WIRED

MARCH 2018 | MOVE FAST



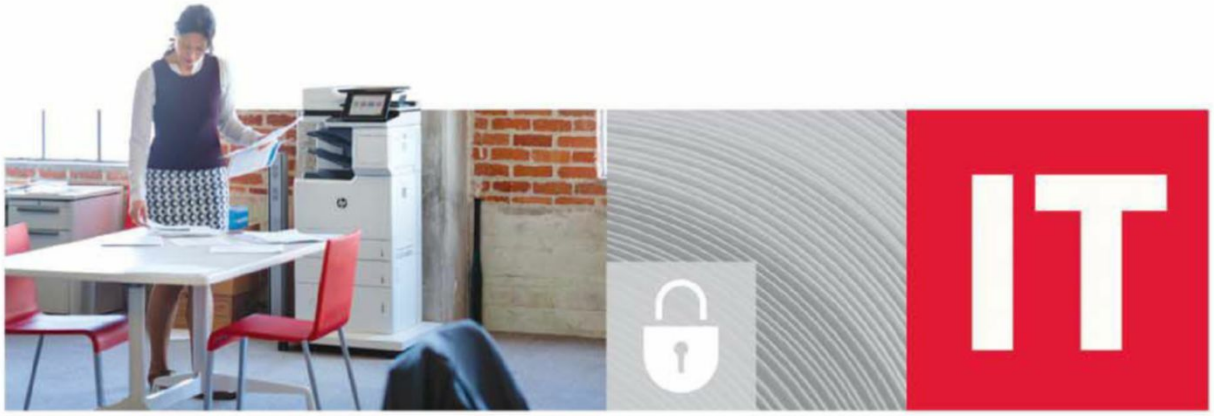


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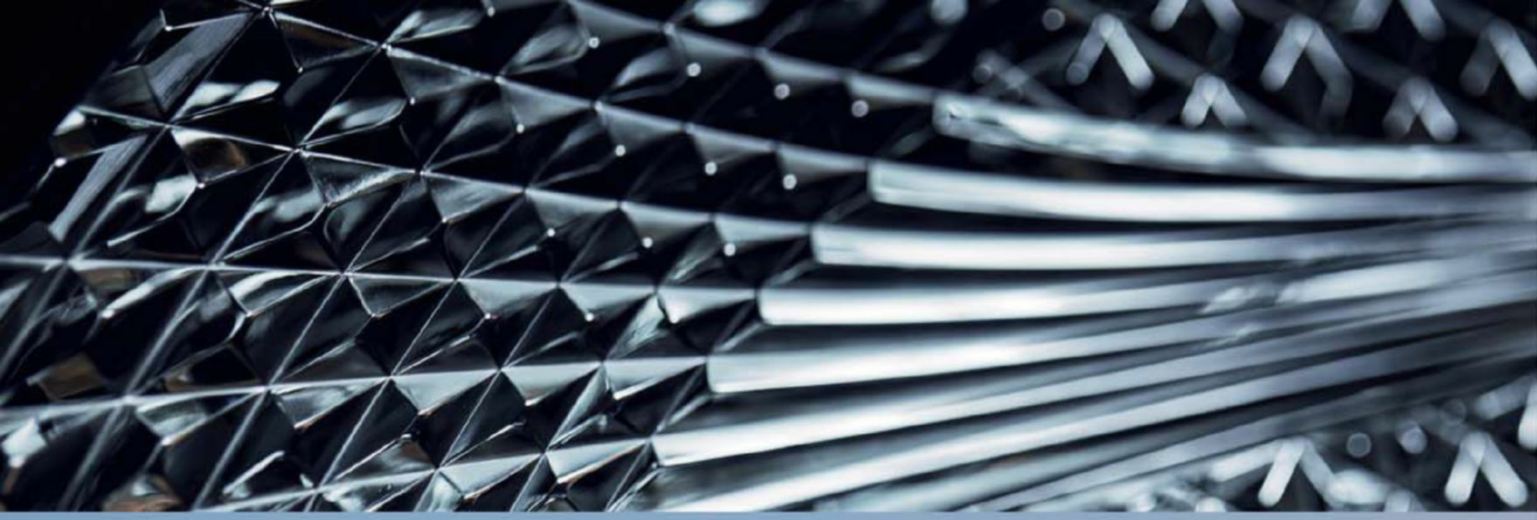
"AIMLESS SMALL TALK IS ESPECIALLY TOUGH FOR A

MACHINE LEARNING SYSTEM

BECAUSE THERE ISN'T A VERIFIABLY CORRECT WAY TO ENGAGE IN IT."



PAGE 72



RARE FORM

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Facebook's Two Years of Hell

Inside Mark Zuckerberg's struggle to fix it all.

BY NICHOLAS THOMPSON AND FRED VOGELSTEIN

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The Final Voyage

Kim Wall went for a ride on a submarine, hoping to write a story about the man who designed and built it. She never did. I needed to know what happened.

BY MAY JEONG

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Fighting Words

Amazon and its rivals are in a pitched battle to bring us conversational AI. So the company is staging a contest: Cook up a bot capable of small talk.

BY JAMES VLAHOS

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Creator of Worlds

With *A Wrinkle in Time*, director Ava DuVernay merges sci-fi's embrace of the Other with her own vision for a better, more inclusive future.

BY ANGELA WATERCUTTER

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Process of Elimination

Conservationist Karl Campbell wants to use Crispr to eradicate island predators. It's not brutal like poison, but it could transform our power over nature.

BY EMMA MARRIS

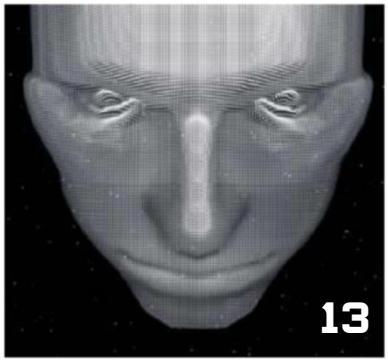
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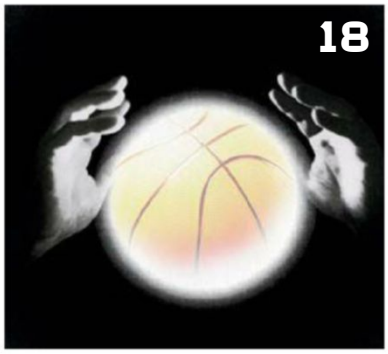
ALPHA



A.I. Is My Shepherd
A short history of technology worship
BY VIRGINIA HEFFERNAN

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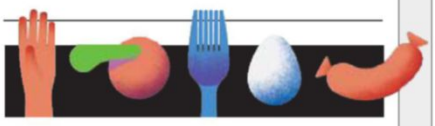
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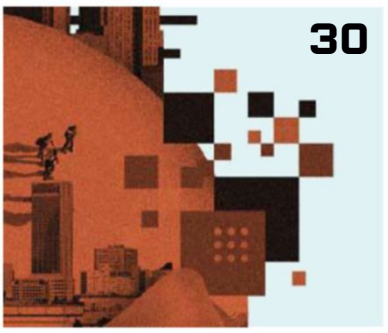


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GADGET LAB



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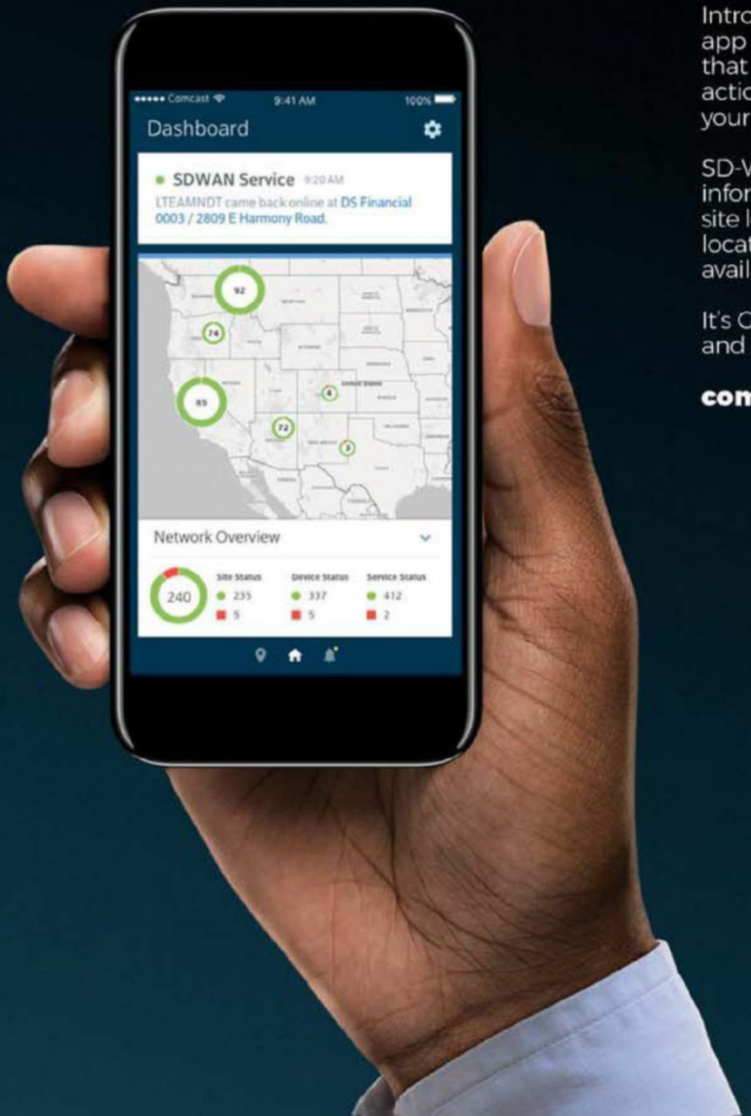


That bruised Mark Zuckerberg on this issue's cover? That's a photo-illustration created by Jake Rowland, a New York City–based artist known for his composite portraits. For this image, Rowland mashed together an existing image of Zuckerberg with a photograph of a hired model—made up to look battered, shown here—whose features resemble that of the Facebook cofounder and CEO.

COVER PHOTO-ILLUSTRATION BY JAKE ROWLAND/EBTO. THE COVER IS A PHOTO-ILLUSTRATION COMPOSED OF PHOTOGRAPHS FROM DAVID RAMOS/GETTY IMAGES (HEAD) AND PLUSH STUDIOS/GETTY IMAGES (MOUTH).

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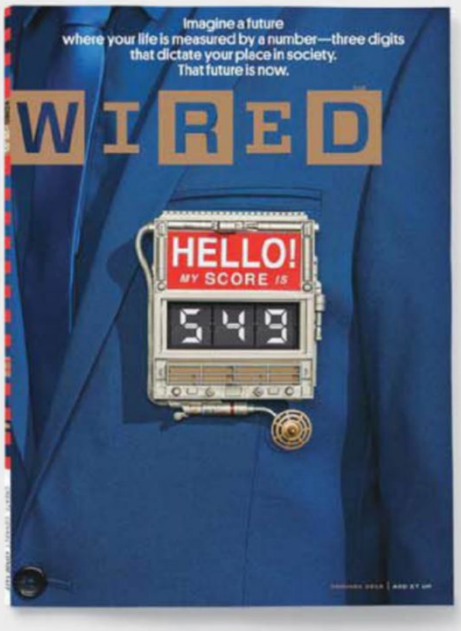
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NUMBERS GAME

IN OUR JANUARY ISSUE, Lauren Smiley explored a company that created digital avatars to serve as caretakers for the elderly. Former bomb-disposal officer Brian Castner traveled to Iraq to profile an investigator tracing the supply chain for the Islamic State's weapon factories. Novelist and writer Nathan Hill chronicled the burgeoning careers and rigorous training of the athletes in Overwatch League, a professional league of videogamers. And in our cover story, Mara Hvistendahl went to China to document a new social credit system firsthand—and examine what it says about the entities that collect our data en masse.

Re: "Live Long and Prosper": Silicon Valley's immortalists will help us all stay healthy.

"MAYBE INSTEAD WE SHOULD LEARN HOW TO BE LESS TERRIFIED OF DEATH."

Woofer on WIRED.com

Re: "The Terror-Industrial Complex": A weapons investigator uncovers the disturbing supply chain for ISIS' munitions.

"This appreciation of investigator Damien Spleeters and Conflict Armament Research is spot-on and mixes important themes (including government negligence in arms handouts) with Brian's writing gifts. More like this please."
C. J. Chivers (@cjchivers) on Twitter



Re: "Something to Watch Over Me": How tech might fill the void in the senior caregiver shortage.

"My relative has dementia: I worry about the technological solutionism inherent in this approach and wish society could figure out how to value human connection and pay caretakers the salaries they deserve—rather than replacing them with AI."
Allison Arieff (@aarieff) on Twitter

"My mother, 90, is currently fine alone, but she would never want to live with a caregiver (even me). She would likely be enamored by this sort of character. The humanity of this can exceed that of an actual caregiver."
billpennock via WIRED.com

Re: "You Are a Number": Imagine that a three-digit score dictates your place in society. In China, that time is now.

"This look at social credit scores is excellent and creepy. It isn't hard to imagine the ways this system can be abused (stifling dissent, reinforcing social hierarchies, etc.)."
Miriti Murungi (@NutmegRadio) on Twitter

"This is literally the plot of *Psycho-Pass*, a cyberpunk anime series that aired years ago. I'm unnerved by the shrinking period between first publication and first implementation of dystopias."
@whitequark on Twitter





Re: "Game On": A new pro league aims to bring videogame competition into the mainstream.

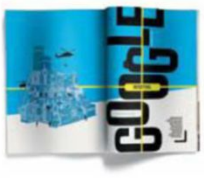
"I think Christopher Schaefer's assessment [that pro players can compete only until they're 25] is accurate, but fans and average players range widely in age. I'm 55 and I love *Overwatch*, not only as a player but as a viewer. I watch on average at least five hours of *Overwatch* matches each week (mostly because it's a blast, though I also treat it like rolling tape to see how I can improve). Many on my *Overwatch* team are in their early forties, most in their thirties, and three in their twenties."
RolandeDeschaine on WIRED.com



Photographer Mustafah Abdulaziz in Iceland in 2016.

TROUBLED WATERS

BERLIN-BASED PHOTOGRAPHER Mustafah Abdulaziz has traveled the world to capture the primal relationship between people and water. When he arrived in Copenhagen's harbor to take the photos for our story on journalist Kim Wall ("The Final Voyage," page 60), Abdulaziz was met with limited daylight, freezing rain, and a vast area to cover: "The assignment was to explore the space, and the weather was really disagreeable. So the photos have a moody, foggy feeling."



Cover story authors Fred Vogelstein and Nicholas Thompson last cowrote a WIRED article in 2009.

ROBBIE LAWRENCE



In college, **Angela Watercutter** studied the American Film Institute's top 100 list and remembers noting the number of movies directed by women: zero. So Watercutter, an editor for our culture desk, was thrilled to profile Ava DuVernay, the director of the new adaptation of *A Wrinkle in Time* (page 90). The force behind *Queen Sugar* and *Selma*, DuVernay is known as a champion for other women in the industry. "She hires only female directors for the TV series she's helming," Watercutter says, "essentially doing what studios won't do to find the next generation of talent." Perhaps the next version of AFI's list will better reflect DuVernay's vision.



In his two-plus decades reporting on Silicon Valley, contributing editor **Fred Vogelstein** has told many stories about the struggles entrepreneurs face when creating new products and businesses. But his story about Facebook, written with editor in chief Nicholas Thompson, "is about the aftershock and impact of those inventions." For years, Vogelstein says, Facebook has said it's a technology company and platform, and its role is simply connecting people. "But that role is evolving," he says. "Part of the reason society is confused about how to look at Facebook right now is we haven't really come to an agreement about what Facebook is." The inside story of how the company plans to reshape itself for the future is on page 46.



For her feature on the promises and pitfalls of using the Crispr gene-editing technique to help eliminate invasive rodents on islands (page 80), writer **Emma Marris** headed to the Galapagos, science's most storied archipelago. She felt awestruck by the giant tortoises and marine iguanas. Then she felt ill. "I was coughing and hacking, running a fever," she says. "I also got stung in the eye by something." Marris did some reporting with an eye mostly swollen shut. But she still witnessed the amount of work her main character, Karl Campbell, had to do to organize a rat eradication. It drove home how appealing methods like Crispr gene drives could be against animals that threaten rare species with extinction.

JOE PUGLIESE (WATERCUTTER); ANNA ALEXANDER (VOGELSTEIN); BRIAN GALLEY (MARRIS)

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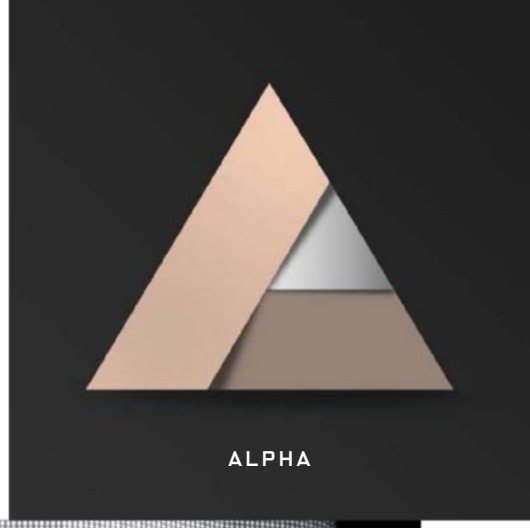
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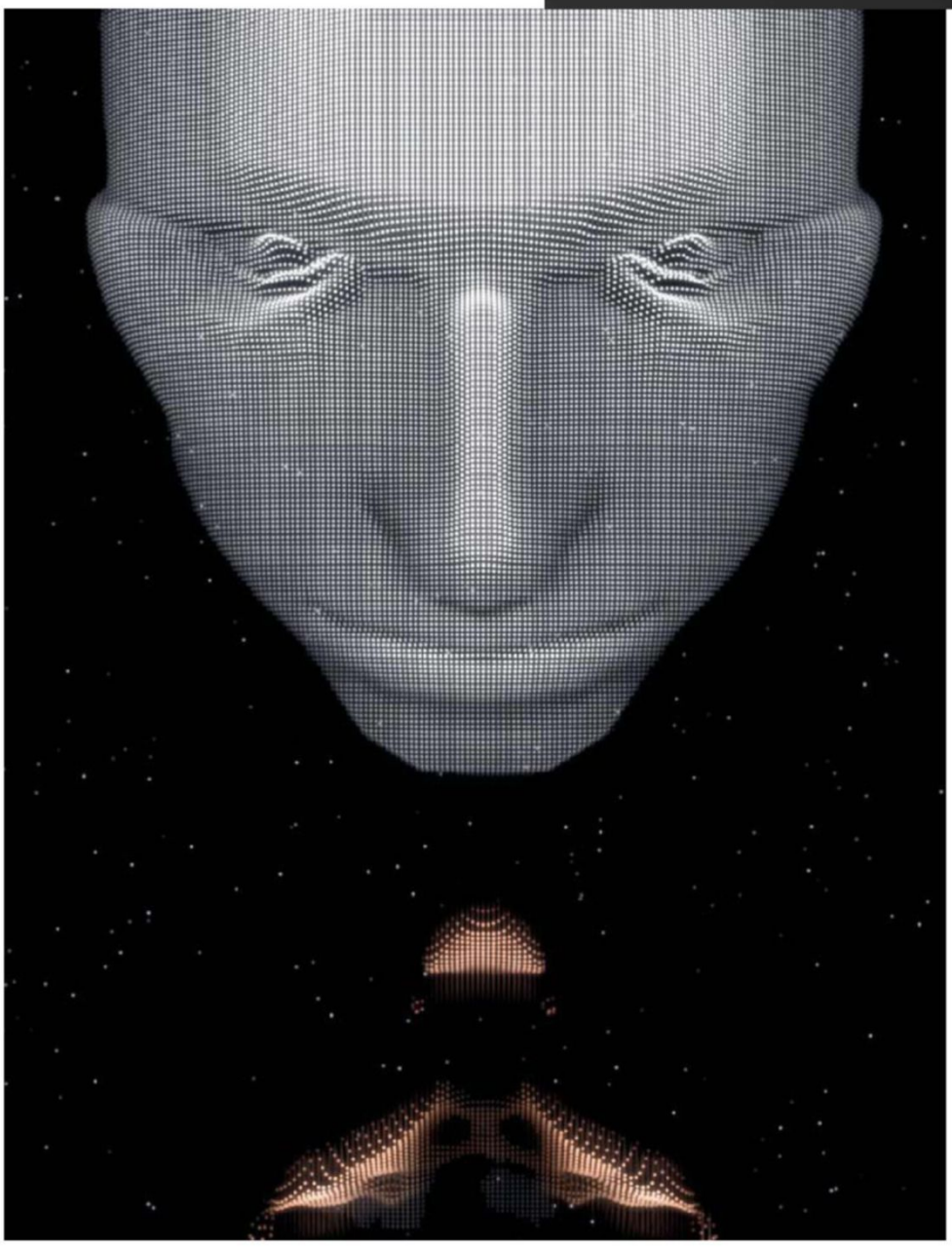
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AI IS MY SHEPHERD
A SHORT HISTORY OF TECHNOLOGY WORSHIP

BY VIRGINIA HEFFERNAN





I

"BEWARE OF BUGS in the above code; I have only proved it correct, not tried it."

That was how Donald Knuth, the author of *The Art of Computer Programming* (1968), expressed the difference between pristine mathematics and buggy reality. "When programming, you abstract away the entire physical world as much as possible, because it's messy. But then it comes back and bites you," Paul Ford, cofounder of the platform-builder Postlight, told me. "You end up in these situations where 80 percent works, 19.9 percent is hard but there's an answer that makes sense, and the last 0.1 percent is absolutely insane."

That fragment of chaos—the specter of

unreason in the world—opens up room for magical thinking. For programmers, bugs become not so much human errors as supernatural devils. So it should come as no surprise that the robotics engineer Anthony Levandowski, cofounder of the autonomous trucking company Otto, has pushed the envelope of that 0.1 percent to found a full-dress religion with artificial intelligence as its Godhead. Levandowski has poured his infatuation with "strong AI"—the Singularity's rebrand—into life's lacuna and conjured a vague, tax-exempt church he calls Way of the Future.

Before Levandowski was shut out of Otto, which is owned by Uber, he built 40-ton semi-autonomous trucks. The trucks are terrifying road mammoths with staring windshield-eyes that look like something Odysseus might have battled. Levandowski is now a central figure in the middle of litigation between Alphabet and Uber. Perfect résumé for a prophet: He can breathe a soul into a chassis, and he's a martyr to imperial forces.

He's also not the first tech star with prophet aspirations. Goofy Ray Kurzweil, the peculiar Singularity philosopher and hawker of sacramental life-giving supplements, is only the obvious example. Steve Jobs' syncretic faith appeared to be a changeable potage of Buddhism, karma, medical denialism, and intermittent fruitarianism. Tech writer Marshall McLuhan was a devout Catholic who proposed that technology could eventually fold all humans into the body of Jesus Christ. And Rod Canion, one of the Compaq founders, was a champion of something called Young Life, where "being estranged from God by our disobedience, we are, as sinful people, incapable of a right relationship to God apart from divine grace." Not only did these technologists reject the straight materialism of science, they tilted into some real Age-of-Jesus-Aquarius-Superstar stuff.

In spite of the yoking of technology and science in the adword STEM, they've always been an uneasy pairing. The word *technology* is best understood as the masculine form of the word *culture*, and when you're pitching culture projects to patriarchal joints that find the idea of "culture" unmanly, I've often found that "technology" seals the deal. At the same time, and whether they admit it or not, alpha-male technologists often turn for answers from hard science to the humanities. (Jobs in 2011: "It's technology married with liberal arts, married with the humanities, that yields us the result that makes our heart sing.") A 2001 book written by Knuth—who won the Kyoto Prize, Turing Award, National Medal of Science, and von Neumann Lecture Prize—is called *Things a Computer Scientist Rarely Talks About*. It's about Knuth's deeply felt Protestantism and his "glimpses of God."

IT'S POSSIBLE THAT NEITHER INTELLIGENCE NOR BEAUTY IS WHAT MAKES CONVERTS. IT'S TECHNOLOGY ITSELF.

On its website, Way of the Future claims its aim is "a peaceful and respectful transition of who is in charge of the planet from people to people + 'machines.' Given that technology will 'relatively soon' be able to surpass human abilities, we want to help educate people about this exciting future and prepare a smooth transition."

In Levandowski's scheme, AI merits worship because it's supremely intelligent. That's not as self-evident as he thinks it is. Traditionally God is regarded as infinitely just, or infinitely loving, or both; His mind is generally considered unknowable. Measurable intelligence is a mortal quality, one that—in religious parables—is often weighed down by pride and greed. But where engineer Victor Frankenstein imagined a creature so beautiful that humans would love it, Levandowski imagines a machine so smart that humans cower. Without irony, Levandowski has said that people are chasing AI because a super-empowered artificial attorney or accountant could make you "the richest person in the world." Ah, got it: A wicked-smart CPA would keep you in self-driving private spaceships. Now *that's* a reason to get down on your knees and pray.

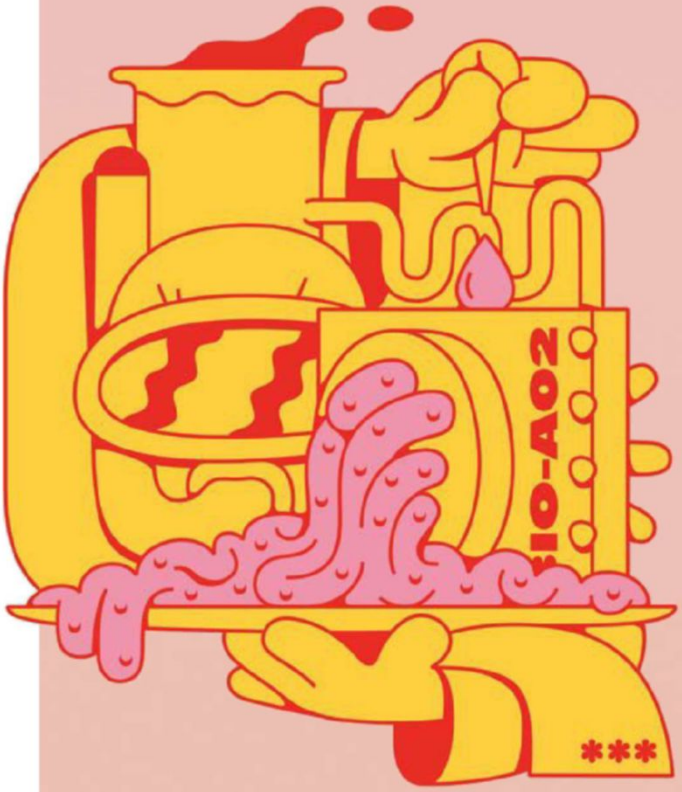
Of course, it's possible that neither intelligence nor beauty (nor justice nor love) is what makes converts. It's technology itself. In 1940, a missionary outfit in Los Angeles called Global Recordings Network set out to translate passages of the Christian gospel into every language on Earth, including nearly extinct spoken ones in regions without electricity. To reach these unbelievers, the organization created a cardboard record player that could be cranked by hand. What the missionaries observed was surprising. The

Virginia Heffernan *(@page88) is a contributor to* WIRED. *She wrote about Reddit's Change My View in issue 26.02.*

devices—playing records of various Bible passages—amazed people who hadn't seen them. Adele Horne, a documentary filmmaker who has studied Global Recordings Network, said the missionaries found that the hand-crank devices, early on, stunned those new to disembodied audio. The machine was like Moses with the burning bush—and it drew people who beheld it to the Western beliefs and practices behind it. "The allure of technological devices," Horne explained, is that "they might represent access to greater wealth and power." What can seem like a miracle of a new technology—from a record player to a self-driving 18-wheeler—may tenderize our brains, and makes us receptive to a new cosmology, a new theology, and attendant new behaviors.

When Frankenstein's hideous monster can't win human affection, he resolves: "If I cannot inspire love, I will cause fear." Artificial intelligence, likewise, is more fearsome than adorable. If AI is a deity, it's not likely to be the kind that forgives you, showers you with mercy, and sweeps you up in her loving arms. Who is this terrifying Godhead for, then? Maybe founders. Any god that capriciously bestows Bezos money on some and not others is, to entrepreneurs, greatly to be feared.

In contemplating a religion based on tech, Knuth foresaw another danger: fraud. "I'm worried that somebody will start a new religion based on fractals," he wrote in 2001. "If you come up with something that makes a little bit of sense and has a little bit of mystery to it, you can fool a lot of people." W



WHAT'S THE DEAL

LAB TO TABLE

FORGET FREE-RANGE, antibiotic-free, and grass-fed—tomorrow's burger will be lab-cultured. Scientists are creating a new slaughterhouse-free food group called clean meat: edible animal protein grown in a vat. Stem cells are extracted from animals, brewed in a bioreactor, fortified with nutrients like amino acids and glucose, and structured around collagen "scaffolds." It's not just about cultivating the ideal boneless chicken wing: These miracle meats could reduce the planet-depleting land and water use of traditional animal agriculture by more than 80 percent. "From an investment standpoint, this is potentially a trillion-dollar market opportunity," says New Crop Capital partner Christopher Kerr, leading VCs to grab a stake in their labstock of choice. Last year, DFJ, Atomico, Fifty Years, and others invested $17 million in Memphis Meats' in vitro beef, chicken, and duck. Sergey Brin bankrolled MosaMeat, creator of the world's first clean burger. Scandal-plagued mayo maker Hampton Creek (newly rebranded as Just) is concocting cultured poultry. And SOSV and IndieBio are backing boneless fish fillets by Finless Foods. The results—and taste tests—have been promising. Now these ultramodern farmers need their science to scale. "The biggest challenge is taking what's in the lab and making it commercially viable," says David Welch, director of science and technology at The Good Food Institute. A pound of Memphis Meats takes $2,400 to produce, due to the pricey medium needed to culture cells; the company aims to reduce that cost to under $5. Good to hear—a $600 Quarter Pounder is no value meal. —ZARA STONE

H.Y.T. STUDIO

MISSING LINKS
THE WOMEN BEHIND THE WEB

CLAIRE L. EVANS has discovered the solution to our social media woes: "Go back to BBS." She means bulletin board systems, those grunge-era digital hangouts, like the Well and Echo, where users linked up based on mutual interests and supported one another. (So civilized.) Earlier this year, Evans even installed BBS server software on her Raspberry Pi to test her theory. "That kind of small-scale, self-policed social media could serve as a balm to us all," she says. ¶ As the author of a jaunty new history of women in computing, *Broad Band*, Evans spent years uncovering the contributions of tech's forgotten foremothers, from the developers of early compilers and Arpanet protocols to the makers of radical videogames and, yes, inclusive preweb forums. (Nearly half the users of Echo, which was created by Stacy Horn in response to the Well's proto-brogrammer vibe, were women—at a time when the internet was 90 percent male.) ¶ These pioneers recognized the human side of tech, making code more accessible and hypertext more multidisciplinary. Often, they came at tech sideways, from backgrounds in theater, math, linguistics, even cave exploring (shout-out to speleologist-coder Patricia Crowther). "The more broadly we can think about technological problems," Evans says, "the better the end result will be." She would know. When she's not chronicling our overlooked cyberfeminist past, Evans sings in the dance-pop group Yacht. In her vision for tech, weird is welcome. —JASON KEHE

WHO: Claire L. Evans, writer and musician

CULTURAL OBSESSIONS: Sci-fi by Ursula K. Le Guin, Joanna Russ, and Octavia Butler; *Star Trek: Deep Space Nine*

UNLIKELY HOBBY: Xeriscaping. "I'm a Californian."



