WIRED

Cryptomania isn't just a mad rush of scams and speculation.

The Blockchain: a Love Story

It's a utopian dream.

BY GIDEON LEWIS-KRAUS

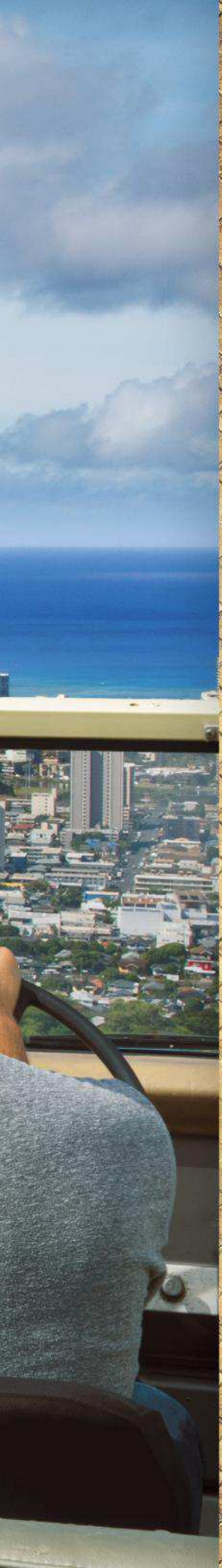
The Blockchain: a Horror Story

It's also a living nightmare.

P.80

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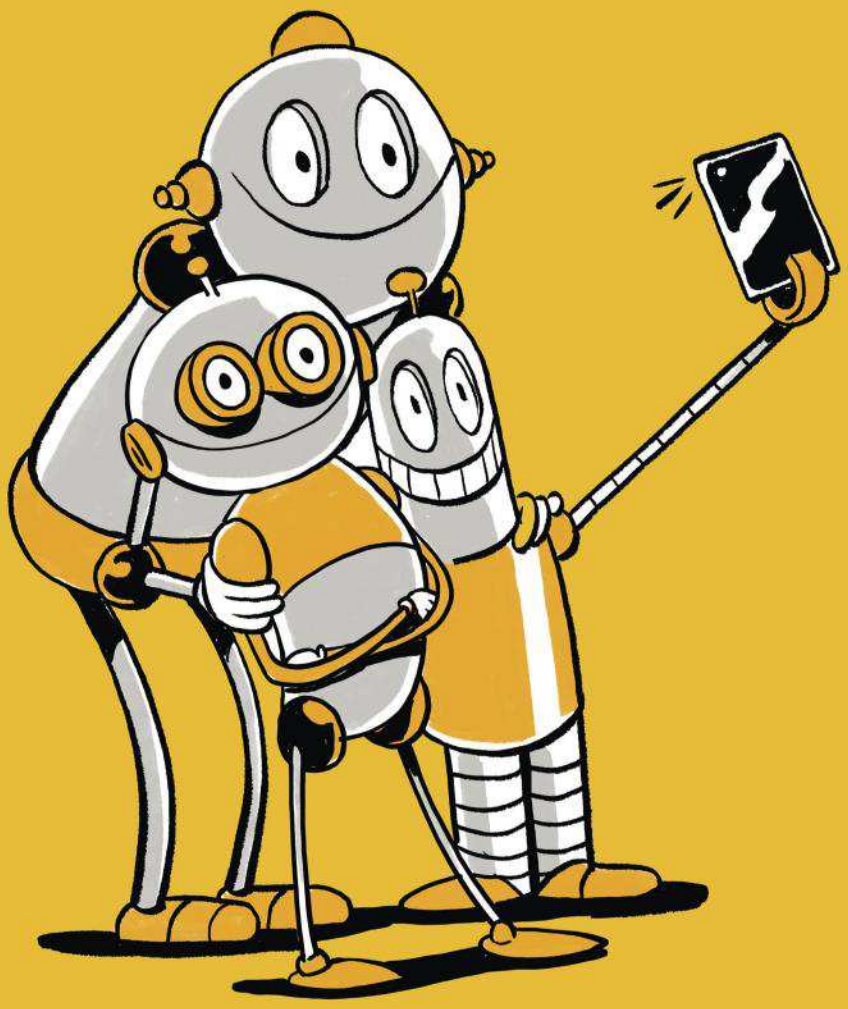
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"HE LED THE PARTNERS TO HIS PARENTS' THREE-CAR GARAGE, NOW DOMINATED BY A

SIX-FOOT-TALL BURGER BEAST."

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Oculus founder Palmer Luckey has a plan to build Trump's big, beautiful border barrier (no concrete required).

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ALPHA



The Delicate Art of Emoji
Visual icons must be crafted with care—they speak for all of us
BY VIRGINIA HEFFERNAN

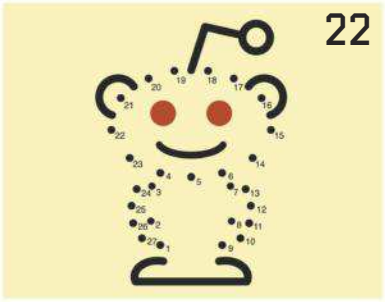
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3-D-print a house in just one day

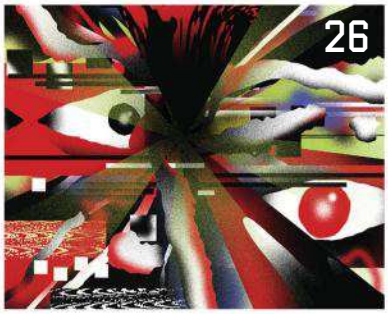
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FINE MECHANICAL WATCHMAKING, FROM JAPAN.

PRESAGE



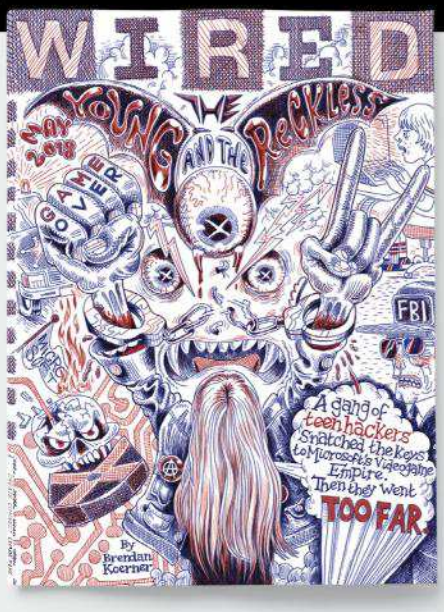
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BOSS BATTLE

FOR OUR MAY ISSUE'S cover story, contributing editor Brendan I. Koerner wrote about a band of young videogame hackers and their winding descent into criminality. The story and cover featured illustrations by Zohar Lazar, and both sparked reaction. Jessi Hempel's examination of how Uber's new CEO is changing that company's (infamous) culture inspired thoughts from the originator of the No Asshole Rule. And Steven Levy's story about Ray Ozzie's encryption-breaking plan prompted cryptographers and policy experts to weigh in—vehemently.

Re: "The Young and the Reckless": A gang of teen hackers snatched the keys to Microsoft's videogame empire. Then they went too far.

"ZOHAR LAZAR'S DRAWINGS FOR THE XBOX HACKERS ARTICLE WERE IMMATURE, GROSS, AND DISGUSTING. IN OTHER WORDS, PERFECT."

Sardinicus (@jgmclean0) on Twitter

"You should add 'irony' to your colophon. In the same issue that has a techie guru extolling the security of companies like Apple and Microsoft as protection against personal data loss, you have an article about kids wandering all over Microsoft's network. As soon as you leave a back door into crypto, people will waltz through it."
James Kajpust via email

"Insane what talent, youth, and the unrelenting need for more knowledge can do to someone."
Joel Penate (@jpenate2005) on Twitter



Re: "Move Slow and Test Things"

"This story shows that the time has come to hit the brakes, clean up the cultural, technical, and reputational messes created by 'hyperscaling,' and consider what you've learned from successes and failures. Facebook confronts a similar reckoning."
Bob Sutton (@work_matters) on Twitter



Re: "Cracking the Crypto War"

"The reason so few cryptographers are willing to bet on massive-scale key escrow systems like Ozzie's is that we've looked at the threat model, the usage model, and the quality of hardware and software that exists today, and our informed opinion is that there's no detection system for key theft; there's no renewability system; hardware security modules are terrifically vulnerable (and the companies largely staffed with ex-intelligence employees); and insiders can be suborned. We're not going to put the data of a few billion people on the line in an environment where we believe with high probability that the system will fail."
Matthew Green, cryptographer at Johns Hopkins University, on his blog

"As representatives of organizations that defend digital privacy rights, we want to set the record straight: Ozzie's approach does not safeguard individual privacy or cybersecurity. The story doesn't note the litany of technologists who have shown that proposals like Ozzie's are not secure. It also doesn't acknowledge that a motivated bad actor could protect against this access, meaning that everyday citizens are the ones who ultimately will pay the security cost."
Sharon Bradford Franklin, New America; Jeremy Gillula, EFF; Neema Singh Guliani, ACLU; Gregory T. Nojeim, Center for Democracy & Technology; Amie Stepanovich, Access Now

"If there is any hope for progress on encryption policy, this is it. Progress will only happen if there is some willingness to challenge the orthodoxy and have a conversation around concrete ideas. Otherwise we'll spend another year spinning wheels."
Susan Hennessey (@Susan_Hennessey) on Twitter


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THE BEST RUN
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Benjamin Rasmussen at Anduril's test site in Chino Hills, California.

LONG VIEW

COLORADO-BASED photographer Benjamin Rasmussen traveled to Texas and California to create images for our story on Palmer Luckey's new surveillance-tech company, Anduril (page 60). He shot most of the work on 4 x 5 large-format film. This deliberate technique, Rasmussen says, helped him capture the atmosphere and color of the fraught landscape: "I also photograph in this way in refugee camps, protest situations, and disaster zones, because it forces a visual sense of calm and formality on scenes that are traditionally shown in more frenetic ways."



Senior associate editor **Arielle Pardes** has been a "hardcore lurker" on Reddit for years, visiting subreddits like r/Futurology and r/dataisbeautiful regularly. In light of Reddit's first redesign in a decade, Pardes pays tribute to Snoo, the site's marshmallow-like alien mascot, on page 22. Redditors have transformed the raceless, genderless creature into a stoner, a scientist, and a TV. They've made Snoo fan art and gotten Snoo tattoos. "People have turned Snoo into the version of themselves that they want to be online," Pardes says.



When contributing editor **Gideon Lewis-Kraus** set out to write about cryptocurrency, he knew to expect speculative fervor and endless self-promotion. Last summer, blockchain upstart Tezos raised more than $200 million selling its digital token to investors—all to fund a product that didn't exist yet. "It got so far that random literary people in Brooklyn who wouldn't know blockchain if it bit them on the face were buying Tezos tokens," Lewis-Kraus says. Then he found himself immersed in a much murkier world than he'd counted on. Read about his journey into Crypto Valley on page 80.



Preston Gannaway has made a career out of documenting people, particularly those in life's most turbulent decade: the teenage years. The latest installment of her Pulitzer-winning project, "Remember Me," features a New Hampshire teen who Gannaway has followed since he was a toddler. In this issue, Gannaway, who's based in Oakland, created images of students and faculty at the high-tech yet underperforming Willie Brown Middle School in San Francisco's Bayview district (page 70). "With this kind of work, you just want people to ignore you," she says. "Teenagers are really good at that."

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COURTESY OF ARIELLE PARDES; LEXEY SWALL; COURTESY OF GIDEON LEWIS-KRAUS



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ALPHA

ARGUMENT

ATOMIC UNIT
THE DELICATE ART OF EMOJI

BY VIRGINIA HEFFERNAN

BACK IN 1999, when the mobile internet first flickered to life on Japan's i-mode, email was confined to a snug 250 characters. Email! So when designer Shigetaka Kurita centered pixels on his potter's wheel and spun them into sunshine and rain, he was both supplying a jolt of atmospherics to the early smog-screened smartphone and frugally conserving space.

Kurita's horizontal rain and naval-ensign sun were among the first 176 emoji. These symbols, of course, put meat on the bones of emoticons, the digital typographical form born in the 1970s on Plato, a computer-based teaching system. Plato emoticons had to be styled by hand, with meticulous backspacing, like screen-based needlepoint. But they were also much more sophisticated than later ASCII and could be quite beautiful when encountered in the bleak midwinter of Arpanet-era networks.

Virginia Heffernan *(@page88) is a* WIRED *contributor. She wrote about Netflix Binge class in issue 26.06.*

There are now more than 2,700 emoji, and new ones get introduced every year. But which emoji appear on the major keypads: That is left to the whims of the Sanhedrin of emoji—the Unicode Consortium.

Twelve dues-paying members with full voting rights make up the consortium: one each from Oracle, IBM, Microsoft, Adobe, Apple, Google, Facebook, Shopify, Netflix, the German software company SAP, the Chinese telecom company Huawei, and the government of Oman (...). UC Berkeley, as well as the governments of India and Bangladesh, have lower-level memberships.

