stick to the ground. We want people and companies to invest here. We have an opportunity to get people to move here. That's my hope.

“I'm sure there will be a Kiruna, but it will be a completely different Kiruna,” he continues. “It might be a Kiruna with fewer people and a lot of problems caused by too few people. On the other hand, people can be very innovative, so who knows?” He exhales a deep breath. “Of course, nobody wishes the company to shut down. It would be a disaster. I hope we can find ways to go deeper.” **B**

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|----------|-------------|-------|---------------------|---|---|
| Industry | 2038 | Story | Andre Tartar | <p>2020 Chinese onshore wind power becomes cheaper than natural gas.</p> <p>2022 Germany gets 50 percent of its energy from renewables, about a quarter of which comes from onshore wind installations; Chinese solar becomes less expensive than natural gas.</p> <p>2025 German solar and onshore wind power become cheaper than natural gas.</p> <p>2028 U.S. solar becomes less expensive than natural gas.</p> | <p>2029 Chinese, German, and U.S. solar become cheaper than coal, as does German wind power.</p> <p>2032 U.S. onshore wind power becomes less expensive than natural gas.</p> <p>2037 China reaches 50 percent renewables.</p> <p>2038 The world gets 50 percent of its energy from renewables, distributed roughly evenly across hydroelectric, solar, and wind power.</p> |
| Energy | | | | | |

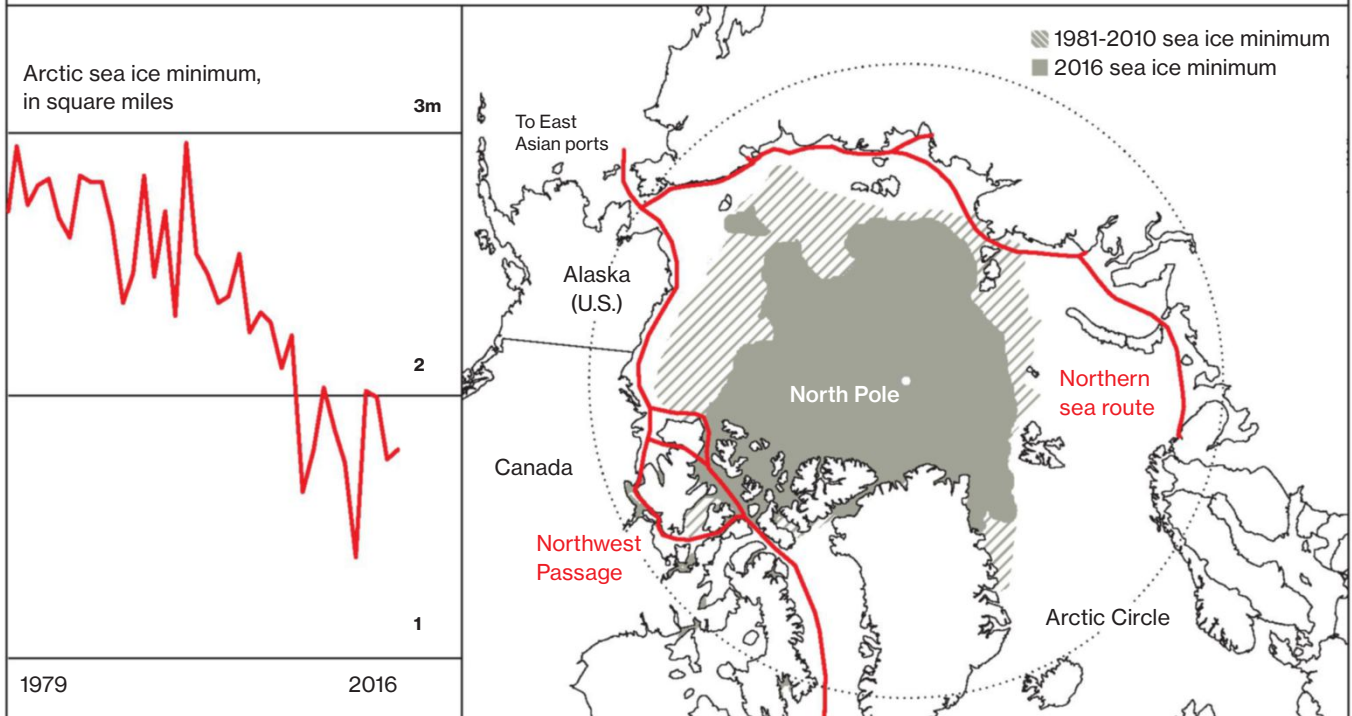
The Clean Energy Revolution Is Here

Despite the natural gas boom in the U.S. and China's continued reliance on coal-powered electricity creation, fossil fuels' days are numbered. As countries around the world invest more in renewables, prices for equipment such as photovoltaic cells and wind turbines (both onshore and off) will drop, according to Bloomberg New Energy Finance, making them that much more accessible.