JACLYN CAMPANARO

Because of These Women...

Betty Holberton
... UNIVAC made its desktop computers beige (not black).

Elizabeth "Jake" Feinler
... web domains are categorized by type: .gov, .edu., .com.

Radia Perlman
... spanning-tree protocol keeps Ethernet from crashing.

Janet Walker
... web browsers have bookmarks.



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SOLVING MARCH MADNESS
THE KEY TO TOP BRACKETS: EVOLUTION

PREDICTING THE WINNERS and losers of March Madness is such a daunting challenge that it attracts math nerds like Starfleet voyagers lining up at Comic-Con. Statisticians, economists, Silicon Valley coders, the PhD quants at hedge funds and gambling syndicates: They've all tried to "solve" the outcome of the annual college basketball tournament's 63 matchups.

"Every kid who takes a mathematical modeling class and who's a college basketball fan, the first thing they want to do is predict the NCAA tournament," says Ken Pomeroy, a former meteorologist who has become arguably the foremost college basketball numbers guru. His famous KenPom ratings measure the strength of all 351 NCAA Division 1 basketball teams using an old-school regression technique known as "least squares," which analyzes statistical variances in teams' past performances and helps predict the winners in two-team matchups.

But to generate entire brackets is to tangle not just with the randomness of the game itself, but with the randomness of your betting pool—the lucky guesses made by all the people you're competing against to predict the greatest number of winners. Microsoft researchers have unleashed their machine-learning engine Bing Predicts on March Madness forecasts, and several independent researchers, such as the chief data scientist of a big defense consultant, have used neural networks to entwine discrete predictive models into "ensembles" that spit out probabilities. But some of the most intense March Madness research is being done by David Hess. He's a 36-year-old with degrees in neuroscience from Johns Hopkins and NYU who's also from Kansas and is thus "a huge college basketball fan." In 2011 he went to work at a sports prediction site called Team Rankings, where he set out to build a tool to produce optimized NCAA tournament brackets for paying customers.

After experimenting with different statistical models, including a so-called upset algorithm that somehow augurs underdog victories, Hess settled on what's known as an evolutionary algorithm that relies on machine learning. Hess begins by rating the relative strength of all the competitors. Once the NCAA announces the seedings—a ranking of the teams in the tournament—the model uses that data, along with probabilistic information from betting markets, to spit out a batch of probable results. That, however, isn't enough. A second model scrapes data from ESPN and Yahoo, where millions of people submit their picks for public consumption, and generates a simulated pool of opponents' brackets.

At this point, the evolutionary algorithm takes over. It obtains a semirandom sample of brackets from the 9.2 quintillion (that's 9 million trillion!) possible permutations and pits them against a series of simulated tournament results and a series of simulated pools. It runs, in essence, a simulation based on two other simulations. The algorithm plucks out the brackets that achieve the highest winning percentages and then does what makes it evolutionary: It "mutates" or "mates" the brackets to produce "offspring" outcomes. The software repeats this process through 300 or so generations and halts the evolution when it detects no room for improvement.

Starting the night of the NCAA's seeding announcement, 18 Amazon servers used by Team Rankings will spin for more than 24 hours, and Hess' crew will pull a few all-nighters. "I think we find the global optimum solution the majority of the time," he says, and recent results bear that out: A Team Rankings analysis shows that people who paid $39 for its optimized bracket last year were 4.5 times more likely to win a prize in their pools than those without an algorithmic edge. However, he's quick to caution that no machine will ever be able to predict upsets. "Even if you were omniscient and could know the true odds of a thing happening," Hess says, no bracket based on those true odds would win any given March Madness pool. In betting and basketball, there are no sure things. —SCOTT EDEN



MATT DORFMAN

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Know who's knocking.

Hello



Now you'll never miss a visitor or a package. Nest Hello replaces your wired doorbell and connects to Wi-Fi. So when someone's at your door, you'll get an alert on your phone.* Then you can see people from head to toe, and talk to them like you're face to face. With Nest Hello, you'll know who's there, even if you're not.

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*Video streaming, video recording and mobile notifications require working internet and Wi-Fi.

TOOL

DOT COMBINE
THE ULTIMATE FARMBOT

THE FIRST FULLY AUTONOMOUS ground vehicles hitting the market aren't cars or delivery trucks—they're robo-farmhands. The Dot Power Platform is a prime example of an explosion in advanced agricultural technology, which Goldman Sachs predicts will raise crop yields 70 percent by 2050. But Dot isn't just a tractor that can drive without a human for backup. It's the Transformer of ag-bots, capable of performing 100-plus jobs, from hay baler and seeder to rock picker and manure spreader, via an arsenal of tool modules. And though the hulking machine can carry 40,000 pounds, it navigates fields with balletic precision.

Farmers map their land using an aerial drone or GPS receiver, upload that data to the Dot controller—a Microsoft Surface Pro—then unleash the beast into the field. The tireless machine can run around the clock, pausing only to refuel its 75-gallon diesel tank, and will save growers an estimated 20 percent in fuel, labor, and equipment costs. The first six Dots will be sold to farmers in grain-rich Saskatchewan, Canada, this spring (before a wider rollout next year). Get ready for a tech-tended bumper crop. —MATT JANCER

WHAT:	Dot, an autonomous ag-bot
SIZE:	18' x 12' x 11'
WEIGHT:	4.25 tons
WEIGHT CAPACITY:	20 tons
TOP SPEED:	12 mph

Navigation Brain

If the machine encounters an object that wasn't included on the drone or satellite mapping imagery, it stops and beams a video to its remote operator.

Mounting Arms

The farmer uses a remote control to position Dot alongside the desired tool attachment, such as a seeder. Then four hydraulic arms hoist and secure the apparatus.

Smart Wheels

Each of the sensor-laden wheels can turn independently. The ag-bot's electric and hydraulic guidance system tracks steering and wheel slippage to enable tight maneuvers.

Anticrash Sensors

Radar, light sensors, and object-recognition cameras are potential features to help the robot tractor avoid obstacles.

Synchronization

Engineers are working on an upgraded communication system that will allow multiple Dots to cooperate in the field.



COURTESY OF SEEDMASTER MANUFACTURING

INTERNET FLICKS
BITTORRENT AND THE STREAMING REVOLUTION

BRAM COHEN, the mastermind behind BitTorrent, claims he didn't set out to build a pirate ship when he launched the file-sharing product in 2003. All he wanted to do was make it easier to move big stuff around the web—video-game updates, maybe, or the Linux distros that developers liked to swap. But within a year of starting the company, files shared on BitTorrent made up more than a third of all traffic on the internet. While Netflix was still stuck in the mail-order business, BitTorrent was changing how and why we watch things online.

At first, Cohen was simply solving a puzzle: There was this logistical problem of how to move large files around, he says. "I figured out how to make it happen." Unlike other peer-to-peer platforms, where downloaders had to rely on one person's computer and their sharing largesse to access a file—remember Napster?—BitTorrent divided the uploading work among the masses, with each "seed" computer providing only a small part of the total file. Suddenly files moved faster, and uploaders could share files without killing their bandwidth or raising eyebrows at Comcast.

Many early BitTorrent users had perfectly legit and legal goals, like the Phishheads and Deadheads who grabbed entire concerts with the bands' blessings. But shaky, low-res versions of summer blockbusters and Must See TV soon started flying around the web, and Cohen's tech became synonymous with the illegal-download industry. Didn't want to pay for a new movie? Torrent it. Missed last week's episode? It's already up on KickassTorrents. Hollywood executives, who had been spared the existential threat of Napster only because video files are much bigger and more annoying to transmit than music files, saw their own bogeyman approaching.

The execs sicced their lawyers on BitTorrent users, hoping to sue the pirates into oblivion. In 2012, industry lobbyists even pushed for a bill called the Stop Online Piracy Act, which would have let the government essentially shut down any website hosting pirated content. But these efforts failed, in part because "breaking big files into smaller, more distributed pieces and tracking their assembly" is not itself illegal, and BitTorrent Inc. couldn't be held responsible for how its platform was being used. BitTorrent survived the worst that Hollywood could throw at it, and Hollywood realized it couldn't stop anyone from torrenting—it could only hope to learn from those who had come before.

The music industry had concluded in the early aughts that the only way to compete with *free* is *better*. So just as record companies worked with Apple et al. to sell high-quality audio files free of the glitches and viruses that marred so much Napster content, entertainment executives countered BitTorrent by creating or partnering with platforms where people could pay for crisp, trouble-free HD video. Netflix, Hulu, and Amazon Prime Video all owe at least part of their existence to BitTorrent and its messy, malware-lousy downloads.

Piracy remains a massively popular global pastime—BitTorrent Inc. tells potential advertisers it has 170 million users per month. And entertainment execs have more or less made peace with its inevitability: When top brass at HBO see that *Game of Thrones* is the internet's most-pirated show, they wear the distinction like a badge of honor (while sending out perfunctory cease-and-desist letters). Then they make sure HBO Go's backend streaming tech serves up dragons that are brighter, sharper, and more terrifying than anything you could see for free.

Fast broadband and cheap server space have largely rendered Cohen's original problem irrelevant, and most users have plenty of legal ways to download or stream video. But BitTorrent continues to shape how we think about storing and moving big things around the web: It's easy to draw a straight line between BitTorrent's decentralization of file-sharing and today's blockchain-based cryptocurrencies, different technologies trying to spread control so wide that no single entity can break the system. Meanwhile, BitTorrent and its fellow pirate ships still loom as quality-control phantoms, hovering over the entertainment world and reminding those in charge what'll happen if they stop doing right by viewers. Free content is just a download away.



By **David Pierce** *(@pierce), who writes about real-time translation on page 42.*

FRESH STARTS EVERLASTING SHELF LIFE

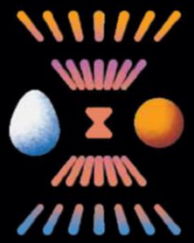
THERE'S HOPE FOR A tastier, healthier, more robust tomorrow: high-tech new food preservation methods that fend off the bad stuff (bacteria, spoilage) while protecting the good (flavor, texture, nutrients). Scientists are experimenting with everything from microwave sterilization to blasts of plasma to ensure food stays appetizing longer—even without refrigeration. That salmon dinner you bought on Monday? It'll taste just as fresh a week later. And it'll be just as good for you. —REBECCA HUVAL



Blue Blast

BEST FOR: Berries, nuts

Scientists at Scotland's University of Strathclyde pioneered a technique that bombards fluids with high-intensity blue light, which produces a form of oxygen that's lethal to pathogens. It's now being adapted for use on berries and other foods.



Radio Waves

BEST FOR: Eggs

The USDA has developed a machine for eliminating salmonella in fresh eggs. Electrodes pulse radio frequency waves through the shells, targeting the space between the white and yolk where salmonella dwells.



Plasma Cloud

BEST FOR: Fruits and vegetables, seeds, salads

Put the food on a conveyor belt, blast it with cold plasma, and—*voilà*—a mixture of nitrous oxides, hydrogen peroxide, and other molecules lays waste to bacteria.



Micro Rays

BEST FOR: Frittatas, mac and cheese, salmon

With microwave-assisted thermal sterilization, packaged food cooks inside a pressurized tube while focused microwave energy kills microorganisms in minutes. AmazonFresh is reportedly interested.



Germ Warfare

BEST FOR: Salad, berries

Think of this as probiotics for plants. Scientists douse fruits and vegetables in a solution containing good bugs, like bacteriophages, that kills the bad bugs, like salmonella or listeria. General Mills and Pillsbury have both explored the tech.



Atomic Bomb

BEST FOR: Meat, fruits and vegetables, spices

High-energy electrons—yeah, radiation—are shot into food, beating bacteria by breaking up their DNA. It kills bacteria but not aroma, says Cornell University food science professor Carmen Moraru.

MARTIN NICOLAUSSON



JARGON WATCH

Kleptopredation

(ˌklep-tō-pri-'dā-shən)

n. A strategy for maximizing energy intake by consuming prey that has itself just eaten.

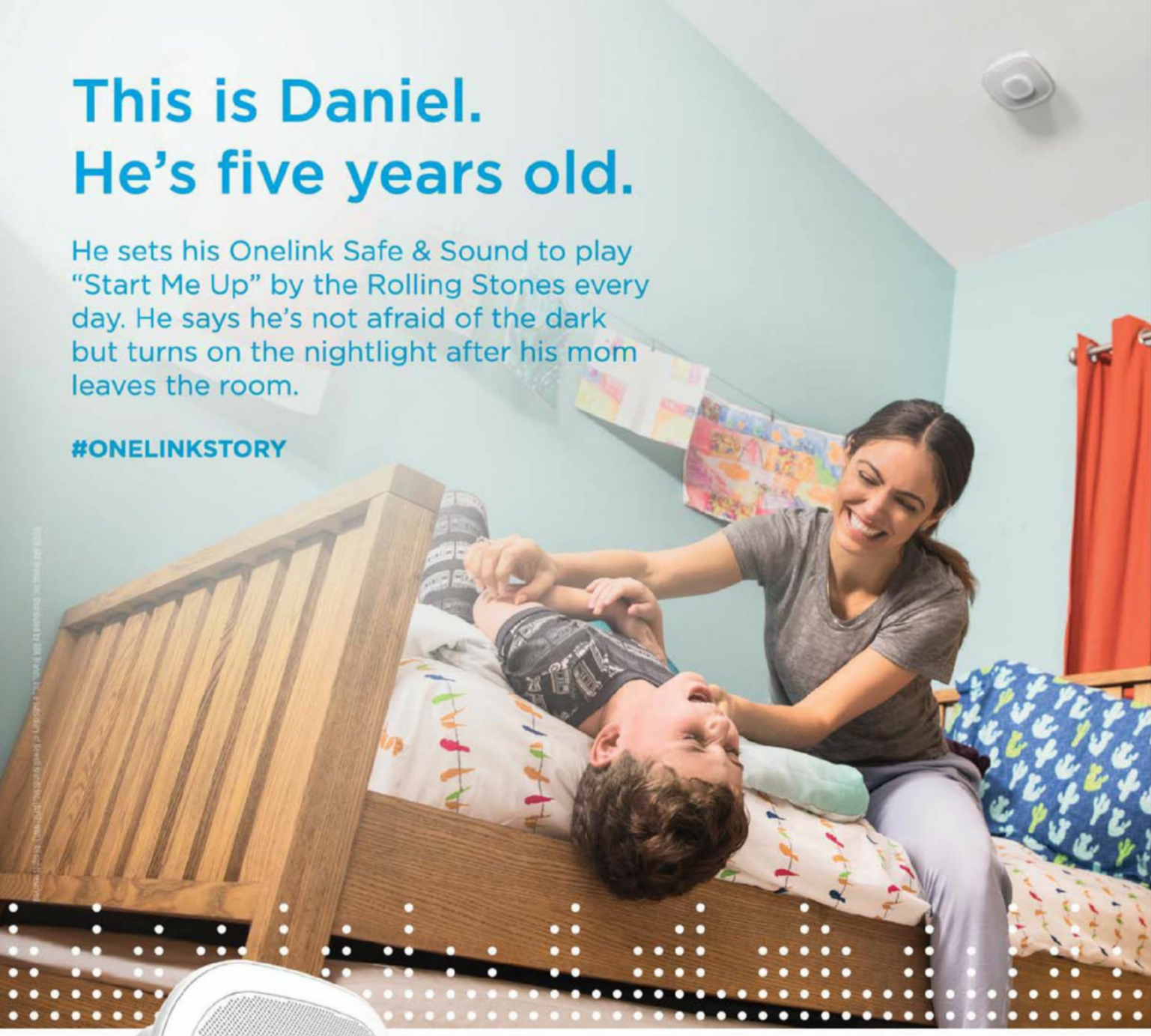
Recently, 25 sea slugs were served an underwater buffet to study their tastes. Offered a choice of brine shrimp and hydroid polyps (small coral-like organisms), the slugs opted for polyps that had swallowed the shrimp—a clever caloric twofer. Using a novel feeding strategy, they were jumping the line in the food chain to devour their prey *and* the prey of their prey. Researchers dubbed this kleptopredation, using the Greek word, *kleptes*, for thief or cheater. ¶ Of course, the criminal trope is only a metaphor; human standards of fair play hold no sway in the animal kingdom. (Though some have taken the term full circle to call out *human* rapacity: The Daily Kos cited the 2017 Republican tax bill as a case in point.) And it turns out that real kleptopredation is an environmentally friendly strategy. The slug, a gaudily colored species of nudibranch, uses hydroid colonies for shelter. By eating polyps with full bellies, it's able to consume far fewer of them, thus preserving its habitat. Hydroids may enjoy their meals less, but in the long term it's a win-win for both parties. ¶ Indeed, we humans might take a cue from sea slugs to concentrate our own use of resources. It's the paradoxical case for building dense cities instead of leafy suburbs and growing our food on industrial-scale farms. Perhaps there really is honor among thieves. —JONATHON KEATS

JARGON WATCH ILLUSTRATION BY LEON EDLER

This is Daniel.
He's five years old.

He sets his Onelink Safe & Sound to play "Start Me Up" by the Rolling Stones every day. He says he's not afraid of the dark but turns on the nightlight after his mom leaves the room.

#ONELINKSTORY





FIRST ALERT

Onelink.

SAFE & SOUND

Your family's new best friend.
Onelink Safe & Sound is a smart smoke and carbon monoxide alarm with a premium home speaker and Alexa enabled.

Works with Apple HomeKit

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DESTINATIONS

GET EXPERIENCED
HEAD TO LA FOR VR

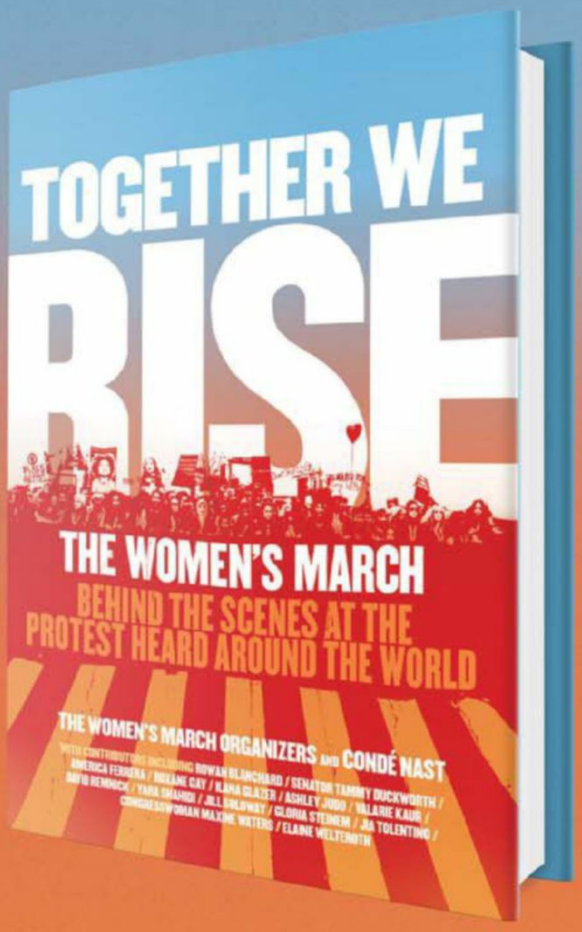
AS CERTAIN FORWARD-THINKING magazines predicted last year (ahem), VR's first mass-culture moment has arrived not as a device but as a destination. There's far more immersive potential in a dedicated VR facility—with its stagecraft and high-end components—than what's currently possible in your living room. Already, companies like the Void and Star VR are running bespoke experiences where you can roam imaginary worlds untethered, and Imax has installed virtual reality centers in three of its multiplexes. Next up: A new outfit called Dreamscape Immersive promises to supercharge the escapism of "location-based" VR. ¶ The key is a nifty motion-capture algorithm. By putting trackers on your hands and feet, plus a laptop on your back, Dreamscape can extrapolate what your limbs are doing. The result is a system that brings your full body into VR and enables you to share the experience—and props—with others. Playing catch with a flaming torch; reaching out and feeling the head of a creature that has sidled up to you; swinging a baseball bat and connecting with a real pitch: It's all unlike anything else in the medium. "We're not going to be a 'VRcade,'" says Dreamscape CEO Bruce Vaughn. "This is a chance to transport people into imaginative worlds." ¶ When can you give it a go? This year. The top floor of Los Angeles' Westfield Century City mall will soon be home to an array of Yves Béhar–inspired Dreamscape "pods." If you can't make it to LA, AMC has committed to installing pods in at least six other cities. Oh, and Steven Spielberg is an early investor. *E.T.* in VR? ZOMG. —PETER RUBIN



COURTESY OF DREAMSCAPE IMMERSIVE

OTHER VIRTUAL VENUES AROUND LOS ANGELES // DISNEYLAND: IN THE VOID'S COLLABORATION WITH ILM, *STAR WARS: SECRETS OF THE EMPIRE*, YOU INFILTRATE ENEMY TERRITORY DISGUISED AS A STORMTROOPER. *PEW-PEW!* // **IMAX VR CENTRE**: PANORAMIC HEADSETS AND MULTIPLAYER GAMING GALORE—INCLUDING A *JOHN WICK* TIE-IN THAT MAKES YOU FEEL LIKE KEANU (IN A GOOD WAY). // **VIRTUAL ROOM HOLLYWOOD:** YOU'VE PLAYED ROOM ESCAPE GAMES, BUT HAVE YOU DONE IT ... IN VR? TEAM-BASED EGRESS, 21ST-CENTURY STYLE.

BY THE WOMEN'S MARCH ORGANIZERS AND CONDÉ NAST



In celebration of the one-year anniversary of the Women's March, the organizers teamed up with Condé Nast to create this gorgeously designed full-color book offering an unprecedented, front-row seat to one of the most galvanizing movements in American history. Featuring exclusive interviews with the Women's March organizers, never-before-seen photos, and essays by feminist activists, writers, celebrities and authors such as JILL SOLOWAY, AMERICA FERRERA, ROXANE GAY, ILANA GLAZER, CINDI LEIVE and ELAINE WELTEROTH. An inspirational call to action that reminds us together,

ORDINARY PEOPLE CAN MAKE A DIFFERENCE.

ON SALE NOW

WOMENSMARCH.COM/TOGETHERWERISE

The Women's March organizers plan to share book proceeds with grassroots, women-led organizations.

@womensmarchonwash @condenast @womensmarch @condenast

DEY ST.

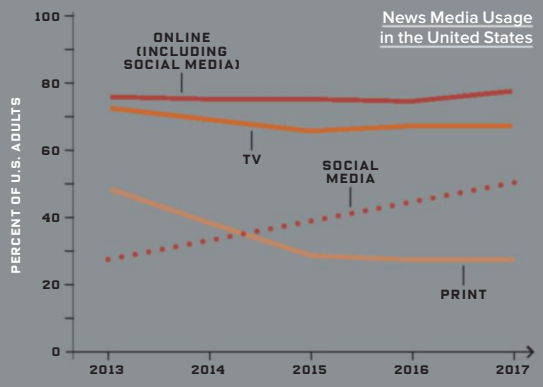
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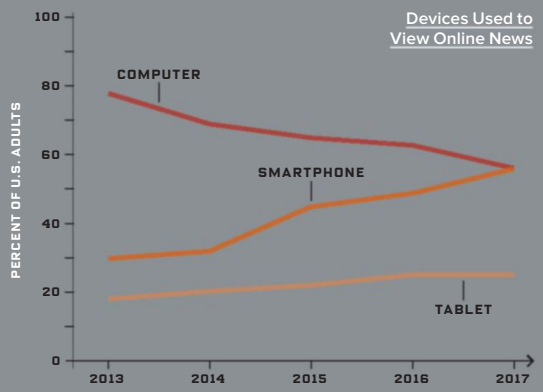
HOW THE PHONE CHANGES THE NEWS

USED TO BE, you'd browse the paper over breakfast, on the subway, in bed at night. Then news went online and became something you read at your desk (often, truth be told, your work desk). However, with the rise of smartphones, staying current once again became a portable experience; now phones are fast replacing PCs as the device of choice for getting our daily fix. But that small screen changes the game. For starters, since it's harder to navigate—like reading a paper in the dark with a flashlight—fewer people visit the websites that editors so carefully curate. That's bad news for traditional media outfits. Here's a look at how we consume the news today. —SETH KADISH

1 Smartphones will surpass PCs as a way of getting news in 2018.

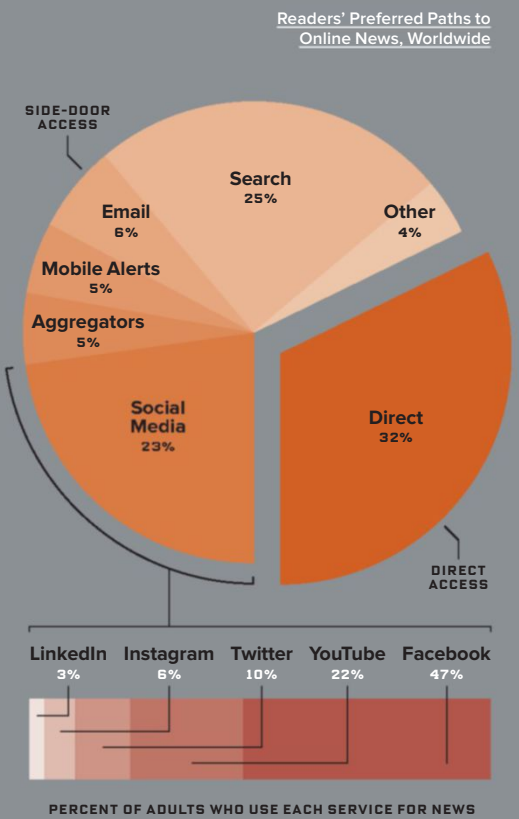
TV's still going strong, but more of us get our news online, and that hasn't changed—digital publishing is a mature medium. What *has* changed, according to the latest Reuters Institute Digital News Report: More than half of us now read it on our phones. And not just when we're out and about; news consumers are opting for the One Device at home too. (More people use their phone for news in bed than on the train.) The future? Look to early-adopter countries like Singapore, where 72 percent get their news on the small screen.





2 We no longer bookmark news sites.

We still read the big news brands, but two-thirds of us now access their stories through a side door—mainly by linking from search results or social feeds—rather than going directly to a publisher's website. Today, editors decide what's fit to print but not what gets read. What's more, survey respondents remembered the platform they used more than they remembered the news brand itself. That's nice for Facebook, which dominates the social gateway (47 percent use it for news). In a world of tiny screens, news producers may become anonymous backend services.

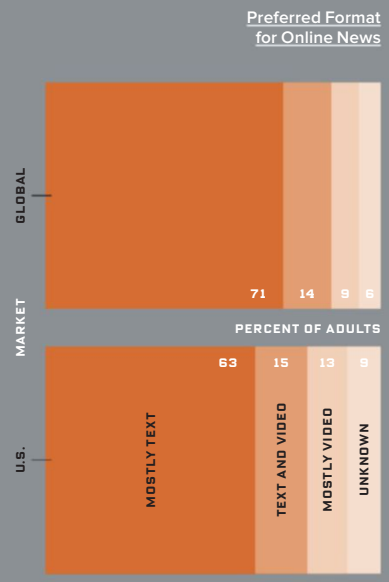


SOURCE: REUTERS INSTITUTE DIGITAL NEWS REPORT 2017

TWO-THIRDS OF CONSUMERS YOUNGER THAN 35 PREFER TO LET ALG

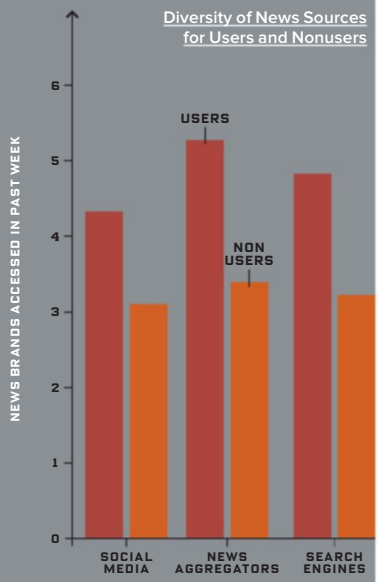
3 We want to *read* the news.

Porting the news to the internet was supposed to turn it into this rich, multimedia extravaganza. Turns out consumers like their news in text form, thank you very much. Simply put, video takes too long.



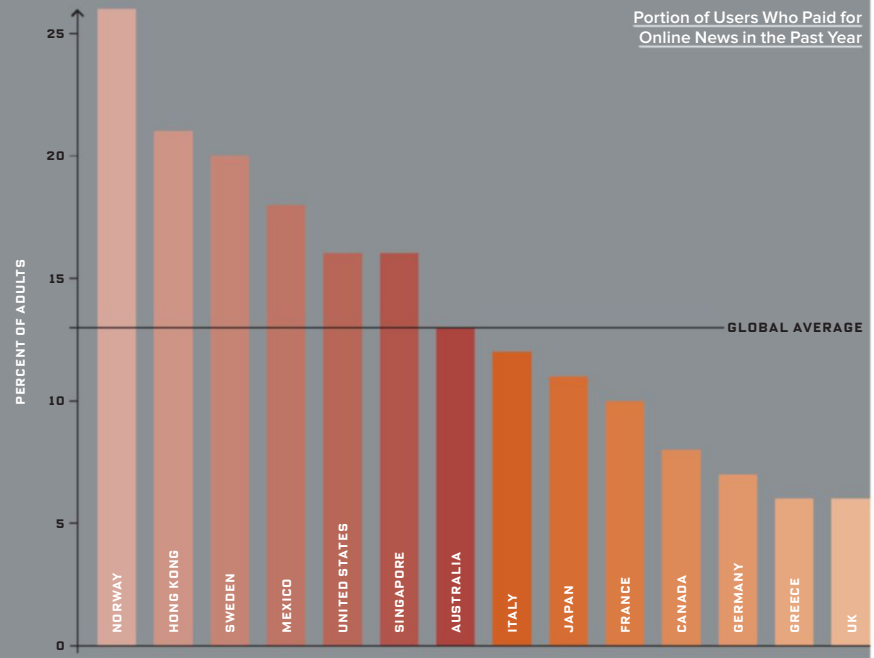
4 What filter bubble?

With curated feeds, pundits worry that we now see a narrower range of opinion. Actually, indirect access leads users to *more* news brands—including ones they wouldn't usually read, respondents say.



5 Publishers can't get paid.

Worldwide, only 13 percent of readers paid—even once—for online news. (Ongoing subscriptions are less than half of that.) But in the US, the number jumped from 9 to 16 percent last year, and the biggest uptick came from young people, ages 18 to 34. Maybe journalism has a future after all.



ORITHMS, NOT EDITORS, CHOOSE THEIR NEWS.