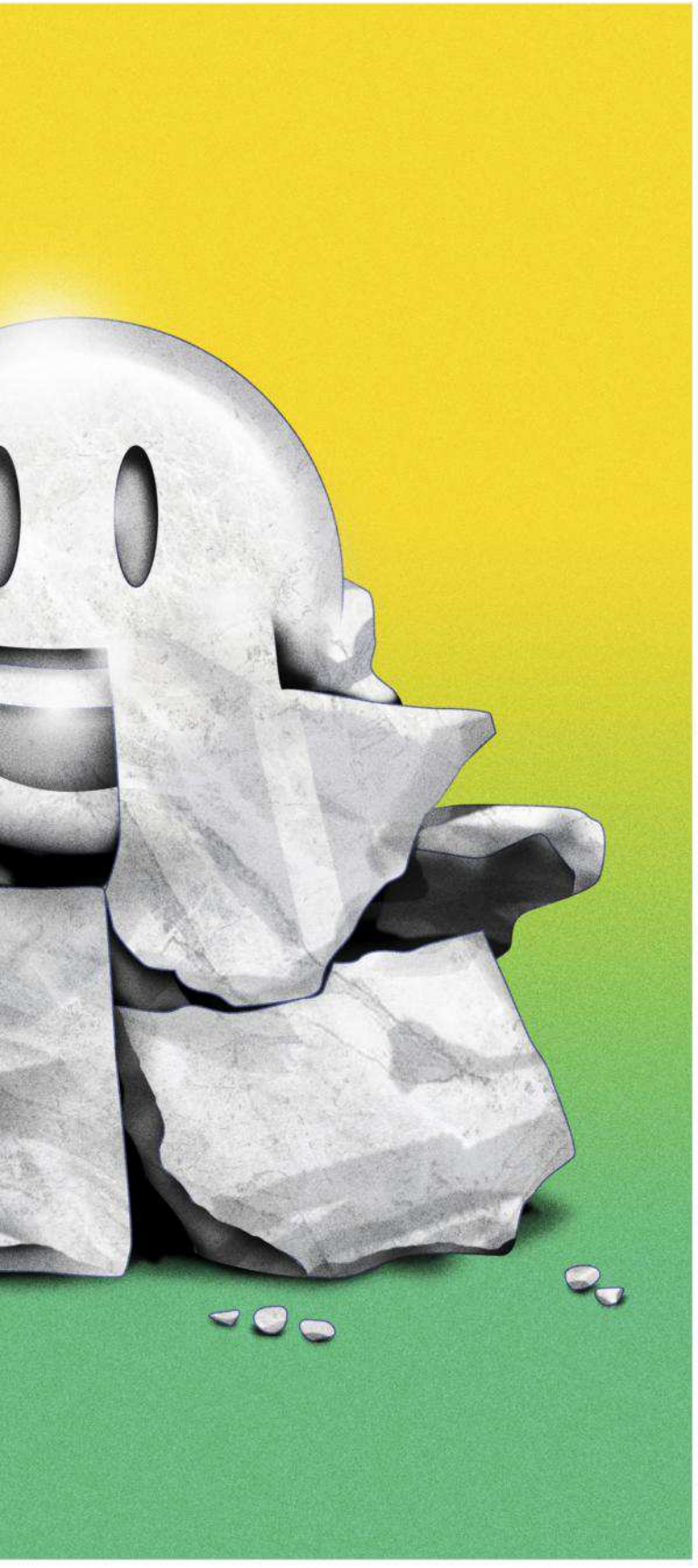
The consortium's chief task is to set the Unicode Standard that gives order to the way text is encoded and represented in the world's writing systems. But when it comes to emoji, Unicode needs political and cultural finesse. Since 2015, the consortium has had to choose the hues available for the complexions of smileys. It has had to OK and reject religious symbols. And one day it may have to decide whether to endorse an emoji family with two gender-fluid parents, or, as is allowed in Oman, a family with one husband and four wives.

In the past year, for example, Unicode faced a sensitive matter: whether to include a menstruation emoji. The glyph, which showed blood-stained underwear, was proposed by an international girls' organization to promote frankness around the delicate subject of uterine linings.

It gets tricky.

Namaste and thanks, therefore, for Jennifer 8. Lee, the investor, journalist, and activist who





keeps a cool head in cultural minefields. Having stormed the then-stodgy Unicode in 2015, when she and designer Yiying Lu (who created the Twitter Fail Whale) successfully campaigned to get a dumpling emoji approved, Lee is now on the inside; she helps lead Unicode's emoji subcommittee. Each year, after lengthy debate, the subcommittee submits a giant list of recommendations to the Unicode Technical Committee. What's discussed in the meetings is strictly confidential, Lee says. But after them, perhaps thanks to Lee's erudition, her diplomacy with competing cultural factions, and her powers of persuasion, the votes are more or less foregone. "We do things by consensus," she says.

Our emoji heroine is very earnest when she waxes idealistic. "Emoji by the people, for the people" is her *Les Miz* rallying cry. It's also the slogan of Emojination, her emoji advocacy group, which often recruits what might be called emoji stakeholders—cultural clans—to oversee a submission.

Lee doesn't show favoritism. She refers anyone with an idea to Unicode. I once told her at a party that I wanted a Soviet hammer-and-sickle emoji, and she looked at me as if I'd proposed doing a biology postdoc at Stanford in September. "You can apply," she said, coolly. Gatekeeper.

Getting approval takes persistence. Bearing the rules firmly in mind—your emoji can't represent a deity, a logo, or a specific person (living, dead, or fictional)—you must write a full-dress proposal for your prospective emoji, to which you're often asked to make revisions, as well as provide speculative data for frequency of use. You must also mock up the icon you're proposing in both color and black and white. Designers almost certainly won't use applicants' designs—emoji images are generally proprietary to the vendor (chiefly Apple or Google)—but they want to get an idea of how you envision it.

To regulate the development of a language is not, strictly speaking, the American way. Unlike French and German, the language of the United States has no organization that polices its use. American English is meant to grow wild and woolly on our shores, spawning dialects and pidgins, wantonly consuming foreign words and locutions, anarchically legitimizing slang and warped grammar.

I WAITED FOR HER TO EXPLAIN HOW EMOJI COULD SUBVERT PATRIARCHY.

But emoji are not American. Born in Japan, they fit most comfortably in Asian languages that are at least partly pictographic. Of course, they're not Japanese either. They're on every continent and conceived as pluralist (hijab, man in tux, two-mom family) without being globalist (no Golden Arches, no Starbucks mermaid). That's a tall order, especially in this moment of renewed tribalism. No wonder emoji need a thoughtful and meticulous Academie Emojiaise. In fact, the regulation of emoji—especially since Lee took her power-to-the-people to Unicode—may

serve as a singular example of how online communication might be supervised with rigor, generosity, and imagination.

Lee gave me a table of emoji under consideration, along with the mocked-up images, explaining that this year's list was stacked with Indian symbols—a tuk-tuk, a sari, a diya lamp. The sari was 💯, as were, elsewhere, garlic, parachute, stethoscope, and sloth. I was already thinking of off-label uses. Could parachute mean "here goes nothing"? But Lee doesn't goof around when it comes to emoji. As a repository of symbolism, these things are serious business; one wrong move and you could anger ... everyone.

So did bloody underwear make the cut?

Lee is at the vanguard of issues of social justice and representation. I waited for her to explain how emoji could subvert patriarchy. I knew I could trust her judgment.

What she said, via text, was "It's a terrible idea."

"Bloody underwear simply isn't very atomic," she went on. "The grammar of emoji pushes us to more atomic units. So skateboard instead of skateboarder, or probing cane instead of person with cane. We can create compound emoji by gluing them together. But each one, on its own, should be atomic."

Not atomic. I decided that meant "gross," and left it alone. But something else occurred to me: What do you use for menstruation, then?

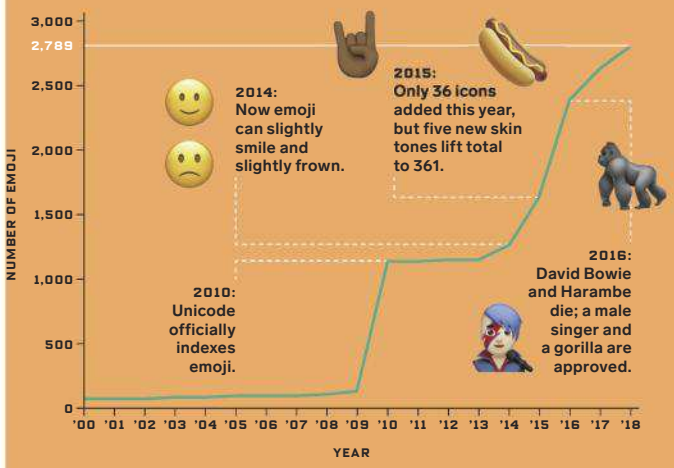
"🌙 + blood drop is the way to go," Lee shot back.

A blood drop emoji?! How had I missed that?

"There is one perhaps coming in 2019," Lee texted, darkly. W

EMOJI EXPLOJI

EMOJI ARE USED so often and in such volume that it feels as though they've been with us forever. In fact, it wasn't until Apple released an emoji keyboard in 2011 that the Cambrian exploji ensued, a flowering to rival the birth of any language. Well, linguists would dispute the term—languages have verbs, emoji (probably) do not. But the emojicabulary continues to expand every year. —ARIELLE PARDES





About That Eggplant ...

Angela Guzman was an intern at Apple when she helped design about 500 of the company's early emoji, including one very explicit piece of fruit. —Ellen Airhart

Q: At the time, did you think the eggplant looked phallic?
A: It literally never crossed my mind.

What was your intention?
To make all the fruit and veggies part of a single set, visually. That meant they all had to take up the same amount of space. To make the eggplant fit, I placed it diagonally.

Which, uh, triggered certain associations.
It's grown in popularity in ways that I did not anticipate.

What emoji do you want to see next?
Plantains. I love the side dish.

Emojidemiology

When Zika erupted in South America, doctors struggled to alert the public. There wasn't a language capable of crossing barriers of environment, education, and ethnicity. Except, some hip scientists realized, emoji. They suggested a mosquito icon, which Unicode approved in February—along with half a dozen other science-y symbols, such as a test tube. Proposals for an Erlenmeyer flask and Bunsen burner, however, were rejected. —A.P.



PROTOTYPE OF MOSQUITO EMOJI, BUZZING ONTO YOUR SMARTPHONE LATER THIS YEAR

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GIF MASTER
THE BEST SHORT CUTS

SAMANTHA SCHARFF MAY be the world's most successful short-storyteller. "Three to six seconds," she says, "is my sweet spot." As a founder of Giphy Studios, the first creative agency devoted to making original GIFs, she knows how to slow your scroll. ¶ Scharff spent nearly two decades producing skits and shorts for *SNL*, *The Colbert Report*, YouTube, and Fox. In 2016, she was recruited by Giphy to launch a production studio, where she introduced "celebrity reaction packs," expressive GIFs filmed in-house and based on popular search terms. Envision a sort of looping human emoji—Michael Bolton miming "Netflix and chill" or Lil Yachty acting "shook." It's a comically emotive, collaborative process, made easier if the subject is naturally effusive and familiar with the clipped, shareable format. (Bolton agreed to get GIFed partly because a family member was into the medium, Scharff says.) Still, creating a crowd-pleasing GIF from scratch is harder than it looks. *You* try telling a funny story in three seconds, sans setup or sound. "I think in punch lines all day long," Scharff says. "We have mere seconds to grab your attention." ¶ Exaggerated eye rolls, it turns out, have incredible reach: On an average day, Giphy's 300 million users share 5 billion GIFs. Now Scharff is channeling that virality to transform Giphy into a full-service entertainment platform, including forays into VR. (Think YouTube, with less baggage.) "I always want to be coming up with new ways to entertain and communicate," Scharff says. As she knows, our affinities—and attention spans—can turn in a second. —LAUREN MURROW

WHO: Samantha Scharff, GIF guru

COLLABORATORS: Gwen Stefani, Mariah Carey, Portugal. The Man, Neil Patrick Harris, Lil Yachty

PASSION PROJECT: Tom Hanks' animated web series *Electric City*, a post-apocalyptic utopia run by a secret society of old women

SCHARFF'S TRENDS TO WATCH: Digital stickers, gamified social networks, blockchain-based crowdfunding



CARA ROBBINS



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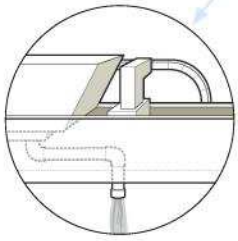
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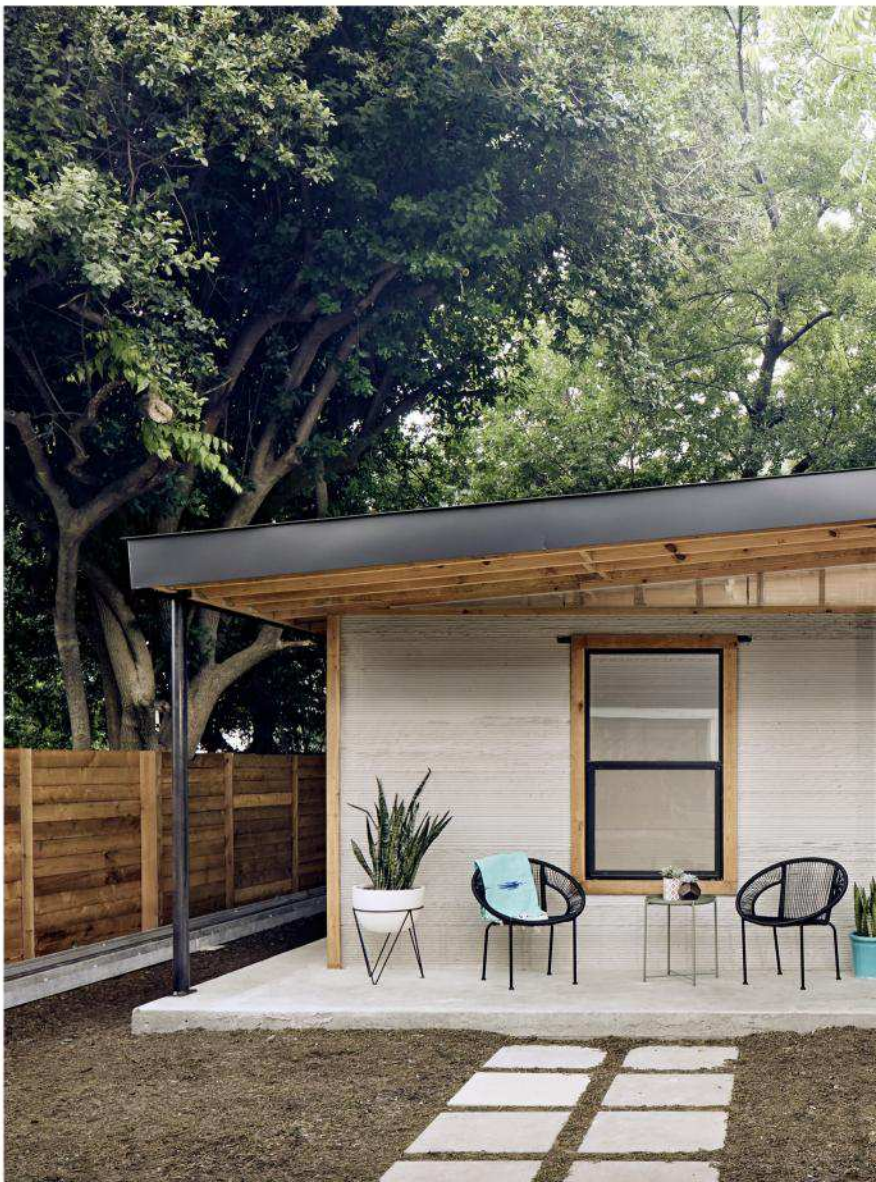
TOOL

HOME MAKER
3-D PRINTING THE FUTURE



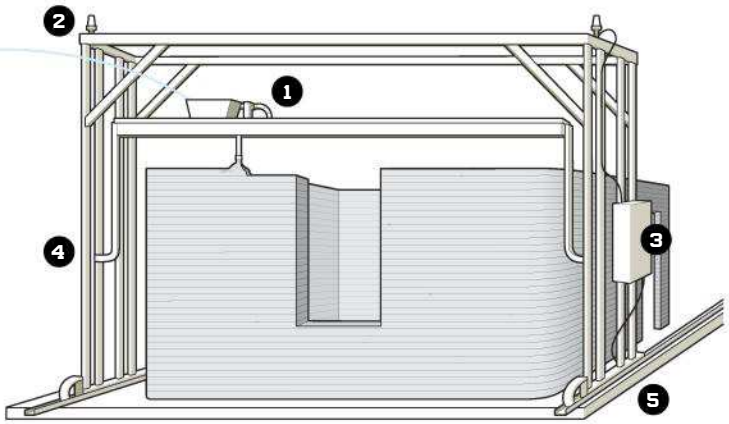
1. MORTAR MIX
The base material is finely tuned to prevent sagging. In the future, Icon also plans to print materials such as insulating foams and plastic.