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|----------|-------------|-------|---------------------|
| Industry | 2040 | Story | Andre Tartar |
| Shipping | | | |

The Navigable Northwest Passage

While the fabled Northwest Passage through Canada's Arctic Archipelago has occasionally thawed enough to allow ships through—as it did in the early 1900s, when Norwegian explorer Roald Amundsen made the first voyage, and in 2013, when the first freighter sailed it—any melt was typically short-lived. But a study of global warming's effect on Arctic transit published in 2013 found that open-water transportation through the passage will be possible for at least part of any given year starting in 2040. Sending container ships along this route would cut about 20 percent off the mileage of the voyage to East Asia from the East Coast of the U.S. and 30 percent off the distance from northwestern Europe.



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| Sooner Than You Think |
| Industries |
| Cybernetics |
| Medicine |
| 2017 |
| Moves a cursor by just thinking about it |
| 2025 |
| Powered exoskeletons that respond to thoughts |
| 2035 |
| Supplemental memory implants? |
| 2045 |
| Immersive telepresence? |
| 2060 |
| Direct brain-to-brain communication? |
| 2060 |
| Story |
| Jeff Wise |

F or the first 54 years of his life, Dennis DeGray was an active guy. In 2007 he was living in Pacific Grove, Calif., not far from the ocean and working at a beachside restaurant. He surfed most mornings. Then, while taking out the trash one rainy night, he slipped, fell, and hit his chin on the pavement, snapping his neck between the second and third vertebrae. DeGray was instantly rendered, as he puts it, “completely nonfunctional from the collarbone south.” He’s since depended on caregivers to feed, clothe, and clean him and meet most any other need. He had every expectation this would be the case for the rest of his life.

“My first six months were really something,” DeGray, now 64, says ruefully from his single room in a Menlo Park nursing facility, decorated with fairy lights, a *National Lampoon* poster, and a 6-foot-tall plastic alien. “And then the next two years were also something. And, frankly, this morning, it’s still something.” He operates his motorized wheelchair by blowing into a straw. Most of his days consist of TV and trips to the local park, the library, and neighborhood restaurants, where familiar staff help him eat.

For the past year, though, the routine has been broken on Mondays and Wednesdays. Around noon, two or three scientists arrive at the nursing facility. They roll out a rack of computer equipment parked in a corner of DeGray’s room and plug a cable into a socket on the top of his head. Once he’s connected, a 1/6-inch-square silicon chip in his motor cortex allows him to move a cursor on a computer screen just by thinking about it.

This so-called brain-computer interface, or BCI, provides a way to directly measure neuron activity and translate it into information or action. To manipulate the cursor on his screen, DeGray imagines that his hand is resting on a ball on a table and that he’s trying to roll it in one of

four directions: left, right, toward, away. When he first tried the system in September 2016, “it was like a bumblebee in the wind, bouncing around,” he says. Soon, though, he got the hang of it, and the researchers used his efforts to teach the computer to better interpret his brain activity. Today, with a keyboard laid out on the screen, DeGray can bang out nine and a half words per minute. If that doesn’t sound speedy in touch-typing terms, well, the Wright Flyer wasn’t a particularly fast airplane.

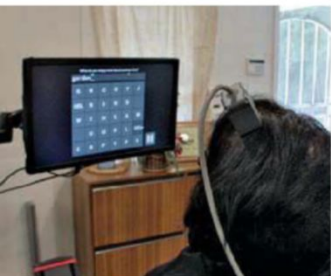
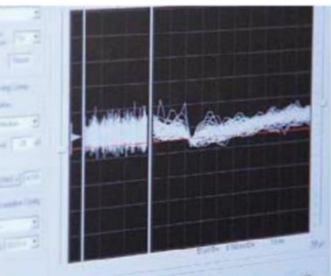
DeGray has been working with BrainGate, a consortium of researchers from the likes of Stanford, Brown, and Case Western Reserve University that’s successfully treated a dozen patients. The BrainGate team is among a growing set of university scientists, government agencies, and startups trying to give humans the ability to sense, control, and communicate with the outside world through the power of thought.