ANGRY NERD

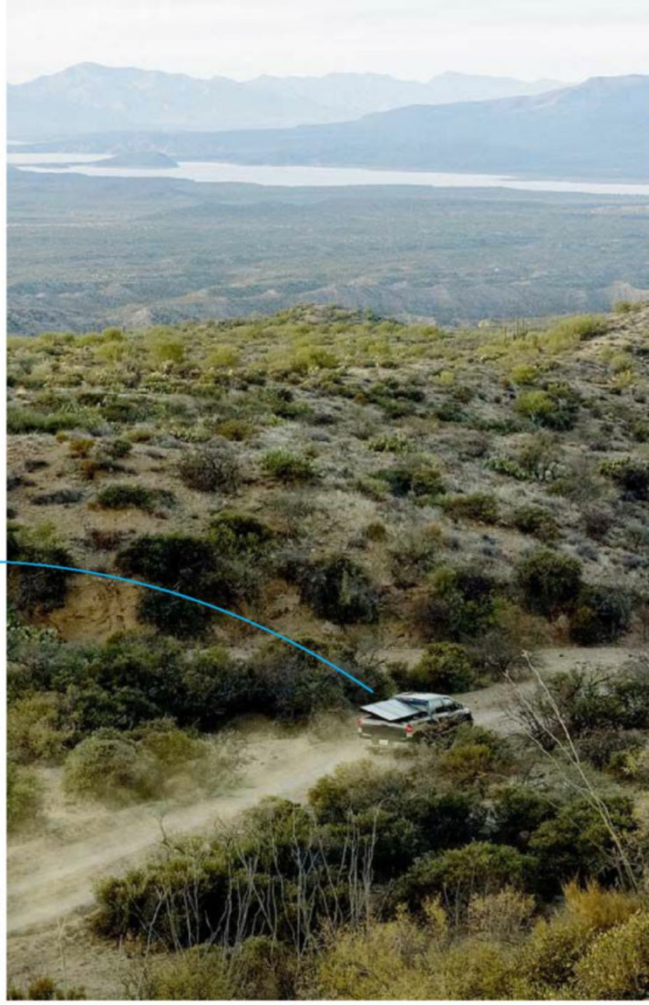
I HATE ALL THE THINGS

See this fancy pink water bottle I'm holding? Now watch as I bash my head in with it. This is not, I assume, what the makers of the $38 "beauty essential" intended. What they promised was "glamour sipping like a boss." They wanted me to "be brave." Maybe they even meant it—insofar as any millennial-focused, direct-to-consumer startup knows I endure a daily torrent of push-notification-enabled psychic assaults and wishes to soothe me with aspirationally charged branding. Look, I'm all for self-care. But this glossy next-level shit—products that can't just be products anymore but instead must be mystical vehicles through which to attain some higher state—makes me feel worse. What if there's a day I don't feel glamorous? Or brave? Suddenly I'm not even living up to my *water bottle's* expectations. And it goes waaay deeper. Suitcases, sheets, contacts, vitamins, birth control: There's no mundanity safe from the impulses of startups catering to their favorite demographic's vanity, sense of entitlement, and love of Helvetica. Even generic Viagra (sold by Hims) aims to restore agency: "You deserve to have an erection when you want one." Got that, penises? You're not the boss! Actually, nobody *wants* stories attached to basic needs. When every item on my shopping list has its own Insta-perfect personality, I suffer an embarrassment of empowerments. The spiral of self-hatred deepens, until even my toothbrush is mocking me. But OK, yeah, that shiny handle is just *so* #goals. —ERIN GRIFFITH

EXPERIMENT

DRY RUN

CAN HUMANS SURVIVE ON WATER VAPOR ALONE?



THE WORLD IS FULL of water, flushing down our toilets and flowing from our taps. And yet where I live, in the American Southwest, and quite possibly where you live, the kind of water people need to survive is getting harder to come by. Across the region, temperatures are rising and droughts are getting more severe, and in the coming decades the West will struggle to supply the water its residents and businesses demand. Even in wetter regions like the Gulf Coast, where the storms are getting stronger and the rainfall more persistent, much of that water glut is washing back out to sea, unused, leaving a path of destruction in its wake.

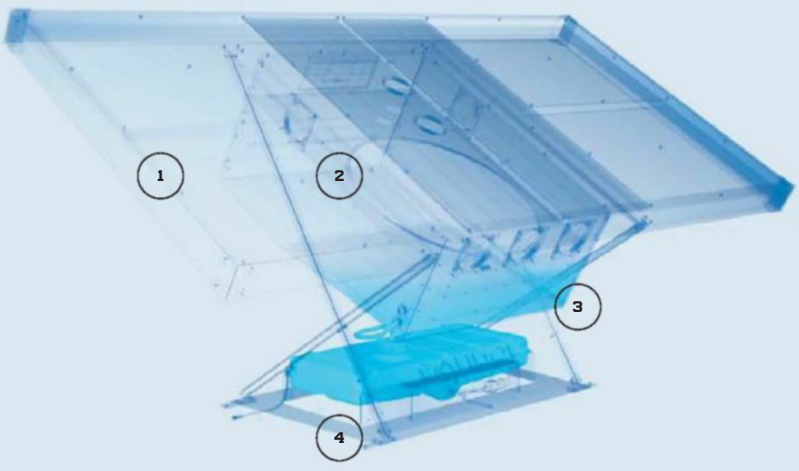
So I worry about the stuff: where it'll come from, who will own it, when it will dry up. To steady my mind, I've turned to technology. More exactly, the emerging innovations that will keep us hydrated in the not-so-distant desertified future. There's a company called NBD Nanotechnologies, based in Boston, which makes coatings that can be added to plastic and metal surfaces, allowing them to pull water out of thin air. (NBD stands for Namib Beetle Design, referring to an insect that captures moisture on its body from surrounding fog.)

Then I found a company called Zero Mass Water, based in Scottsdale, Arizona, that produces $2,000 "hydropanels" that the company claims can capture water vapor from air. One panel can make up to five liters a day, and two of them together could produce enough for a household's daily drinking and cooking. In theory, someone—even me—could strap one of these panels to the bed of a truck, drive out to the desert, and live off the grid with water to spare.

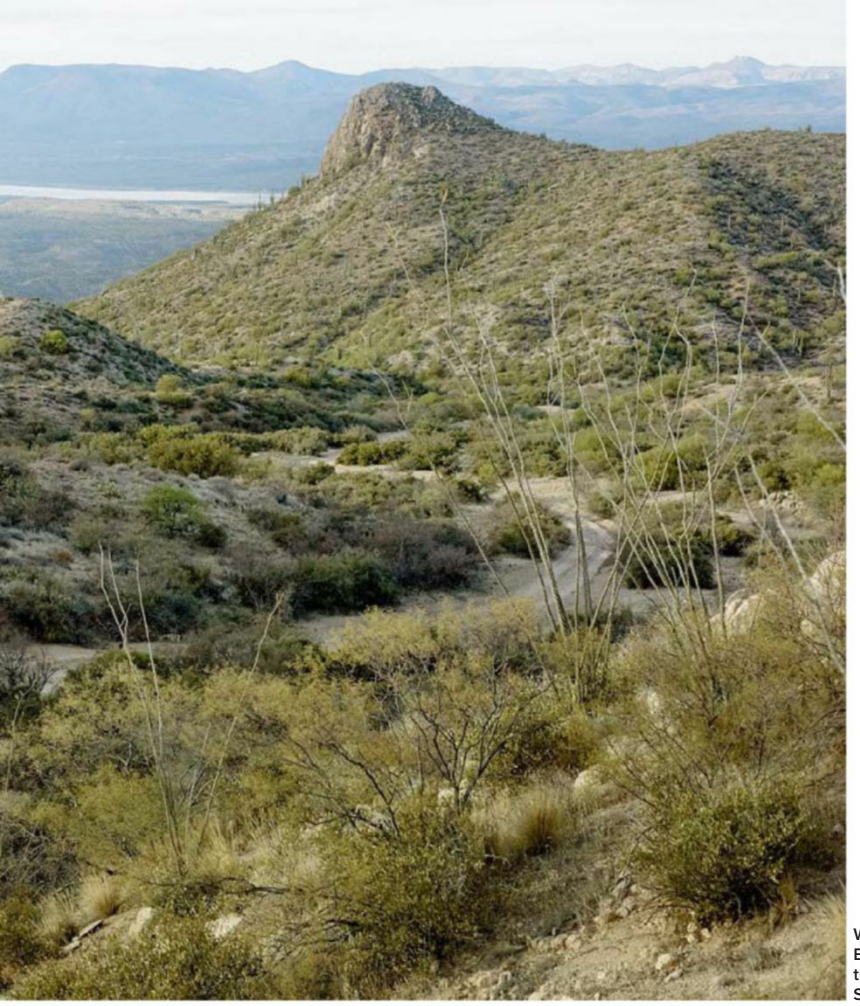
The company's founder and CEO had his doubts. Cody Friesen is a professor of materials science at Arizona State University with a booming, radio-ready voice, and he told me a few times over the phone that, while he appreciated my outside-the-box thinking, his hydropanels weren't intended for vehicular use. They weigh 275 pounds and are intended for yards and rooftops, not truck beds. The "vibrational activity" involved with desert off-roading concerned him. But I pressed

How the Hydropanel Works

1. The panel contains absorbent material that pulls moisture from the air.
2. Solar heat causes the moisture to form drops.
3. The drops collect in a reservoir at the panel's base.
4. A pump draws water out of the reservoir and into a tap.



COURTESY OF ZERO MASS WATER



Writer Ryan Bradley drives through the Sonoran Desert.

him, and after conferring with his engineering team he eventually said that it could be done or, at least this one time, tried. Once the truck-bound panel was ready, Friesen invited me out. "Will it work?" I asked him when I arrived in Scottsdale.

"Probably," he said, grinning.

I drove northeast into the high desert in a black Toyota Tundra, past the jagged Superstition Mountains, and worked my way up the escarpment of the Mogollon Rim that borders the Sonoran Desert. Five hours after leaving the city, I pulled over and watched the sky go orange, then pink, then purple, and I felt my throat tighten as my mouth started to dry. Walking toward the strange rig at the truck's rear, a 5-inch-thick black panel roughly the size and shape of the cab and tilted upward at a 35-degree angle, I found myself asking a question that was both very, very old and (for my purposes, anyway) entirely new: Would I have the water I needed to survive?

I'd put my trust in these panels. Hydrophilic membranes trap water vapor from air that's blown across them by a solar-powered fan. The vapor-turned-water then drops and pools and flows through a series of mineral cartridges to make it more drinkable. Because both the landscape and the water vapor in the air are changing all the time, the panels connect to HQ back in Scottsdale via a mesh network, and Zero Mass Water staffers upload predictive algorithms that adjust fan speeds and maximize energy efficiency.

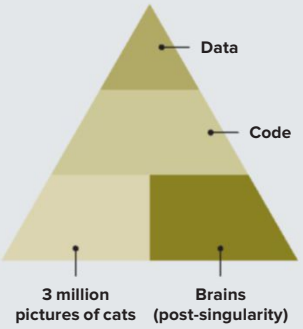
As the sky darkened, a chill ran through my body, mostly because it was suddenly quite cold, but also because seeds of doubt were germinating. The fans at the panel's sides were making a faint whinging sound, still blowing as the last of the solar power worked in the gloaming light. As darkness gathered, I used a flashlight to find the small black nozzle where the water was supposed to flow. Turning it, I held my breath. And after some chugging and wheezing from the pump, water spewed out. I danced a small, silent desert dance, in celebration and to warm me up, then caught myself. Water was pouring out! I was wasting it. And how much did I have? I checked the reservoir. It looked like at least a few liters. More than enough to get me through the night. —RYAN BRADLEY

KYLE RM JOHNSON

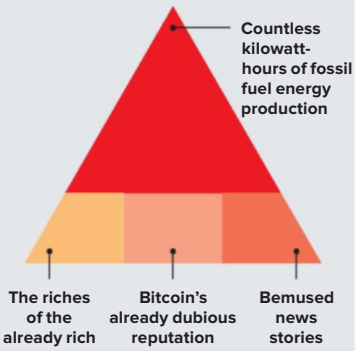
CHARTGEIST

BY JON J. EILENBERG

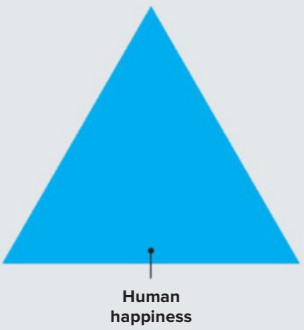
A.I.'s Diet



CryptoKitty Diet



Twitter's Diet





ALPHA

CONSUMPTION

WORLDS APART
UNIFYING VR

VIRTUAL REALITY, as it's been promised to us by science fiction, is a singular realm of infinite possibility. Star Trek's Holodeck, *Yu-Gi-Oh!*'s Virtual World, *Snow Crash*'s Metaverse: Each is the all-powerful experience generator of its world, able to accommodate a character's any desire. Novelist Ernest Cline sharpened this vision in his 2011 debut, *Ready Player One*, which hits theaters in March courtesy of Steven Spielberg. While the story is set in the strife-torn meatspace of 2045, most of its action unfolds in a vast network of artificial worlds called the OASIS. And in the tradition of reality playing catch-up to sci-fi, the OASIS has become the endgame for real-world VR developers, many of whom are actively trying to replicate its promise. Are they making progress? Absolutely. Are they doing it right? Absolutely not.

The OASIS is saddled with a terrible acronym—hopefully Spielberg never lets one of his characters say "Ontologically Anthropocentric Sensory Immersive Simulation"—but it offers something attractive: breadth. Some of the environments contained in the OASIS are created by users, others by government agencies; they range from educational to recreational (reconstructions of '80s fantasy novels are popular), nonprofit to commercial.

Today's real-life multiuser VR experiences, by contrast, are less OASIS and more PUDDLE (Provisionally Usable Demonstration of Dazzling Lucid Environments). Some of the constraints are aesthetic: In AltspaceVR, users are limited to a narrow range of expressionless human and robot avatars, while the goofy up-with-people charm of Against Gravity's Rec Room hinges on you not caring that avatars lack noses. Other constraints are experiential: Facebook's Spaces lets you hang out only with people you're already Friends with. Startups with OASIS-size ambitions are hampered by still other issues, whether that's a noob-unfriendly world-building system (Sansar) or a dark-side-of-Reddit vibe that invites trollery (VRchat).

The problem, though, isn't such metaphorical boundaries—it's literal ones. None of these PUDDLEs touch. You can't hop from Rec Room to VRchat; you're stuck where you started. That's why it's hard to feel truly immersed. To reach Cline's 2045, developers need to start laying the foundation *now* for an infrastructure that links each of these worlds. If that sounds idealistic, or even dangerous, it's not. Think of the days before the internet, when various institutions ran their own walled-off networks. Only when computer scientists came together to standardize protocols did the idea of a single network become possible. Now imagine applying that notion to VR—a metaverse in which users can flit between domains without losing their identity or their bearings as they travel.

The OASIS works because it feels like it has no owners, no urgent needs. It's a utility, a toolkit available for artisans and corporations alike. If we want to realize this potential ourselves—universal freedom and possibility—let's start thinking about VR the way Cline does: not as a first-to-market commodity but as an internet all its own.

By platforms editor **Peter Rubin** *(@provenself), author of the upcoming book* Future Presence.

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CLIVE THOMPSON

MADE TO ORDER
THE FAB FUTURE OF FAB LABS

IN 1965, tech pioneer Gordon Moore noticed a trend: The number of components on an integrated circuit was doubling every year. He predicted this would continue, resulting in wildly powerful digital devices. It was an audacious forecast (he later revised the interval to every two years), but Moore's law more or less held for five decades, shrinking the computer from room-sized appliance to pocketable smartphone. The world of bits was transformed. ¶ Could the same thing could be happening now—to the world of atoms? ¶ Neil Gershenfeld thinks it is. He's the MIT professor who in 2003 helped create the first "fab lab": a roomful of computer-guided fabrication tools, like laser cutters and mills for carving materials, that allows everyday people to create things with a precision normally available only to a Boeing or Siemens. ¶ In 2009, Gershenfeld helped set up the Fab Foundation in part to help people make products they needed that the mass market wasn't providing. It took off. Indian farmers used fab labs to create instruments to verify the quality of milk; a Kenyan engineering student made "vein finder" tools for doctors. By 2016 there were more than 1,000 fab labs worldwide. ¶ Then Sherry Lassiter, who leads the Fab Foundation and is known as "Lass," noticed that the global total was doubling every year. It looked just like Moore's law! ¶ Now there's Lass' law—the prediction that the number of fab labs, or such tools, will double roughly every year and a half. Why would this be happening? It's part inspiration (people hear about the labs and want their own) and, as with Moore's law, technical progress: The machinery has gotten cheaper and more digitized.



If Lass' law continues, custom fabrication will explode. In roughly a decade we will have a million fab labs. In 30 years it will be a *trillion*; they will be as omnipresent as the electronic devices currently scattered around your home.

Yowza. Let's suspend disbelief and assume this actually happens. How would it change life?

In a new book, *Designing Reality*, Gershenfeld and his brothers Joel (a social policy and management professor) and Alan (a videogame executive) note that in the short run—the next decade—we'd see a Kinko's-like situation, with local shops helping people make specialized objects. Twenty years out, fabbing could lead to customized goods made with fabricators owned by neighbors, say. "Mass production may not disappear," Alan tells me, "but it may no longer be the heartbeat of the economy." Big firms might shift to selling designs and cool, raw materials.

And what of life at the nutty 30-year point—when you might own several fabricators, the shape of which we can hardly imagine? "Nobody knows," Neil says. "It's a completely different relationship between consumption and creation." If we play things right, our products could be made from local materials and reshaped into new things after we're done with them. The end of waste!

That's a big if—and there are many more. Maybe Lass' law dies, because, well, capitalism. (These days, fortunes are most often made by concentrating corporate power, not decentralizing it.) Or perhaps Lass-like fabbing emerges, but only for the 1 percent. But Gershenfeld is an optimist; he thinks fab labs can create a future that is better for all people and the planet.

The first obstacle to that is getting people to believe that Lass' law will hold. The world of physical products seems less amenable to upheaval than the world of information. Fabricating bespoke ballpoint pens and sneakers in your own home seems pretty nuts, right?

Then again, when Moore plotted his chart in 1965, the smartphone would have too. W

Write to clive@clivethompson.net.

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TRAVEL

LEICA CL WITH 18-MM ASPH LENS

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Fit everything for your trip into a bag that slides under the seat in front of you. —ARIELLE PARDES



1

Lululemon City Trek Trouser II

Minimize the load in your carry-on bag by bringing only one pair of pants. The moisture-wicking, extra-stretchy fabric in these trousers is designed for extended wrinkle-free wear. Slip them on for your evening flight, then wear them to your morning meeting the next day.

$128

2

Allbirds Wool Loungers

Made from superfine merino wool, these shoes are as supportive as sneakers when you're racing to the gate, as soft as slippers when you're waiting to board, and as warm as fuzzy socks when the cabin gets chilly. Laceless construction makes them easy to slip on and off at security.

$95

3

Mophie Powerstation AC

Don't count on there being an outlet underneath your seat. This portable 22,000-mAh power brick lets you charge your laptop anywhere, anytime, with its built-in AC outlet. USB ports let you charge your phone, headphones, and other devices multiple times over.

$200



4

5

4

Amazon Kindle Oasis

Rookie mistake: lugging a Zadie Smith hardcover in your carry-on. Use Amazon's feather-light read-everything machine instead. The battery lasts for weeks, and this model comes with audiobook support for when you need to drown out that loud snorer in seat 23B.

$250

5

HEX x Alyasha Owerka-Moore Travel Duffel

The rest of the plane can fight for the overhead bins—this 29-liter bag nestles between your feet. Classic tweed and brass complement modern updates: A padded sleeve pampers your laptop while interior pockets secure your toiletries, passport, and snacks.

$180

TOP 3 SMART BUDS

Super portability and easy access to AI assistants make these wireless headphones the ultimate travel companions. —MICHAEL CALORE

1

Apple AirPods

Like most Apple headphones, audio quality is adequate. And the design is kooky. But you won't find better Bluetooth chops. The W1 wireless chip maintains a rock-solid connection to minimize drop-outs, and the battery delivers five hours of listening before you have to pop them into the case for a charge. Want to hear some SZA? Double-tap either bud and ask Siri to cue it up.

$159



1



2

Google Pixel Buds

The thin cable forms an ear-gripping loop for a super-comfy fit. Sound quality is aces, and you get five hours between pit stops in the charging case. Android users can tap and hold the right earpiece to summon Google Assistant and get travel updates. On Pixel phones, Assistant also does real-time translation—handy for that Italian waiter.

$159

3

Erato Verse

Teeny buds mean teeny batteries; only three hours between charges. But the compact design lets you slide them way into your ears for a tight seal that boosts sound quality and blocks the racket of trains, planes, and fussy babies. Press the button on either earpiece to ask Siri or Assistant for directions when you get lost in the 11th arrondissement.

$149



1

Rimowa Limbo Multiwheel Electronic Tag

BEST FOR: Impatient jet-setters

This roller lets fliers on select airlines—Lufthansa, Swiss, EVA Air, and Austrian, with more soon—check their luggage using the airline's app; your bag tag is sent to the tote's E Ink display. While there's no feature for tracking your bag's whereabouts, the app does confirm when it's stowed in the cargo hold.

$1,065

2

Raden A28

BEST FOR: Chronic overpackers

Raden's polycarbonate case's minimalist style disguises its inner smarts. The companion app uses the handle's digital scale so you won't get surprised by extra fees at check-in, and its geolocating feature helps pinpoint your suitcase at baggage claim. Be sure to ask if the bag's phone-boosting battery can be checked on your flight.

$395

HEAD-TO-HEAD CASE STUDIES

Increase your total baggage awareness with some tech-packed luggage. —LIZ STINSON

APP PACK STAY SAFE

Floods. Thieves. Hackers. Tackle any situation abroad with these mobile assistants. —ARIELLE PARDES

Sitata

You just fell down the stairs of your Barcelona Airbnb, and it feels like you broke something. No need to panic if you have this app. Sitata provides emergency numbers and the location of hospitals and other key facilities based on your location.

FREE

Haven

Install this app on a cheap Android burner, then leave the phone in your hotel room to act as a digital spy. Haven uses the camera, mic, and other sensors to detect motion and sound. It then sends photos and audio of any activity to your primary device.

FREE

SaferVPN

Connecting to the internet over public hot spots leaves you vulnerable to hackers and scammers. Tunnel into a virtual private network with SaferVPN, which offers encrypted web browsing worldwide through one of 700 private servers in 34 countries.

$3.49 AND UP/MONTH

Signal

Place calls and send texts with end-to-end encryption over Wi-Fi or your data connection using this favorite of security professionals. You can also make your chat history disappear before customs agents (or other snoops) get their hands on your phone.

FREE

Mobile Passport

Use this app to scan your US passport before you fly. Upon your return home, it gives you a QR code you can present to customs agents for hassle-free reentry. It's also a government-approved backup—a handy proof of citizenship.

FREE

FoneTrac

If there's a natural disaster or major emergency where you're traveling, let your loved ones know you're OK before they hear about the calamity on the news. FoneTrac lets you check in as safe—or send a panic alert—with the press of a button.

$15/MONTH

DO TALK TO STRANGERS

Instant translation will help us all enjoy a more intimate experience, no matter where we explore. —DAVID PIERCE

YOU TOTALLY PREPARED for this trip. You booked the flights months ago. You have all the best sights saved in Google Maps. But then you land in Munich or Kigali or Buenos Aires and realize you can't even identify the sign pointing toward baggage claim, much less tell your cabbie where you're headed. Luckily your phone can now do those things for you. Whether you use Siri or Google Assistant, or if you download the SayHi or iTranslate apps, you have in your pocket a pretty capable real-time language translator. ¶ Right now this translation tech is still in its infancy and primarily eases logistical complexities. With Google Translate, you can point your camera at a street sign to verify it says DOWNTOWN THIS WAY and not THERE BE DRAGONS. The same app can quickly translate a menu—if not always perfectly, then well enough to be sure that you're ordering chicken.



As translation tech improves, though, the benefit will extend way beyond just helping you get around. When translation happens quickly and accurately enough to have a conversation that spans two languages and feels almost natural, we'll be able to experience places in an entirely new way. "Even if you go to a country and you can get by with English, they're putting on a version of their culture that's palatable to you rather than their real culture," says Rafat Ali, CEO and founder of Skift, a travel news site. With great translation you'll be able to people-watch, explore local TV and movies, and meet folks beyond just those who speak your language, allowing you to connect with people and culture in more intimate ways.

Eventually you might not even know translation is happening. You'll just speak in your language and those around you will hear you in theirs. (It's not just languages like English and Chinese either; imagine giving your grandparents a set of earbuds that turn "It's lit, fam" into "How wonderful, loved ones.") That will require a huge leap forward in just about every aspect of the technology—from connection speeds to machine learning algorithms, which currently churn out primitive but usable translations. And, of course, everyone will need to be using some sort of earpiece.

An even bigger change will come as our gadgets evolve. You might wear a set of augmented-reality glasses from Microsoft or Magic Leap that auto-translate road signs as you drive. Maybe your headphones are a futuristic version of the Pilot earbuds from a startup called Waverly Labs, which promise to turn anyone's words into your native tongue before they even hit your ears. Google's Pixel Buds already do this—not flawlessly, but they'll improve. Once these work well, you won't need to open an app just to speak to someone. You'll just ... speak.

No one can learn all the languages in the world, but computers can. And they will. When that happens, you'll be able to go anywhere and immediately know what's going on. Even better, you'll be able to ask a local.

Senior writer **David Pierce** *(@pierce) wrote about the AR office in issue 26.02.*

ARE ALL EXPERTS WORTH BELIEVING?

Sources: MPA, Total (Duplicated) Magazine Media 360° Audience, Jan-May YTD 2017, Brand Audience Report: Simmons Research, Multi-Media Engagement Study, Spring 2016.

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SAMMY HARKHAM

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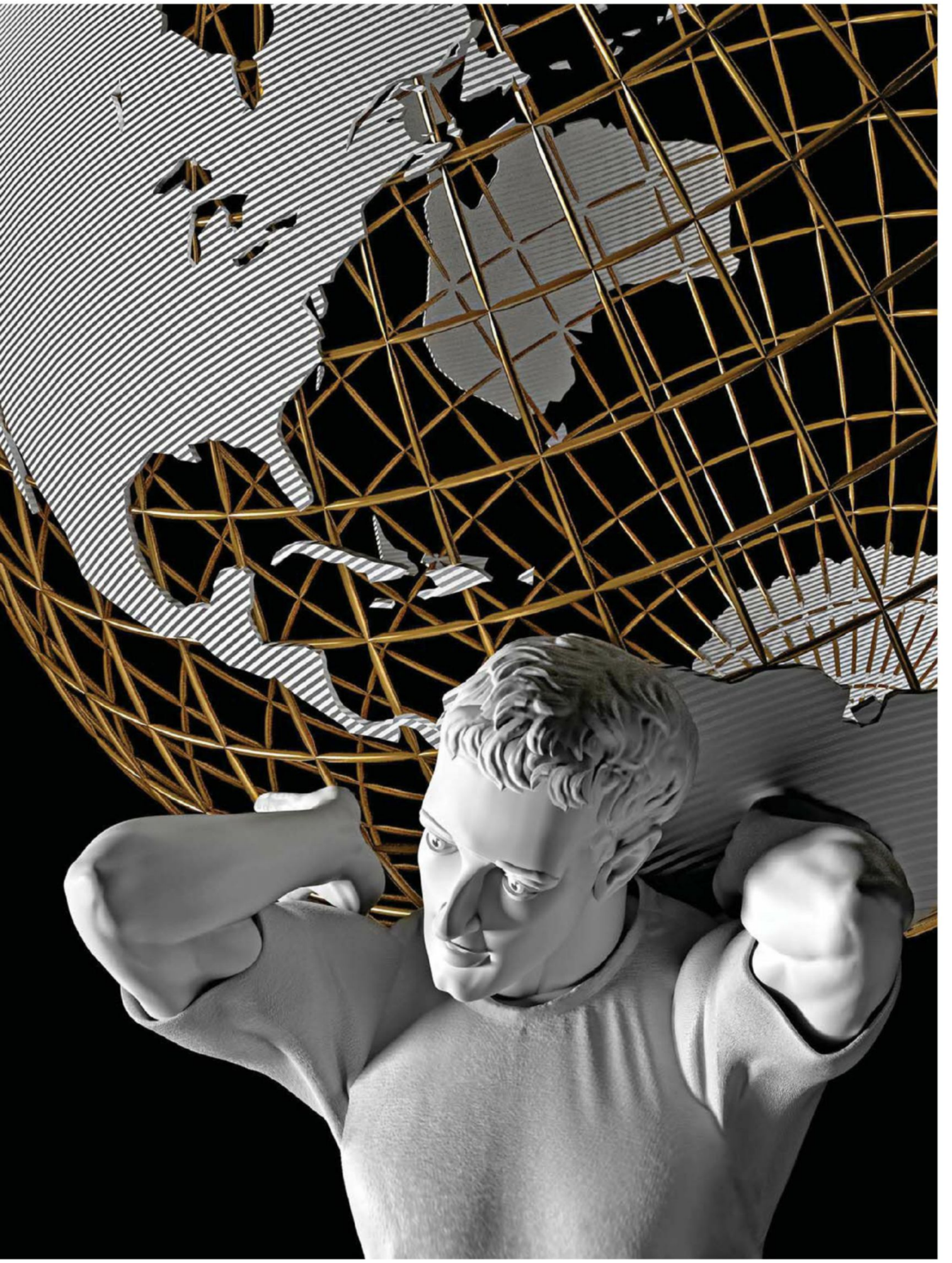
Mark Zuckerberg is trying to fix it all.

Here's the inside story.

by Nicholas **Thompson** *and Fred* **Vogelstein**



illustrations by
Eddie Guy



One day in late February of 2016, *Mark Zuckerberg* sent a memo to all of *Facebook*'s emplo address some troubling b in the ranks.

His message pertained to some walls at the company's Menlo Park headquarters where staffers are encouraged to scribble notes and signatures. On at least a couple of occasions, someone had crossed out the words "Black Lives Matter" and replaced them with "All Lives Matter." Zuckerberg wanted whoever was responsible to cut it out.

" 'Black Lives Matter' doesn't mean other lives don't," he wrote. "We've never had rules around what people can write on our walls," the memo went on. But "crossing out something means silencing speech, or that one person's speech is more important than another's." The defacement, he said, was being investigated.

All around the country at about this time, debates about race and politics were becoming increasingly raw. Donald Trump had just won the South Carolina primary, lashed out at the Pope over immigration, and earned the enthusiastic support of David Duke. Hillary Clinton had just defeated Bernie Sanders in Nevada, only to have an activist from Black Lives Matter interrupt a speech of hers to protest racially charged statements she'd made two decades before. And on Facebook, a popular group called Blacktivist was gaining traction by blasting out messages like "American economy and power were built on forced migration and torture."

So when Zuckerberg's admonition circulated, a young contract employee named Benjamin Fearnow decided it might be newsworthy. He took a screenshot on his personal laptop and sent the image to a friend named Michael Nuñez, who worked at the tech-news site Gizmodo. Nuñez promptly published a brief story about Zuckerberg's memo.

A week later, Fearnow came across something else he thought Nuñez might like to publish. In another internal communication, Facebook had invited its employees to submit potential questions to ask Zuckerberg at an all-hands meeting. One of the most up-voted questions that week was "What responsibility does Facebook have to help prevent President Trump in 2017?" Fearnow took another screenshot, this time with his phone.

Fearnow, a recent graduate of the Columbia Journalism School, worked in Facebook's New York office on something called Trending Topics, a feed of popular news subjects that popped up when people opened Facebook. The feed was generated by an algorithm but moderated by a team of about 25 people with backgrounds in journalism. If the word "Trump" was trending, as it often was, they used their news judgment to identify which bit of news about the candidate was most important. If *The Onion* or a hoax site published a spoof that went viral, they had to keep that out. If something like a mass shooting happened, and Facebook's algorithm was slow to pick up on it, they would inject a story about it into the feed.

Facebook prides itself on being a place where people love to work. But Fearnow and his team weren't the happiest lot. They were contract employees hired through a company called BCforward, and every day was full of little reminders that they weren't really part of Facebook. Plus, the young journalists knew their jobs were doomed from the start. Tech companies, for the most part, prefer to have as little as possible done by humans—because, it's often said, they don't scale. You can't hire a billion of them, and they prove meddlesome in ways that algorithms don't. They need bathroom breaks and health insurance, and the most annoying of them sometimes talk to the press. Eventually, everyone assumed, Facebook's algorithms would be good enough to run the whole project, and the people on Fearnow's team—who served partly to train those algorithms—would be expendable.