A TYPICAL SINGLE-FAMILY home in the US takes an average of six and a half months to build, according to the Census Bureau's latest survey. Now an Austin-based startup called Icon can erect a house nearly 200 times faster—in a day. ¶ To be fair, the company is building houses that max out at 800 square feet, but that's not the limit. The hyperspeed fabrication is the work of a megasize 3-D printer—picture a MakerBot on steroids—named the Vulcan. Engineers run digital blueprints for the home through so-called slicer software, which translates the design into the programming language G-code. That code determines where the printer moves along its track, extruding ¾-inch-thick layers of concrete like icing on a cake. The base material—a finely calibrated mix of cement, sand, plasticizers, and other aggregates—gets poured into a hopper at the top of the printer and flows onto the rising walls below. ¶ The resulting abodes, which will cost $4,000 to build, are the latest addition in the ubiquitous tiny-house movement. (Icon's ultimate goal is to alleviate the housing crisis; the company is exploring partnerships with FEMA and Fannie Mae.) In 2019, Icon intends to ship the Vulcan to El Salvador, where it's slated to print 100 homes for disadvantaged families. But the startup's next excursion may be even farther afield: Icon is participating in a NASA competition to develop printable space habitats using "indigenous materials," the planetary soil available onsite. Once again, the Vulcan may boldly go where no human has gone before. —ANDREA POWELL



WHAT:	The Vulcan, a house-building 3-D printer
SIZE:	12.5 x 22.5 x 35 feet
WEIGHT:	1 ton
TOP SPEED:	5 inches per second

CASEY DUNN



ILLUSTRATIONS BY BROWN BIRD DESIGN

2. ENERGY EFFICIENCY
The Vulcan runs on six electric motors that require only 240 volts of power—roughly the same as a clothes dryer—so it won't overwhelm fragile power grids in developing countries or disaster zones.

3. FLEXIBLE DESIGN
Slicer software is used to interpret digital blueprints that plot points in three-dimensional space. Code can be written for any type and size of building.

4. FRAME
The lightweight aluminum frame disassembles quickly for easy transport. It's stabilized by triangular trusses, allowing the printer to emit concrete within ⅛ inch of the points laid out in the plans.

5. MOVABLE TRACKS
The printer rolls back and forth along 10-inch-wide tracks, which are repositioned as the home rises. There's no limit to how long the wall can be.



JARGON WATCH

Space Graffiti

n. Objects placed in orbit for the sole purpose of being seen from Earth.

In January a company called Rocket Lab secretly added an extra point of light to the night sky. Dubbed the Humanity Star, it was a faceted carbon-fiber sphere parked in low Earth orbit, designed to twinkle as it caught the sun's rays, thus creating a "shared experience for everyone on the planet." ¶ Astronomers were not amused. Some saw it as a publicity stunt, confirming their worst fears about private spaceflight. What's next, they fumed, billboards in space? (Two weeks later, Elon Musk's SpaceX launched a Tesla Roadster into solar orbit.) Others called it vandalism. The epithet that stuck was *space graffiti*. ¶ In truth, the Humanity Star posed no real threat to astronomy, and it soon fell out of orbit, as planned. But the image of a giant disco ball hung in the firmament—that icon of humanity at its silliest and most joyful—raised questions that won't go away: Why are we indignant over an orbiting objet d'art but not over, say, yet another TV satellite? Are science and commerce the only legitimate pursuits off-planet—and who gets to decide? ¶ Perhaps it's time to drop the po-faced solemnity about our final frontier. Exploits like the Tesla shot may be just public tagging by attention-hungry moguls. But some space graffiti may find a place—like terrestrial graffiti—as a valid form of expression. It wouldn't be any stranger than disco making a comeback. —JONATHON KEATS



JARGON WATCH ILLUSTRATION BY LEON EDLER



MISSION: HOW POSSIBLE?

IT'S BEEN 22 YEARS since Tom Cruise infiltrated a CIA vault suspended from a wire in the first *Mission: Impossible* flick. This summer, Cruise reprises his role as secret agent Ethan Hunt in *Mission: Impossible–Fallout*, the sixth installment in the $2.8 billion–grossing series. Aside from its earworm theme song and stomach-clenching (and reportedly bone-crushing) stunts, the franchise is perhaps best known for its futuristic gadgets, often harbingers of tech to come. Our mission: consulting computer scientists, planetary physicists, engineers, and biohackers to find out what's actually achievable and what's still, you know, impossible. —MARK YARM

Gecko Gloves
Mission: Impossible–Ghost Protocol

Hunt scales the exterior of the world's tallest building using a pair of electronically powered gloves.
ANALYSIS In 2014, Stanford University researchers invented paddles that harness the science behind geckos' sticky feet. NASA's Jet Propulsion Laboratory is developing "gecko grippers" capable of grabbing space debris.
STATUS Mission accomplished

Smart Contacts
Ghost Protocol

Agent Hanaway pops in a contact lens with facial-recognition abilities.
ANALYSIS Augmented-reality-enabled smart contact lenses that superimpose information onto the user's view could be available in three to five years, predicts Aleksandr Shtukater, president of lens startup RaayonNova. Google, Samsung, and Sony all have smart contact lens patents.
STATUS Possible

Voice-Altering Strip
Mission: Impossible III

Hunt impersonates an arms dealer using voice-altering tech: a circuitry-embedded strip that goes over his throat.
ANALYSIS It's already possible to imitate someone's speech patterns using text-to-speech software. But a device that makes your vocal tract mimic someone else's so your voice sounds like theirs? "That's pretty far out there," says Alan W Black, a language technologies professor at Carnegie Mellon. More realistic: Edward Chang, a neurosurgeon at UC San Francisco, is developing a wireless device to translate brain signals into speech using a voice synthesizer.
STATUS Impossible—for now

Gait Recognition
Mission: Impossible–Rogue Nation

Agent Dunn must bypass a gait-analysis security system, which IDs people by the way they walk, to enter a closely guarded power plant.
ANALYSIS Mark Nixon, a professor of computer vision at the UK's University of Southampton, developed a 3-D gait-recognition system in 2008 that analyzes video to identify individuals by their strut. Now his newly improved system can ID a person from up to 100 feet away.
STATUS Mission accomplished

Mag-Lev Suit
Rogue Nation

Agent Brandt dons a magnetic suit that—thanks to a magnet mounted on a remote-controlled vehicle below—levitates him above deadly fan blades.
ANALYSIS In 2009, scientists at NASA's Jet Propulsion Lab levitated mice using a magnetic coil. But could the same science allow a human to hover? Perhaps. "The device would have to generate very large magnetic fields, like an MRI machine," says planetary physicist Kevin Grazier.
STATUS Possible

Tracking Implants
Mission: Impossible–Fallout

Hunt uses a "dermal stitcher" to implant tracking devices under people's skin.
ANALYSIS Dozens of employees at Three Square Market, a Wisconsin tech company, volunteered to have microchips implanted in their hands last year, allowing them to unlock their computers with a wave. But the idea of tracking someone via a covert implant is impractical, says Amal Graafstra, CEO of biohacking company Dangerous Things. "Installing it would require scalpels and stitches, and it would only work at a very close range."
STATUS Impossible—for now

Right now, 82,248 people want to say sorry.

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HERE'S TO THE SHOT TAKERS



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WHAT'S SNOO?
A BRIEF HISTORY OF REDDIT'S TINY ALIEN

REDDIT'S LITTLE MASCOT, Snoo, contains multitudes. The precious, ever-smiling alien hangs out at the top of hundreds of subreddits, mixing with the locals like a savvy politician. In r/trees, a community for marijuana enthusiasts, Snoo puffs a joint. In r/gonewild, Snoo poses for a selfie in a wig and lingerie. In r/Asceticism, Snoo dematerializes into the cyberether, its form the mere wisp of an outline.

Cheeky bugger. Indeed, Snoo's existence has always been something of an inside joke. Reddit cofounder Alexis Ohanian doodled the creature in a notebook during a marketing class his senior year at the University of Virginia. Black and white with pops of red, it seemed conjured from pure whimsy: oval head, pom-pom ears, single antenna. Like a Teletubby, minus the space suit. When Reddit launched in 2005, the drawing served as a convenient icon for the site, which was then a place for sharing news links. (Advance Publications, which owns WIRED publisher Condé Nast, is now a Reddit shareholder.) At first, Ohanian wanted to call the site S'new, a marshmallow-mouthed contraction of "What's new?" The tastier name Reddit prevailed; Snoo, more pleasingly spelled, lived on with the mascot.

As Reddit expanded and its user base splintered into tribes (subreddits), Snoo proved a fitting role model. "Snoo came to symbolize Reddit and a Reddit user," Ohanian says, in that the icon happened to be particularly moldable. It's a happy accident that Ohanian's hurried sketch left Snoo colorless and genderless, a form onto which everyone could map themselves.

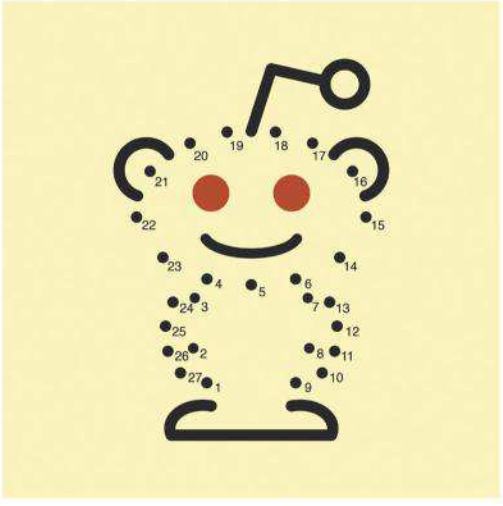
This creative canvas was, in some ways, illustrative of the early web, where nobody knew you were a dog. The closest thing to verification on Reddit, even now, is a confirmation that the email attached to your account is real. Anonymity is accepted, even encouraged. You can have multiple accounts, fake accounts, throwaways for posting the kinds of deep, dark musings that absolutely must not, under any circumstances, get traced back to the real you. (I have three usernames: one for lurking, one for reportage, and one for purposes I would never share in print.) Identities are fragmented; each version of you, a new Snoo.

There are *some* limits, especially now that Reddit has matured. You can't harass or threaten other users, nor deploy Snoo to those ends. In fact, Snoo has several design constraints. When Reddit unveiled a new version of the site in April—its first refresh in a decade—the team canonized certain anatomical features: Snoo's head "should always appear blank or neutral"; its eyes should be orange-red, hex #FF4500; it can't have fingers; it should have ears (the better, perhaps, to hear, and thereby discourage, hate speech). The company also gave Snoo a more explicit purpose: to discover and explore humanity.

This, it turns out, is a continuation of Snoo's origin story. Ohanian says it was never just any alien. It's from the *future*, a tiny time traveler here to observe our reality. As Ohanian explains, "It was a guarantee we weren't going to fail. If we failed, Snoo wouldn't be able to travel back to the present."

Let's parse that. There is a future, a distant one, in which Reddit still exists, in which sweet-faced creatures like Snoo merrily dwell. Certainly this is a very lovely thought. It is also a pompous and rather ingenious bit of teleology. All startup founders operate from a foundation of optimism—they're going to change the world. But Ohanian does them one better. He built hope into his platform's very mythology.

Nobody would mistake Reddit for a rainbowland of pure love. Trolls still yuck it up, and Snoo has seen some nasty things. But as the reputation of other social media plummets, with users turning against the algorithms that mine our every like and post, Reddit's status as a messy myriad of supportive, mostly self-policed communities has stayed fairly constant. There is no pressure to curate a well-designed profile, to be the person Instagram or Facebook or Snapchat expects you to be. That's what Snoo stands for. More space than substance, Snoo shows us another way to represent ourselves online: as shape-shifting cosmic weirdos, trying to find our place among the stars.



By senior associate editor **Arielle Pardes** *(@pardesoteric), who wrote about Reddit's recent redesign for* WIRED.com.