So far these advances are limited to controlled settings, but there’s big money dedicated to getting them out into the world faster than most people imagined when DeGray broke his neck. Bryan Johnson, founder of the payments service Braintree, has committed \$100 million to a BCI startup called Kernel. Facebook Inc. is developing a skullcap it says will allow users to mentally type their thoughts at 100 words per minute. Tesla Inc. and SpaceX Chief Executive Officer Elon Musk is backing a similar technology from startup Neuralink that he says supports his vision of a “closer merger of biological intelligence and digital intelligence.” The Pentagon’s research and development arm, the Defense Advanced Research Projects Agency (Darpa), is funding nine BCI projects it aims to bring to the U.S. Food and Drug Administration for clinical trials in three to five years. Justin Sanchez, director of Darpa’s Biological Technologies Office, predicts that medical device makers will be able to apply BCI hardware to a wide range of projects. DeGray is focused on one in particular: bypassing damaged nerves to reconnect his brain and body. “Ten years from now,” he says, “a guy is going to fall down just like I did, and in short order he’ll wake up in the morning, and someone will put his exoskeleton on, and he’ll get up and walk to Starbucks.”

The wiring together of brains and computers is a saddle-worn sci-fi trope. Think of William Gibson’s hacker heroes “jacking in” to cyberspace, or the captive humans plugged into the Matrix, or RoboCop. In practice, though, the brain is a lot tougher to hack. It contains 100 billion microscopic neurons, each connected to thousands of others. While some parts of the motor and sensory cortices correspond to parts

Better Typing Through Mind Control

The cyborg world that Elon Musk and Mark Zuckerberg are talking about seems far off. But brain-computer interfaces are already here



of a person's body, most elements of the brain, including the areas responsible for language and memory, aren't as intuitively organized. In fact, we hardly understand them at all.

The least invasive tool for measuring brain activity is the electroencephalogram, or EEG, which works through an array of electrodes fastened to the scalp and measures the strength of the electric field in each spot. This kind of gear is safe, cheap, and imprecise, best suited to applications that ask researchers only to distinguish between the brain activity required for sharply contrasting thoughts: left vs. right, up vs. down. To restore function to quadriplegics, BCI devices need vastly better precision and speed. For now, the only way to achieve that is by affixing sensors directly to the cerebral cortex.

Cutting into the brain to insert electrodes is about as tricky and dangerous as you'd think. (Maybe a little more so.) But people have been doing it, albeit with some public outcry, since at least the 1950s, when controversial neurologist José Rodríguez Delgado experimented with the cortices of epileptics and schizophrenics. In the '90s neuroscientist Phil Kennedy implanted electrodes in the brains of subjects suffering from locked-in syndrome, a paralysis of almost all voluntary muscles besides those that control the eyes, so they could type out messages. (The FDA halted Kennedy's work because of safety concerns.) Around that time, Brown professor John Donoghue began developing neural interfaces to study how the brain turns thought into action, which ultimately led to the BrainGate project.

"The field is progressing very, very quickly," says David Borton, head of the Brown Neuromotion Laboratory. The past year has been particularly impressive. Researchers at the University of Pittsburgh Medical Center connected touch sensors from a robot's fingertips to a paralyzed man's sensory cortex so he could feel what it was touching. At Case Western, scientists linked a paralyzed man's motor cortex to a computer that electrically stimulated muscles in his arm, enabling him to bring a forkful of food from a dish to his mouth. At Brown, Borton's team implanted electrodes and a wireless transmitter in a monkey's motor cortex and connected it to a receiver wired to the animal's leg, restoring its walking motion.

Taken together, these procedures provide a road map for artificial workarounds of nervous system malfunctions caused by accident or disease. The minds of quadriplegic patients could be reconnected to their own muscles or patched into machines. Borton says it's a question of when, not if.

Just as Lasik surgery has gone from Kubrickian nightmare to the sort of thing you get done over

lunch hour, brain implants could come to be a reasonable intervention for conditions such as Parkinson's, epilepsy, or chronic pain. They might even be used to improve healthy brains by adding memory storage or enabling communication by thought alone.

Stare at the ceiling long enough, and it's easy to worry about the darker possibilities of BCI. The kind of cybernetic fusion that gives us a doorway out of our bodies and minds could also give other people a way in. Once tiny robots can change people's moods, what can't they change? What does spam, social media addiction, or hacking look like inside your brain?

That's a ways off, as DeGray notes. He's been reading up on BCI research and is convinced that he'll eventually be able to do a lot more than type nine and a half words a minute. "We're building the foundation, learning how to directly control things from the cortex," DeGray says.

Already several companies, including Raytheon Co. and Lockheed Martin Corp., have developed powered exoskeletons that augment the strength of healthy bodies. If scientists can develop sensors and actuators that allow quadriplegics to feel and manipulate objects, they can integrate human and exoskeleton into a fully functioning cyborg. That will be no small feat—neurologists don't fully understand how our brains seamlessly coordinate sensation and action—but one day paralysis will effectively be a solved problem.