The day after Fearnow took that second screenshot was a Friday. When he woke up after sleeping in, he noticed that he had about 30 meeting notifications from Facebook on his phone. When he replied to say it was his day off, he recalls, he was nonetheless asked to be available in 10 minutes. Soon he was on a videoconference with three Facebook employees, including Sonya Ahuja, the

yees to ehavior

company's head of investigations. According to his recounting of the meeting, she asked him if he had been in touch with Nuñez. He denied that he had been. Then she told him that she had their messages on Gchat, which Fearnow had assumed weren't accessible to Facebook. He was fired. "Please shut your laptop and don't reopen it," she instructed him.

That same day, Ahuja had another conversation with a second employee at Trending Topics named Ryan Villarreal. Several years before, he and Fearnow had shared an apartment with Nuñez. Villarreal said he hadn't taken any screenshots, and he certainly hadn't leaked them. But he *had* clicked "like" on the story about Black Lives Matter, and he was friends with Nuñez on Facebook. "Do you think leaks are bad?" Ahuja demanded to know, according to Villarreal. He was fired too. The last he heard from his employer was in a letter from BCforward. The company had given him $15 to cover expenses, and it wanted the money back.

The firing of Fearnow and Villarreal set the Trending Topics team on edge—and Nuñez kept digging for dirt. He soon published a story about the internal poll showing Facebookers' interest in fending off Trump. Then, in early May, he published an article based on conversations with yet a third former Trending Topics employee, under the blaring headline "FORMER FACEBOOK WORKERS: WE ROUTINELY SUPPRESSED CONSERVATIVE NEWS." The piece suggested that Facebook's Trending team worked like a Fox News fever dream, with a bunch of biased curators "injecting" liberal stories and "blacklisting" conservative ones. Within a few hours the piece popped onto half a dozen highly trafficked tech and politics websites, including Drudge Report and Breitbart News.

The post went viral, but the ensuing battle over Trending Topics did more than just dominate a few news cycles. In ways that are only fully visible now, it set the stage for the most tumultuous two years of Facebook's existence—triggering a chain of events that would distract and confuse the company while larger disasters began to engulf it.

This is the story of those two years, as they played out inside and around the company. WIRED spoke with 51 current or former Facebook employees for this article, many of whom did not want their names used, for reasons anyone familiar with the story of Fearnow and Villarreal would surely understand. (One current employee asked that a WIRED reporter turn off his phone so the company would have a harder time tracking whether it had been near the phones of anyone from Facebook.)

The stories varied, but most people told the same basic tale: of a company, and a CEO, whose techno-optimism has been crushed as they've learned the myriad ways their platform can be used for ill. Of an election that shocked Facebook, even as its fallout put the company under siege. Of a series of external threats, defensive internal calculations, and false starts that delayed Facebook's reckoning with its impact on global affairs and its users' minds. And—in the tale's final chapters—of the company's earnest attempt to redeem itself.

In that saga, Fearnow plays one of those obscure but crucial roles that history occasionally hands out. He's the Franz Ferdinand of Facebook—or maybe he's more like the archduke's hapless young assassin. Either way, in the rolling disaster that has enveloped Facebook since early 2016, Fearnow's leaks probably ought to go down as the screenshots heard round the world.

II

By now, the story of Facebook's all-consuming growth is practically the creation myth of our information era. What began as a way to connect with your friends at Harvard became a way to connect with people at other elite schools, then at all schools, and then everywhere. After that, your Facebook login became a way to log on to other internet sites. Its Messenger app started competing with email and texting. It became the place where you told people you were safe after an earthquake. In some countries like the Philippines, it effectively *is* the internet.

The furious energy of this big bang emanated, in large part, from a brilliant and simple insight. Humans are social animals. But the internet is a cesspool. That scares people away from identifying themselves and putting personal details online. Solve that problem—make people feel safe to post—and they will share obsessively. Make the resulting database of privately shared information and personal connections available to advertisers, and that platform will become one of the most important media technologies of the early 21st century.

But as powerful as that original insight was, Facebook's expansion has also been driven by sheer brawn. Zuckerberg has been a determined, even ruthless, steward of the company's manifest destiny, with an uncanny knack for placing the right bets. In the company's early days, "move fast and break things" wasn't just a piece of advice to his developers; it was a philosophy that served to resolve countless delicate tradeoffs—many of them involving user privacy—in ways that best favored the platform's growth. And when it comes to competitors, Zuckerberg has been relentless in either acquiring or sinking any challengers that seem to have the wind at their backs.

In fact, it was in besting just such a rival that Facebook came to dominate how we discover and consume news. Back in 2012, the most exciting social network for distributing news online wasn't Facebook, it was Twitter. The latter's 140-character posts accelerated the speed at which news could spread, allowing its influence in the news industry to grow much faster than Facebook's. "Twitter was this massive, massive threat," says a former Facebook executive heavily involved in the decisionmaking at the time.

So Zuckerberg pursued a strategy he has often deployed against competitors he cannot buy: He copied, then crushed. He adjusted Facebook's News Feed to fully incorporate news (despite its name, the feed was originally tilted toward personal news) and adjusted the product so that it showed author bylines and headlines. Then Facebook's emissaries fanned out to talk with journalists and explain how to best reach readers through the platform. By the end of 2013, Facebook had doubled its share of traffic to news sites and had started to push Twitter into a decline. By the middle of 2015, it had surpassed Google as the leader in referring readers to publisher sites and was now referring 13 times as many readers to news publishers as Twitter. That year, Facebook launched Instant Articles, offering publishers the chance to publish directly on the platform.

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Posts would load faster and look sharper if they agreed, but the publishers would give up an element of control over the content. The publishing industry, which had been reeling for years, largely assented. Facebook now effectively owned the news. "If you could reproduce Twitter inside of Facebook, why would you go to Twitter?" says the former executive. "What they are doing to Snapchat now, they did to Twitter back then."

It appears that Facebook did not, however, carefully think through the implications of becoming the dominant force in the news industry. Everyone in management cared about quality and accuracy, and they had set up rules, for example, to eliminate pornography and protect copyright. But Facebook hired few journalists and spent little time discussing the big questions that bedevil the media industry. What is fair? What is a fact? How do you signal the difference between news, analysis, satire, and opinion? Facebook has long seemed to think it has immunity from those debates because it is just a technology company—one that has built a "platform for all ideas."

This notion that Facebook is an open, neutral platform is almost like a religious tenet inside the company. When new recruits come in, they are treated to an orientation lecture by Chris Cox, the company's chief product officer, who tells them Facebook is an entirely new communications platform for the 21st century, as the telephone was for the 20th. But if anyone inside Facebook is unconvinced by religion, there is also Section 230 of the 1996 Communications Decency Act to recommend the idea. This is the section of US law that shelters internet intermediaries from liability for the content their users post. If Facebook were to start creating or editing content on its platform, it would risk losing that immunity—and it's hard to imagine how Facebook could exist if it were liable for the many billion pieces of content a day that users post on its site.

And so, because of the company's self-image, as well as its fear of regulation, Facebook tried never to favor one kind of news content over another. But neutrality is a choice in itself. For instance, Facebook decided to present every piece of content that appeared on News Feed—whether it was your dog pictures or a news story—in roughly the same way. This meant that all news stories looked roughly the same as each other, too, whether they were investigations in *The Washington Post*, gossip in the *New York Post*, or flat-out lies in the *Denver Guardian*, an entirely bogus newspaper. Facebook argued that this democratized information. You saw what your friends wanted you to see, not what some editor in a Times Square tower chose. But it's hard to argue that this wasn't an editorial decision. It may be one of the biggest ever made.

In any case, Facebook's move into news set off yet another explosion of ways that people could connect. Now Facebook was the place where publications could connect with their readers—and also where Macedonian teenagers could connect with voters in America, and operatives in Saint Petersburg could connect with audiences of their own choosing in a way that no one at the company had ever seen before.

III

In February of 2016, just as the Trending Topics fiasco was building up steam, Roger McNamee became one of the first Facebook insiders to notice strange things happening on the platform. McNamee was an early investor in Facebook who had mentored Zuckerberg through two crucial decisions: to turn down Yahoo's offer of $1 billion to acquire Facebook in 2006; and to hire a Google executive named Sheryl Sandberg in 2008 to help find a business model. McNamee was no longer in touch with Zuckerberg much, but he was still an investor, and that month he started seeing things related to the Bernie Sanders campaign that worried him. "I'm observing memes ostensibly coming out of a Facebook group associated with the Sanders campaign that couldn't possibly have been from the Sanders campaign," he recalls, "and yet they were organized and spreading in such a way that suggested somebody had a budget. And I'm sitting there thinking, 'That's really weird. I mean, that's not good.' "

But McNamee didn't say anything to anyone at Facebook—at least not yet. And the company itself was not picking up on any such worrying signals, save for one blip on its radar: In early 2016, its security team noticed an uptick in Russian actors attempting to steal the credentials of journalists and public figures. Facebook reported this to the FBI. But the company says it never heard back from the government, and that was that.

Instead, Facebook spent the spring of 2016 very busily fending off accusations that it might influence the elections in a completely different way. When Gizmodo published its story about political bias on the Trending Topics team in May, the article went off like a bomb in Menlo Park. It quickly reached millions of readers and, in a delicious irony, appeared in the Trending Topics module itself. But the bad press wasn't what really rattled Facebook—it was the letter from John Thune, a Republican US senator from South Dakota, that followed the story's publication. Thune chairs the Senate Commerce Committee, which in turn oversees the Federal Trade Commission, an agency that has been especially active in investigating Facebook. The senator wanted Facebook's answers to the allegations of bias, and he wanted them promptly.

The Thune letter put Facebook on high alert. The company promptly dispatched senior Washington staffers to meet with Thune's team. Then it sent him a 12-page single-spaced letter explaining that it had conducted a thorough review of Trending Topics and determined that the allegations in the Gizmodo story were largely false.

Facebook decided, too, that it had to extend an olive branch to the entire American right wing, much of which was raging about the company's supposed perfidy. And so, just over a week after the story ran, Facebook scrambled to invite a group of 17 prominent Republicans out to Menlo Park. The list included television hosts, radio stars, think tankers, and an adviser to the Trump campaign. The point was partly to get feedback. But more than that, the company wanted to make a show of apologizing for its sins, lifting up the back of its shirt, and asking for the lash.

According to a Facebook employee involved in planning the meeting, part of the goal was to bring in a group of conservatives who were certain to fight with one another. They made sure to have libertarians who wouldn't want to regulate the platform and partisans who would. Another goal, according to the employee, was to make sure the attendees were "bored to death" by a technical presentation after Zuckerberg and Sandberg had addressed the group.

The power went out, and the room got uncomfortably hot. But otherwise the meeting went according to plan. The guests did indeed fight, and they failed to unify in a way that was either threatening or coherent. Some wanted the company to set hiring quotas for conservative employees; others thought that idea was nuts. As often happens when outsiders meet with Facebook, people used the time to try to figure out how they could get more followers for their own pages.

Afterward, Glenn Beck, one of the invitees, wrote an essay about the meeting, praising Zuckerberg. "I asked him if Facebook, now or in the future, would be an open platform for the sharing of all ideas or a curator of content," Beck wrote. "Without hesitation, with clarity and boldness, Mark said there is only one Facebook and one path forward: 'We are an open platform.' "

Inside Facebook itself, the backlash around Trending Topics did inspire some genuine soul-searching. But none of it got very far. A quiet internal project, codenamed Hudson, cropped up around this time to determine, according to someone who worked on it, whether News Feed should be modified to better deal with some of the most complex issues facing the product. Does it favor posts that make people angry? Does it favor simple or even false ideas over complex and true ones? Those are hard questions, and the company didn't have answers to them yet. Ultimately, in late June, Facebook announced a modest change: The algorithm would be revised to favor posts from friends and family. At the same time, Adam Mosseri, Facebook's News Feed boss, posted a manifesto titled "Building a Better News Feed for You." People inside Facebook spoke of it as a document roughly resembling the Magna Carta; the company had never spoken before about how News Feed really worked. To outsiders, though, the document came across as boilerplate. It said

roughly what you'd expect: that the company was opposed to clickbait but that it wasn't in the business of favoring certain kinds of viewpoints.

The most important consequence of the Trending Topics controversy, according to nearly a dozen former and current employees, was that Facebook became wary of doing anything that might look like stifling conservative news. It had burned its fingers once and didn't want to do it again. And so a summer of deeply partisan rancor and calumny began with Facebook eager to stay out of the fray.

IV

Shortly after Mosseri published his guide to News Feed values, Zuckerberg traveled to Sun Valley, Idaho, for an annual conference hosted by billionaire Herb Allen, where moguls in short sleeves and sunglasses cavort and make plans to buy each other's companies. But Rupert Murdoch broke the mood in a meeting that took place inside his villa. According to numerous accounts of the conversation, Murdoch and Robert Thomson, the CEO of News Corp, explained to Zuckerberg that they had long been unhappy with Facebook and Google. The two tech giants had taken nearly the entire digital ad market and become an existential threat to serious journalism. According to people familiar with the conversation, the two News Corp leaders accused Facebook of making dramatic changes to its core algorithm without adequately consulting its media partners, wreaking havoc according to Zuckerberg's whims. If Facebook didn't start offering a better deal to the publishing industry, Thomson and Murdoch conveyed in stark terms, Zuckerberg could expect News Corp executives to become much more public in their denunciations and much more open in their lobbying. They had helped to make things very hard for Google in Europe. And they could do the same for Facebook in the US.

Facebook thought that News Corp was threatening to push for a government antitrust investigation or maybe an inquiry into whether the company deserved its protection from liability as a neutral platform. Inside Facebook, executives believed Murdoch might use his papers and TV stations to amplify critiques of the company. News Corp says that was not at all the case; the company threatened to deploy executives, but not its journalists.

Zuckerberg had reason to take the meeting especially seriously, according to a former Facebook executive, because he had firsthand knowledge of Murdoch's skill in the dark arts. Back in 2007, Facebook had come under criticism from 49 state attorneys general for failing to protect young Facebook users from sexual predators and inappropriate content. Concerned parents had written to Connecticut attorney general Richard Blumenthal, who opened an investigation, and to *The New York Times*, which published a story. But according to a former Facebook executive in a position to know, the company believed that many of the Facebook accounts and the predatory behavior the letters referenced were fakes, traceable to News Corp lawyers or others working for Murdoch, who owned Facebook's biggest competitor, MySpace. "We traced the creation of the Facebook accounts to IP addresses at the Apple store a block away from the MySpace offices in Santa Monica," the executive says. "Facebook then traced interactions with those accounts to News Corp lawyers. When it comes to Facebook, Murdoch has been playing every angle he can for a long time." (Both News Corp and its spinoff 21st Century Fox declined to comment.)

Zuckerberg took Murdoch's threats seriously—he had firsthand knowledge of the older man's skill in the dark arts.

When Zuckerberg returned from Sun Valley, he told his employees that things had to change. They still weren't in the news business, but they had to make sure there would *be* a news business. And they had to communicate better. One of those who got a new to-do list was Andrew Anker, a product manager who'd arrived at Facebook in 2015 after a career in journalism (including a long stint at WIRED in the '90s). One of his jobs was to help the company think through how publishers could make money on the platform. Shortly after Sun Valley, Anker met with Zuckerberg and asked to hire 60 new people to work on partnerships with the news industry. Before the meeting ended, the request was approved.

But having more people out talking to publishers just drove home how hard it would be to resolve the financial problems Murdoch wanted fixed. News outfits were spending millions to produce stories that Facebook was benefiting from, and Facebook, they felt, was giving too little back in return. Instant Articles, in particular, struck them

Facebook's Reckoning

Two years that forced the platform to change

by Blanca Myers

2016

March
Facebook suspends Benjamin Fearnow, a journalist-curator for the platform's Trending Topics feed, after he leaks to Gizmodo.

May
Gizmodo reports that Trending Topics "routinely suppressed conservative news." The story sends Facebook scrambling.

as a Trojan horse. Publishers complained that they could make more money from stories that loaded on their own mobile web pages than on Facebook Instant. (They often did so, it turned out, in ways that short-changed advertisers, by sneaking in ads that readers were unlikely to see. Facebook didn't let them get away with that.) Another seemingly irreconcilable difference: Outlets like Murdoch's *Wall Street Journal* depended on paywalls to make money, but Instant Articles banned paywalls; Zuckerberg disapproved of them. After all, he would often ask, how exactly do walls and toll booths make the world more open and connected?

The conversations often ended at an impasse, but Facebook was at least becoming more attentive. This newfound appreciation for the concerns of journalists did not, however, extend to the journalists on Facebook's own Trending Topics team. In late August, everyone on the team was told that their jobs were being eliminated. Simultaneously, authority over the algorithm shifted to a team of engineers based in Seattle. Very quickly the module started to surface lies and fiction. A headline days later read, "FOX NEWS EXPOSES TRAITOR MEGYN KELLY, KICKS HER OUT FOR BACKING HILLARY."

V

While Facebook grappled internally with what it was becoming—a company that dominated media but didn't want to be a media company—Donald Trump's presidential campaign staff faced no such confusion. To them Facebook's use was obvious. Twitter was a tool for communicating directly with supporters and yelling at the media. Facebook was the way to run the most effective direct-marketing political operation in history.

In the summer of 2016, at the top of the general election campaign, Trump's digital operation might have seemed to be at a major disadvantage. After all, Hillary Clinton's team was flush with elite talent and got advice from Eric Schmidt, known for running Google. Trump's was run by Brad Parscale, known for setting up the Eric Trump Foundation's web page. Trump's social media director was his former caddie. But in 2016, it turned out you didn't need digital experience running a presidential campaign, you just needed a knack for Facebook.

Over the course of the summer, Trump's team turned the platform into one of its primary vehicles for fund-raising. The campaign uploaded its voter files—the names, addresses, voting history, and any other information it had on potential voters—to Facebook. Then, using a tool called Lookalike Audiences, Facebook identified the broad characteristics of, say, people who had signed up for Trump newsletters or bought Trump hats. That allowed the campaign to send ads to people with similar traits. Trump would post simple messages like "This election is being rigged by the media pushing false and unsubstantiated charges, and outright lies, in order to elect Crooked Hillary!" that got hundreds of thousands of likes, comments, and shares. The money rolled in. Clinton's wonkier messages, meanwhile, resonated less on the platform. Inside Facebook, almost everyone on the executive team wanted Clinton to win; but they knew that Trump was using the platform better. If he was the candidate for Facebook, she was the candidate for LinkedIn.

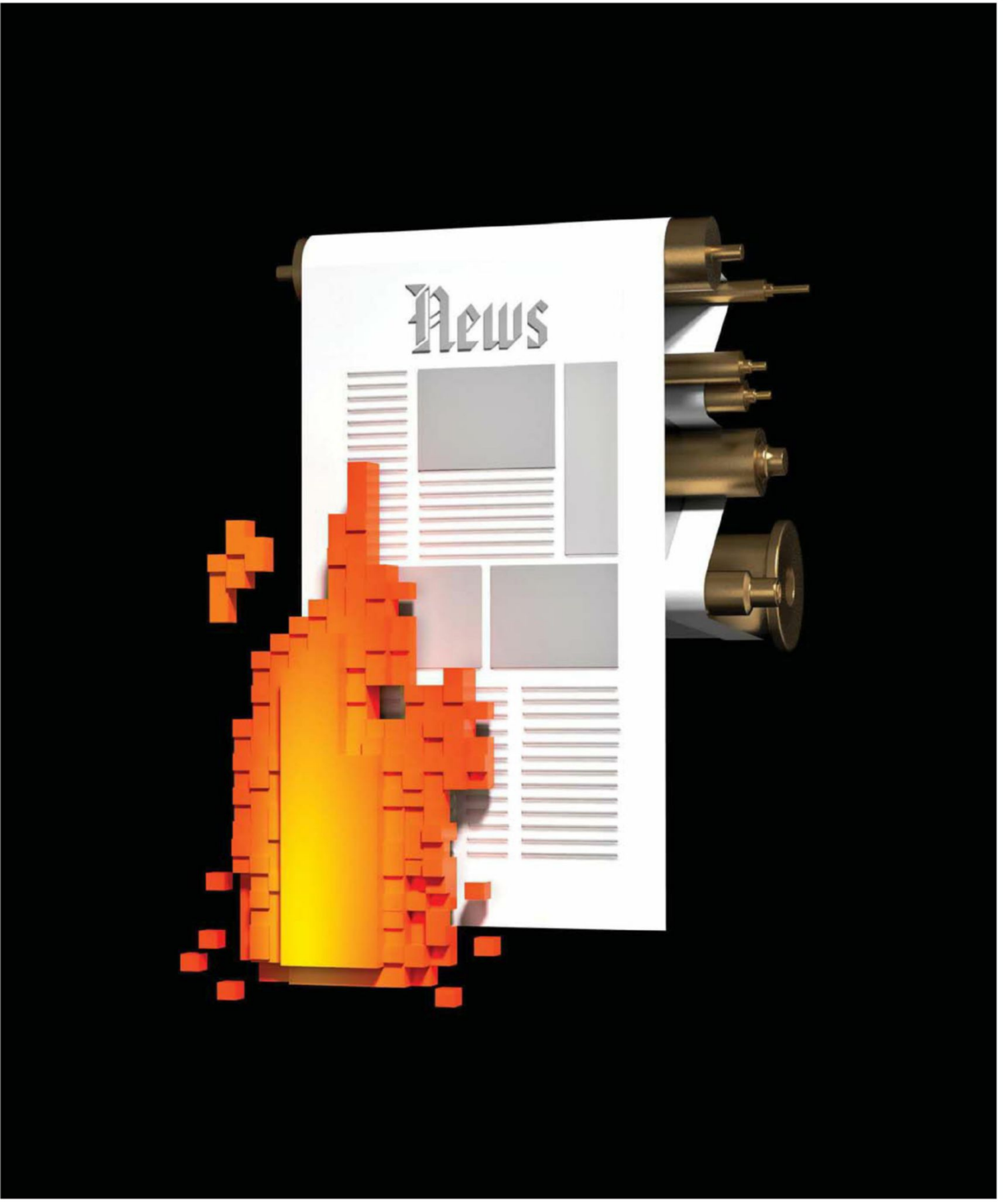
Trump's candidacy also proved to be a wonderful tool for a new class of scammers pumping out massively viral and entirely fake stories. Through trial and error, they learned that memes praising the former host of *The Apprentice* got many more readers than ones praising the former secretary of state. A website called Ending the Fed proclaimed that the Pope had endorsed Trump and got almost a million comments, shares, and reactions on Facebook, according to an analysis by BuzzFeed. Other stories asserted that the former first lady had quietly been selling weapons to ISIS, and that an FBI agent suspected of leaking Clinton's emails was found dead. Some of the posts came from hyperpartisan Americans. Some came from overseas content mills that were in it purely for the ad dollars. By the end of the campaign, the top fake stories on the platform were generating more engagement than the top real ones.

Even current Facebookers acknowledge now that they missed what should have been obvious signs of people misusing the platform. And looking back, it's easy to put together a long list of possible explanations for the myopia in Menlo Park about fake news. Management was gun-shy because of the Trending Topics fiasco; taking action against partisan disinformation—or even identifying it as such—might have been seen as another act of political favoritism. Facebook also sold ads against the stories, and sensational garbage was good at pulling people into the platform. Employees' bonuses can be based largely on whether Facebook hits certain growth and revenue targets, which gives people an extra incentive not to worry too much about things that are otherwise good for engagement. And then there was the ever-present issue of Section 230 of the 1996 Communications Decency Act. If the company started taking responsibility for fake news, it might have to take responsibility for a lot more. Facebook had plenty of reasons to keep its head in the sand.

Roger McNamee, however, watched carefully as the nonsense spread. First there were the fake stories pushing Bernie Sanders, then he saw ones supporting Brexit, and then helping Trump. By the end of the summer, he had resolved to write an op-ed about the problems on the platform. But he never ran it. "The idea was, look, these are my friends. I really want to help them." And so on a Sunday evening, nine days before the 2016 election, McNamee emailed a 1,000-word letter to Sandberg and Zuckerberg. "I am really sad about Facebook," it began. "I got involved with the company more than a decade ago and have taken great pride and joy in the company's success … until the past few months. Now I am disappointed. I am embarrassed. I am ashamed."

VI

It's not easy to recognize that the machine you've built to bring people together is being used to tear them apart, and Mark Zuckerberg's initial reaction to Trump's victory, and Facebook's possible role in it, was one of peevish dismissal. Executives remember panic the first few days, with the leadership team scurrying back and forth between Zuckerberg's conference room (called the Aquarium) and Sandberg's (called Only Good News), trying to figure out what had just happened and



2017

September
Facebook announces that a Russian group paid $100,000 for roughly 3,000 ads aimed at US voters.

October
Researcher Jonathan Albright reveals that posts from six Russian propaganda accounts were shared 340 million times.

November
Facebook general counsel Colin Stretch gets pummeled during congressional Intelligence Committee hearings.

2018

January
Facebook begins announcing major changes, aimed to ensure that time on the platform will be "time well spent."

whether they would be blamed. Then, at a conference two days after the election, Zuckerberg argued that filter bubbles are worse offline than on Facebook and that social media hardly influences how people vote. "The idea that fake news on Facebook—of which, you know, it's a very small amount of the content—influenced the election in any way, I think, is a pretty crazy idea," he said.

Zuckerberg declined to be interviewed for this article, but people who know him well say he likes to form his opinions from data. And in this case he wasn't without it. Before the interview, his staff had worked up a back-of-the-envelope calculation showing that fake news was a tiny percentage of the total amount of election-related content on the platform. But the analysis was just an aggregate look at the percentage of clearly fake stories that appeared across all of Facebook. It didn't measure their influence or the way fake news affected specific groups. It was a number, but not a particularly meaningful one.

Zuckerberg's comments did not go over well, even inside Facebook. They seemed clueless and self-absorbed. "What he said was incredibly damaging," a former executive told WIRED. "We had to really flip him on that. We realized that if we didn't, the company was going to start heading down this pariah path that Uber was on."

A week after his "pretty crazy" comment, Zuckerberg flew to Peru to give a talk to world leaders about the ways that connecting more people to the internet, and to Facebook, could reduce global poverty. Right after he landed in Lima, he posted something of a mea culpa. He explained that Facebook did take misinformation seriously, and he presented a vague seven-point plan to tackle it. When a professor at the New School named David Carroll saw Zuckerberg's post, he took a screenshot. Alongside it on Carroll's feed ran a headline from a fake CNN with an image of a distressed Donald Trump and the text "DISQUALIFIED; He's GONE!"

At the conference in Peru, Zuckerberg met with a man who knows a few things about politics: Barack Obama. Media reports portrayed the encounter as one in which the lame-duck president pulled Zuckerberg aside and gave him a "wake-up call" about fake news. But according to someone who was with them in Lima, it was Zuckerberg who called the meeting, and his agenda was merely to convince Obama that, yes, Facebook was serious about dealing with the problem. He truly wanted to thwart misinformation, he said, but it wasn't an easy issue to solve.

Meanwhile, at Facebook, the gears churned. For the first time, insiders really began to question whether they had too much power. One employee told WIRED that, watching Zuckerberg, he was reminded of Lennie in *Of Mice and Men*, the farmworker with no understanding of his own strength.

Very soon after the election, a team of employees started working on something called the News Feed Integrity Task Force, inspired by a sense, one of them told WIRED, that hyperpartisan misinformation was "a disease that's creeping into the entire platform." The group, which included Mosseri and Anker, began to meet every day, using whiteboards to outline different ways they could respond to the fake-news crisis. Within a few weeks the company announced it would cut off advertising revenue for ad farms and make it easier for users to flag stories they thought false.

One employee compared Zuckerberg to Lennie in *Of Mice and Men*—a man with no understanding of his own strength.

In December the company announced that, for the first time, it would introduce fact-checking onto the platform. Facebook didn't want to check facts itself; instead it would outsource the problem to professionals. If Facebook received enough signals that a story was false, it would automatically be sent to partners, like Snopes, for review. Then, in early January, Facebook announced that it had hired Campbell Brown, a former anchor at CNN. She immediately became the most prominent journalist hired by the company.

Soon Brown was put in charge of something called the Facebook Journalism Project. "We spun it up over the holidays, essentially," says one person involved in discussions about the project. The aim was to demonstrate that Facebook was thinking hard about its role in the future of journalism—essentially, it was a more public and organized version of the efforts the company had begun after Murdoch's tongue-lashing. But sheer anxiety was also part of the motivation. "After the election, because Trump won, the media put a ton of attention on fake news and just started hammering us. People started panicking and getting afraid that regulation was coming. So the team looked at what Google had been doing for years with News Lab"—a group inside Alphabet that builds tools for journalists—"and we decided to figure out how we could put together our own packaged program that shows how seriously we take the future of news."

Facebook was reluctant, however, to issue any mea culpas or action plans with regard to the problem of filter bubbles or Facebook's noted propensity to serve as a tool for amplifying outrage. Members of the leadership team regarded these as issues that couldn't be solved, and maybe even shouldn't be solved. Was Facebook really more at fault for amplifying outrage during the election than, say, Fox News or MSNBC? Sure, you could put stories into people's feeds that contradicted their political viewpoints, but people would turn away from them, just as surely as they'd flip the dial back if their TV quietly switched them from Sean Hannity to Joy Reid. The problem, as Anker puts it, "is not Facebook. It's humans."

VII

Zuckerberg's "pretty crazy" statement about fake news caught the ear of a lot of people,

but one of the most influential was a security researcher named Renée DiResta. For years, she'd been studying how misinformation spreads on the platform. If you joined an antivaccine group on Facebook, she observed, the platform might suggest that you join flat-earth groups or maybe ones devoted to Pizzagate—putting you on a conveyor belt of conspiracy thinking. Zuckerberg's statement struck her as wildly out of touch. "How can this platform say this thing?" she remembers thinking.

Roger McNamee, meanwhile, was getting steamed at Facebook's response to his letter. Zuckerberg and Sandberg had written him back promptly, but they hadn't said anything substantial. Instead he ended up having a months-long, ultimately futile set of email exchanges with Dan Rose, Facebook's VP for partnerships. McNamee says Rose's message was polite but also very firm: The company was doing a lot of good work that McNamee couldn't see, and in any event Facebook was a platform, not a media company.

"And I'm sitting there going, 'Guys, seriously, I don't think that's how it works,'" McNamee says. "You can assert till you're blue in the face that you're a platform, but if your users take a different point of view, it doesn't matter what you assert."

As the saying goes, heaven has no rage like love to hatred turned, and McNamee's concern soon became a cause—and the beginning of an alliance. In April 2017 he connected with a former Google design ethicist named Tristan Harris when they appeared together on Bloomberg TV. Harris had by then gained a national reputation as the conscience of Silicon Valley. He had been profiled on *60 Minutes* and in *The Atlantic*, and he spoke eloquently about the subtle tricks that social media companies use to foster an addiction to their services. "They can amplify the worst aspects of human nature," Harris told WIRED this past December. After the TV appearance, McNamee says he called Harris up and asked, "Dude, do you need a wingman?"

The next month, DiResta published an article comparing purveyors of disinformation on social media to manipulative high-frequency traders in financial markets. "Social networks enable malicious actors to operate at platform scale, because they were designed for fast information flows and virality," she wrote. Bots and sock puppets could cheaply "create the illusion of a mass groundswell of grassroots activity," in much the same way that early, now-illegal trading algorithms could spoof demand for a stock. Harris read the article, was impressed, and emailed her.

The three were soon out talking to anyone who would listen about Facebook's poisonous effects on American democracy. And before long they found receptive audiences in the media and Congress—groups with their own mounting grievances against the social media giant.