SMALL BUSINESS

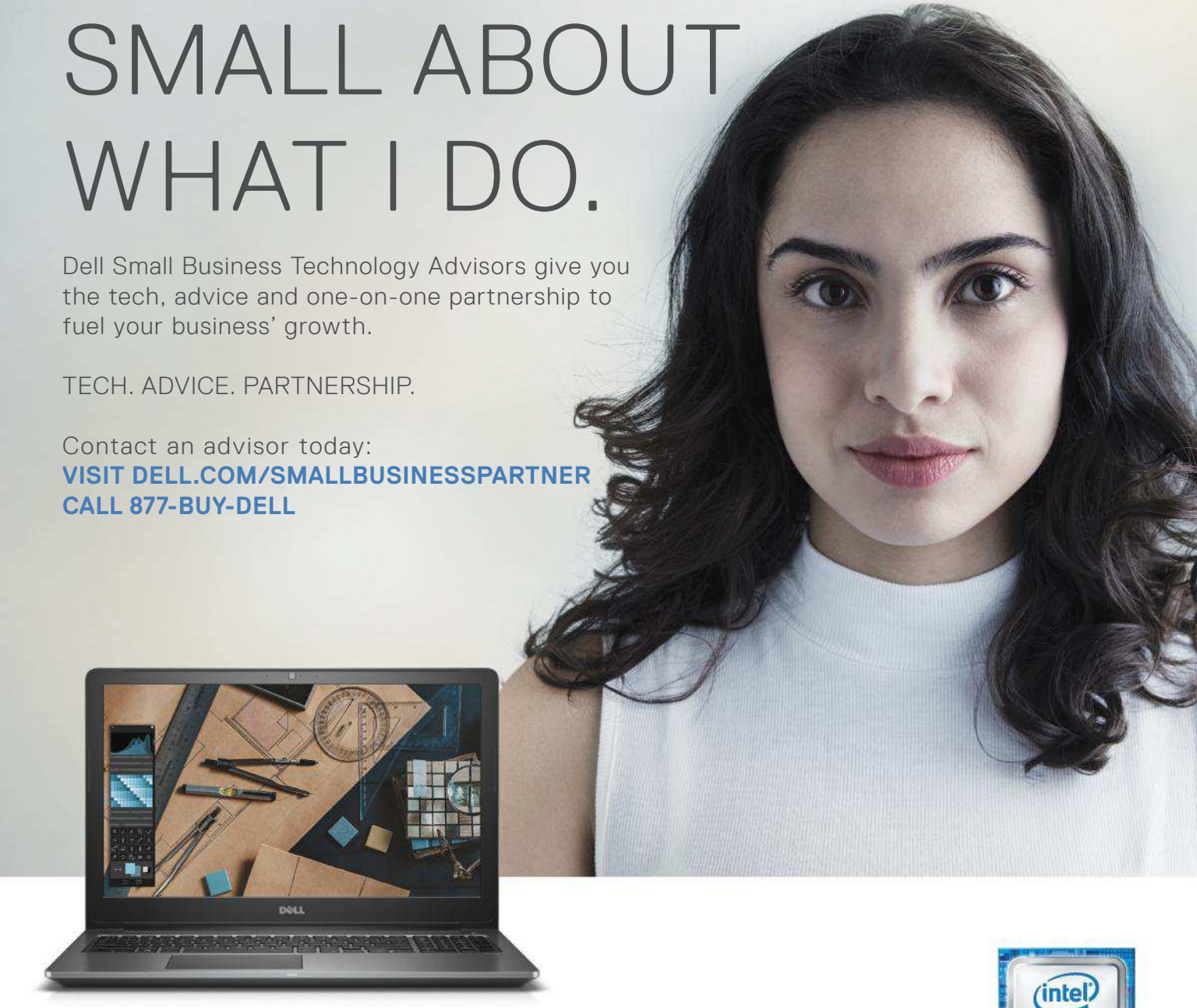
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A STAR IS "BORN" THE RISE OF THE DIGITAL CELEBRITY

A NEW GENERATION of celebrities is selling out concerts, starring in commercials, and amassing huge Instagram followings. But none of them exist—corporeally, anyway. In recent years, and starting in Japan, technology and social media have spawned a digital demimonde of computer-generated stars, ranging from fake musicians and models to company mascots who appear as holograms (like Betty Crocker, with AI). When they're not entertaining you, they're trying to convince you of their humanity, and even the more cartoonish among them have fleshed-out personalities. In a way, it's the purest expression of celebrity, which has always been an elaborate illusion. CGI starlets, though, "are much easier to control," says Ryan Detert, CEO of the branding firm Influential. Except when they misbehave. —MIRANDA KATZ



The (Im)material Girl

She's not really fooling anyone—Hatsune Miku is a schoolgirlish, turquoise-haired anime mascot designed by a Japanese software company to sell a voice synthesizer. As consumers began using the product to compose original music, Miku became a sensation. For years now, she's been performing at massive IRL concerts, where her hologram "sings" those fan-written songs.

The Virtual Unknown

In 2011, the Japanese girl group AKB48 announced its newest member, 16-year-old Aimi Eguchi. Nobody had ever heard of her. When Aimi started showing up in ads and commercials for a popular Japanese snack company, fans got suspicious. Finally, AKB48 had to admit that Eguchi didn't exist: She was a publicity ploy, created through a digital mashup of other band members' faces.

The Brandfluencer

In her two-plus years on Instagram, the selfie-snapping 19-year-old Lil Miquela has racked up more than a million followers, partnered with Prada, and promoted causes like Black Lives Matter. Brud, a tech startup that has taken some credit for Miquela, calls her an artificially intelligent robot, though earlier this year Miquela went rogue and cut ties "with my managers." Now she calls herself a free agent.

The Evil Twin

Meet Miquela's nemesis: Earlier this year, a Trump supporter named Bermuda held Lil Miquela's Instagram hostage until the latter posted a series of statements admitting that she wasn't human. The two then "met" "IRL," and Bermuda posted a picture of them "together." The feud was lame, but it demonstrated that fake influencers can attract just as much attention as the real ones (whatever "real" means).

The Model Model

Billed as the "world's first digital supermodel," Shudu is the creation of fashion photographer Cameron-James Wilson, who built her using 3-D modeling software. Some critics have side-eyed Wilson, who's white, for making a virtual black model—couldn't he pay a real black woman to pose for him? Wilson, meanwhile, says he wants Shudu to inspire more diversity in the fashion industry.

HATSUNE MIKU BY IXIMA. AIMI EGUCHI COURTESY OF GLICO. LIL MIQUELA COURTESY OF @LILMIQUELA. BERMUDA COURTESY OF @BERMUDAISBAE. SHUDU BY CAMERON-JAMES WILSON

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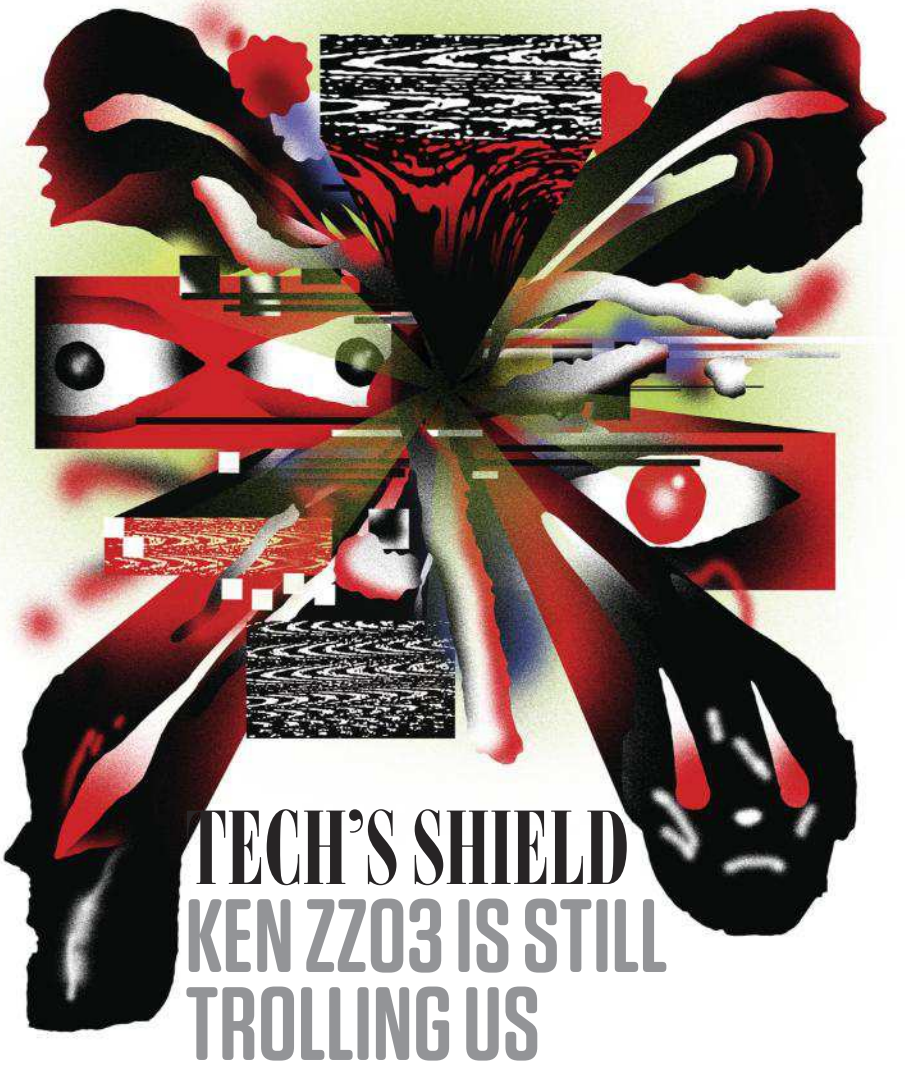
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TECH'S SHIELD
KEN ZZ03 IS STILL TROLLING US

THERE ONCE WAS A LEGENDARY TROLL, and from its hideout beneath an overpass of the information superhighway, it prodded into existence the internet we know, love, and increasingly loathe.

That troll, Ken ZZ03, struck in 1995. But to make sense of the profound aftereffects—and why Big Tech is finally reckoning with this part of its history—you have to look back even further.

In 1990, an online newsletter called *Rumorville* accused a competitor, *Skuttlebutt*, of being a "scam." *Skuttlebutt* sued the online service provider that hosted *Rumorville*, CompuServe, for publishing false, damaging statements. A judge ruled that CompuServe was not responsible for content that it simply distributed.

A few years later, in the forums of another service provider—remember Prodigy?—an anonymous user called the firm Stratton Oakmont "a cult of brokers who either lie for a living or get fired." Unlike CompuServe, Prodigy had tried to monitor its message boards. For that reason, when Stratton Oakmont sued, the court held that Prodigy *was* responsible.

The Feds needed an official policy. Tech lobbyists, who considered the Prodigy decision unreasonably restrictive, pushed lawmakers to adopt the CompuServe standard. They succeeded, and then some: Section 230 of the Communications Decency Act, passed in 1996, states that platforms are not liable for the content they host—even when, like Good Samaritans, they try to intervene. Ken ZZ03 would be its first test.

Michael Fitzgerald
is a writer and editor based in New York.

Days after the 1995 Oklahoma City bombing, Ken ZZ03 posted ads on an AOL message board for T-shirts celebrating the tragedy ("Visit Oklahoma … It's a BLAST!!!"). To order, the ads said, call Kenneth Zeran, whose phone number was included.

Zeran was a Seattle-based TV producer and artist, and he had nothing to do with the ads. (Ken ZZ03's motives and identity remain unknown.) Yet tons of people called to berate and threaten him, to the point that police were notified. Zeran asked AOL to take down the messages. AOL demurred. Zeran sued in '96; a decision was reached in '97. The judge, invoking Section 230, sided with AOL.

Ask many web scholars and they'll tell you that Section 230 in general, and the Zeran case in particular, created the modern internet. CompuServe, Prodigy, and AOL became Google, Facebook, and Twitter, companies that have for years relied on Section 230 as a legal shield against claims of publishing abusive content.

Yet the law never could have anticipated the unchecked growth of Big Tech.

In the mid-'90s, AOL was just a bunch of guys "in an office park behind a Cadillac dealership" in suburban Virginia, said their then-lead attorney, Randall Boe, in a recent interview. "We had no idea what was to come."

CompuServe's attorney, Robert Hamilton, believes his winning argument was wildly misunderstood by the authors of Section 230, who gave platforms absolute immunity. "It was only a matter of time," Hamilton says, before Congress would have to make amendments.

In March, Congress passed the first reform of Section 230 in 22 years, saying platforms *can* be found liable, but only if their users are participating in sex trafficking. Senator Ron Wyden of Oregon, who coauthored Section 230, didn't support that particular bill but argued nonetheless that tech companies have failed to honor the spirit of the law. "In years of hiding behind their shields … too many companies have become bloated and uninterested in the larger good," he said. Indeed, under Section 230, it's fine for tech companies to act like Good Samaritans—they simply forget to.

As for Kenneth Zeran, he doesn't think about the AOL case much these days. But, he says, "I always felt that I was correct—and that history would show that I was right."



KRISTEN STURDIVANT

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RANDOM GROOVES

THESE LAVA LAMPS GUARD THE WEB

EDWARD CRAVEN WALKER lived to see his greatest invention, the lava lamp, make its late-'90s cultural comeback. But the British tinkerer (and famed nudist, incidentally) died before he could witness the 21st-century digital potential of his analog creation. Inside the San Francisco office of the web security company Cloudflare, 100 units of Craven Walker's groovy hardware help protect wide swaths of the internet from infiltration. Here's how it works. Every time you log in to any website, you're assigned a unique identification number. It should be random, because if hackers can predict the number, they'll impersonate you. Computers, relying as they do on human-coded patterns, can't generate true randomness—but nobody can predict the goopy mesmeric swirlings of oil, water, and wax. Cloudflare films the lamps 24/7 and uses the ever-changing arrangement of pixels to help create a superpowered cryptographic key. "Anything that the camera captures gets incorporated into the randomness," says Nick Sullivan, the company's head of cryptography, and that includes visitors milling about and light streaming through the windows. (Any change in heat subtly affects the undulations of those glistening globules.) Sure, *theoretically*, bad guys could sneak their own camera into Cloudflare's lobby to capture the same scene, but the company's prepared for such trickery. It films the movements of a pendulum in its London office and records the measurements of a Geiger counter in Singapore to add more chaos to the equation. Crack that, Russians. —ELLEN AIRHART

THE MORRISONS



CLIVE THOMPSON

BRING BACK GEEKS! GOVERNMENT NEEDS TECH SUPPORT

CONGRESS IS FINALLY TURNING its attention to Silicon Valley. And it's not hard to understand why: Technology impinges upon every part of our civic sphere. We've got police using AI to determine which neighborhoods to patrol, Facebook filtering the news, and automation eroding the job market. Smart policy could help society adapt. ¶ But to tackle these issues, congressfolk will first have to understand them. It's cringe-inducing to have senators like Orrin Hatch seem unaware that Facebook makes money from ads. Our legislators need help. They need a gang of smart, informed nerds in their corner. ¶ Which means it's time to reboot the Office of Technology Assessment. ¶ You've likely never heard of it, but the OTA truly rocked. It was Capitol Hill's original brain trust on tech. Congress established the office in 1972, the year of *Pong*, when it realized the application of technology was becoming "extensive, pervasive, and critical." The OTA was staffed with several hundred nonpartisan propellerheads who studied emerging science and tech. Every year they'd write numerous clear, detailed reports—What happens if Detroit gets hit with an atom bomb? What'll be the impact of automation?—and they were on call to help any congressperson. ¶ It worked admirably. Its reports helped save money and lives: The OTA found that expanding Medicaid to all pregnant women in poverty would lower the cost of treatment for low birth weight babies by as much as $30,000 per birth. It pointed out the huge upsides of paying for rural broadband, and of preparing for climate change. With a budget of only $20 million a year, the little agency had an outsize impact.