The technology will also extend the distance between user and machine. Pressure-sensitive pads on a robot's fingertips could feed into the sensory cortex of a user in the next room, the next state, or half a world away, and motor information traveling the other way could guide the robot hand to act. "It doesn't really matter where the brain is located," DeGray says. "I'll be able to fly like a bird at some point. Literally, the sky's the limit."

DeGray is ready for a change. His breath-operated wheelchair can get him the 2½ miles from his bedroom to BrainGate's Stanford lab and back, but the chair's best feature, he says, lets him hike himself up an extra 13 inches by blowing into the straw to manipulate a digital menu on the chair's screen. That 13-inch difference means "I can sit at a bar and watch the soccer game on TV and talk to the guy next to me, just like another guy." Imagine, he says, stripping away the rest of the social barriers he feels.

The potential to reconnect with people one-to-one, I suggest, could be enormous. "Enormous," DeGray says. "All capital letters, double exclamation points at the back end. Enormous." **E**

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| Sooner Than You Think | Game Changer |
| | Industry |
| | Carbon Capture |

Christoph Gebald and Jan Wurzbacher



The pair of climate engineers who are building a business out of sucking CO₂ from the atmosphere

More than a decade into their friendship, Christoph Gebald and Jan Wurzbacher can't decide which of them is the thinker and which is the doer. They met in 2003 during their first week as undergraduates at ETH Zurich, a Swiss technical university, where they studied engineering and quickly bonded over their shared loves for mountain climbing and beer. Also, "we were kind of would-be entrepreneurs from the beginning," Gebald says. They've been egging each other on ever since, swapping big-idea and get-things-done roles.

Climeworks, the company they started in Zurich in 2009, was inspired by Gebald's master's thesis, which applied an engineering perspective to the removal of carbon dioxide from Earth's atmosphere. In June, when the first of the duo's carbon-collecting machines went online, they became the first people to make money by de-warming the planet, collecting CO₂ directly from the air and selling it for use in greenhouses.

Each CO₂ collector, called a capture plant, looks like a 7-foot-tall box fan with a tiny jet engine inside. As its turbine sucks in air, chemical filters isolate the greenhouse gas. It can then be pumped for use as is, but Wurzbacher and Gebald are hoping customers will pay them to sequester it in the ground, permanently. The founders like to cite the findings of the Intergovernmental Panel on Climate Change,

which says CO₂ storage will be an essential part of meeting global targets to limit the Earth's warming. "Climeworks is on the leading edge of this," says Steve Bohlen, an energy technology program manager at Lawrence Livermore National Laboratory, a federal research facility near San Francisco. In July, Bohlen cited Climeworks as a company to watch in testimony on carbon capture technology before the U.S. Senate subcommittee on the environment.

Earlier this year the company secured its first commercial partner, contracting with a local farmer of tomatoes and cucumbers to supply 900 tons of CO₂ per year to his greenhouses, where it works as a sort of gaseous fertilizer, speeding up photosynthesis. Climeworks' founders say their near-term goal is to capture 1 percent of global carbon emissions by 2025, but the grand plan is to help humans remove more CO₂ from the atmosphere than they're pumping into it. "We're insurance as the going gets tough," Wurzbacher says. "The world will need affordable machines that can recork the CO₂ genie on a massive scale, render it usable or harmless in storage." Working around the clock, each capture plant can vacuum about 50 tons of CO₂ from the atmosphere a year, Wurzbacher says. He and Gebald declined to share pricing details but said costs will fall rapidly once production ramps up.

Some costs, however, are tough to predict. "Our biggest headache planning ahead is second-guessing politicians. Political support for climate protection is prone to wobble," Gebald says. "Even so, we're witnessing an independent private-sector drive to curb CO₂ that's resilient to politics. We're counting on a big role for Climeworks in the emerging carbon economy." **B**

Story
Brian Parkin

Illustration
Sam Kerr

Gebald, b.
1983, Greater
Nuremberg,
Germany

Wurzbacher, b.
1983, Hamburg

Spun off their
company with
the help of
Switzerland's
Venturelab
accelerator
program

Have a rule that
they don't stay
mad at each
other longer than
an hour



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A photograph of an offshore wind farm with several white wind turbines on yellow foundations in the ocean under a blue sky with light clouds.

*ON A CLEAR DAY,
YOU CAN SEE THE
FUTURE.*

The U.S. needs more renewable energy, a problem felt on Block Island, RI, where residents paid some of the highest electricity prices in the country while burning a million gallons of harmful diesel fuel each year.

Citi provided long-term financing to help Deepwater Wind build the first offshore wind farm in the U.S. – part of Citi's \$100 billion commitment to finance sustainable energy projects. The Block Island Wind Farm could help lower electric bills by up to 40 percent and reduce carbon emissions by 40,000 tons a year, ushering in a new era of American renewables.

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