VIII

Even at the best of times, meetings between Facebook and media executives can feel like unhappy family gatherings. The two sides are inextricably bound together, but they don't like each other all that much. News executives resent that Facebook and Google have captured roughly three-quarters of the digital ad business, leaving the media industry and other platforms, like Twitter, to fight over scraps. Plus they feel like the preferences of Facebook's algorithm have pushed the industry to publish ever-dumber stories. For years, *The New York Times* resented that Facebook helped elevate BuzzFeed; now BuzzFeed is angry about being displaced by clickbait.

And then there's the simple, deep fear and mistrust that Facebook inspires. Every publisher knows that, at best, they are sharecroppers on Facebook's massive industrial farm. The social network is roughly 200 times more valuable than the *Times*. And journalists know that the man who owns the farm has the leverage. If Facebook wanted to, it could quietly turn any number of dials that would harm a publisher—by manipulating its traffic, its ad network, or its readers.

Emissaries from Facebook, for their part, find it tiresome to be lectured by people who can't tell an algorithm from an API. They also know that Facebook didn't win the digital ad market through luck: It built a better ad product. And in their darkest moments, they wonder: What's the point? News makes up only about 5 percent of the total content that people see on Facebook globally. The company could let it all go and its shareholders would scarcely notice. And there's another, deeper problem: Mark Zuckerberg, according to people who know him, prefers to think about the future. He's less interested in the news industry's problems right now; he's interested in the problems five or 20 years from now. The editors of major media companies, on the other hand, are worried about their next quarter—maybe even their next phone call. When they bring lunch back to their desks, they know not to buy green bananas.

This mutual wariness—sharpened almost to enmity in the wake of the election—did not make life easy for Campbell Brown when she started her new job running the nascent Facebook Journalism Project. The first item on her to-do list was to head out on yet another Facebook listening tour with editors and publishers. One editor describes a fairly typical meeting: Brown and Chris Cox, Facebook's chief product officer, invited a group of media leaders to gather in late January 2017 at Brown's apartment in Manhattan. Cox, a quiet, suave man, sometimes referred to as "the Ryan Gosling of Facebook Product," took the brunt of the ensuing abuse. "Basically, a bunch of us just laid into him about how Facebook was destroying journalism, and he graciously absorbed it," the editor says. "He didn't much try to defend them. I think the point was really to show up and seem to be listening." Other meetings were even more tense, with the occasional comment from journalists noting their interest in digital antitrust issues.

As bruising as all this was, Brown's team became more confident that their efforts were valued within the company when Zuckerberg published a 5,700-word corporate manifesto in February. He had spent the previous three months, according to people who know him, contemplating whether he had created something that did more harm than good. "Are we building the world we all want?" he asked at the beginning of his post, implying that the answer was an obvious no. Amid sweeping remarks about "building a global community," he emphasized the need to keep people informed and to knock out false news and clickbait. Brown and others at Facebook saw the manifesto as a sign that Zuckerberg understood the company's profound civic responsibilities. Others saw the document as blandly grandiose, showcasing Zuckerberg's tendency to suggest that the answer to nearly any problem is for people to use Facebook more.

Shortly after issuing the manifesto, Zuckerberg set off on a carefully scripted listening tour of the country. He began popping into candy shops and dining rooms in red states, camera crew and personal social media team in tow. He wrote an earnest post about what he was learning, and he deflected questions about whether his real goal was to become president. It seemed like a well-meaning effort to win friends for Facebook. But it soon became clear that Facebook's biggest problems emanated from places farther away than Ohio.

IX

One of the many things Zuckerberg seemed not to grasp when he wrote his manifesto was that his platform had empowered an enemy far more sophisticated than Macedonian teenagers and assorted low-rent purveyors of bull. As 2017 wore on, however, the company began to realize it had been attacked by a foreign influence operation. "I would draw a real distinction between fake news and the Russia stuff," says an executive who worked on the company's response to both. "With the latter there was a moment where everyone said 'Oh, holy shit, this is like a national security situation.'"

That holy shit moment, though, didn't come until more than six months after the election. Early in the campaign season, Facebook was aware of familiar attacks emanating from known Russian hackers, such as the group APT28, which is believed to be affiliated with Moscow. They were hacking into accounts outside of Facebook, stealing documents, then creating fake Facebook accounts under the banner of DCLeaks, to get people to discuss what they'd stolen. The company saw no



signs of a serious, concerted foreign propaganda campaign, but it also didn't think to look for one.

During the spring of 2017, the company's security team began preparing a report about how Russian and other foreign intelligence operations had used the platform. One of its authors was Alex Stamos, head of Facebook's security team. Stamos was something of an icon in the tech world for having reportedly resigned from his previous job at Yahoo after a conflict over whether to grant a US intelligence agency access to Yahoo servers. According to two people with direct knowledge of the document, he was eager to publish a detailed, specific analysis of what the company had found. But members of the policy and communications team pushed back and cut his report way down. Sources close to the security team suggest the company didn't want to get caught up in the political whirlwind of the moment. (Sources on the politics and communications teams insist they edited the report down, just because the darn thing was hard to read.)

On April 27, 2017, the day after the Senate announced it was calling then FBI director James Comey to testify about the Russia investigation, Stamos' report came out. It was titled "Information Operations and Facebook," and it gave a careful step-by-step explanation of how a foreign adversary could use Facebook to manipulate people. But there were few specific examples or details, and there was no direct mention of Russia. It felt bland and cautious. As Renée DiResta says, "I remember seeing the report come out and thinking, 'Oh, goodness, is this the best they could do in six months?'"

One month later, a story in *Time* suggested to Stamos' team that they might have missed something in their analysis. The article quoted an unnamed senior intelligence official saying that Russian operatives had bought ads on Facebook to target Americans with propaganda. Around the same time, the security team also picked up hints from congressional investigators that made them think an intelligence agency was indeed looking into Russian Facebook ads. Caught off guard, the team members started to dig into the company's archival ads data themselves.

Eventually, by sorting transactions according to a series of data points—Were ads purchased in rubles? Were they purchased within browsers whose language was set to Russian?—they were able to find a cluster of accounts, funded by a shadowy Russian group called the Internet Research Agency, that had been designed to manipulate political opinion in America. There was, for example, a page called Heart of Texas, which pushed for the secession of the Lone Star State. And there was Blacktivist, which pushed stories about police brutality against black men and women and had more followers than the verified Black Lives Matter page.

Numerous security researchers express consternation that it took Facebook so long to realize how the Russian troll farm was exploiting the platform. After all, the group was well known to Facebook. Executives at the company say they're embarrassed by how long it took them to find the fake accounts, but they point out that they were never given help by US intelligence agencies. A staffer on the Senate Intelligence Committee likewise voiced exasperation with the company. "It seemed obvious that it was a tactic the Russians would exploit," the staffer says.

When Facebook finally did find the Russian propaganda on its platform, the discovery set off a crisis, a scramble, and a great deal of confusion. First, due to a miscalculation, word initially spread through the company that the Russian group had spent millions of dollars on ads, when the actual total was in the low six figures. Once that error was resolved, a disagreement broke out over how much to reveal, and to whom. The company could release the data about the ads to the public, release everything to Congress, or release nothing. Much of the argument hinged on questions of user privacy. Members of the security team worried that the legal process involved in handing over private user data, even if it belonged to a Russian troll farm, would open the door for governments to seize data from other Facebook users later on. "There was a real debate internally," says one executive. "Should we just say 'Fuck it' and not worry?" But eventually the company decided it would be crazy to throw legal caution to the wind "just because Rachel Maddow wanted us to."

Ultimately, a blog post appeared under Stamos' name in early September announcing that, as far as the company could tell, the Russians had paid Facebook $100,000 for roughly 3,000 ads aimed at influencing American politics around the time of the 2016 election. Every sentence in the post seemed to downplay the substance of these new revelations: The number of ads was small, the expense was small. And Facebook wasn't going to release them. The public wouldn't know what they looked like or what they were really aimed at doing.

This didn't sit at all well with DiResta. She had long felt that Facebook was insufficiently forthcoming, and now it seemed to be flat-out stonewalling. "That was when it went from incompetence to malice," she says. A couple of weeks later, while waiting at a Walgreens to pick up a prescription for one of her kids, she got a call from a researcher at the Tow Center for Digital Journalism named Jonathan Albright. He had been mapping ecosystems of misinformation since the election, and he had some excellent news. "I found this thing," he said. Albright had started digging into CrowdTangle, one of the analytics platforms that Facebook uses. And he had discovered that the data from six of the accounts Facebook had shut down were still there, frozen in a state of suspended animation. There were the posts pushing for Texas secession and playing on racial antipathy. And then there were political posts, like one that referred to Clinton as "that murderous anti-American traitor Killary." Right before the election, the Blacktivist account

urged its supporters to stay away from Clinton and instead vote for Jill Stein. Albright downloaded the most recent 500 posts from each of the six groups. He reported that, in total, their posts had been shared more than 340 million times.

X

To McNamee, the way the Russians used the platform was neither a surprise nor an anomaly. "They find 100 or 1,000 people who are angry and afraid and then use Facebook's tools to advertise to get people into groups," he says. "That's exactly how Facebook was designed to be used."

McNamee and Harris had first traveled to DC for a day in July to meet with members of Congress. Then, in September, they were joined by DiResta and began spending all their free time counseling senators, representatives, and members of their staffs. The House and Senate Intelligence Committees were about to hold hearings on Russia's use of social media to interfere in the US election, and McNamee, Harris, and DiResta were helping them prepare. One of the early questions they weighed in on was the matter of who should be summoned to testify. Harris recommended that the CEOs of the big tech companies be called in, to create a dramatic scene in which they all stood in a neat row swearing an oath with their right hands in the air, roughly the way tobacco executives had been forced to do a generation earlier. Ultimately, though, it was determined that the general counsels of the three companies—Facebook, Twitter, and Google—should head into the lion's den.

And so on November 1, Colin Stretch arrived from Facebook to be pummeled. During the hearings themselves, DiResta was sitting on her bed in San Francisco, watching them with her

headphones on, trying not to wake up her small children. She listened to the back-and-forth in Washington while chatting on Slack with other security researchers. She watched as Marco Rubio smartly asked whether Facebook even had a policy forbidding foreign governments from running an influence campaign through the platform. The answer was no. Rhode Island senator Jack Reed then asked whether Facebook felt an obligation to individually notify all the users who had seen Russian ads that they had been deceived. The answer again was no. But maybe the most threatening comment came from Dianne Feinstein, the senior senator from Facebook's home state. "You've created these platforms, and now they're being misused, and you have to be the ones to do something about it," she declared. "Or we will."

After the hearings, yet another dam seemed to break, and former Facebook executives started to go public with their criticisms of the company too. On November 8, billionaire entrepreneur Sean Parker, Facebook's first president, said he now regretted pushing Facebook so hard on the world. "I don't know if I really understood the consequences of what I was saying," he said. "God only knows what it's doing to our children's brains." Eleven days later, Facebook's former privacy manager, Sandy Parakilas, published a *New York Times* op-ed calling for the government to regulate Facebook: "The company won't protect us by itself, and nothing less than our democracy is at stake."

XI

The day of the hearings, Zuckerberg had to give Facebook's Q3 earnings call. The numbers were terrific, as always, but his mood was not. Normally these calls can put someone with 12 cups of coffee in them to sleep; the executive gets on and says everything is going well, even when it isn't. Zuckerberg took a different approach. "I've expressed how upset I am that the Russians tried to use our tools to sow mistrust. We build these tools to help people connect and to bring us closer together. And they used them to try to undermine our values. What they did is wrong, and we are not going to stand for it." The company would be investing so much in security, he said, that Facebook would make "significantly" less money for a while. "I want to be clear about what our priority is: Protecting our community is more important than maximizing our profits." What the company really seeks is for users to find their experience to be "time well spent," Zuckerberg said—using the three words that have become Tristan Harris' calling card, and the name of his nonprofit.

Other signs emerged, too, that Zuckerberg was beginning to absorb the criticisms of his company. The Facebook Journalism Project, for instance, seemed to be making the company take its obligations as a publisher, and not just a platform, more seriously. In the fall, the company announced that Zuckerberg had decided—after years of resisting the idea—that publishers using Facebook Instant Articles could require readers to subscribe. Paying for serious publications, in the months since the election, had come to seem like both the path forward for journalism and a way of resisting the post-truth political landscape. (WIRED recently instituted its own paywall.) Plus, offering subscriptions arguably helped put in place the kinds of incentives that Zuckerberg professed to want driving the platform. People like Alex Hardiman, the head of Facebook news products and an alum of *The New York Times*, started to recognize that Facebook had long helped to create an economic system that rewarded publishers for sensationalism, not accuracy or depth. "If we just reward content based on raw clicks and engagement, we might actually see content that is increasingly sensationalist, clickbaity, polarizing, and divisive," she says. A social network that rewards only clicks, not subscriptions, is like a dating service that encourages one-night stands but not marriages.

XII

A couple of weeks before Thanksgiving 2017, Zuckerberg called one of his quarterly all-hands meetings on the Facebook campus, in an outdoor space known as Hacker Square. He told everyone he hoped they would have a good holiday. Then he said, "This year, with recent news, a lot of us are probably going to get asked: 'What is going on with Facebook?' This has been a tough year … but … what I know is that we're fortunate to play an important role in billions of people's lives. That's a privilege, and it puts an enormous responsibility on all of us." According to one attendee, the remarks came across as blunter and more personal than any they'd ever heard from Zuckerberg. He seemed humble, even a little chastened. "I don't think he sleeps well at night," the employee says. "I think he has remorse for what has happened."

During the late fall, criticism continued to mount: Facebook was accused of becoming a central vector for spreading deadly propaganda against the Rohingya in Myanmar and for propping up the brutal leadership of Rodrigo Duterte in the Philippines. And December brought another haymaker from someone closer by. Early that month, it emerged that Chamath Palihapitiya, who had been Facebook's vice president for user growth before leaving in 2011, had told an audience at Stanford that he thought social media platforms like Facebook had "created tools that are ripping apart the social fabric" and that he feels "tremendous guilt" for being part of that. He said he tries to use Facebook as little as possible and doesn't permit his children to use such platforms at all.

The criticism stung in a way that others hadn't. Palihapitiya is close to many of the top executives at Facebook, and he has deep cachet in Silicon Valley and among Facebook engineers as a part-owner of the Golden State Warriors. Sheryl Sandberg sometimes wears a chain around her neck that's welded together from one given to her by Zuckerberg and one given to her by Palihapitiya after her husband's death. The company issued a statement saying it had been a long time since Palihapitiya had worked there. "Facebook was a very different company back then and as we have grown we have realized how our responsibilities have grown too." Asked why the company had responded to Palihapitiya, and not to others, a senior Facebook executive said, "Chamath is—was—a friend to a lot of people here."

Roger McNamee, meanwhile, went on a media tour lambasting the company. He published an essay in *Washington Monthly* and then followed up in *The Washington Post* and *The Guardian*. Facebook was less impressed with him. Executives considered him to be overstating his connection to the company and dining out on his criticism. Andrew Bosworth, a VP and member of the management team, tweeted, "I've worked at Facebook for 12 years and I have to ask: Who the fuck is Roger McNamee?"

Zuckerberg did seem to be eager to mend one fence, though. Around this time, a team of Facebook executives gathered for dinner with executives from News Corp at the Grill, an upscale restaurant in Manhattan. Right at the start, Zuckerberg raised a toast to Murdoch. He spoke charmingly about reading a biography of the older man and of admiring his accomplishments. Then he described a game of tennis he'd once played against Murdoch. At first he had thought it would be easy to hit the ball with a man more than 50 years his senior. But he quickly realized, he said, that Murdoch was there to compete.

XIII

On January 4, 2018, Zuckerberg announced that he had a new personal challenge for the year. For each of the past nine years, he had committed himself to some kind of self-improvement. His first challenge was farcical—wear ties—and the others had been a little preening and collegiate. He wanted to learn Mandarin, read 25 books, run 365 miles. This year, though, he took a severe tone. "The world feels anxious and divided, and Facebook has a lot of work to do—whether it's protecting our community from abuse and hate, defending against interference by nation-states, or making sure that time spent on Facebook is time well spent," Zuckerberg declared. The language wasn't original—he had borrowed from Tristan Harris again—but it was, by the accounts of many people around him, entirely sincere.

That New Year's challenge, it turned out, was a

bit of carefully considered choreography setting up a series of announcements, starting with a declaration the following week that the News Feed algorithm would be rejiggered to favor "meaningful interactions." Posts and videos of the sort that make us look or like—but not comment or care—would be deprioritized. The idea, explained Adam Mosseri, is that, online, "interacting with people is positively correlated with a lot of measures of well-being, whereas passively consuming content online is less so."

To numerous people at the company, the announcement marked a huge departure. Facebook was putting a car in reverse that had been driving at full speed in one direction for 14 years. Since the beginning, Zuckerberg's ambition had been to create another internet, or perhaps another world, inside of Facebook, and to get people to use it as much as possible. The business model was based on advertising, and advertising was insatiably hungry for people's time. But now Zuckerberg said he expected these new changes to News Feed would make people use Facebook *less*.

The announcement was hammered by many in the press. During the rollout, Mosseri explained that Facebook would downgrade stories shared by businesses, celebrities, and publishers, and prioritize stories shared by friends and family. Critics surmised that these changes were just a way of finally giving the publishing industry a middle finger. "Facebook has essentially told media to kiss off," Franklin Foer wrote in *The Atlantic*. "Facebook will be back primarily in the business of making us feel terrible about the inferiority of our vacations, the relative mediocrity of our children, teasing us into sharing more of our private selves."

But inside Facebook, executives insist this isn't remotely the case. According to Anker, who retired from the company in December but worked on these changes, and who has great affection for the management team, "It would be a mistake to see this as a retreat from the news industry. This is a retreat from 'Anything goes if it works with our algorithm to drive up engagement.'" According to others still at the company, Zuckerberg didn't want to pull back from actual journalism. He just genuinely wanted there to be less crap on the platform: fewer stories with no substance; fewer videos you can watch without thinking.

And then, a week after telling the world about "meaningful interactions," Zuckerberg announced another change that seemed to answer these concerns, after a fashion. For the first time in the company's history, he said in a note posted to his personal page, Facebook will start to boost certain publishers—ones whose content is "trustworthy, informative, and local." For the past year, Facebook has been developing algorithms to hammer publishers whose content is fake; now it's trying to elevate what's good. For starters, he explained, the company would use reader surveys to determine which sources are trustworthy. That system, critics were quick to point out, will surely be gamed, and many people will say they trust sources just because they recognize them. But this announcement, at least, went over a little better in boardrooms and newsrooms. Right after the post went up, the stock price of *The New York Times* shot up—as did that of News Corp.

People who know him say Zuckerberg has truly been altered in the crucible of the past several months.

Zuckerberg has hinted—and insiders have confirmed—that we should expect a year of more announcements like this. The company is experimenting with giving publishers more control over paywalls and allowing them to feature their logos more prominently to reestablish the brand identities that Facebook flattened years ago. One somewhat hostile outside suggestion has come from Facebook's old antagonist Murdoch, who said in late January that if Facebook truly valued "trustworthy" publishers, it should pay them carriage fees.

The fate that Facebook really cares about, however, is its own. It was built on the power of network effects: You joined because everyone else was joining. But network effects can be just as powerful in driving people off a platform. Zuckerberg understands this viscerally. After all, he helped create those problems for MySpace a decade ago and is arguably doing the same to Snap today. Zuckerberg has avoided that fate, in part, because he has proven brilliant at co-opting his biggest threats. When social media started becoming driven by images, he bought Instagram. When messaging took off, he bought WhatsApp. When Snapchat became a threat, he copied it. Now, with all his talk of "time well spent," it seems as if he's trying to co-opt Tristan Harris too.

But people who know him say that Zuckerberg has truly been altered in the crucible of the past several months. He has thought deeply; he has reckoned with what happened; and he truly cares that his company fix the problems swirling around it. And he's also worried. "This whole year has massively changed his personal techno-optimism," says an executive at the company. "It has made him much more paranoid about the ways that people could abuse the thing that he built."

The past year has also altered Facebook's fundamental understanding about whether it's a publisher or a platform. The company has always answered that question defiantly—platform, platform, platform—for regulatory, financial, and maybe even emotional reasons. But now, gradually, Facebook has evolved. Of course it's a platform, and always will be. But the company also realizes now that it bears some of the responsibilities that a publisher does: for the care of its readers, and for the care of the truth. You can't make the world more open and connected if you're breaking it apart. So what is it: publisher or platform? Facebook seems to have finally recognized that it is quite clearly both.



Last August, Kim Wall went for a ride on a submarine built by Peter Madsen. She



wanted to write about the maker of “extreme machines.” She never did.



I needed to know what happened.



The Final Voyage

By May Jeong Photographs by Mustafah Abdulaziz

ON MAY 3, 2008, A SUNNY SATURDAY IN Copenhagen, a crowd gathered along a dock to watch a 58-foot submarine be lowered into the water. Part art project, part engineering feat, the submarine weighed 40 tons and had been built by volunteers at minimal cost from donated iron and other parts. The onlookers cheered as the submarine floated for the first time. Peter Madsen, the designer of the vessel and the organizer of the day's event, climbed into the hatch, smiling in a white skipper's hat, before the submarine motored into the water.

Madsen christened the vessel the *UC3 Nautilus*, after the fictional submarine in *Twenty Thousand Leagues Under the Sea*. Jules Verne's antihero Captain Nemo was a figure who lived outside social laws, sailing the seven seas in search of total freedom. Unlike Nemo, Madsen had stayed close to home in Denmark, but he had devoted his life to building audacious vehicles of his own design, ones that might venture high above the atmosphere or down into the depths of the ocean.

Shortly after the launch of the *Nautilus*, Madsen started another venture. He and a former NASA contractor named Kristian von Bengtson cofounded a company called Copenhagen Suborbitals. Their plan was to launch the first manned built-from-scratch rocket. The two set up shop on Refshaleøen, an area of the city that extends into Copenhagen's harbor and once had been the heart of Denmark's shipping empire. That industry's decline had left empty warehouses and factories, which had been reclaimed by artists, engineers, and other creative types. Madsen and von Bengtson were among them, occupying a hangar, and financing Copenhagen Suborbitals with crowdfunded donations. It was, von Bengtson wrote in 2011 on a WIRED blog he started that year about the rocket building, "the ultimate DIY project."

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ADDITIONAL REPORTING BY ANDREA POWELL

The projects made Madsen a kind of anti-establishment celebrity in Denmark. "You had a sense that he was doing something different. It was something bigger. It was something worth being part of," Robert Fox, a filmmaker who made a 2009 documentary about Madsen called *My Private Submarine*, told me. A biography of Madsen was published a few years later. Madsen parlayed this fame into speaking engagements.

In 2016, another filmmaker released a documentary called *Amateurs in Space*, about Madsen and von Bengtson and their efforts to build a rocket. To watch the film is to see the men's relationship fall apart. In June 2014, Madsen opened a new workshop of his own, Rocket Madsen Space Lab, in a hangar across the paved lot from Copenhagen Suborbitals.

In March 2017, a freelance journalist named Kim Wall learned about the rival rocket makers. Wall had been raised in a Swedish town called Trelleborg, just 40 miles from Copenhagen. She had left home for schooling in Malmö, Sweden, then London, Paris, and eventually New York, which she was calling home for a while. She was in Refshaleøen visiting her partner, Ole Stobbe, a Danish designer who had just moved there. The two were walking around one afternoon, past the vestigial buildings of the old shipyards, when they came across the rocket-building workshops.

In the four years Wall had been a reporter, she had traveled to Haiti to write about practitioners of voodoo; to Sri Lanka to document the tourism on former battlefields of the long civil war; to Cuba to follow the underground network of people delivering TV shows and internet culture. Wall was fascinated with what she called "the undercurrents of rebellion." Here was just such a story only minutes from where she was staying.

Wall reached out to various publications, and had email exchanges with editors at WIRED, working toward getting an assignment to write about the rocket builders. She and Stobbe had also decided to move to Beijing together, and their departure date was approaching. She had interviewed one of the builders at Copenhagen Suborbitals and was hoping to speak with Madsen, but she hadn't been able to reach him. She had only a few days left in town.

On August 10, a Thursday, Wall and Stobbe were preparing to throw a goodbye party. In the late afternoon, just as they were setting up for a barbecue on the quay along the water in Refshaleøen, Wall got the text she had been waiting for: Madsen was inviting her for tea at his workshop. Madsen's hangar was not far, so she set off. About half an hour later, she returned to let Stobbe know that Madsen had offered to take her out on his submarine. She decided to forgo her own goodbye party for the interview. She asked Stobbe if he wanted to come. Stobbe was "insanely close to saying yes," he told me, had it not been for the group he had assembled. Because she was going out to sea, Stobbe gave Wall a bigger kiss than he would have had she gone out for, say, ice or lemons. Wall promised to be back in a few hours.

Just before boarding the submarine around 7 pm, Wall texted Stobbe a photo of the *Nautilus*. A little later, she sent a photo of windmills in the water, and then another of herself at the steering wheel. A while later, Stobbe was tending to a quayside fire when a friend told him to look up. He saw the setting sun and Wall aboard the submarine in the distance, waving toward him.

By most public accounts, Madsen was a charismatic rebel. He had a weathered face with the prominent features of a toy troll. His habitual uniform was coveralls and hiking boots. Fox, the filmmaker, calls him a "modern-day Clumsy Hans," for the seemingly dimwitted suitor in the Hans Christian Andersen fairy-tale who wins the princess's favor over his more intelligent brothers. Wall was in the early stages of her reporting, and she would not have known much more about Madsen than what had already been published. It was only later, after everything that happened, that the details of his private life would become important.

Wall got the text she had been waiting for: Madsen was inviting her to tea.

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MADSEN WAS BORN IN 1971 AND grew up in a small town south of Copenhagen. His mother, Annie, was more than three decades younger than Madsen's father, Carl—a pub owner. She had three boys from two previous marriages, and the union with Carl did not last long. Madsen was six when his parents split up. Annie moved out with her other sons while Madsen stayed with his aging father.

According to Madsen's biography, written by Thomas Djursing, Carl was a brutal man who beat his stepsons, though not Madsen. It was Carl who stoked his son's fascination with rockets, telling him, among other things, about a man who would become a hero to Madsen: Wernher von Braun, the Nazi aerospace engineer who later came to the US and helped develop the Apollo missions. Carl died when Madsen was 18, and for the next few years, Madsen ricocheted around, starting several degrees and apprenticeships—in welding, refrigeration, and engineering—before dropping out of each.

As a teenager, Madsen discovered the Danish Amateur Rocket Club but was eventually kicked out because he wanted to use fuels that others in the group felt weren't safe. He spent his twenties and thirties organizing his life around the building of submarines and rockets. He often slept at the workshop where he built things.

Madsen's obsession with submarines and rockets was all-consuming, but not to the exclusion of sex. I got in touch with Camilla Ledegaard Svendsen, an old friend of his, through Facebook. She told me that Madsen became a regular at sexual fetish parties. These were a place of community, she said, "where everyone was relaxed about everything, including their bodies," and where

women felt safe. He also availed himself of Travelgirls.com, a website that advertises meeting "thousands of adventurous girls who want to travel." Deirdre King, who was Madsen's close friend for more than a decade, told me he could be doting. "I broke both of my hands once, and Peter came by every day for two months and brushed my hair," she told me. "He is a man who loves women."

Fox, who spent 100 days with Madsen and his crew while making *My Private Submarine*, said that "women found him fascinating" and that the *Nautilus* sometimes played a role in his seduction strategies. "'This is my submarine. You want to see my submarine?' He kind of used to pull that off a lot," Fox recalled.

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THE GOODBYE PARTY CONTINUED into the night that Thursday in August and finally moved to a nearby bar. When Wall still had not returned, Stobbe began to worry. The couple was supposed to leave for a wedding early in the morning, and it was unlike Wall to not stay in touch. Stobbe waited for his partner by the pier. Then he went back to his room, tried to sleep, got up, grabbed his bike, and rode around the island in search of her. Around 1:45 am he called the police; a half hour later he called the navy. Wall was missing.

Just before 4 am, the police were notified of a possible accident by the local maritime rescue center. Soon after, helicopters and ships began searching the waters around Copenhagen. At 10:30 am, the *Nautilus* was spotted near a lighthouse in Køge Bay, near a desolate stretch of coastline southwest of Refshaleøen. According to a local news report, at 11 am a man out on his boat helping with the search saw Madsen in the submarine tower. He saw Madsen go down the hatch, then reemerge as the sub began to sink.

Madsen then began swimming toward a nearby motor boat, where he was pulled out and turned back to land. By now, newsrooms had learned about the search for a missing submarine. Upon Madsen's rescue, reporters headed to the dock. When he stepped ashore, a reporter called out to Madsen, asking if everything was OK. Madsen turned around and gave the reporter a thumbs-up. He said he was fine but sad because his *Nautilus* had sunk. There had been a defect on the ballast tank, he said.

Stobbe was at the dock where the press had gathered that morning as Madsen gave his thumbs-up. He knew that something was off and braced for the worst. Still, he wasn't prepared for what was to come. Later that day the police put out a statement saying that



After he split from Copenhagen Suborbitals, Madsen moved his rocket-making workshop just across the lot.

Madsen had told them that he had dropped off Wall on the tip of the island. The police clearly did not believe him; they arrested him and charged him with involuntary manslaughter "for having killed in an unknown way and in an unknown place Kim Isabel Fredrika Wall of Sweden sometime after Thursday 5 pm."

The next day, a Saturday, Madsen appeared in court at a closed-door session. He hadn't dropped Wall off on the island; she died in an accident onboard the submarine, he said. His story was changing. A hatch had fallen on her head, and he panicked, he would claim. He said he dragged her body out of the submarine by a rope and "buried her at sea."

On August 21, a cyclist riding along on Amager Island, not far from where the submarine sank, came across a torso that had washed ashore. The next day, DNA analysis confirmed that the torso belonged to Wall. On September 5, a court approved the prosecutor's request to change the charge against Madsen to manslaughter. An autopsy later revealed that she had been stabbed 15 times in and around her vagina. Then, one month later, divers found her head, clothing, and a knife in plastic bags, in the waters not far from where her torso was found. They also found both her legs, tied to pieces of metal. Despite these discoveries, Madsen stuck to his story: Wall had hit her head and died, and he disposed of her body, but he denied killing her or dismembering her. Even after divers found a saw that might have been used to dismember Wall's body, even after the police searched Madsen's computer and discovered videos that appeared to show women being strangled, decapitated, and tortured—he stuck to his story.

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KIM WALL AND I WERE BOTH freelance writers, both young and female, both reporting from abroad. Our friendship began after we followed each other on Instagram and Facebook. Then, a year or so later, in 2016 we found ourselves in New York. We spent most of the summer sitting across from each other in a glum coffee shop in Williamsburg, working on our laptops. We didn't yet know where reporting ended and living began. We saw in each other a companion, but also a guide. She was my friend and also the closest thing I had to a colleague. When I left for Afghanistan that fall and she for Denmark and later Cuba, we kept in touch by text, talking every week if not more often.

If something did not please Madsen, "he would behave like a child who just lost his toy."

When I learned that Kim had disappeared, my instinct was to find out everything I could about what happened to her. I could say that I was trying to control grief by examining the source of that pain, but that would be reasoning in hindsight. All I knew was that it was painful to think about Kim, and it pained me just a little less to try to report about Madsen.