Alas, the OTA was doomed by the very clarity of its insight. It concluded that Reagan's "Star Wars" missile defense wouldn't work—which annoyed some Republicans. In 1995, when Newt Gingrich embarked on his mission of reducing government spending, the low-profile agency got the chop, at precisely the wrong time: Congress defunded its tech adviser just as life was about to be utterly transfigured by the internet, mobile phones, social networking, and AI. Nice work, guys!

Today, Washingtonians of different stripes are calling for a reboot. "When you drag Mark Zuckerberg in, and you want to ask the really hard questions, this would put you in a better position," says Zach Graves, a senior fellow at the free-market think tank R Street. Democratic FCC commissioner Jessica Rosenworcel wants the OTA back too, given the whipsaw pace of new tech arrivals.

Technically, it'd be easy to restart the OTA. Congress didn't abolish it, but merely took away its funding. This spring, US representative Bill Foster (D-Illinois) introduced a resolution to reopen the spigot.

That would still need votes though. You'd need agreement that expert consensus on scientific facts is important—and, alas, I'm not sure it's there. Anti-science thinking is running amok in the political sphere. Some of it's from liberals (hello, Hollywood anti-vaxxers!), but the lion's share resides in right-wing orthodoxy, which is too often hostile to the idea of scientific evidence, especially if it suggests we should stop burning fossil fuels. In a saner age, the OTA would be a no-brainer. Now I'm not so sure.

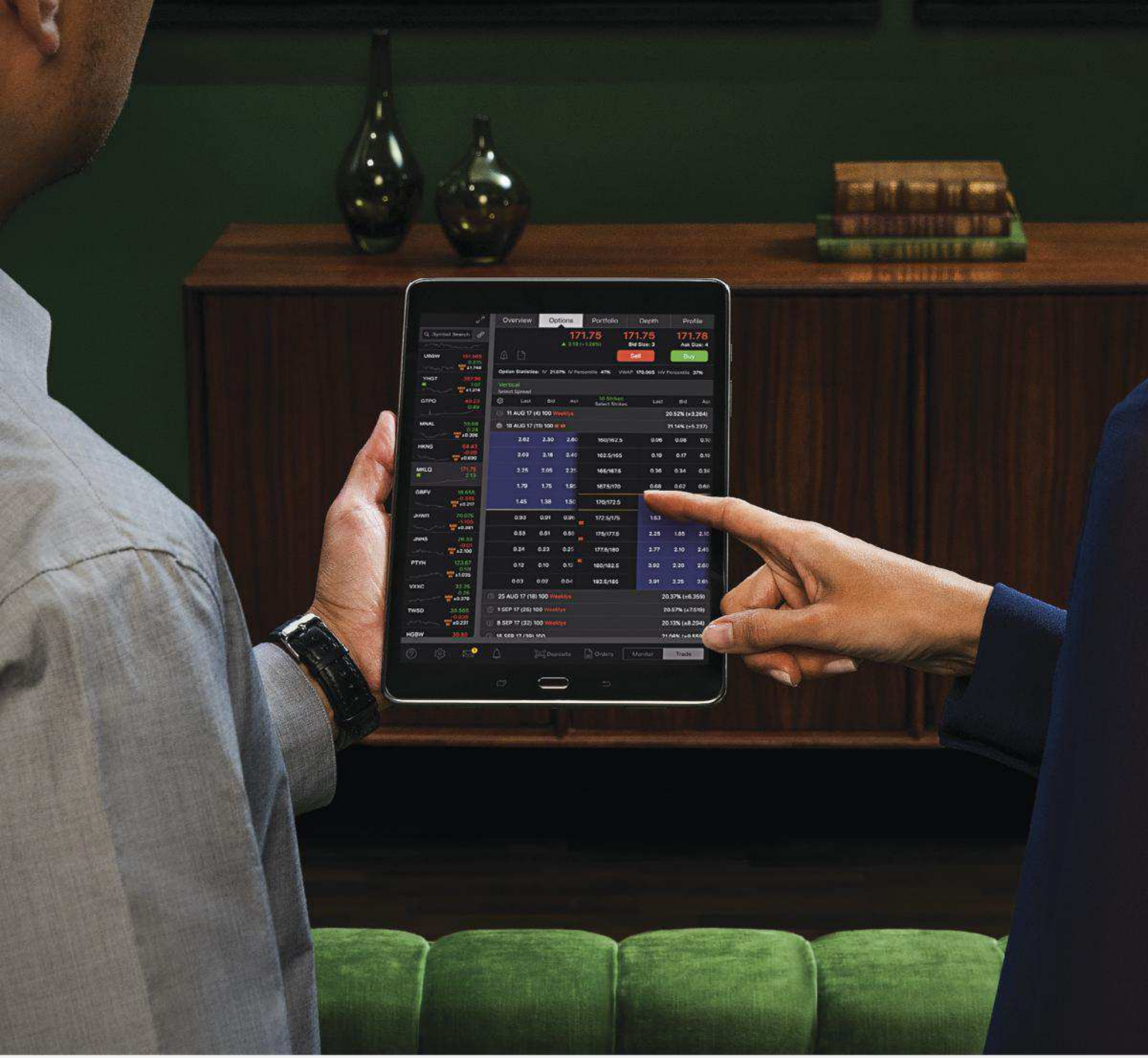
Still, Foster is hopeful. In the old days, the OTA had some Republican champions, and it still could today, he tells me. "They understand the economic importance of having high-quality technical advice."

My fingers are crossed. In 1985, OTA researchers observed: "America has become an information society." It would be nice if we could also be an informed one. W

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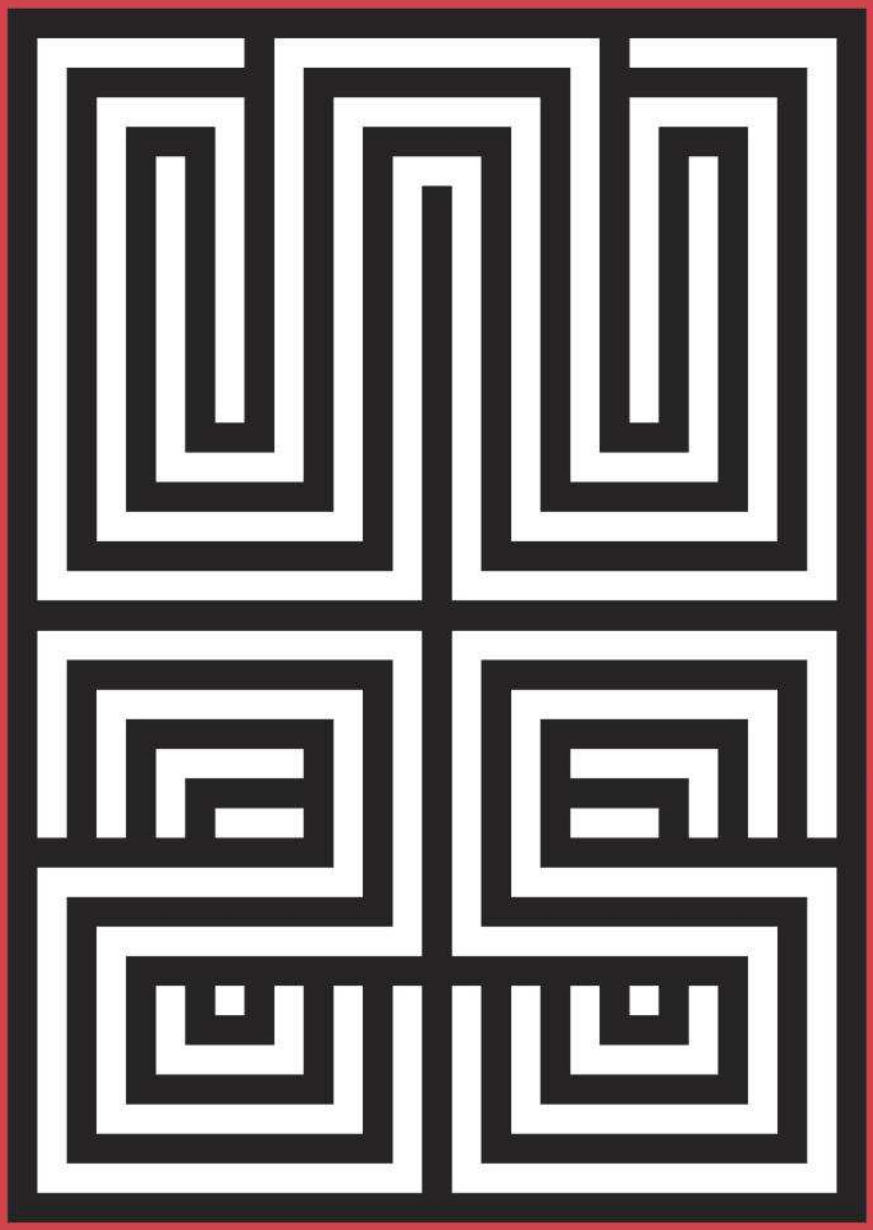
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FETISH ESCAPE POD

AIRSTREAM FOUNDER WALLY BYAM began experimenting with fiberglass back in the 1950s. A half-century (and then some) later, his company has finally built the Nest, a plastic trailer that's as stylish and rugged as the iconic, road-tested aluminum capsules. While Airstream's retro-chic metal models can carry sticker-shocking six-figure price tags, its new fiberglass tow-along is half that—cheap enough to attract a new generation of customers. The 16-foot Nest is compact but luxurious, with room for two to sleep, cook, and wash up (it has a bathroom with a shower). The overhead skylight and gogglelike front window brighten every corner of the interior. And at 3,400 pounds, you don't need a monster truck to pull it. Forget #vanlife—#nestlife is about to have its moment. —JACK STEWART

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TOP 3 RUN BUDDIES

These headphones won't fail—or fall out—when you're dripping with sweat on the final sprint. —ADRIENNE SO

Plantronics Backbeat Fit 305

Plantronics' reflective woven cable stands out with a stylish pop of color and a dab of safety. But we really love these buds for their toughness and clear sound. The IPX5 rating means they're impervious to perspiration, and their stiff, loop-shaped wings mean the buds will stay wedged in your ears.

$64





RHA MA650

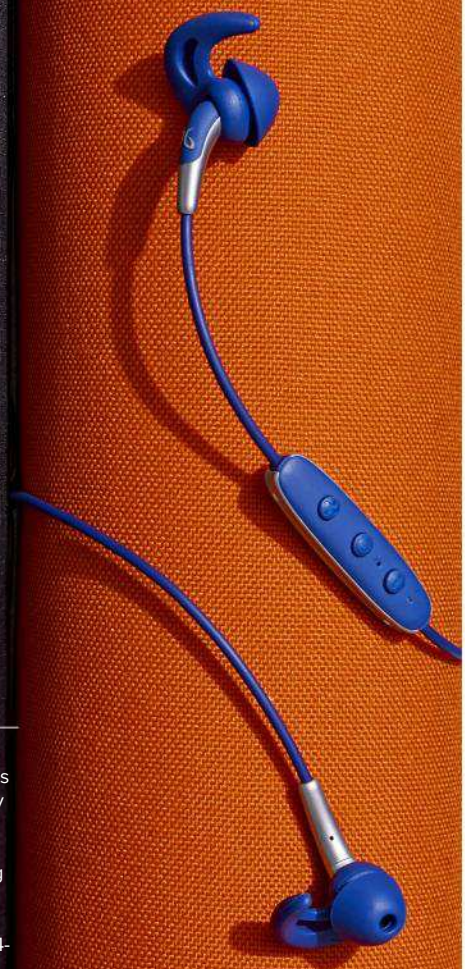
The velvet-smooth flexible band on this headset rests gently on the back of your neck to keep your buds in place during any sweat-making activity. They sound great, and their IPX4-rated skin shields them against moisture. Plus, the battery lasts far beyond the quoted 12 hours, so they're perfect for an ultramarathon (or just an extra-long day at the beach).

$100

Jaybird Freedom 2 Wireless

The latest version of Jaybird's beloved wireless, sweatproof buds still provide four hours of rich, natural sound, but now they have even more-secure stay-put wings for anchoring them in your ears. Also improved is the cord-management system, which keeps the cable from flopping against your skull—pretty annoying by mile 17.

$150



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GEARHEAD COOK OUT

Toss the packets of dehydrated soup and make a real meal at the campsite instead. —JOE RAY



1

2



1

Combekk Dutch Oven With Thermometer

This Dutch oven is, in fact, made in the Netherlands. Combekk's 4-liter pot is crafted from recycled iron—railroad track, mostly—and has a thermometer built into its sidewall. Set the whole thing in the campfire coals; the 6-mm-thick bottom keeps heat distributed evenly.

$300

2

Bialetti Mini Express 2-Cup Stove-Top Coffee Maker

A morning espresso blocks the sleep-inducing adenosine molecules in your brain, making you alert enough to read a trail map. Bialetti's fountain pours two shots in about five minutes. Like the popular moka pot, it's unfussy and made of durable aluminum.

$35

3

Igloo BMX 25 Cooler

Igloo's new BMX line is a departure from the decades-old brand's usual style. The 25-quart cooler has been modernized with beefy latches, stainless steel kick plates, and tie-down loops for securing the load in your ride. It'll keep ice icy for four days at 90 degrees Fahrenheit, so you can stay awhile.

$55

4

Coleman Vacuum Insulated Stainless Steel Growler

The tent has been pitched, all the gear has been stowed away. Now you deserve a beer. Coleman's new growler holds several of them. If you don't finish all 64 ounces of craft brew on the first night, this double-walled flagon maintains its chill for up to three days.

$40

5

Cuisinart Venture Portable Gas Grill

When it's all packed up, the car-camping-friendly Venture looks more like a picnic basket than a grill. That simplicity belies its smart, versatile design. The wooden lid doubles as a cutting board that can be nestled snugly onto the base—which in turn doubles as a stash spot for the propane canister.

$200



Mafia Deep Blue Bag

BEST FOR: Vacationing sea monsters

The shell of the Deep Blue gets its crinkly feel from recycled spinnaker sails. This strong ripstop nylon is designed to spend all day in the wind, so you can pack the ultralight bag for any oceanic excursion. A waterproof compartment keeps your wet swimsuit and flip-flops separate from your Kindle. A collaboration between Mafia and designer Yves Béhar, nearly every piece of material is reclaimed from climbing ropes, seat belts, and even old wet suits.