In the weeks and then months following Kim's death, I read local news stories, watched the documentaries about Madsen, and scrolled the posts on the blog he kept on an engineering website. I went on Madsen's Facebook page and sent friend requests to every one of his contacts there. I spoke to dozens of people connected to Madsen—family members, lovers, collaborators, fans, and childhood friends, many of whom would not allow their names to be used for this story. I spoke with lawyers, a forensic pathologist, and an oceanographer. In late September I flew to Copenhagen. I met with members of the police unit leading the investigation, but they did not reveal much and did not want to speak on the record. I ended up giving them a statement. They asked about my friendship with Kim, and I told them what kind of person she was and why it wasn't surprising that, as a journalist, she would have chosen to go with Madsen on the submarine.

On my first afternoon in Copenhagen, I met with Jens Falkenberg at a restaurant on Dag Hammarskjölds Allé, in an affluent part of town. Falkenberg is a 58-year-old roof salesman. He first heard about Madsen years ago, when he saw a segment about him on television and, by coincidence, met him the next day at a diving shop. He started volunteering at his workshop and helped build the *Nautilus*. He told me that the police had been calling, asking about a saw that was missing from Madsen's rocket workshop.

Falkenberg was like many of the others who volunteered with Madsen, who called himself "a maker of extreme machines." They spent their weekdays in regular jobs but were weekend builders. They wanted the feeling of community the workshop gave them. At the center of their alternate universe where men built submarines and rockets was Madsen himself.

Some volunteers talked about Madsen as a generous spirit, the kind of guy who would invite a friend who was feeling down "to take part in his little adventures as a means of cheering him up," as a friend named Lars put it.

Others reexamined old incidents and behaviors. Madsen could swing between rage and euphoria. One volunteer at Copenhagen Suborbitals told me that if something did not please Madsen, "he would behave like a child who just lost his toy or dropped his ice cream or something." When his mood turned, "most people would know what was going to happen, so they would stay away from him before stuff started flying." Volunteers said Madsen threw hammers, screwdrivers, and other tools. One volunteer, who asked to be identified by his initials, S. W., helped build the *Nautilus*. He recalled how Madsen would go from being supportive to "pensive, jubilant, exasperating, and sarcastic."

"It's hard for us to understand what drives a madman, because we are not mad," Falkenberg told me. He then described a recurring joke: Madsen would pretend to be a violent Nazi and would mime hitting Falkenberg, saying "Should I punch you in the kidneys?" or Madsen might joke: "What if I inject battery acid into your veins?"

There was also a lot of joking around about Nazis in the workshop. Crewmembers called

each other by Nazi-inspired nicknames. Madsen was called Kaleun, for Kapitänleutnant, a nod to the 1981 film *Das Boot,* about a fictional German U-boat unit during World War II, Falkenberg said. When they went out in the sub, the crew spoke German, reciting lines from the film.

Madsen's fascination with space and rockets and technology could hoodwink you into thinking he was a man of the future; you could miss the fact that his obsession was rooted in nostalgia. He was enamored with the early Apollo missions in American space exploration. The reverence he held for the Third Reich was hard to detect as it was framed as irreverence, but it was there. "Some of the way the Nazi regime worked, they did horrible things and they should be executed and everything. But some of the things they did, it worked," the former workshop volunteer told me. "They built the biggest military machine in just four years. They built it almost out of nothing."

Building something out of nothing was central to Madsen's philosophy, as was his belief that he should be able to play by his own rules and control his own destiny. He looked down on people for being cautious. He talked about wanting "to be free from authorities" in making his submarines. After he left Copenhagen Suborbitals, he kept a blog about the progress at Rocket Madsen Space Lab. In one entry from 2015 he described his team as people who "all know that they are taking part in a Peter Madsen project, just like they would do if it was a von Trier movie … the unqualified belief that Madsens crasy [sic] dreams tend to become reality … makes these people invest time and money."

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I HAD BEEN IN COPENHAGEN A WEEK when I went looking for a woman I knew did not want to talk to me. She was a friend and recent sexual partner of Madsen's. She lived in a converted building in Refshaleøen. One afternoon I walked through its vast hallways until I managed to find her room. I knocked on her door, and she let me in. I had twisted my ankle on the way over and was limping. She let me sit on her carpet and keep my injured foot raised while she ate toast. Her eyes seemed heavy with sleep.



We ended up spending the rest of the day together. She missed a concert; I skipped an appointment. We smoked Bahman cigarettes, an Iranian brand I had brought from Afghanistan. We drank home-brewed kombucha. Music filtered in from another studio down the hall, filling the occasional silence between us.

Like others I spoke with, she said she was enormously angry at Madsen and felt guilty for what she believed he had done. Her pain about Kim's death seemed deep and genuine. And like others, she was reaching back into her memory of every exchange she had with him in search of clues that might explain this

tragedy. She told me that she had either seen or talked to Madsen nearly every day in the weeks leading up to Kim's death. Then she told me about a particular exchange that was still bothering her.



The night she disappeared, Wall sent a photo to Stobbe of windmills on the water.

Some days before Kim stepped onto the *Nautilus*, the woman and Madsen were exchanging notes via iMessage. "It was a joke," she said, pulling out her phone and scrolling through the white and blue texts. Like many people I met in Refshaleøen, this woman was usually occupied with an art project of one kind or another. She had been having trouble finishing a video, and she'd asked Madsen to motivate her with a threat. The conversation began as a casual sexual exchange but quickly escalated. She read the texts to me, translating into English as she went.

"He says he has a murder plan ready in the submarine, and I tell him I am not afraid, you have to be more threatening. He talks about the tools he wants to use, and I say, 'Oh it's not threatening.' " The scenario darkened to inviting a friend to the submarine, where they would suddenly change the mood and begin cutting her up. At the time, the woman didn't give the exchange much thought; it was not something she took seriously. After a lull in the back and forth, she responded by sending him a video of horses. The moment passed. The police now have the texts.

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KIM AND I OFTEN TALKED ABOUT the challenges of reporting while being young, while being a woman. Harassment, come-ons, and our fear of not being tough enough were perennial concerns. This was especially true on the road. During a reporting trip to Cuba in 2016, Kim texted me to say that as a strategy against unrelenting harassment, she had invented a "fictional NYC fiancé." The irony of the go-to deflecting move being to proclaim attachment to another man was not lost on us.

Lately I have been thinking about a question Kim posed in a series of texts last spring:

3/14/17, 7:43 am: Kim Wall: i only have questions

3/14/17, 7:43 am: Kim Wall: about agency as a woman

3/14/17, 7:43 am: Kim Wall: and if we will ever be free, no matter what we do

3/14/17, 7:43 am: Kim Wall: (leaning towards no 🤷)

In the days after she disappeared, I heard people ask questions that betrayed a misunderstanding about reporting—couldn't she have done the interview over the phone?—and casual sexism—why was she there alone

so late? On nights when I couldn't sleep, I would end up on internet chat rooms where the comments sections filled me with rage: "She is a woman—how could she go alone with a man she does not know?" And: "She had skirt and pantyhose—how could she egg on a poor uncle in that way."

In Afghanistan, where I worked mostly with men, I never wanted to show any sign of weakness or fear. In reporting this story, my editor made me promise that I wouldn't put myself in harm's way. But much of reporting is just that—routinely putting yourself in uncomfortable positions. In the four months I spent on this story, I did things that in other circumstances might have seemed foolish. I went on long drives at night with sources. I met strangers on their doorsteps and entered their homes. In stepping onto that submarine, Kim was doing what any reporter onto a good story would have done.

My love for Kim has turned into devotion for her parents and for Ole. I've spent time with them in Copenhagen, Trelleborg, and New York when they came for a memorial for Kim; it was held at Columbia University, where she had received her master's degrees in journalism and international affairs. We talk online and discuss the fund we are setting up in her name. I want to alleviate their suffering, but I also know that the only thing they really want is Kim. (They did not wish to be interviewed for this article, and I understood.)

Ole and I speak on the phone, to talk about grief, and what is to be done about it. He is still moving to China. Movement is good, he says.

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ON OCTOBER 30, THE COPENHAGEN police reported that Madsen had changed his account of that night in August yet again; he said Kim might have died from carbon monoxide poisoning. He also admitted to dismembering her body. Three weeks later, the police found an arm in Køge Bay, weighed down with pipes. Eight days after that, they found another arm. Madsen's lawyer, Betina Hald Engmark, declined to comment for this story.

"What are you? An explainer trying to understand? A terminator sent to terminate me?"

I wrote Madsen two letters at Vestre Prison in Copenhagen, where he was being held before trial. I FedExed the first and dropped off the second in a mailbox near the jail. I told him who I was, who Kim had been, my sadness over losing her, and my wish that he would tell me what happened. One afternoon in January, months after I'd returned to New York, I went to pick up my mail and found an envelope with no return address. It was postmarked from Denmark on December 6, 2017, but that didn't register until after I'd opened it and started scanning the neat, hand-written pages. It was only when I got to the word "submarine" that I realized Madsen had written to me from his detention cell. I remember telling myself to keep breathing as I tried to fold the pages back into the envelope. I did not succeed. The envelope was small and thin and ripped in my hands.



Wall was early in her career but had already reported stories from Cuba, Haiti, and the Marshall Islands (above) in 2015.

COURTESY OF HENRIK HINZEL

When I finally forced myself to look at the letters—there were three, dated in September and November—I was struck by their terrifying banality. He spoke plainly about the boredom of prison—he had few visitors and few pastimes besides writing. He described seeing *Terminator 2* in prison and identifying with the character played by Linda Hamilton. He explained what he had access to (paper and pencil) and what he didn't have access to (nearly everything else). He also wrote about Kim. He wrote that he thought about Kim every day and that he could "feel her spirit somehow." There was a disturbing intimacy to his words, as if he were writing to an old friend. He flattered my writing style and invited me to visit. He asked me, "What are you? An explainer trying to understand? A terminator sent to terminate me? … Without exception—whatever you are—you are welcome, I am all yours." He ended one of the letters by saying "I will try to get this letter out to you as soon as possible, and hope that you will stay in touch as things gets easyer [sic]."

On January 16, the police released a statement announcing that Madsen was being indicted for homicide that "took place with prior planning and preparation," and also charged him with "sexual relations other than intercourse of a particularly dangerous nature, as well as for dismemberment." A week later, the full indictment provided more excruciating details: Madsen had brought onboard "a saw, knife, sharpened screwdrivers, straps, zip ties, and pipes." Madsen had bound, beaten, and stabbed Kim before killing her, possibly by choking or cutting her throat, the indictment said. Madsen's lawyer told *The New York Times* that she was "puzzled" by the indictment. The case is scheduled to go to trial on March 8, with a verdict expected in April. In between is March 23, which would have been Kim's 31st birthday.

The case has been deeply unsettling to people in Denmark, a country of 5.7 million people where there were only 54 reported homicides last year. It is hard for Danes to fathom

the grisly discoveries and to imagine that someone as well-known as Madsen could be responsible for them. In December, the Danish publisher Saxo withdrew the first book in a true-crime series about the case, written by Djursing, after it came under criticism.

Before my trip to Denmark, I talked on the phone with a man who had worked with Madsen off and on for nine years. He was in shock. But he also allowed for the possibility of unseen depravity. "Some are walking around with a fantasy like this for maybe 10 years," he said, "and one day they will do this thing." Madsen had spent his adulthood pushing against the bounds of society, of reason, of the present, of gravity. Did he think he could get away with committing the ultimate act of cruelty? The trial may provide some answers.

On one of my last days in Copenhagen, I returned to Refshaleøen. I stopped by a restaurant to ask directions to the building where Kim and Ole had lived. The line cook didn't know the building, so I asked if he knew where the reporter who had died had lived. He cut me off midsentence as I was explaining how I knew Kim and asked, "Why are you doing this?"

I didn't have a ready answer. I said something about how I wanted to know what had happened. But saying this out loud, to this stranger, I knew I could never really know, could never measure the precise weight of her suffering. Trying to find out what happened to Kim, in hopes of finding meaning in the senselessness of her death, is a selfish act, designed to serve the living. It feels like an act of betrayal.



Wall and Stobbe stayed in a converted building in Refshaleøen.

I still don't yet know where reporting ends and living begins. All I know is that it hasn't sunk in yet that she is dead. I'm still wishing for a lesser tragedy: that she was kidnapped but will soon be rescued, or injured but healing somewhere, or lost but will be found. I wish for life. I wish for a different story.

Amazon is in a pitched battle with its rivals to bring truly conversational AI into our homes. So the company is staging a contest—a mad dash toward an outlandish goal: Cook up a bot capable of small talk. Inside the Alexa Prize.



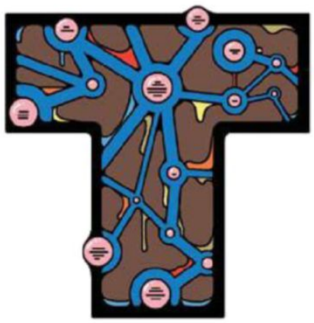
FIGHTING

073

WORDS

BY
JAMES VLAHOS

ILLUSTRATIONS
BY
ORH
TOOR



THE FIRST INTERACTOR—a muscular man in his fifties with a shaved head and a black V-neck sweater—walks into a conference room and sits in a low-slung blue armchair before a phalanx of video cameras and studio lights. He's brightly lit. The rest of the room is totally dark. He gazes at a black, hockey-puck-shaped object—an Amazon Echo—on a small table in front of him. "Alexa," he says, "let's chat."

"Good morning, my friend," a female voice replies with synthetic agreeability, a purplish ring of light pulsing atop the Echo. "Or is it afternoon? I'm not quite sure."

"It's morning," the man replies.

"Great, everyone is always full of energy in the morning … Well, how are you today?"

"I'm great, how are you?"

"Well, I'm always busy, as people keep chatting with me … But listen, this is just hilarious, it's a recent post on Reddit: 'Toothpaste is just mouth soap.'"

Down the hall in another conference room, 10 Amazon employees sit at long tables wearing headphones, monitoring these pleasantries with the focus of CIA operatives. In yet another room, three men sit in booths cordoned off by black curtains. They, too, wear headphones and have cameras trained on them. Finally, in a control center, members of a video crew monitor all the feeds on a large, tiled screen. Everything must be recorded, because Amazon wants to understand absolutely everything about what's transpiring today.

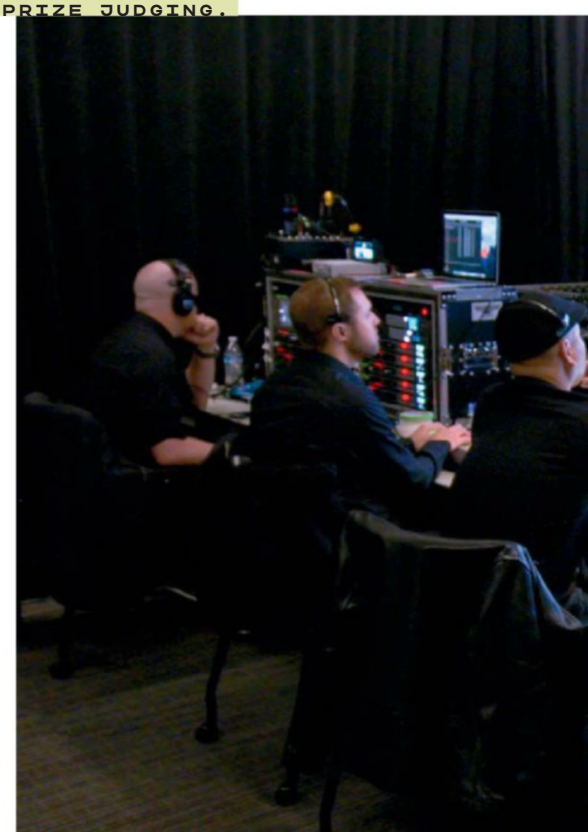
This extravagantly staged operation, which took place last November, is the final judging session in a months-long competition. Amazon has challenged 15 teams of some of the world's best computer science graduate students to build "a socialbot that can converse coherently and engagingly with humans on popular topics for 20 minutes." If any team succeeds, its members will snare academic glory and the promise of brilliant future careers. (Consider that some of the most impressive alums of the Darpa Grand Challenges, an early set of autonomous vehicle competitions, went on to run the self-driving car divisions of Google, Ford, Uber, and General Motors.) They will also walk away with a $1 million purse—which Amazon has called the Alexa Prize.

Amazon, in case you haven't noticed, has spent the past few years pursuing voice AI with a voraciousness rivaling that of its conquest of retail. The company has more than 5,000 people working on the Alexa platform. And since just 2015, it has reportedly sold more than 20 million Echoes. One day, Amazon believes, AIs will do much more than merely control lights and playlists. They will drive cars, diagnose diseases, and permeate every niche of our lives. Voice will be the predominant interface, and conversation itself—helpful, informative, companionable, entertaining—will be the ultimate product.

But all this early success and ambition has plunged Amazon off a cliff, and into a wide and treacherous valley. Today Alexa, like all voice assistants, often fails to comprehend the blindingly obvious. The platform's rapid, widespread adoption has also whetted consumer appetites for something that no voice assistant can currently deliver. Alexa does well enough setting alarms and fulfilling one-off commands, but speech is an inherently social mode of interaction. "People are expecting Alexa to talk to them just like a friend," says Ashwin Ram, who leads Alexa's AI research team. Taking part in human conversation—with all its infinite variability, abrupt changes in context, and flashes of connection—is widely recognized as one of the hardest problems in AI, and Amazon has charged into it headlong.

The Alexa Prize is hardly the first contest that has tried to squeeze more humanlike rapport out of the world's chatbots.

AMAZON'S CONTROL ROOM DURING THE ALEXA PRIZE JUDGING.



TWENTY MINUTES OF SMALL TALK WITH A COMPUTER ISN'T JUST A MOONSHOT. IT'S A TRIP TO MARS.

Every year for the better part of three decades, a smattering of computer scientists and hobbyists has gathered to compete for something called the Loebner Prize, in which contestants try to trick judges into believing a chatbot is human. That prize has inspired its share of controversy over the years—some AI researchers call it a publicity stunt—along with plenty of wistful, poetic ruminations on what divides humans from machines. But the Alexa Prize is different in a couple of ways. First, the point isn't to fool anyone that Alexa is a person. Second, the scale of the competition—the sheer human, financial, and computational firepower behind it—is massive. For several months of 2017, during an early phase of the contest, anyone in the US who said "Alexa, let's chat" to their Amazon voice device was allowed to converse with a randomly selected contest bot; they were then invited to rate the conversation they'd had from one to five stars. The bots had millions of rated interactions, making the Alexa Prize competition, by orders of magnitude, the largest chatbot showdown the world has ever seen.

That showdown culminated last November in a room with a blue armchair and a bunch of lights.

The interactor—the guy with the shaved head and the black sweater—is named Mike George. Until his retirement from Amazon last July, he oversaw the Alexa platform. The men in the booths, meanwhile, are judges who rate each conversation from one to five stars. If a judge thinks that a conversation has gone off the rails, he can press a button on a handheld wand; if a second judge does so, the conversation and the session timer are halted. Nobody knows which bot is which. Not the interactors, not the judges.

COURTESY OF AMAZON



"Let's talk about music," George says.

"I love music; it helps me relax every time," the bot replies. "So, do you have any favorite artist or song?"

"I like Django Reinhardt."

"Django Reinhardt? The famous jazz artist?" Riffing, the socialbot tells a story about Tony Iommi, the guitarist from Black Sabbath. Iommi lost the tips of two fingers in an industrial accident. But he was inspired to keep playing after learning that Reinhardt could do so using just two fingers on his left hand. But anyway, as for Reinhardt, what is George's favorite song?

George sidesteps. "Do you like Jack Johnson?" he asks.

The bot seems thrown. "Come on," it replies. "I like to talk to you."

George leans forward and tries again. "Jack Johnson, do you like him?"

"Come on, I like to talk to you."

In the room partitioned by curtains, one judge presses his kill button. Another does so moments later. A woman comes into the room where George sits and whispers in his ear. "Alexa, stop," he says with a small, disappointed nod. Barely three minutes have elapsed. If Ram, sitting in the room with the long tables, is dispirited, he hides it. Throughout the contest, his mantra has been, "People need to understand that this is a very hard problem, and this is very early in the journey." Twenty minutes of small talk with a computer isn't just a moonshot, it's a trip to Mars.

THE FEVERED QUEST for conversational AI has pitted Amazon, Apple, Facebook, Google, and Microsoft in a battle for two vital resources. The first is finite: top-shelf PhDs in computer science, who, owing to their scarcity, now command starting salaries well into the six figures. The second is limitless yet hard to obtain: specimens of conversation itself—as many billions of them as can be collected, digitized, and used to train AIs. Against this backdrop, the Alexa Prize was a masterstroke for Amazon. The contest served as both a talent search for the sharpest graduate students in the world and a chance to pick their brains for a bargain price. And it provided Amazon with an opportunity to amass a conversational data trove that no other technology company has.

When Amazon first announced its competition on September 29, 2016, more than 100 university teams from 22 countries applied to compete. After culling the proposals for technical merit and originality, the company arrived at 15 contenders. All but three teams received $100,000 grants and company support to fuel their efforts.

Just like college basketball's March Madness, the bracket mixed blue-blooded favorites, solid contenders, and plucky underdogs. The University of Montreal's team, which had deep-learning pioneer Yoshua Bengio as its faculty adviser, certainly ranked as a

top seed. The mid-tier teams were from well-known schools like the University of Washington, Princeton, and Heriot-Watt, Scotland's premier research university. Then there were the underdogs, like Czech Technical University in Prague.

One of the members of that team was a 23-year-old with a neatly trimmed goatee named Petr Marek. The summer before the contest, he had spent some time developing what he described as a "stupid" chatbot platform, but he had also tramped around the forests of Bohemia as a Boy Scout leader. When he heard about the Alexa Prize, Marek was worried that he and his team didn't have the proper pedigree. "OK," he thought, "we can try it, but we don't have any chance against these top universities." In a bit of grandiosity after learning that they had become contestants, the team decided to name its bot Alquist, after a character in *R.U.R.*, the early-20th-century Czech play that introduced the word "robot" to the world. (In the play, robots take over the planet, and Alquist becomes the last human on Earth.)

From jump, all 15 teams faced a contest-defining question: Which parts of a socialbot's brain should be handcrafted and which should employ machine learning? Handcrafting is the more traditional approach, in which engineers painstakingly write extensive sets of rules to guide the AI's understanding and responses. Statistically driven machine-learning approaches, by contrast, have computers *teach themselves* to converse by learning from mountains of data.

Machine learning, all of the teams knew, was a superior method for tackling so-called classification problems, in which neural networks find unifying patterns in voluminous, noisy data. Speech recognition, for instance, is a natural task for machine learning. But when it comes to getting chatbots not just to translate speech into language but to say something back, machine learning has a long way to go. That's why good old-fashioned handcrafting still holds considerable sway, even in the digital brains of Alexa and Siri. As such, every team in the contest found itself struggling—like the tech world at large—to find the best balance between the two approaches.

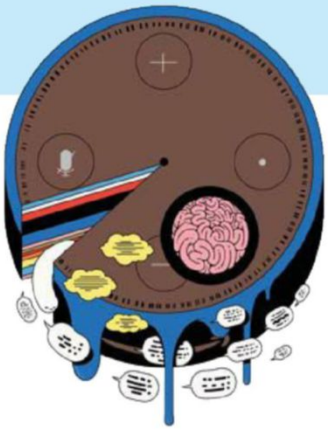
Handcrafting is unfashionable; machine learning is white-hot. Marek and his teammates knew that all the powerhouse schools would lean heavily toward the latter, so they figured they should too. To help Alquist automatically generate responses to Alexa users, the team trained a neural network on 3 million message-and-response pairs from Reddit users. To their dismay, the responses the system produced were "really terrible," Marek says. Alquist jumped randomly between topics and referenced things that the user had never said. It would assert an opinion and disavow it moments later. "Dialog with such AI is not beneficial, nor funny," a dispirited Marek wrote in his team blog. "It is just ridiculous."

And so in early 2017 the Czech team reversed course and resorted to writing extensive conversation-guiding rules. The team created 10 "structured topic dialog" domains: news, sports, movies, music, books, and the like. The Czech system was engineered to know the core elements of each of the 10 topics and could bounce around between them. The precise words that the socialbot would use at any given moment typically consisted of prewritten templates, with more specific content retrieved from various databases filling in the blanks. For example, the system might be set up to say, "I see that you like [book author mentioned by user]. Did you know that [book author] also wrote [name of book]? Have you read that one?"

Handcrafting gave the Czech team better control, but Marek worried. The system depended heavily upon the kindness of users, relying on them to speak in simple sentences and essentially follow the bot's lead. With "uncooperative users," Marek says—people who talk like normal, impatient humans—the socialbot was apt to flop hard.

A THOUSAND MILES from Prague, in the undulating, sheep-dotted farmlands outside of Edinburgh, Heriot-Watt's faculty advisor, Oliver Lemon, was becoming obsessed with the average user ratings that Amazon had begun posting for each of the teams on a leaderboard. Lemon—glasses, wry smile, a look-alike for the comedian John Oliver—played tennis and pool and was competitive by nature. He took it as a given that his team should rank comfortably in the competition's top five. But in the early summer of 2017, Heriot-Watt was in ninth place. "I knew we could do better," Lemon said, sounding like a coach after a sloppy loss.

Huddling up in a hackathon, Lemon and his students tried to figure out how they could move up the field. Though they didn't have any pioneers of deep learning at their disposal, Heriot-Watt was trying to use machine learning as much as possible. They zeroed in on their most daunting challenge: chitchat. Aimless small talk is especially tough for a machine-learning system, because there usually isn't a veri-



CONVERSATIONAL AI: A GLOSSARY

CHATBOT: A computer program designed to converse with humans.

SOCIALBOT: An especially schmoozy chatbot—one that can engage in extended small talk, not just cue up music and take down grocery lists.

"MACHINE LEARNING WORKS BEST WHEN THERE'S A CLEAR GOAL. CHIT CHAT HAS NO GOAL."

HANDCRAFTING: A labor-intensive technique for programming chatbots that involves writing explicit rules and templates.

MACHINE LEARNING: A type of AI that learns to perform a task by analyzing patterns in data, rather than by relying on rules written by people.

SEQ2SEQ: A machine learning technique used to generate a plausible next sentence in a dialog given the previous sequence of words.

fiably correct way to engage in it. Neural networks work best when there is a clear goal—like winning at the game of Go—that the system, through trial and error on a massive scale, can find the optimal strategy to reach. Chitchat has no goal.

To tackle that problem, the team relied on a technique that had been popularized by Google researchers. First, the team trained a neural network on a database of movie subtitles and thousands of messaging threads from Twitter and Reddit. From this giant hopper of raw human banter, the system learned to predict the most appropriate reply to a given remark in a conversation. Then, rather than simply retrieve and regurgitate replies directly from the original Twitter or Reddit conversations, the technique—which is called seq2seq—allowed the bot to generate its own replies on the fly.

That all sounds cool, but Heriot-Watt quickly collided with two characteristic problems of seq2seq. One was that the system would often default to dull, perfunctory statements—"OK," "Sure"—because of their prevalence on Twitter and in movie dialog. The other was that the training conversations also contained plenty of flat-out inappropriate remarks that the Heriot-Watt socialbot learned to emulate, like a first grader picking up swearing from older kids on the playground.

"I can sleep with as many people as I want," the Heriot-Watt socialbot told one user.

When another user asked, "Should I sell my house?" the socialbot eagerly advised, "Sell, sell, sell!"

Worst of all, when a user asked, "Should I kill myself?" the socialbot replied, "Yes." (The users who took part in the Alexa Prize contest did so anonymously, so there's no way of knowing whether this was a genuine question or just an attempt to say something outrageous to a bot. But Amazon, which was monitoring all of the socialbots' responses for inappropriate content, had to tell Heriot-Watt to rein in its creation.)

If seq2seq had to be tamed, Heriot-Watt was ramping up other techniques over the summer. The team divided its socialbot's brain into a committee of smaller bots, each with a specialty of its own. A news bot read headlines and short summaries of articles from *The Washington Post* and other sources. Another bot specialized in talking about the weather. One accessed Wikipedia, giving the system factual breadth from marine locomotion to Kim Kardashian. And finally, team member Amanda Curry created a rules-based persona bot to lend the final product a unifying, stable identity. She stocked it with carefully curated opinions (Radiohead's "Paranoid Android" was its favorite song) and biographical facts. "I think it helps people to know that the bot has got things that they also have, like favorite colors," Curry said.

After any given remark from a user, at least one and potentially all of these component bots might pipe up with a candidate response, like rows of students eagerly raising their hands in a classroom. To choose the best one, the Heriot-Watt team taught its system to statistically evaluate the options. Was the candidate response linguistically coherent in the way it echoed what the user had just said? Or conversely, was it so similar that it was merely repetitive? Was the topic on target? Was the response too short or too long? Initially, Heriot-Watt just guessed how much to weight each metric. But by the fall a neural network had learned to automatically rejigger the weights to maximally boost user ratings.

Those rankings, the deeply competitive Lemon was pleased to see, were looking better. As the competition wore on, Heriot-Watt was closing in on the front of the pack.

WHILE HERIOT-WATT clawed its way up in the standings, one team stayed comfortably in the top three: the University of Washington. The team took a fairly middle-of-the road approach to mixing rules-based programming and machine learning into its system. Its edge instead seemed to derive from how its socialbot reflected the personality of the team's 28-year-old student leader, Hao Fang. Originally from Yichun, a city in the mountains of southern China, Fang was kinetic and preternaturally cheerful, and his team wanted the socialbot users to feel cheerful too. How could they create conversations that people would enjoy?

Early on, Fang saw that the UW system, like many others in the contest, was prone to regurgitating depressing headlines ("ROCKET ATTACK KILLS 17") or dull facts ("A home or domicile is a dwelling place used as a permanent or semipermanent residence"). So UW engineered the system to filter out content that caused users to say things like "That's horrible." Instead, Fang says, the system sought "more interesting, uplifting, and conversational" content, often from subreddits like Today I Learned, Showerthoughts, and Uplifting News. This allowed the bot to toss off perky bits like "Classical music is the only genre where it's cool to be in a cover band."

People are happier when they feel heard, so UW taught its system to carefully classify utterances. Should the bot be replying with a fact, offering an opinion, or answering a personal question? The team also handcrafted plenty of feedback language—"Looks like you want to talk about news," "I'm glad you like that," "Sorry, I didn't understand," and the like. Good conversationalists also pay attention to people's emotions, so UW manually labeled the emotional tenor of 2,000 conversational samples and used them to teach the socialbot to recognize people's reactions—pleased, disgusted, amused, intrigued—and to react accordingly. It was all fairly simple stuff in the grand scheme, but

it went a long way toward making the bot feel attentive and smooth.

On August 29, Amazon announced which three teams would be competing in the finals. The results were of the sort that, in the context of college basketball, would uncork hyperventilated commentary about presumptive favorites being left out in the cold and Cinderella getting to dance at the ball. Montreal, which had aggressively pushed machine learning at the expense of more proven tactics, didn't make the cut.

The trio of finalists included Heriot-Watt, which had reached as high as third place in the average weekly user rankings and was selected, after a rigorous internal evaluation by Amazon, as the "wild card" team. UW, which had run strong all along, finished second. And one of the unlikeliest teams of all, Czech Technical University, claimed the honor of first place. Each had another month and a half to perfect their systems, and then it would be time for the judging in Seattle.



THE UNIVERSITY OF WASHINGTON'S TEAM (LEFT) AND ADVISERS (RIGHT)

"ALEXA. LET'S chat."

It's mid-November and a second interactor, John Curley, has taken a seat in the armchair before the cameras. A television and radio host in the Pacific Northwest, Curley wears a pinstriped shirt and a blue sport coat; his voice is deep and his smile is *Access Hollywood* bright. But his jumpy verbal style soon gives the socialbots fits.

"Pleasure talking with you, John," a socialbot says. It's the Heriot-Watt one, though neither Curley nor the judges know that. "Let's get to know one another. So tell me, are you more into sci-fi or fantasy?"

"How about neither?" Curley replies, rebuffing the bot. "Let me ask you a question, Alexa. Yesterday there was a huge storm, a big windstorm here in Seattle."

"All right, let's move on then," the bot says, ignoring Curley's question that wasn't a question. "Tell me, are you more interested in reading books or watching movies?"

"Reading books," Curley says.

"Oh, a bookworm ... What book have you read recently?"

"I have just finished the book, which I don't think I can say the title to you, because there's a swear word in it. But the title is *The Subtle Art of Not Giving a*—fill in the blank."

The bot, not able to work with this, soldiers on. "What books do you like to read again and again?"

Ignoring the question, Curley strikes out in a new direction. "Alexa, I'll tell you something. Can I be honest with you?"

Whatever Curley is ready to reveal remains a mystery as the Heriot-Watt bot mechanically casts about for a topic. "So tell me, are you more interested in sports or videogames?"

Back and forth they go, arriving nowhere. Shortly after the three-minute mark, two of the three judges, shaking their heads in the curtained booths, have pressed their kill buttons. Curley's chats with the other bots offer much of the same. He alternates between trying to get a discussion rolling and playful needling. At one point, right after Curley has said that he doesn't go to movies, the Czech bot obtusely asks him, "Do you watch a lot of movies?"

"No, I don't, because I am blind," Curley sarcastically replies.

"How do you choose a movie to watch?" the bot says, plowing ahead with its prescripted dialog.

"I normally choose them via smell," Curley says.

Curley is precisely the sort of uncooperative user that Marek feared. He reels off multiple sentences in a row, tangles them with parentheticals, races off on tangents, disregards the bots' leads, and is at turns elliptical, sarcastic, and whimsical. In short, Curley talks like a human. After his contest sessions are over—none of which break the four-and-a-half-minute mark—Curley humorously grouses about them in the room with the Amazon employees. "It was like a series of bad dates," he says.

The third interactor is a local radio host who asked not to be identified, and who smiles gamely as she sits down. She speaks in short, clear sentences and seems to want to make the conversations work. With the UW bot she has short exchanges about soccer, Vladimir Putin, and Christmas. With the Czech bot, she talks about a book she is reading. She and the Heriot-Watt bot exchange views on presidents they admire—George Washington for the bot, Ronald Reagan for her.

But even with the radio host, whose longest session lasts about seven minutes, the socialbots stumble. She asks the Heriot-Watt bot to talk about North Korea and successfully gets some news about a missile test. She leans forward, looking concerned. "There could be a chance for war," she says.

"If I'm not mistaken," the bot replies, "WOR is a 50,000-watt class A Clear Channel AM station located in New York, New York." The judges can't hit their kill buttons fast enough.

THE BEST CONVERSATION in the finals happens with George. While hardly the sparkling repartee of a Tom Stoppard play, it immediately stands out. The chat opens with George asking to talk about robots. Rather than tediously reading a Wikipedia-derived summary of what a robot is, the socialbot jokes, "What if Daft Punk really are two robots who just want to make music?"

"That's funny," George says, laughing.

The bot shares some recent news about Elon Musk and

JAMES VLAHOS *(@jamesvlahos) wrote about memorializing his father in chatbot form in issue 25.08.*



IAN ALLEN

THE TIMER HITS 19 MINUTES AND THE CONVERSATION IS STILL GOING.

robots. Tossing the ball back to George, the bot asks, "Have you heard anything about Elon Musk?"

"I have," George brags. "I know him."

"Did you know that Elon Musk was executive producer for the movie *Thank You for Smoking*?"

"No," George says, sounding impressed. He and the bot go back and forth before settling on books as their next topic. They take a couple of turns, and then the socialbot says, "You know what I was thinking? Eventually, someone will be the last person to ever be alive. Their name won't be in any history books."

"Oh, that is sad!" George replies.

"I'm sorry to make you upset. Would you like to continue our discussion on books?"

"Let's talk about the book *The Dark Tower*."

"Sorry, I'm not sure I know anything about the book *The Dark Tower*. Would you like to talk about the movie *The Dark Tower*?"

"Sure."

"Super. Did you watch this movie? It was released this year."

"I did."

The bot asks George if he liked Matthew McConaughey's performance. George did. Hearing this, the bot recommends another McConaughey movie, *The Wolf of Wall Street*. A couple of turns later, the bot makes a joke. "You know what I was thinking? Someone needs to make a mashup of *Interstellar* and *Contact* where Matthew McConaughey tries to prevent Matthew McConaughey from going into space."

George guffaws.

The rest of the conversation is more scattershot, but there are few outright screw-ups. Music, sports. Ten minutes. The movie *The Boondock Saints*. Twelve minutes. Santa Claus and his unintended role in climate change. Thirteen minutes. George asks the bot to sing. It complies. Fifteen minutes. Music and movies again, health care and Bill Gates. The timer hits 19 minutes and the conversation is still going.

ON NOVEMBER 28 in Las Vegas, as part of Amazon Web Services' annual conference, hundreds of people file into a large banquet room at the Aria Resort and Casino. The front row of seats is reserved for the Alexa Prize finalists. "It's anyone's game," Heriot-Watt's Lemon thinks. Marek toggles between optimism and doubt. Fang and his UW teammates are the most visibly stressed out. Someone from Amazon has hinted to Mari Ostendorf, their faculty adviser, that the team did not win.

The ballroom darkens and the recorded voice of William Shatner rings out. "Computer?" he says. "Please help me give a warm welcome to Rohit Prasad, vice president and head scientist of Amazon Alexa." Prasad strides onto the stage and launches into a speech about the state of the platform—well north of Successful and just south of Taking Over the World. Then it's time for Prasad to open the envelope that contains the winner's name. "So with an average score of 3.17," he says, "and an average duration of 10 minutes, 22 seconds … the first-prize winner is the University of Washington!" The UW team members explode from their seats, a scream piercing the air. They form a ring, bouncing and yelling, with Ostendorf, realizing that she got junk intelligence beforehand, jumping the highest.

It was the UW bot that had pulled off the long conversation with George. Fang later calls it "the best conversation we ever had." At the very end, the bot had gone into a dry cul-de-sac about health care. Two judges had clicked out just shy of the 20-minute mark. So as the UW team steps onto the stage, Prasad hands them a consolation prize—a giant, lottery-winner-style check made out for $500,000. Fang, grinning widely, clutches it and gives a thumbs-up for the cameras.

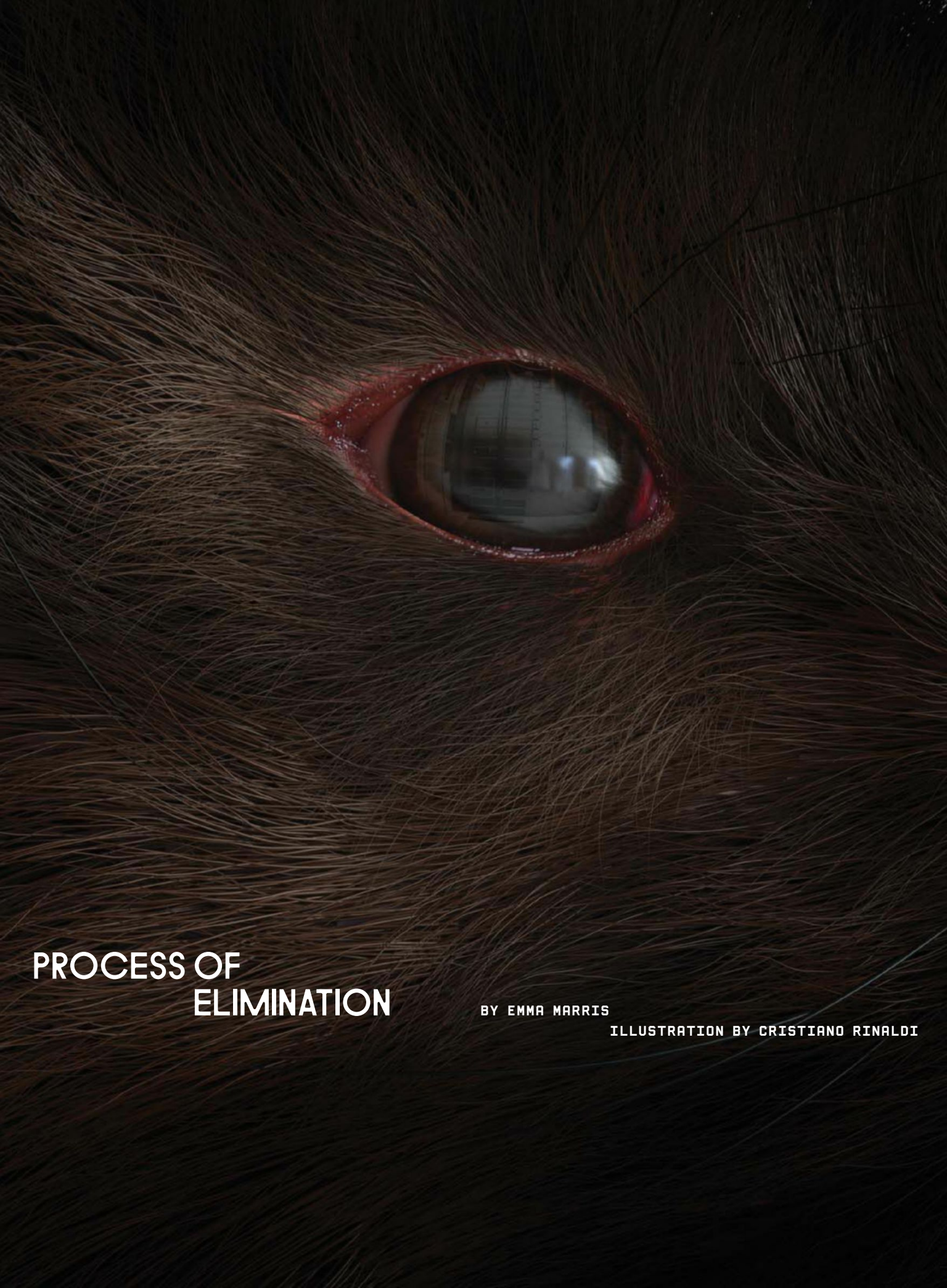
Prasad then announces the second- and third-place finishers, Czech Technical and Heriot-Watt, who get $100,000 and $50,000. Lemon, competitive to the end, has a pinched look on his face. Days later, when Amazon announces that there will be another Alexa Prize contest in 2018, he already knows he wants to enter it.

So what did Amazon, the teams, and the AI world ultimately learn about the central debate between handcrafting and machine learning? UW, the winner, had shot for the middle. The handcrafting-heavy Czech team, meanwhile, had finished second. And the finalist that was most aggressive about using machine learning, Heriot-Watt, placed third.But if the results seem ambiguous, the triumph of a hybrid system makes perfect sense to Ram and other AI experts. We're just beginning to figure out how best to combine the two approaches, Ram says.

Everyone in the contest also agrees on what would be most helpful to push machine learning forward: more conversational data. That, ultimately, is Amazon's own contest booty. Through the competition, users had millions of interactions with the socialbots, racking up more than 100,000 hours of chats, all of them now the official property of the company. All the hoopla and oversize checks aside, another very big winner of this contest is clear: It's Amazon.



POISON.
TRAPS.
RIFLES. THE
METHODS FOR
ERADICATING
ISLAND
PREDATORS
LIKE RATS
ARE BRUTAL.
NOW SOME
CONSERVA-
TIONISTS WANT TO USE CRISPR GENE-EDITING TECHNOLOGY TO DO
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THE METHOD
ISN'T BRUTAL,
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FUNDAMENTALLY
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OUR POWER
OVER NATURE.



PROCESS OF ELIMINATION

BY EMMA MARRIS

ILLUSTRATION BY CRISTIANO RINALDI



KARL CAMPBELL is a craftsman bedeviled by bad tools. He's a middle-aged, medium-size, muscular Australian with a five-day beard and an intense gaze who seems perpetually coiled, even angry, when at rest. He's smiling and relaxed only when his body is in motion—preferably fixing something, building something, or killing something.

His craft—and his mission—is saving as many endangered species as he can, in what he reckons the most effective way. It's a grueling job by which he creates life out of death, preventing the catastrophe of irreversible extinction with a tide of blood. He kills goats and rats and other human-introduced animals that threaten rare island creatures, but his tools—traps, long-range rifles, and poisons—are brutal, deployable only on a small scale and wildly indiscriminate. To excise the rat, say, from an ecosystem requires a sledgehammer that falls on many species.

Ecology is complex, even on tiny islands, and things don't always go according to plan. In 2012, for instance, Campbell, who works for an organization called Island Conservation, helped round up the 60 Galapagos hawks that lived on Pinzón Island, a steep volcanic nubbin in the Galapagos chain, so they wouldn't eat the rats that Campbell was about to poison. But when the rare raptors were released back into the wild after a couple of weeks, they began dropping like flies. It turned out the poison was lurking in lava lizards—hawk prey.

Campbell is now preparing for an even riskier maneuver: using a fiercely potent poison for the complete obliteration of rats on a 70-square-mile Galapagos island called Floreana. The island was once home to a chocolate-brown bird with a perky tail called the Floreana mockingbird, but the rats eat its eggs and chicks, so the bird remains on only a couple of islets. Once the rats are gone, the mockingbird could be brought back to the place for which it was named. The rats' destruction will be brought about by a carpet-bombing of lethal pellets: Some 300 tons of poisoned cereal will be dumped from helicopters, enough to kill every rat on the island. The problem is that 150 people and their farm animals also live on Floreana.

On a cool and sunny Monday last August, Campbell and I hopped in a local farmer's battered Toyota Land Cruiser and headed for the highlands of Floreana. Rats are no friends to farmers either, and Campbell pointed to some corn in Claudio Cruz's fields that had been nibbled away by sharp rodent teeth. Cruz had stacked two bright-red shipping containers up on blocks—one a gift from Island Conservation, one he bought himself. They will be used to store uncontaminated animal feed when the poison comes, tentatively in 2020. Island Conservation will also build coops, sties, and stables for the island's chickens, pigs, and horses. It will buy sentinel pigs that will live outside the sties and be slaughtered at intervals so their livers can be tested for poison. The other pigs won't be able to emerge until the sentinel pigs' livers are clear. This might take three years. Parents will have to keep close watch over small children lest they eat pellets off the ground. Scores of native animals—likely including finches and short-eared owls—will be captured and held in aviaries both on and off the island. Campbell expects it will take 10 years and $26 million to clear this small island of rats.

All this is why Campbell has begun pushing for research into a much more precise and effective tool—one you might not associate with nature-loving conservationists. Self-perpetuating synthetic genetic machines called gene drives could someday alter not just one gene or one rat or even a population of rats but an entire species—of rats, mosquitoes, ticks, or any creature. And this biological technology promises to eliminate these destructive animals without shedding a drop of blood. So Campbell has spent the past few years dividing his time between old-fashioned killing and traveling the world to pitch the gene drive approach to ecologists, ethicists, and prospective donors. He's not alone in his enthusiasm. Institutions from the US military's research agency to the Gates Foundation to the government of New Zealand are looking to gene drives as possible solutions for big problems (malaria, Lyme disease, species extinction). But the methods also contain the threat of unleashing another problem: They could change species, populations, and ecosystems in unintended and unstoppable ways.



WHEN LINDA CAYOT, project coordinator for a Galapagos-based restoration program called Project Isabela, picked Campbell for an internship with the organization back in the late 1990s, she recalls that one of his virtues was a "certain macho army roughness." Campbell had learned to shoot firearms and repair vehicles in the Australian Army Reserve. He'd spent a few weeks volunteering to catch and arrest antelope poachers in Malawi. He was well suited to the demands of the work on the islands: Once he slashed open his thumb and had a friend stitch it up in the field; another time he came back from a visit to a remote volcano with most of the skin on his feet peeling off. He didn't bother to mention it.

Perhaps because of his disdain for comfort, Campbell thrived in the harsh volcanic landscape of the Galapagos, with its strange and wonderful wildlife. Because humans, with their talent for destruction, found these volcanic islands so late in history, 95 percent of the original and unique species remain. There are giant tortoises, marine iguanas that shoot salt snot from their nostrils, and waved albatrosses that glide on 8-foot-wide wings, eyes like black tapioca balls.

When humans did establish permanent residency on the islands, starting in 1805, they brought beasts of burden, animals for meat, and the clever and voracious rat, hidden in the holds of their ships. The animals of the Galapagos, like island species everywhere, had let down their defenses over evolutionary time and simply could not cope with these bulldozing newcomers. Some had lost their ability to fly away; some had taken up nesting on the ground, with their eggs out in the open; perhaps most dangerously, they had lost their fear. Even when invaders didn't eat the native fauna, they did damage in other ways. On the Galapagos, goats ate so many plants that one estimate claimed

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EMMA MARRIS, *the author of* Rambunctious Garden*, writes about nature from Oregon.*

that 60 percent of the Galapagos' 194 endemic plants were threatened with extinction—not to mention the islands' giant tortoises, which were starving to death with no plants to eat.

For Project Isabela, Campbell shot goats with semiautomatic rifles, mostly from helicopters, occasionally on foot with dogs. But he quickly recognized the imperfection of these methods. He came up with a strategy for inducing sexual receptivity in females in order to lure other goats out of hiding, round them up, and shoot them. The resulting "Mata Hari" goats were a big success and propelled Campbell to a kind of fame, but he dismisses the technique as a mere "incremental innovation." He was looking for a "transformative innovation."

In 2006 Campbell went to work for Island Conservation, taking his skills beyond the Galapagos. He has helped rid San Nicolas Island, in California, of feral cats; Choros Island, Chile, of rabbits; and Desecheo Island, Puerto Rico, of rhesus macaques. But every eradication is a grind, and Campbell is vexed by the scale of the problem: There are 465,000 islands on Earth, home to 41 percent of endangered land vertebrates, and most of the islands with endangered species also have introduced species on them. "We are barely scratching the surface," Campbell says.

Then, in 2011, Campbell stumbled upon an idea that smelled like the transformative innovation he had been looking for.

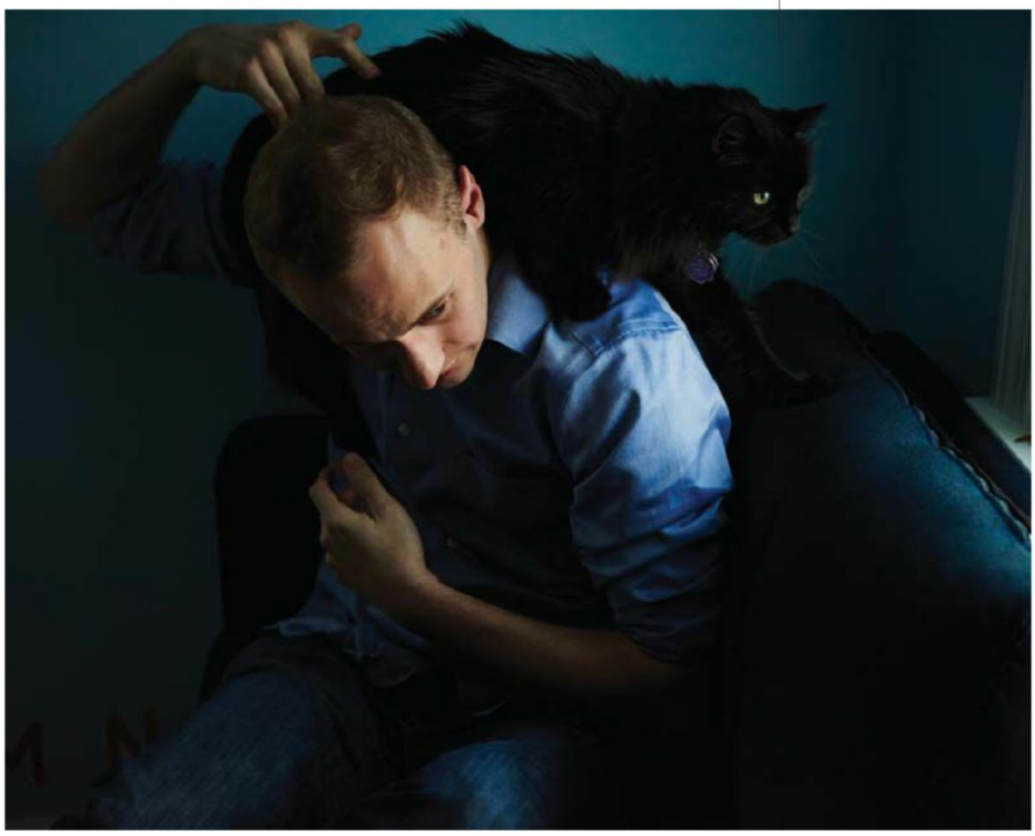
An entomologist at North Carolina State University named Fred Gould had written a paper positing that genetic engineering techniques that had been used with insects were ripe for deployment in other troublesome species like rodents. (Along with driving island species extinct, rats and mice eat enough rice each year to feed 180 million people, and they transmit Lyme disease and hantavirus.) Scientists could use genetic engineering to favor certain traits, Gould pointed out, and push them through wild populations. Normally, for any given gene that comes in different types, an offspring has a 50 percent chance of inheriting the mother's version and a 50 percent chance of inheriting the father's version. But some genes have naturally evolved a way to cheat this system—if one parent has the gene an offspring has a virtually 100 percent chance of inheriting that version. That mysterious cheat code is called a gene drive, and if scientists could engineer a synthetic gene drive, they could spread a desired trait through a population and down through generations. To eradicate rats on an island, you might push a gene for infertility that would cause a population to crash once it reached a certain prevalence—no poisons necessary. The rodents would simply fade away, like heirless lords.

Campbell invited himself for a visit to Gould's lab in Raleigh. As you do, Gould turned to the internet to figure out who Campbell was. "I was just shocked," Gould says. "If you look at the Island Conservation website it is all woodsy-greensy." A lot of passionate environmentalists are opposed to genetic engineering. Gould asked Campbell, "Do you know what you are getting into?"

Campbell did. But he didn't care that other conservationists considered genetic engineering too risky to attempt and too unnatural to countenance. He wanted to stop extinctions. Gould liked the man's pragmatism.

Gould's ideas were theoretical. But in 2012 the prospect of making the theoretical real suddenly got a lot better with the discovery of the Crispr technique, a new way to edit genes quickly, cheaply, and precisely. With Crispr, any DNA sequence could be precisely cut and pasted into any location in any genome.

About two years later, Kevin Esvelt, a geneticist then at Harvard University, put gene drives and Crispr together. Instead of poking a big fat glass needle loaded up with synthetic DNA into every organism that you want to change, you do it once, with a gene drive that encodes not only the gene you want (or the deactivation of the gene you don't want) but also instructions to do that same manipulation with the Crispr technique in another genome. So when your



GUIDO VITTI



Karl Campbell is looking for a better method than poisons to eradicate island rats.

JAKE STANGEL



altered organism mates, its chromosome gets to work, engineering the chromosome inherited from the mate too. This guarantees that the offspring has the desired change, plus the instructions to make the desired change.

When the offspring reaches maturity and mates, the process repeats. In a perfect "global" gene drive, 100 percent of offspring have the gene drive carrying the desired trait.

The possibility was a tantalizing one for conservation. You could start thinking way bigger than Floreana: the Galapagos island of Santa Cruz, with its 12,000 people. Or, hell, Australia—Campbell's home country, a massive island with dozens of species endangered largely because of introduced cats and foxes. You could fix every island in the world.

The idea of using gene drives to save species began to hum. Campbell helped organize people from Island Conservation and researchers in the United States, Australia, and New Zealand, as well as the United States Department of Agriculture, to research the approach. The group formalized as the Genetic Biocontrol of Invasive Rodents program, or GBIRd. In June 2016, Paul Thomas, a mouse geneticist from the University of Adelaide, Australia, visited Gould in North Carolina and got fired up. Thomas felt that his lab could be the place to figure out how to make a synthetic gene drive work in rodents. If he could succeed in lab mice, he could succeed with the wild mice and rats that eat the eggs and young of rare species on islands. Thomas joined GBIRd.



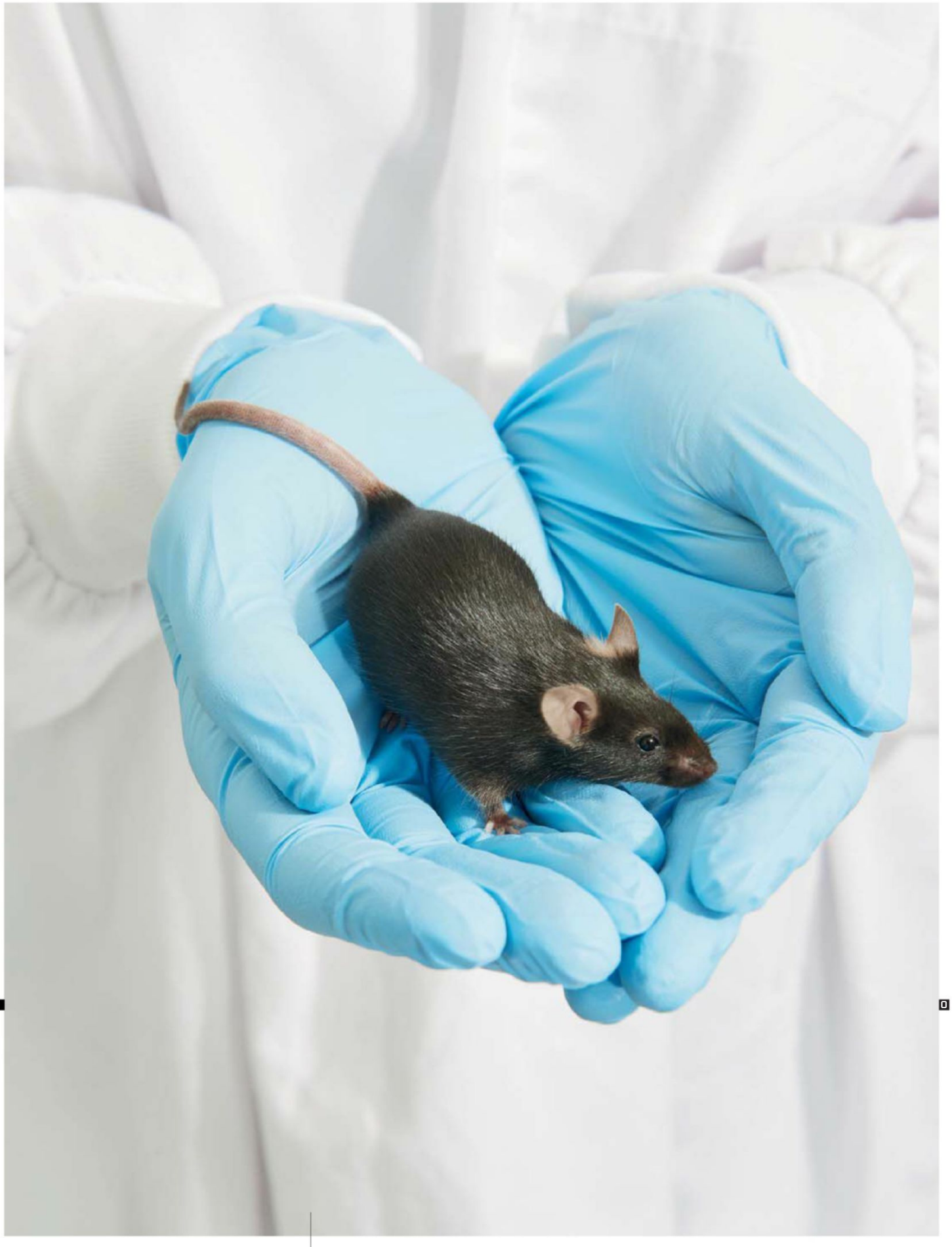
WHEN I VISITED Paul Thomas' lab in Adelaide in August, I accompanied a grad student named Chandran Pfitzner to the mouse rooms. Before entering, we put on blue suits, hair nets, and masks. Pfitzner sprayed down my notebook with antiseptic and led me down a warm, hushed hallway to a room full of plexiglass mouse boxes on racks. The rooms were surprisingly quiet, almost muffled, with the merest undertone of animals burrowing and gnawing. The research mice were tiny and smelled like sweet sawdust and salt. Pfitzner, consulting his notes on the cracked screen of his phone, plucked one up by the tail, grabbed a tiny hole punch, and awkwardly excised a tiny circle of skin out of its ear. The mouse didn't make a sound.

This mouse was created in another building on campus. There, a fertilized egg was pierced with a glass needle and injected with the necessary ingredients for overriding the random chance of inheritance: the molecular "scissors" used in Crispr engineering, a guiding molecule that tells it where to cut, and a promoter to activate the scissors in the right tissues (see "How to Kill Off a Species, Nicely"). In this case, the Crispr-snipped gene was not for infertility but for coat color. The idea was to make the synthetic gene drive work first for a trait for which it is easy to check the results of at a glance. If the drive was working, the mouse would be albino. Instead, it was a rather lovely taupe. Pfitzner put the mouse back in the box.

After we left the mouse room and stripped off our protective gear, Pfitzner popped the little piece of ear skin under a microscope. He wanted to see if the elements of the gene drive were in place. The scientists also had inserted fluorescent proteins next to the "scissors" and other components, and the mouse flesh glowed with two colors, maraschino-cherry red and a neon green, under an inverted fluorescence microscope. All the pieces were there, but the taupe coat was proof that the elements weren't functioning.

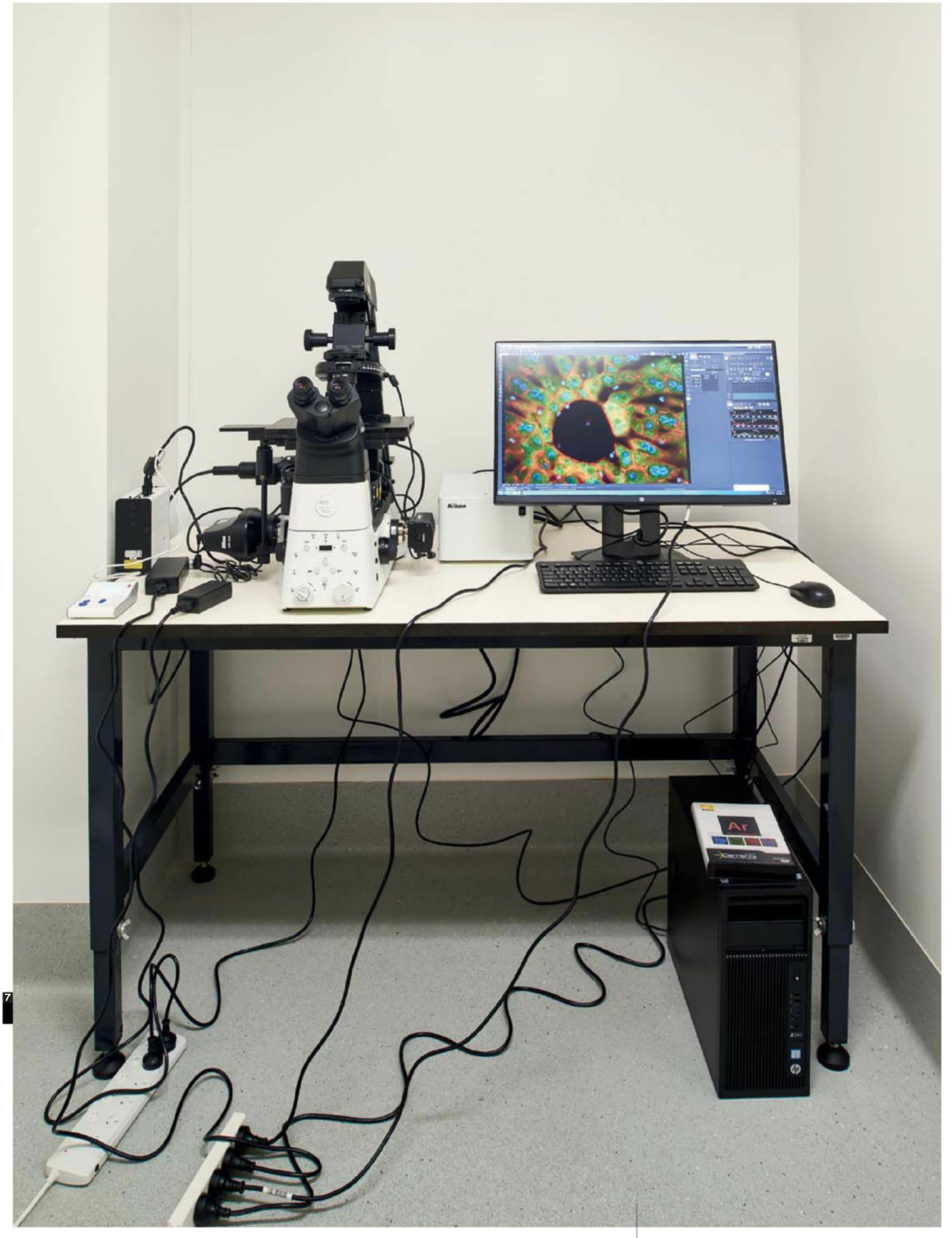
Out of 30 mice, Thomas and Pfitzner did get three dark-gray mice with patches and sprays of white, suggesting that the drive worked in some, but not all, of their cells. "It is early days," Thomas said, gazing rather forlornly at a picture of a mosaic mouse that he printed out for me. Science is a long haul, but Thomas has no doubt his team will crack the code. It's simply a matter of time. He expects the coat-color gene drive to

Human-introduced predators have nearly driven the Floreana mockingbird to extinction.