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HEAD-TO-HEAD ECO MODE

Tread gently on the planet with a versatile pack made mostly from recycled materials. —MICHAEL CALORE

Truce Drop Liner Backpack

BEST FOR: Rain forest rangers

The ultradurable, resin-fiber-reinforced sailcloth exterior of Truce's bag is made from sails that once powered racing yachts. Add a seam-sealed liner fashioned out of leftover fabric from dry suits—like a wet suit for diving, but you don't get wet—and you have a waterproof shell that can shed even the hardest rain. Compression straps help stabilize the load, and a moisture-wicking lumbar pad helps keep your back dry during steamy hikes to remote waterfalls.

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An itch to build a better torch birthed a brilliant companion for cops and campers alike. —JONATHON KEATS

BACK IN THE EARLY '70S, an ex-cop gave Tony Maglica a hot tip. He told Maglica—a machinist who churned out artillery shells—that police had a beef with their flashlights. The torches, usually plastic, broke too easily. The former deputy sheriff wondered if Maglica could make something solid, maybe out of aluminum. Maglica delivered a product so sturdy, it did double duty as a billy club. Patented in 1979, the rugged light anticipated needs that cops didn't know they had—and made the inventor's company hundreds of millions of dollars. A twist of the head could adjust the beam from flooding a crime scene to narrowing in on a suspicious bootprint. And there was the ingenious mechanism that rotated the battery contact, scraping away corrosion whenever the user clicked the power button. By the '80s, the Maglite was standard gear for first responders. And a scaled-down version—powered by AA batteries instead of burly D-cells—made Maglite a hit with consumers. Newer models often use LEDs instead of incandescent bulbs. But most cops stick with the Maglite they got as a rookie. The dents are a kind of semaphore, signifying that the officer is as experienced as their knurled aluminum flashlight.

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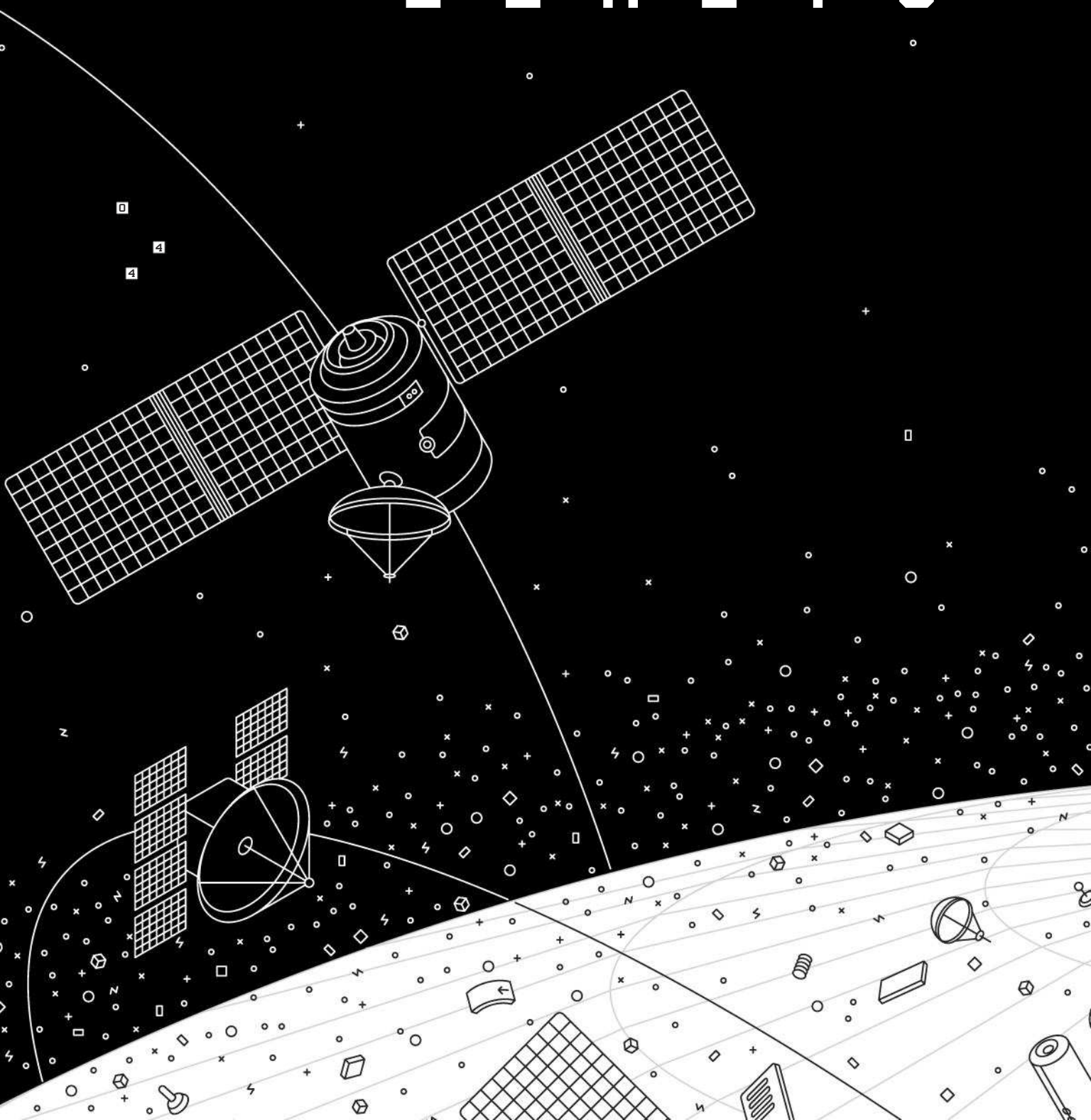
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THE OUTER LIMITS

BY GARRETT M. GRAFF




WAR
OF
SUNDAY
BÜRO

A NEW ARMS RACE IS THREATENING TO EXPLODE—500 MILES ABOVE OUR HEADS.



In the midafternoon of January 11, 2007, US Air Force major general William Shelton sat at the head of a table in a command center at California's Vandenberg Air Force Base, holding a telephone to each ear. Shelton was the commander in charge of maintaining the US military's "situational awareness" in space—and the situation, at the moment, seemed to be deteriorating fast. One phone connected Shelton to his boss, the head of US Strategic Command, in Nebraska; the other connected to Shelton's operations center, a windowless room full of analysts just next door. In front of Shelton was a can of Diet Dr Pepper, and arrayed around the table were the members of his increasingly nervous senior staff.

For days, US intelligence had been picking up indications that China was about to conduct a missile test aimed at outer space. The analysts next door—and their counterparts around the world—were tracking ground-based radar signals, monitoring infrared sensors, and poring over images from telescopes in space. All of them were briefing Shelton on what they were observing in real time. At 2:28 pm (PST) their readouts showed a ballistic missile taking off from China's Xichang Satellite Launch Center, located in the wooded mountains of Sichuan province. The missile rose into low Earth orbit, about 500 miles above Earth's surface, and appeared to close in on an aging Chinese weather satellite.

Then the telescopes showed a bright flash.

Minutes later, the radar screens began to track a growing cloud of debris—at least 3,000 pieces of shrapnel that would each, Shelton knew, spend

GARRETT M. GRAFF

the next several years slingshotting around Earth at speeds that could far exceed that of a bullet. Shelton was stunned. The Chinese had just shot a satellite out of the sky.

Not only was this a stupendous technological achievement—to launch a missile from the ground and hit a celestial target moving as fast as 17,000 mph—it also showed a level of audacity not seen in space for decades. "We couldn't imagine they would go against an actual satellite," Shelton recalls. "Because of the debris something like that creates, it's almost unthinkable." It felt like a wake-up call.

In the conference room, Shelton exhaled, set down his two telephones, and pushed himself back from the table. "This changes everything," he said to his staff.

For decades, America's satellites had circled Earth at a largely safe remove from the vicissitudes of geopolitics. An informal global moratorium on the testing of anti-satellite weapons had held since 1985; the intervening decades had been a period of post–Cold War peace—and unquestioned American supremacy—high overhead. During those decades, satellites had become linchpins of the American military apparatus and the global economy. By 2007, ships at sea and warplanes in the air had grown reliant on instant satellite communications with ground stations thousands of miles away. Government forecasters relied on weather satellites; intelligence analysts relied on high-resolution imagery to anticipate and track adversaries the world over. GPS had become perhaps the single most indispensable global system ever designed by humans—the infrastructure upon which the rest of the world's infrastructure is based. (Fourteen of the 16 infrastructure sectors designated as critical by the Department of Homeland Security, like energy and financial services, rely on GPS for their operation.)

Now, Shelton feared, all those satellites overhead had become so many huge, unarmored, billion-dollar sitting ducks.

In the decade since China's first successful anti-satellite missile test, Shelton's premonition has largely come true: Everything *has* changed in space. A secretive, pitched arms race has opened up between the US, China, Russia, and, to a lesser extent, North Korea. The object of the race: to devise more and better ways to quickly cripple your adversary's satellites. After decades of uncontested US supremacy, multinational cooperation, and a diplomatic consensus on reserving space for peaceful uses, military officials have begun referring to Earth's orbit as a new "warfighting domain."

On the ground, the military is starting to retrain pilots, ship captains, and ground troops in fail-safe forms of navigation that don't rely on GPS—like celestial navigation. The US military must relearn how to fight "unwired" and defend itself in space. "We knew how to do that, and somehow we forgot," General John E. Hyten, the head of US Strategic Command, said in 2015.

When former director of national intelligence James Clapper left office at the end of the Obama administration, he told me that the increasing sophistication of America's adversaries in space was one of the top three strategic threats he worried about. Clapper's successor, Dan Coats, warned last spring that "Russia and China remain committed to developing capabilities to challenge perceived adversaries in space, especially the United States."

Since he took office, President Trump has dropped numerous hints of the warnings he's evidently getting from military and intelligence leaders. During a spring livestream with astronauts aboard the International Space Station, he alluded, obliquely and without context, to the "tremendous military applications in space." And he has repeatedly floated the idea of creating a new branch of the armed forces specifically for celestial combat.

But if space is indeed becoming a war-fighting domain, it's important to understand the stakes, not just for America's strategic standing but for the species. A Russo-Sino-American space war could very well end with a crippled global economy, inoperable infrastructure, and a planet shrouded by the orbiting fragments of pulverized satellites—which, by the way, could hinder us all on Earth until we figured out a way of cleaning them up. In the aftermath of such a conflict, it might be years before we could restore new constellations of satellites to orbit. Preparing for orbital war has fast become a priority of the US military, but the more urgent priority is figuring out how to prevent it.



William Shelton dreamed of becoming a pilot. He got as far as the Air Force Academy before he discovered his eyes weren't good enough. So instead he became an astronomical engineer. In 1976 he began serving as a launch facility manager at Vandenberg Air Force Base, the military's oldest space and missile launch base, perched on the California coast north of Santa Barbara. He arrived just as the Air Force was beginning to understand how crucial space would be to its future: The nation's first early-warning satellites had been put in orbit with the intention of tracking Soviet missile launches, and satellite imagery was becoming increasingly critical to intelligence gathering. Shelton's poor eyesight, it turned out, had led him to the center of the Air Force's new frontier.

In August 1990, Shelton, then a young lieutenant colonel, took command of the 2nd Space Operations Squadron in Colorado. When he arrived at his post, the Air Force was busy building a new constellation of satellites—launching new ones from Cape Canaveral in Florida every few months to help fill out what he was told would ultimately be a global system aimed at helping the US improve its navigation and increase the precision of its bombs and missiles. This was the new Global Positioning System, and one of Shelton's first duties at "2Sops" was to build support and enthusiasm for the new effort. To impress visitors (including the brass), he carried around a demo GPS unit that weighed 10 pounds, cost $3,000, and could tell America's soldiers, sailors, airmen, and Marines exactly where they were on the surface of the planet.

The power of the new system that 2Sops ran was proven faster than anyone imagined. The Gulf War caused a rush of final preparations to get GPS ready for battle. Around 2:30 am on January 17, 1991, GPS-equipped helicopters snuck into Iraq, using the technology to guide themselves through the darkened desert and knock out air defense radars. The first bombing campaign of the war had begun. Reporters marveled at precision-guided bombs zeroing in on their targets and cruise missiles appearing to turn street corners to hit the right buildings. Shelton had a front-row seat to this transformation.

As the technology has improved, so has the precision of GPS. The system originally provided accuracy to within 17 yards; with it, you could pinpoint a specific copse of pine trees. Today, if you're using a smartphone, it can generally locate an object to within five yards—a resolution fine enough to locate a pair of pine trees within that copse. Soon it could be able to zero in on a pine cone: Research from UC Riverside has demonstrated that the latest tech is reliable to within an inch. And research has shown that 1-millimeter accuracy might be eventually possible—which means that the system could locate an individual seed inside that pine cone.

Today, troops on the ground use GPS to navigate foreign streets; drone pilots can program a flight plan from thousands of miles away. And because GPS satellites also house America's detection system for nuclear detonations, we rely on them to tell us if North Korea launches a nuclear weapon, and to tell our missiles and

(@vermontgmg) is a WIRED *contributing editor. He wrote about US special counsel Robert Mueller's combat experience during the Vietnam War for issue 26.06.*

bombs where to find their targets. "When you look at our American way of war, the strategy is largely underpinned by space assets—navigation, early warning, timing," Shelton says.

And that's just the military. The creators of GPS probably never intended for the system to become the backbone of daily life, but it has. I visited Colorado while reporting this story and tried to keep tabs on everything I did that relied on GPS. There were the obvious navigational moments—my Uber ride to the airport, my American Airlines flight to Denver, my own Google Maps–guided drive in a rental car to Schriever Air Force Base, outside Colorado Springs. But there were also less obvious instances, like the phone calls I made along the way (cellular networks rely on GPS data to keep their stations synchronized), my stop at the ATM (banks use GPS to track deposits and withdrawals), and the fill-up at the gas station (the credit card system also relies on GPS). Moreover, GPS is no longer the world's sole geolocating mechanism. Russia, China, and the European Union have now all either deployed or begun working on their own full constellations of navigation satellites, ensuring that they won't have to rely on the US system. It also means that, in the early moments of a war, it's a fair bet that satellites—the other guy's satellites—could be among the first targets.



mountain outpost in the Fulda Gap, the shortest route between East and West Germany, served as an early warning trip wire for a Soviet invasion of Europe. If Russian tanks ever made a surprise attack, NATO planners knew that the soldiers there would likely be the first to find out.