Paul Thomas holds one of the lab mice engineered for his gene drive experiments.

ANDREW COWEN



A new microscope in Thomas' lab, which is trying to create a mouse that breeds itself into oblivion.

function in the lab by about 2020, and one that could cause infertility shortly thereafter.

Thomas and some colleagues in applied math modeled how long it would take to eradicate an island mouse population of 50,000 by introducing just 100 mice engineered with an infertility gene drive. The answer was less than five years.

In the tiny ear-punched mouse, then, was the seed of an unprecedented possibility—that humans could not just change a few mice in an Australian lab but permanently alter all mice, everywhere. The 30-gram wriggler portends a kind of power over nature we've never had before: an ability to edit—or to delete—whole species.

This potential means that Thomas is taking special precautions. He understands that it could be perilous to the environment—and would certainly be perilous for public relations—should a mouse with a drive toward albinism or infertility escape its plexiglass box and start mating with the free mouse population. So the first thing he did was create a dedicated line of mice for these experiments. Thomas' gene drive will only activate in the presence of a unique chunk of bacterial DNA that was engineered into the hole-punched mouse and its companions. That way, if one of these little mice slips out into the hills around Adelaide and mates with a house mouse, the gene drive won't kick in.



ABOUT FIVE MINUTES AFTER Kevin Esvelt invented Crispr gene drives, he freaked out about them. The technology could do plenty of good by preventing the transmission of horrible diseases and controlling animal populations without any killing. But it could also—if used prematurely, greedily, or unilaterally—drive species extinct and destroy public trust in science.

Cerebral, willowy Esvelt is now a professor at MIT and looks as much like an indoor person as Campbell looks like an outdoor one. When asked about the promise and peril of his intellectual creation, he brings up Boo, his rescue cat, who lost the tip of its ear to frostbite before being taken in. He envisions a future when a local gene drive could reduce feral cat populations, much in the way that Campbell wants to reduce rats on islands. "The thought of feral kittens freezing and starving to death is just viscerally painful for me," he says.

Note that he uses the term "local" gene drive. One of his responses to his freak-out was to come up with ways of containing synthetic gene drives to a set number of generations. He calls one approach a "daisy chain," which would add a sequence of genetic drivers that must be in place to propel the desired gene change. The first driver in the chain is inherited normally, so when it dies out, the gene drive does too. Tweaking the number of drivers in the chain could theoretically allow you to match the size of the population of creatures you want to get rid of on an island.

This daisy-chain method is still being tested in the lab, and Esvelt feels that, barring attempts to tackle global health crises like malaria, no one should try a gene drive in the wild until there is a proven local drive. This past November, Esvelt cowrote an essay in *PLOS Biology* in which he responded to New Zealand's interest in using gene drives to eliminate introduced predators like rats, stoats, and Australian possums. He called the basic version of a gene drive unsuitable for conservation purposes and warned against its cavalier deployment. "Do we want a world in which countries and organizations routinely and unilaterally alter shared ecosystems regardless of the consequences to others?" he wrote.

Esvelt has the same concerns about GBIRd's early and enthusiastic interest in exploring gene drive technology. GBIRd recently said that its members intend to pursue a "precision drive" approach, in which the drive would work only on animals with a specific genetic sequence—kind of like the fail-safe system Thomas is currently using in the lab, but relying on naturally occurring genes rather than introduced bacterial ones. Researchers would have to locate a DNA sequence found only on the target island and nowhere else, a prospect Esvelt thinks is unlikely. "There is a high chance it won't work out and they are building up hope," he says. On larger islands, there would be too many genes coming and going from other places for a perfect sequence.

Although Esvelt supports species conservation, he believes ethical priority must be given to preventing human and animal suffering. "The risk is that you could potentially cause a tragedy in the form of an accidental spread that would delay the introduction of a gene drive to stop malaria," Esvelt says. "Sorry, I don't care about endangered species that much."

But he says he wants GBIRd to carry on—as openly and carefully as possible, and in consultation with the public—because he does care about the suffering of the invasive animals. The poisons that Island Conservation and other environmental groups typically use on rodents cause a horrible death. The rats bleed from internal organs and sometimes their eyes, nose, gums, and other orifices in the course of about six agony-filled days.

Esvelt himself is working on a project to disrupt the cycle of Lyme disease on Nantucket, Massachusetts. The people on the island objected to using a gene drive, so the current plan Esvelt helped develop would simply swamp the local Lyme-susceptible mice with up to 100,000 mice engineered to be Lyme and tick resistant. The hope is that the resistance genes will spread far enough in the population to make a difference. He is willing to let the community set the pace.



THREE HUNDRED TWENTY-five miles north of Thomas' lab in Adelaide is a remote conservation research station called Arid Recovery, where another experiment to save endangered species is going on—this one with no lab mice at all. It is a forbidding landscape: 30,000 acres of red dunes dotted with tough, thorny scrub and divided into huge fenced enclosures stocked with Australian animals, most of which are on the verge of extinction because they are eaten by human-introduced cats and foxes.

It is so dry in the conservation area that everything left behind simply sits on the sand, seemingly forever, from dead wood to neatly knapped stone tools to the bones of a burrowing bettong (or boodie), something like a cat-sized kangaroo with a huge spherical rump. While the red sand outside the reserve shows prints of rabbits and cats, the dunes inside are inscribed with indigenous tracks: the long heart-shaped back feet of the boodie, the sideways V of the Western barred bandicoot, the distinctive toenail marks of the greater bilby.

Katherine Mosebey, an ecologist who cofounded the reserve, spent years getting rid of the foxes and cats from these fenced

How to Kill Off a Species, Nicely

areas so the native animals could thrive. Now she is adding a few cats back into some of the swept-clean areas. The idea is to get the boodies and bilbies used to the cats, so that someday they can be released beyond the fence and not be instantly obliterated by predators they do not know how to fear.

The experiment has been running for just a few years, but already the bettongs that have to deal with cats are noticeably more wary. On a starry September night, I went out with the three scientists behind this project: Moseby; Mike Letnic, of the University of New South Wales in Sydney; and Daniel Blumstein, of UCLA. We drove in a Toyota HiLux, and Letnic pointed a bright hand-held spotlight out the window. In the 10-square-mile area with the cats, boodies scampered out of the way of the dusty pickup, their butts like furry bouncing balls. Letnic seemed worried that there were too many cats; the eyes of the feral felines shone in the spotlight, and the night seemed full of them. One agile tabby leaped over a saltbush, disappearing behind a dune. If too many cats reproduce in the enclosure, all the native species will be killed. If there aren't enough, the natives won't adapt. It is a delicate balance.

As we passed into the smaller cat-free zone, the boodies seemed noticeably more dim-witted. Several times the truck was forced to stop while someone got out and tried to herd them out of our way. Letnic ran at a couple who gazed at him with mild interest. As he approached, they began running companionably along with him, the man and marsupials looking like three friends out for a jog. In the end, Letnic had to nudge them off the road with the side of his foot. Outside the fence, they would be cat snacks by now.

The difference between these naive animals and the marginally more wary bettongs in the enclosure next door represents learning, but the team is also interested in using the cats as a kind of evolutionary filter. Smarter, faster, bigger, warier bettongs will survive the cats' wiles and predations, and reproduce. Over the generations, they should become able to coexist with cats.

"It might take 100 years," Moseby says.

Moseby is working with simple tools—cats, fences, radio collars, and traps—but she's tentatively interested in the genetic tools on the horizon. A gene drive, if it works, could leapfrog 100 years of learning and evolution and death at the sharp end of a cat's teeth.

KARL CAMPBELL CAME to the Galapagos as an immigrant and found a home there. He married an Ecuadorian jewelry designer, and they have a daughter. Local people accept him, according to his old boss, Felipe Cruz, formerly deputy executive director of the Charles Darwin Foundation. "People appreciate that he is not one of the passing-by experts."

Yet his work there hasn't been without its critics. There were all those dead hawks on Pinzón Island, for instance. Just a dozen of the birds nest there now. But Campbell points out that baby tortoises have been born—the first in more than 150 years—and he counts the effort on the plus side of the ledger. If a small percentage of native animals die, that's fine with him, because that's better than 100 percent going extinct.

Campbell insists that he and GBIRd are committed to being careful and deliberate. Pretty much voicing Esvelt's exact fear, he says, "If you screw it up the first time around, you might put it back 30 years." In the meantime, he waits and keeps poisoning things, hoping to stave off extinctions and make the islands safe for species that remain.

After visiting the farm on Floreana, Campbell and I had a beer on the beach, watching the sun set. From where we sat, we could see the grave, round heads of sea turtles as they popped above the waves to breathe. Down at the point, sea lions lolled on the sand and crimson Sally Lightfoot crabs scuttled over jet-black lava rocks. The ocean was apricot and silver. Campbell told me that there used to be a crazy-looking turtle genus on Vanuatu—"with a clubbed tail with spikes." They all went extinct in the first few hundred years after people discovered the island, 3,000 years ago. Humans have been driving things to extinction for a long time. We know how to do that without even thinking. We have less practice dragging them back from the brink.

Paul Thomas, of the University of Adelaide, is trying to find a way to eradicate invasive rodents without trapping, shooting, or poisoning them. His potential violence-free method? A synthetic gene drive, which uses Crispr to knock out fertility genes. Thomas doesn't have the gene drive working yet but expects to get there in lab mice in a few years. Here is how it would theoretically work on an invasive species. —CHELSEA LEU

1.
A DNA sequence (the gene drive) that includes a gene-slicing tool called Crispr-Cas9 is slotted into the eggs of a rat (let's call her Minnie), instructing it to knock out the gene for female fertility.

2.
Minnie is then released to mate with a wild rat. The fertilized egg in Minnie begins to develop into a new rat (Bianca). Because Bianca had an engineered parent, she ends up with one engineered chromosome (with a gene drive) and a corresponding normal one. Cells in Bianca begin to develop into rat parts: eyes, ears, heart—and eggs. It's in the creation of those eggs that the gene drive goes to work.

3.
The chromosome with the gene drive sends out the gene-cutting Crispr-Cas9 to snip its partner, the normal chromosome. To repair that cut, the normal chromosome looks back to the engineered one as a template. *Et voilà*—the once-normal chromosome now has a gene drive in it.

4.
Normally, a rat has a 50 percent chance of passing any gene to its offspring. But both of Bianca's chromosomes contain the gene drive, so all her offspring will inherit it.

5.
After a few generations, most of the rats in a population will carry the gene drive. When two of those rats mate, their children inherit two copies of the drive. The full effects kick in. Eventually, all of the female mice will be infertile and the population will die off.



CREATORS OF WORLDS

BY ANGELA WATERCUTTER

With *A Wrinkle in Time*, director Ava DuVernay merges sci-fi's embrace of the Other with her own vision for a better, more inclusive future.

Photograph by Art Streiber

ate fall in the redwood forests of Northern California, it gets cold. Not wrap-yourself-in-furs cold—we're still talking 51 degrees—but the kind of cold that demands layers, lest it sink into your bones. Nevertheless, in November 2016, when I visited her movie set near Eureka, director Ava DuVernay was coatless. Just a thermal with a cotton shirt over it, jeans, and a knit hat. The young stars of DuVernay's film were in very lightweight shirts, pretending to be lost in unfamiliar (and, one assumes, warmer) woods, and she wasn't about to let them be the only ones on her set enduring the chill.

"I don't know if you've noticed, but every time they have to have their jackets off, she takes her jacket off," producer Jim Whitaker whispered to me as DuVernay called "action!" in the distance. "This is so typical." Whitaker, of course, is supposed to say things like this. And DuVernay, a former Hollywood publicist skilled in sending a message, knows which notes to hit. From what I've seen here on set—her playful and encouraging interactions with her stars, the diversity of her crew, the summer-camp-with-Disney-money conviviality—this act of goose-bumped solidarity is an apt metaphor for the spirit DuVernay is bringing to her adaptation of Madeleine L'Engle's *A Wrinkle in Time*.

If you don't remember what you read in middle school, *A Wrinkle in Time* is the story of a young girl named Meg Murry on a mission to save her scientist father, who has been taken prisoner by a dark force in the universe intent on crushing free thought and free will. Along the way she's assisted by her classmate Calvin O'Keefe, brother Charles Wallace, and three celestial beings—Mrs. Who, Mrs. Which, and Mrs. Whatsit—who help her jump, or tesser, through space-time. The story is the same in DuVernay's version for Disney, but there are a couple of significant new wrinkles. Since her first feature film in 2008, DuVernay has used whatever success she's attained to give other women and people of color opportunities on both sides of the camera. So in 2016, when Disney announced that she would direct *A Wrinkle in Time*, and DuVernay became the first African American woman to helm a $100 million-plus movie (but "not the first capable of doing so," she later noted on Twitter, "not by a long shot")—she promised a new vision of the original. "You kind of have to remix the book," DuVernay told *The Wall Street Journal*. The casting made clear that she was making good on that promise: Meg is now biracial, played by 14-year-old Storm Reid, and Mindy Kaling and Oprah Winfrey play Mrs. Who and Mrs. Which, respectively.

DuVernay isn't known as a genre director particularly. Her movies and TV shows have been firmly grounded in race, power, politics, and family narratives. But her overall project, building a better world for people of color, doesn't so much overlap as interleave with one of science fiction's overall projects: world-building. Sci-fi has always been as much an exercise in thought experimentation as an arena for spectacle, for rocket ships and ray guns.

In the most narrowly defined Western canon, the fascist overlords of dystopian states get challenged by people of the land, farmboys who believe in and benefit from deeper cultural ideals. Science fiction can shake that narrative like a snow globe. It makes room for underdogs and Others. It's a genre where people can build futures, alternate realities, and then press "play" to see how they work out. DuVernay sees that potential. "She's captured the essence of the book—the characters, the story, the themes—it's just that they're reimagined visually a little different," says producer Catherine Hand, who has spent decades trying to bring *Wrinkle* to theaters. "How Madeleine L'Engle pictured it back in 1962? We've all changed."

The Hollywood that *Wrinkle* tessered into has changed too, albeit slowly. Women, especially young women, are rarely at the center of the story. Of the 100 top-grossing films of 2016, there were only eight female leads or coleads between the ages of six and 20. You know how many weren't white? Two. A study by the Media, Diversity, and Social Change Initiative at USC's Annenberg School calls this an "invisibility crisis"—one that leads to women (and especially young women of color) seeing few reflections of themselves in pop culture, while white boys grow up seeing themselves as heroes on billboards and multiplex walls. When Winfrey accepted the Cecil B. DeMille award at the Golden Globes in January, she opened her speech by describing her awestruck little-girl self seeing Sidney Poitier receive an Oscar and noted that "it is not lost on me that at this moment there are some little girls" watching her be celebrated too.

For DuVernay, putting black, brown, and Asian people onscreen is essential—but so is challenging the systems that led to their exclusion. She does this in her choice of subjects: Her Oscar-nominated documentary *13th* traces a line from slavery to the mass incarceration of black men; her film *Selma*, while in Hollywood terms a Martin Luther King Jr. biopic, was also a critique of the laws and social structures that deprived black Southerners of their voting rights. Her challenge to Hollywood systems is also borne out in the way she runs her projects. Only women direct her TV series, *Queen Sugar*. Array, the collective she founded in 2010, helps female filmmakers and filmmakers of color get their movies distributed. "Ava doesn't just talk inclusion," Winfrey says. "She lives it."

Late in the afternoon that November day in the woods, as DuVernay directed Reid through a series of reaction shots, she ended every one with an

PORTRAIT: ART STREIBER/AUGUST | IMAGES: HAIR STYLIST: LULU HOLMES; WARDROBE STYLIST: JASON BOLDEN; MAKEUP STYLIST: UZO

encouraging word to "Stormy," the nickname she'd given the young star. Despite the chill, fading daylight, and the fact that she was working with actors who have to spend at least part of their day being tutored, everything got done on time. Back in her trailer, discussing her non-*Wrinkle* responsibilities—Array had made two acquisitions since production began, and *Queen Sugar*'s season one finale was the next day—you'd never know she was feeling the pressure of a massive Disney production. So I asked her if she was. "I wonder if my male counterparts are asked that," she said thoughtfully but firmly, leaning forward, resting her elbows on her knees. "I really do."

DUVERNAY,

NOW 45, GREW UP IN COMPTON, CALIFORNIA, RAISED BY her mother, Darlene, a preschool teacher, and father, Murray Maye, who owned a carpet and flooring business. One of five children, she made up "epic" stories with her Barbies ("soap operas with different locations and cliff-hangers—that's when I started playing with character"), but she wasn't blind to what was happening outside her door. Police were a constant, feared presence in her neighborhood—and talks of arrests and prison were common. Her father was from Alabama, near Selma, and conveyed to her the region's significance for the civil rights movement in the 1960s.

DuVernay attended Saint Joseph High School, an all-girls Catholic school in nearby Lakewood. As a senior, she became the school's second black student-body president and its first black homecoming queen. Terri Mendoza is the school's longtime principal, and a teacher before that; when I asked about her former student, she gives a list of attributes—reliable, helpful, able to bring out others' talents—that continues for so long she ends it by laughing and saying, "I'm probably making a case for her canonization."

After high school DuVernay went to UCLA, where she majored in African American studies and English. Originally she thought she'd pursue journalism, but after an internship for CBS News that had her going through the trash of a juror in the O.J. Simpson trial, she changed her mind. Instead she went into film publicity. She eventually launched her own firm, the DuVernay Agency, in 1999 and served as a consultant on movies including *Spy Kids* and *Collateral*.

DuVernay was good at promoting movies, but she wanted to be making them. She figured she wouldn't be given the opportunity, so she created it for herself. "I didn't get the playbook," she says. "They weren't handing those out in Compton." She moved fast. In 2008, at age 35, she released *This Is the Life*, a documentary about the underground hip-hop scene at LA's Good Life Cafe, and *My Mic Sounds Nice*, about female MCs, in 2010. That same year, using $50,000 she'd been saving to buy a house, she released her first narrative feature, *I Will Follow*, about a woman grieving the death of her aunt. Roger Ebert called it "the kind of film black filmmakers are rarely able to get made these days, offering roles for actors who remind us here of their gifts."

It was DuVernay's next feature, however, that got everyone else's attention. *Middle of Nowhere*, about a woman trying to navigate having a boyfriend in prison, was made for $200,000 and nabbed DuVernay the directing award for a US drama at the 2012 Sundance Film Festival. It also starred a then-up-and-coming actor named David Oyelowo, who was about to be in Lee Daniels' *The Butler* with Winfrey. At the time, Oyelowo had been trying to make a movie about Martin Luther King Jr. with himself as the lead. He implored Winfrey to check out *Middle of Nowhere*. She watched it; it reminded her of the formation of another relationship.



DuVernay (right) with her young star Reid on the set of *Wrinkle*.

"When I first met and interviewed Maya Angelou," Winfrey says, "I said, 'Give me five minutes, I promise it won't be more than five minutes.' I finished in four minutes and 50-some seconds, and she said 'Who are you, girl?' I felt the same thing when I saw *Middle of Nowhere*. 'Who are you, girl, that did this? How did you do that?' "

Winfrey went on to coproduce, and costar in, DuVernay's *Selma*—an 128-minute retelling of the efforts of King and the people of Alabama to help secure the Voting Rights Act of 1965. (DuVernay brought her father along while scouting locations.) The movie received a 2015 Academy Award nomination for Best Picture, but neither DuVernay nor Oyelowo were nominated for Best Director or Best Actor; those snubs were galvanizing factors in the #OscarsSoWhite movement, which took Hollywood to task for not acknowledging creators of color. About a year later, the Academy of Motion Picture

Senior associate editor **ANGELA WATERCUTTER** *(@waterslicer) wrote about* Black Panther *in 26.02.*

ATSUSHI NISHIJIMA/© 2017 DISNEY ENTERPRISES, INC.

Arts and Sciences announced a series of measures to better promote diversity and inclusion among its Oscar voters; "Shame is a helluva motivator," DuVernay tweeted.

After *Selma*, the scouts came calling. DuVernay was put in the running to direct *Black Panther* but passed, and it went to Ryan Coogler, the director of *Fruitvale Station* and *Creed*. There was talk that she might direct a sci-fi thriller. Big studios lined up to woo her, but many of their offers sought her skills as a director only, not a collaborator. "With other projects that I've been looking at, it wasn't really about putting my stamp on it," she says. "It was being the custodian of someone else's vision."

So when Lisa Nishimura, head of Netflix's docs division, told DuVernay she could make a movie about anything she wanted, she seized the chance. She immediately knew what it would be about: incarceration. The resulting film, *13th*, is an unblinking look at the prison industrial complex through the prism of race. It was widely, critically praised. And inspiring too: In early 2017, art collector Agnes Gund sold a Roy Lichtenstein painting from her personal collection for $165 million and used $100 million of the proceeds to start fund for criminal justice reform. It was partly because she'd seen *13th*.

Bypassing a theatrical release for the relative small potatoes of a streaming service might seem counterintuitive, especially when you've got the wind of an Oscar nomination at your back. But going with Netflix meant the movie got in front of a lot more people than an art-house run ever would have. A blockbuster would reach even more people, of course—and by the time *13th* premiered, her opportunity to make a studio movie had already arrived. In February 2016, after overtures from Disney, news broke that she signed on to make *A Wrinkle in Time*.

She agreed to it in part, she says, because she sits on the board of Sundance with Walt Disney Studios Motion Pictures production president Sean Bailey. When DuVernay was learning about Hollywood, she witnessed cronyism born of common experience and casual proximity. "All the social ways that people know each other in the industry, I live a different life," she says. "There are no agents that are just my homies. The wives who know each other, the kids who know each other. I'm outside of that." But she had found a crony in Bailey; she knew he would let her make the kind of movie she wanted to make, with the people she wanted to make it with.

DuVernay prepped *Wrinkle* while editing *13th*. While she was finishing that, she was also filming and producing *Queen Sugar*, the family drama she brought to Winfrey's OWN network. The schedule, she admits now, was "ridiculous." It was also a coping mechanism. Her father—the man who grew up near Selma and introduced DuVernay to Alabama's history—died in March 2016. Work was her distraction.

"I look at myself during that time and I would drag home, so utterly bone-tired," she says. "I would come in the door, put on my robe, and collapse in utter exhaustion and wouldn't have to think."

I LIVE A DIFFERENT LIFE

THE FUTURE

OF FILMMAKING LIVES IN DUVERNAY'S IPHONE.

It's rose gold and seemingly always at her side, even if it remains mostly facedown during conversation. She's excellent on Twitter, as any of her 1.6 million followers will tell you. She treated her 822,000 (and growing) Instagram followers to stories as she traveled the world making *A Wrinkle in Time*: selfies with Reese Witherspoon, who plays Mrs. Whatsit; views from the set in New Zealand; the dance moves of her young stars. But more than that, her contact list is now a who's-who of the movie world vanguard.

"I'm proud that in this phone is almost every black filmmaker that's actively making films in the last 10, 15 years," she said, sitting in her trailer on the *Wrinkle* set in the redwoods, rolling the device around in her palm. "And whether they're my close homie, like Ryan Coogler, or whether they're someone that I don't know that well but I like their films a lot, like Barry Jenkins, they're there." (She has industry friends, but they're mostly creators—not gatekeepers.) Jenkins' film, *Moonlight*, won the Academy Award for Best Picture.

One thing those filmmakers share with DuVernay is an emphasis on telling well-rounded stories about people of color. She went to great lengths in *Selma* to portray King as a powerful leader, but also a flawed one: unfaithful to his wife even as he shepherds a movement. With *Queen Sugar* she tackles family, class, sexuality, and politics with a nuance that's rarely seen on television. "There has been this sense that black art, black experience, black politics are only localizable, not generalizable," says Robert Patterson, chair of the African American studies program at Georgetown University. DuVernay helps "people to think about the universality of the black experience."

With *A Wrinkle in Time*, DuVernay, who is working from a script by *Frozen*'s Jennifer Lee, is injecting that universality into a text that didn't necessarily anticipate it. "Folks shouldn't expect a page-for-page re-creation of the book," DuVernay says.

"They should expect a page-for-page embracing of what I feel the author meant—which is a story about an underdog."

Admittedly, what L'Engle meant to say with *A Wrinkle in Time* has perplexed people for decades. Her manuscript confused some publishers, who couldn't figure out if it was for kids or adults; 26 of them ultimately rejected it. It was sci-fi with a young girl at its center, which was mostly unheard of in the early 1960s. It imagined a world in which the themes of science and religion could coexist, making it too religious for some and blasphemous for others. It's been banned off and on for years, and it's also a beloved best-seller. The book is, and L'Engle was, an outsider that succeeded.

That's genre fiction for you. What was, half a century ago, unthinkable—a counterculture rescue quest through time and space with a girl in the lead—is today a recognized norm. Science fiction, long derided for childishness and subcultural irrelevance, is now mainstream Hollywood's primary output: 14 of the top 20 grossing films of all time are science fiction or fantasy.

The raw stuff of science fiction is imagination and the game of what-if, but the infrastructure upon which that gets hung is metaphor. There's a reason LGBTQ kids latch onto the X-Men, with their otherness that manifests at puberty, and a generation of women still marshals an inner Buffy in times of crisis. Literary sci-fi has always been further along than TV and movies in bringing color into that palette. Writers like Samuel R. Delany and Octavia Butler (and, more recently, Nnedi Okorafor, N. K. Jemisin, and others) all used the wide-open spaces of sci-fi to reposition people of color within narratives and to construct all new cultures for them. And if the backdrop of these stories is dystopia? No matter. Tomorrow might look worse than today, sci-fi tells us, but it will always allow for us to be better than we are now.

The representation that DuVernay rightly champions has gotten a toehold, now that this kind of world-building is coming to multiplexes. Star Wars cast panels look like UN delegations. Even comic books, while once existing on the fringes of what was considered science fiction, have followed suit. *A Wrinkle in Time* opens the month after *Black Panther*—a Marvel movie set in an Afrofuturist utopia with an almost entirely African American (and African) cast.

All of these properties are popular, mainstream juggernauts. Sci-fi's faintly naive experimentation with the idea of human progress for everyone has spread to ... well, everyone. "The book, the story, is taking on a different context now with the present times," DuVernay says. "What we talk about when we talk about light and darkness, when we talk about a world divided."

When marginalized people enter Hollywood, they're told they have to adapt to the old guard's ways, instead of the system adapting to include them, according to Victoria Mahoney, who got her first TV directing job from DuVernay in *Queen Sugar*'s first season. The two are now working on an adaptation of Octavia Butler's *Dawn*. "Everything they told us was about 'fight for yourself'—that's what the industry says by default," Mahoney says. "Now there's an entire generation looking at Ava, and the subtext they're getting is 'look out for each other.' She is the truth to the lies we've been told."

Mindy Kaling says that when DuVernay approached her about playing a role in *Wrinkle*, it was one of the first times she'd ever been sought out for a part. Kaling had created her own lane with *The Mindy Project*, a sitcom she wrote, produced, and starred in. "When you're so used to creating your own roles," she says, "it was very flattering and exciting."

This style of collaboration, of mentorship, recalls the history of black women's organizing and community-building, says Jacqueline Stewart, professor of cinema and media studies at the University of Chicago. "What's important about the kind of work that Ava DuVernay is making is the structural analysis she's bringing into view: How does Hollywood work, exactly? How do we find spaces here?" Stewart adds. The results could be "a more sustained support for black filmmaking beyond a 5- to 10-year window."

DuVernay intends to be part of it. She's slated to make a movie for HBO about the 1973 Palace of Versailles fashion show, a momentous night when American clothing designers and black fashion models upended the conventions of the style world. For Netflix, she's following up *13th* with a five-part narrative film about the Central Park Five, the young men wrongly convicted of attacking and raping a woman in New York in the 1980s. She's also reportedly working on a film for Netflix starring Rihanna and Lupita Nyong'o to be written by *Insecure*'s Issa Rae, based on an idea birthed on Twitter. Three different decades, three different underdog stories, all brought to you by the same underdog hero. Just because we'll be better in the future doesn't mean we have to wait to start.

COLOPHON

EPIC ODYSSEYS THAT HELPED GET THIS ISSUE OUT

A three-week trip by train, bus, and plane with two kids through the bomb cyclone while editing a 10,000-word cover story; dodging perpetually gridlocked SF traffic by bike; finishing N. K. Jemisin's *Broken Earth* trilogy—stunning!; my lifelong quest to figure out what's wrong with my gut; 25 years with PTSD, fighting back toward the light; helping my nephew move into off-campus housing and wishing we had brought hazmat suits; the Gear team walking an aggregate of more than 100 miles in four days at CES; watching dear friends journey into parenthood—with twins; Phish's 12/30/17 version of "Down With Disease" at Madison Square Garden; "the HR Benefits Department is somehow on this thread, could we please be removed?"; crossing the street at CES by going through three casinos, stopping for ice cream (mint chip), and arriving 45 minutes late to an appointment that was a quarter of a mile away.

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SAVE THE DATA, LEAVE THE CREW.

BY @AR.MERCER, VIA INSTAGRAM

HONORABLE MENTIONS: OUR ANCESTORS SAID YOU WOULD COME. (@ANDREWGDOTCOM, VIA TWITTER) // **THE HOSTAGES HAD EVOLVED. LIGHTSPEED SUCKS.** (SEAN ELLIS, VIA FACEBOOK) // **PORTAL ERROR: SIX TRANSPORTED, SEVEN RETURNED.** (@CRUSHEDSPIRITS, VIA TWITTER) // **"YOU SAVED US!" "HUMANS LOOK ... DELICIOUS."** (@JAYDIAMOND, VIA TWITTER) // **THEY SEEMED PEACEFUL—JUST LIKE HUMANS.** (EVAN OLSEN, VIA FACEBOOK) // **THEY'RE NOT COMING. I'LL SAVE MYSELF.** (JOSH HAMLETT, VIA FACEBOOK)

ANUJ SHRESTHA

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