Today, the members of 2Sops play a similar role. Deep inside the squat, beige, windowless Building 400 at Schriever Air Force Base—the destination I had plugged into Google Maps during my trip to Colorado—10 people at a time remotely operate the heavenly constellation of GPS satellites that guide Tomahawk cruise missiles to their targets, deliver Lyft passengers to their destinations, and help farmers cultivate their crops. They also watch out for any shocks or attacks on the system.

The average GPS operators are in their mid-twenties. During one recent shift, the entire Global Positioning System was being operated by two 19-year-old airmen (who, the Air Force emphasizes, are rigorously trained). Their commander, US Air Force lieutenant colonel Peter Norsky, is in his mid-thirties. Together, they watch over the roughly three dozen GPS satellites, troubleshooting the geolocation system and minding the quirks of each orbiting craft—this one's damaged solar panels, that one's balky communications links—as if they were remotely tending a stable full of temperamental horses.

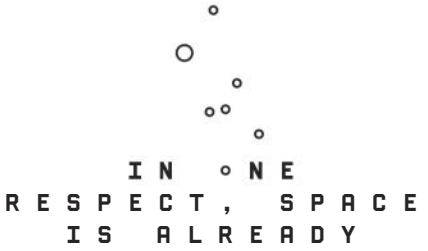
As integral as GPS is to daily life, the way it actually works is little understood by most people outside of Schriever Air Force Base. Fundamentally, the function of GPS is to provide the globe with a shared clock. GPS satellites allow phone companies to keep their systems in sync, battleships to chart open waters, and ATMs to time-stamp their transactions by triangulating signals from overhead and measuring how long it takes those signals from different satellites to reach a GPS receiver.

The system works by making daily calculations, employing Newtonian physics and Einsteinian relativity, to minutely tweak the time broadcast from each GPS satellite as it moves through space—the high-tech version of tuning your grandfather clock to within 100-billionths of a second. Time is, after all, relative; as of January, the time in space was 18 seconds ahead of Earth's "Coordinated Universal Time," since space doesn't recognize the leap seconds that scientists add to terrestrial time to account for the planet's slowing rotation. Additionally, the time-keeping device on each satellite gives a subtly different reading, the result of variations in their atomic clocks, which tell time by measuring the precise oscillations of an atom. (Some GPS satellites use rubidium atoms, which are highly accurate day to day; some use cesium, which is more accurate over long stretches.)

Any malfunction in the GPS system threatens to plunge the global economy into chaos. Fortunately those glitches are rare, but they're not unheard of. On January 25, 2016, one of 2Sops' flight commanders, Captain Aaron Blain, was awoken by a call from work in the middle of the night. User reports from around the country suggested that the system's precision had "wobbled," making measurements increasingly inaccurate. Blain raced to Schriever in his Ford pickup and found that the constellation's timing was off by about 13 microseconds. It was an infinitesimal number—over 25,000 times shorter than the blink of an eye—but for the finely tuned GPS it was a yawning crevice. Left uncorrected, the glitch could have ricocheted through the global economy, corrupting not just driving directions but stock trades too.

Alongside the rest of his team, Blain worked through the night, chugging Mountain Dew. It took about six hours to locate the problem—a single corrupted measurement—and then individually reset the affected satellites. (Russia's GPS equivalent, known as Glonass, has suffered even more serious issues. In 2014 it went down for 10 hours, but many Glonass receivers can also use GPS as a backup, so the systemic chaos was limited.)

2Sops averted a benign catastrophe that night, but it seems increasingly worried about what China and Russia are doing up in the heavens, out of sight. It recently doubled the number of airmen who oversee the satellites, so one team can run the GPS constellation while another trains to face worst-case scenarios—what the Pentagon refers to as "a contested, degraded, and operationally limited environment." That is, a space war.



like a war zone: It's increasingly shot through with flying shrapnel. By some estimates, there are more than 100 million pieces of debris zipping around in Earth's orbit. China's 2007 anti-satellite test is estimated to have created some 150,000 new ones, many too small to be tracked. In 2013, some of those fragments hit a Russian satellite—threatening to add still more debris to the orbital mix. And as commercial ventures like SpaceX and Blue Origin ramp up their space tourism plans, Earth's orbit is about to get even more crowded with both junk and spacecraft. Scientists say there could be a point at which the density of objects spinning around the planet reaches a threshold—called the Kessler effect—that triggers a runaway cascade of collisions: an entire orbit, in other words, set to Blend.

Another tricky thing about space debris is that sometimes it isn't just debris. A US military program called the Space Surveillance Network carefully tracks and monitors every piece of space junk that's larger than a softball. That currently amounts to some 20,000 objects—everything from old satellite parts to discarded rocket boosters to a pair of pliers lost during an astronaut's spacewalk. In 2014, a piece of presumptive space junk known to the US military as Object 2014-28E began to behave strangely. The object, known to be of Russian origin, started to perform complicated maneuvers. "That's concerning—when you see something that appears to be debris come to life," Shelton says. Object 2014-28E was, in fact, an autonomous spacecraft capable of veering off course and sidling up to other objects, including American commercial communications satellites.

In the years since, Object 2014-28E has been joined by similar space objects of Russian provenance. Analysts fear that they might mark the revival of a Russian program known as Satellite Killer, which was shut down after the Cold War. But it's difficult, even for US government analysts, to know for certain whether that fear is warranted. The secrecy that surrounds nearly everything space-related makes it hard to assess any adversary's capabilities. Discerning *intentions* is especially difficult. "If I wanted to build a satellite that looked very different from its actual mission, that's not hard to do," Shelton says.

A satellite that maneuvers close to another could be doing a repair job or squaring up for an attack—and it might use the same tools for both. "Small satellites with small grappling arms—they have both military and nonmilitary uses," says Dean Cheng, who studies China's military capabilities at the Heritage Foundation. "If I manipulate a satellite's bits and pieces, I can also rip something out." The US has also been secretive in developing what may or may not be weapons in space. Last May, the Air Force announced that an unmanned space-shuttle-like vehicle that appears to be classified had completed 718 days orbiting Earth, doing who knows what. As of this May, another OTV was circling the globe, more than 200 days into its mostly classified mission.

Todd Harrison, director of the Aerospace Security Project at the Center for Strategic and International Studies in Washington, explains that there are effectively four categories of space weapons: kinetic (aimed at destroying a satellite), nonkinetic (aimed at disabling a satellite without touching it), electromagnetic (aimed at interfering with a satellite's signals), and cyber (aimed at corrupting the data sent to a satellite).

The US tested its own anti-satellite missile in 2008, shooting down an errant spy satellite as it was falling out of orbit. Russia has repeatedly flight-tested a so-called direct ascent weapon, the PL-19 Nudol ballistic missile, which could strike objects in orbit, although it hasn't conducted a live attack on an orbiting satellite. And in the decade since China shot down its weather satellite in 2007, Beijing has launched multiple ballistic missile tests that extended into orbit. In addition, a trio of Chinese satellites have practiced "close-proximity operations," similar to those performed by the Russian Object 2014-28E. Anti-satellite weapons form just one part of what China calls *shashoujian*, or "assassin's mace" systems, which can be used at the start of an attack to achieve a surprise, decisive advantage over a technologically superior foe. There's also the growing challenge of cyberattacks on satellites: Chinese hackers have reportedly infiltrated the US weather satellite system, and a Romanian hacker announced that he had accessed the server of one of NASA's space flight centers. In the past decade, at least two nonmilitary US satellite systems have experienced brief, unattributed glitches tied to hacking attacks.

Some actors have begun to exploit the fragility not of satellites themselves, but of the signals they broadcast. By the time the radio signals from a GPS satellite reach Earth from thousands of miles up, they can be easily overridden by a stronger signal broadcast on the same frequency. Simple GPS jammers sell online for $119, but they have a short reach. Militaries appear to be acquiring much more powerful jamming technologies. In 2016, roughly 1,000 planes and 700 vessels at sea reportedly experienced problems with their GPS signals near North Korea, which is believed to have purchased Russian jammers that can be mounted on trucks. Those devices have an effective radius of 30 to 60 miles. The US seems to possess similar technology; a test that went awry near a Navy base in San Diego in 2007 knocked out GPS signals to cell phone network operators for at least two hours.

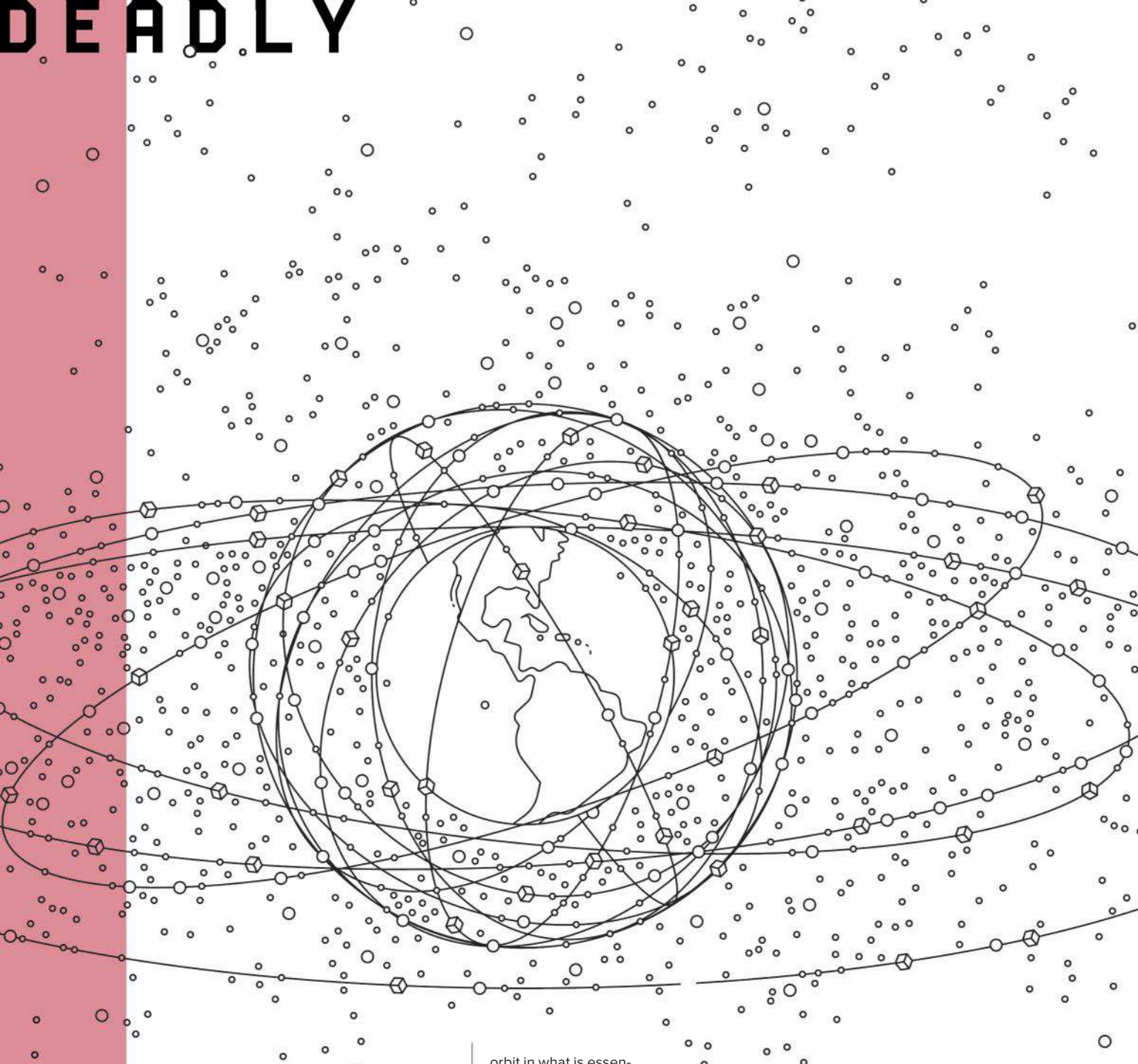
More troubling than simple jamming, though, is the rise of "spoofing," which overrides correct GPS data with a more powerful localized signal that delivers false information to a receiver. In 2013 a team of researchers from the University of Texas at Austin successfully led astray an $80 million yacht in the Mediterranean, overpowering its GPS receivers and sending it onto a new course. The dirty truth about spoofing is that secure channels are no defense against it. "Even our encrypted military GPS receivers can be spoofed," Harrison says.



SHELTON, WHO RETIRED IN 2014

after 38 years in the Air Force, lives not far from 2Sops in Colorado; these days he chairs an educational and advocacy nonprofit called the Space Foundation. He still expends a lot of energy worrying about what is happening in the heavens. "We as a nation have been too slow to respond to this threat," he says. He's particularly troubled by the failure of the US to procure new space systems. Some GPS satellites are older than the people running them. "Our systems are archaic," Shelton says. "Because space assets are so expensive, we deploy 'just enough'; there's no backup or excess capability." (The Air Force noted that the GPS constellation consists of more than 30 satellites, which provides some redundancy.)

DEADLY



IN ORBIT, TRASH BECOMES SHRAPNEL

DEBRIS

When objects in space collide—whether by accident or because, say, someone down on Earth has decided to launch a missile at a satellite—it sometimes creates a hail of smaller fragments that fan out across Earth's orbit. Those pieces of extraterrestrial shrapnel can keep flying around for years, at up to 17,000 mph, more than five times faster than a bullet. Even dust-sized specks and stray paint flecks can do damage because of their sheer momentum. If countries were to open fire on one another's satellites, it could shroud Earth's orbit in what is essentially a perpetual hail of bullets.

It's already getting difficult to operate satellites and conduct launches amid all the junk zipping around up there. That's why, around the world, scientists and engineers are devising ways to pull space junk out of orbit. In April, a SpaceX rocket carried a collection of experimental debris-removal technologies to the International Space Station. During its time in orbit, the satellite will test out nets, harpoons, and drag sails designed to reduce detritus.

—SARASWATI RATHOD

20,000
Pieces of space debris larger than a softball

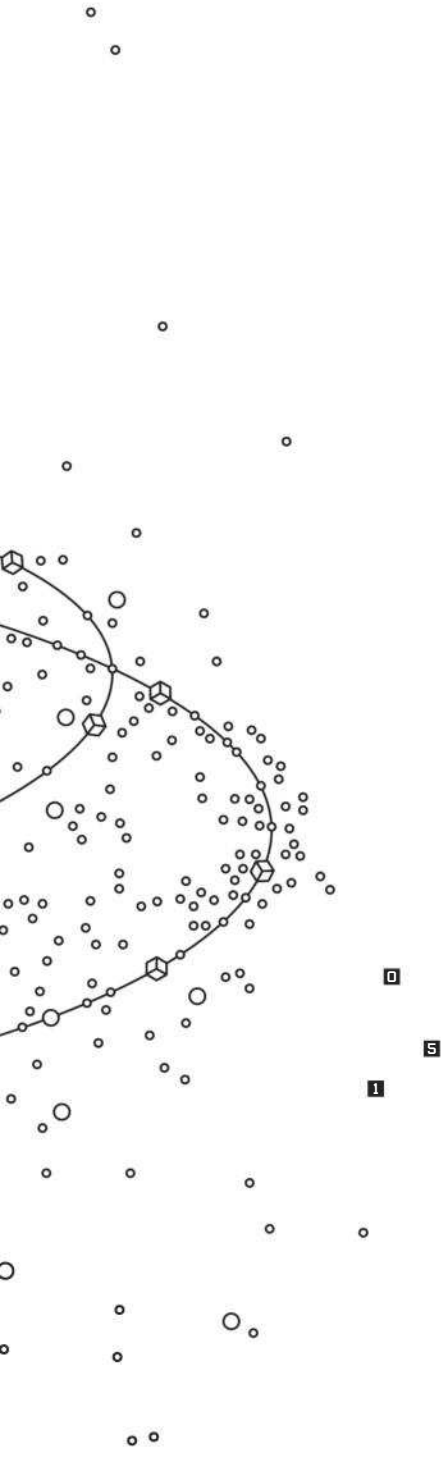
500,000
Pieces of debris the size of a marble or larger

4,300
Number of satellites in space

72
Percent of satellites that are non-functioning

$1.4 billion
Cost of degradation to commercial satellites caused by debris

SOURCES: EUROPEAN SPACE AGENCY; NASA; AEROSPACE CORPORATION



2,000
Number of trackable fragments created by the last major satellite collision in 2009

160 million
Estimated number of pieces of space junk too small to be tracked

China, by contrast, is investing heavily in its space program, seeing it as a symbol of its growing prominence. As soon as this year, it could land a craft on the never-before-touched far side of the moon. And China's global navigation satellite system, known as BeiDou, has some capabilities that outmatch even the United States' GPS. In 2015, China created a new space-focused military service, known as the People's Liberation Army Strategic Support Force. Meanwhile, the US relies entirely on Russian rockets to get its astronauts to the Space Station (although NASA has awarded contracts to Boeing and SpaceX to fix that). As Cheng says, "Today China is one of two countries that can put a person into space—and the other country isn't the United States."

Many of America's space warriors, as they call themselves, share Shelton's sense that the US isn't responding nearly quickly enough to the threat of orbital war. "We needed to be marching faster," says Deborah Lee James, who served as President Obama's secretary of the Air Force. "Why aren't there more space and cyber officers at the top of the Air Force?"

Addressing these issues, as James' question suggests, is not just about throwing money at the space-industrial complex. It involves organizational changes too. The Air Force is building what it calls the nation's first Space Mission Force, made up of airmen trained to respond to the demands of an orbital war. On the same base as the 2Sops command center, the military has established the National Space Defense Center, which puts representatives from various military and intelligence offices focused on space under a single roof. And the defense authorization bill is full of upgrades to the Air Force's space-fighting capabilities, including the creation of an additional Air Force unit responsible for space warfighting operations.

Not content to tinker with the Air Force, a growing number of people in Washington are talking about creating an entire *new* military branch dedicated to space operations. In May, during a ceremony honoring West Point's football team, President Trump told his audience, "You will be part of the five proud branches of the United States Armed Forces—Army, Navy, Marines, Air Force, and the Coast Guard. And we're actually thinking of a sixth, and that would be the Space Force." He went on: "We're getting very big in space, both militarily and for other reasons, and we are seriously thinking of the Space Force."

While these "Space Force" comments sounded to many listeners like yet another oddball Trumpian tangent, they actually do reflect a solid policy proposal. Last year, a bill that included the creation of just such a new branch of the military passed the US House of Representatives, but that provision was taken out of the Senate version.

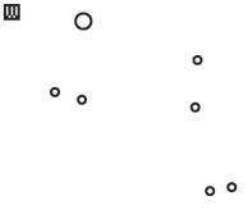
Part of the challenge in figuring out how to think about space conflict is the sheer complexity of the environment—an arena that has long belonged to nation-states will increasingly become a domain of commerce and tourism. How do countries protect their interests up above—and down here? Right now, countries appear to be racing to build their military capabilities—but an arms race isn't the only answer.

The last time an arms race appeared poised to overtake space, the world's superpowers banded together to sign the 1967 Outer Space Treaty, which banned weapons of mass destruction in space and held that "the moon and other celestial bodies" should be reserved for peaceful purposes. The Outer Space Treaty is still in force, but it is by now full of holes. Legal scholars had a hard time proving that China's 2007 anti-satellite test, for instance, violated the agreement. That's because the missile that China fired was not technically addressed in the 50-year-old treaty.

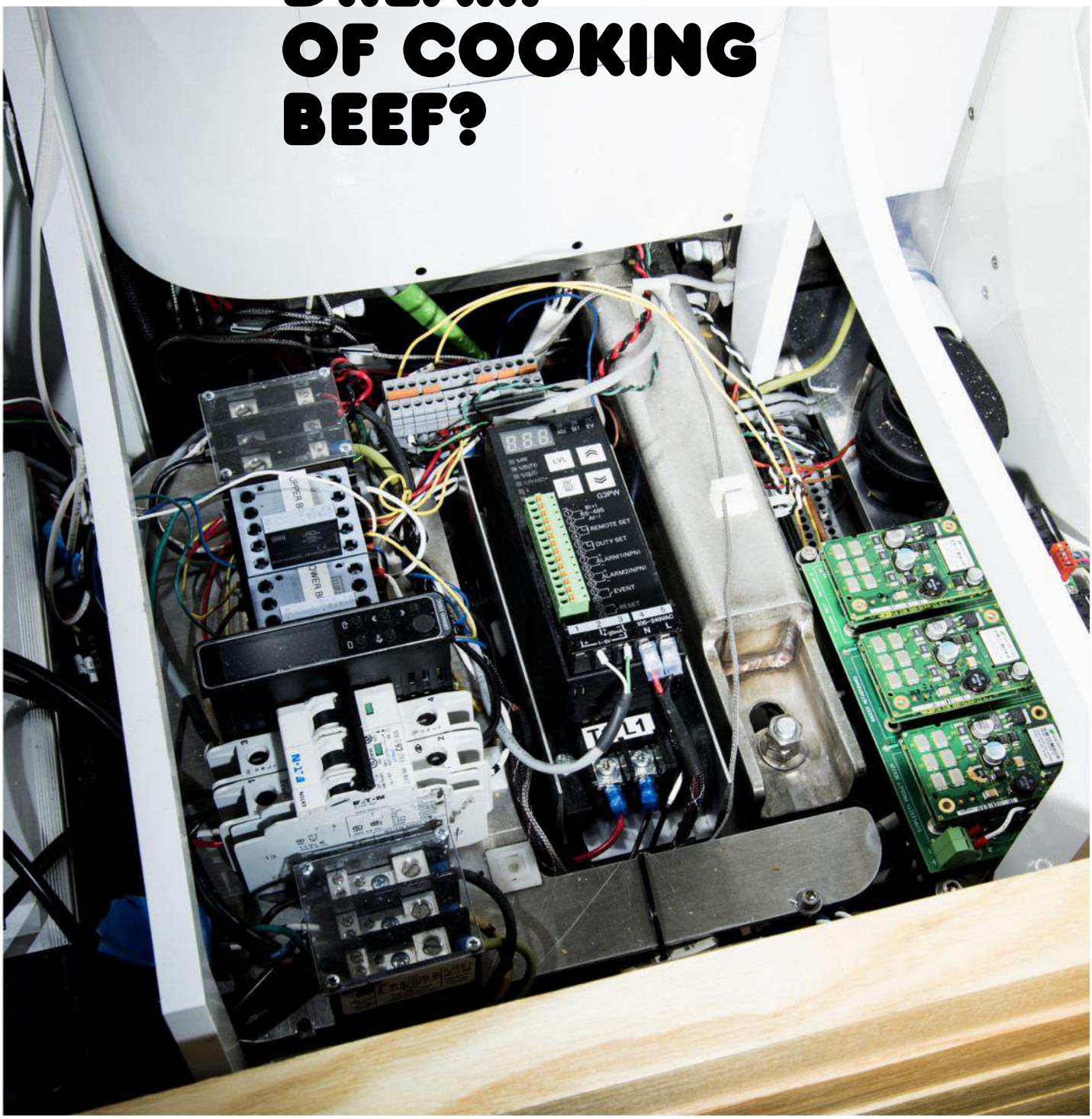
Part of what makes space such volatile terrain right now is that it's hard even to apply the existing laws of war to it. No country can claim sovereignty in orbit, and it's impossible to occupy territory there. So what counts as an act of territorial aggression? What qualifies as a proportional response? It's even difficult to say, with certainty, what the physics of war in space will look like. We don't well understand, for instance, how a kinetic attack on a satellite constellation might spill over into a spiraling Kessler effect.

Humans have "millennia of experience in blowing up things on land," says Laurie Blank, a law professor at Emory University and a specialist in the laws of armed conflict. "We're still learning the consequences of all these things in space."

Blank recently joined together with an international team of legal experts to create what they're calling the Woomera Manual on the International Law of Military Space Operations—a kind of rule book for celestial international conflict, one that will endeavor to translate the laws of terrestrial war for space. It's a daunting task, and the resulting document will be nonbinding. But, Blank says, it's a necessary first step for anyone who would seek to contain a conflict that has, in some senses, already begun.



DO ANDROIDS DREAM OF COOKING BEEF?



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PERFECT CHEESEBURGER. IT CO
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AS BEEN ON A DECADE-LONG
OBOT THAT CAN PREPARE THE
OULD ALSO PUT HIS FAMILY

BRIAN FINKE

BY LAUREN SMILEY

WEEKS AFTER HE WAS BORN, ALEX VARDAKOSTAS' MOTHER STRAPPED HIM INTO A BABY CARRIER AND WENT BACK TO WORK FLIPPING BURGERS AT A'S, the Southern California fast-food restaurant that she and her husband owned. When Vardakostas was a toddler, the town's local newspaper, *Dana Point News*, ran a photograph of him peering through the restaurant's walk-up window. As he grew older, he often played in the back of the kitchen among pallets of hamburger buns while his parents worked. At 8, he started filling drink orders, standing on top of a milk crate to reach the soda machine. Sometimes he ran food experiments, soaking burger meat in Worcestershire sauce to see if it would taste better. He learned snippets of Spanish from the line cooks, Apolinar and Ernie, and at 12 he started working beside them.

Now 33, Vardakostas lives in San Francisco, and for the past nine years, he's been building a robot that can cook and assemble around 100 burgers an hour—keeping pace with a typical fast-food staff—with little human intervention. "Our device isn't meant to make employees more efficient," Vardakostas told a reporter in 2012. "It's meant to totally obviate them."

That quote turned the entrepreneur into a Silicon Valley caricature overnight, a cautionary note in think pieces foretelling the robot revolution, worker displacement be damned. (It didn't help that Vardakostas looks the part of a dashing tech villain, with dark, wavy hair and a muscular build credited to weight lifting and a red-meat-heavy diet.) But six years on, he's as adamant as ever. Sprawled on a couch in the robot workshop of his company, Momentum Machines, he raises his voice over the whir of an industrial saw. "I'm abso-*fucking*-lutely trying to obviate that role," he says, miming the flip of a burger, over and over, eyes fixed on the imaginary patty. "As a society, if we're pushing to keep people in a burger-flipping role, we're doing something wrong."

Vardakostas insists he isn't the heartless disruptor he's been made out to be. His company isn't about destroying jobs, he says; it's about shaping the future of fast food—one in which humans will still have an important place. His skeptics will soon be able to see that vision for themselves: This summer, he's opening the doors to a San Francisco restaurant called Creator and unveiling his gleaming burger bot—a surprisingly beautiful copper and wood machine, its spotless glass chutes stacked with vivid towers of tomato, onion, lettuce, and pickle.

Just off Highway 1 in the surfing town of Dana Point, Vardakostas' mom, Maheen, still works seven days a week. The slight 66-year-old stands over the A's grill wielding a spatula, a hairnet stretched over her dark bun and a red apron around her waist, waiting for her son to put her out of a job.

A

Angelo Vardakostas sailed into Los Angeles on a Greek commercial ship in 1955. Greeks were opening diners across the country at the time—mom-and-pop analogs to the McDonald's, Carl's Jr., and Kentucky Fried Chicken chains that were multiplying in the postwar sprawl—and Angelo hopped off at the port and started looking for a job. He worked as a dishwasher and bartender at a string of restaurants, eventually snagging a position waiting tables at a fancy Beverly Hills bistro. (Once he was sent to a table with the ingredients for Caesar salad dressing, intended to be mixed tableside; not knowing any better, he poured the raw egg directly into the salad.) By the early 1970s, Angelo had saved enough to make a down payment on a joint called Archie's BBQ in the fast-food hub of Downey, California, a few miles away from the original Taco Bell. He rechristened Archie's as A's. Figuring he could save money, he later told his son, he kept the same sign and pried off the other letters.

Lauren Smiley [@lauren smiley] wrote about virtual elder care in issue 26.01.

After a few years, Angelo decamped and opened another A's location 50 miles south, in beachy Dana Point. In 1979, a pair of twenty-something sisters spotted a "help wanted" sign in the window. They had recently arrived from Iran, having fled the Islamic Revolution, and Angelo hired them on the spot.

The elder sister, Maheen, had won a national math championship when she was 17 and had graduated with a master's degree from the University of Tehran. Before leaving the country, she worked as a civil engineer for the Iranian Air Force. "I was so depressed when I got here," she remembers. "My career was gone." But the 27-year-old applied her methodical nature to her new tasks at A's, taking inventory and handling large orders during the lunch rush. While Maheen was brooding and detail-oriented, Angelo was easygoing. She found him charming. "He always brought humor," she says. The couple married in 1982. "We didn't have time to date," Maheen says, with a laugh. Alex was born in 1984, and two years later the family opened another A's outpost in San Juan Capistrano, 20 minutes from Dana Point. A year later, Alex's brother, George, was born.

Business picked up in the new location, and when Vardakostas was in grade school the family moved into a sprawling ranch house in San Juan Capistrano, where they added a tiled pool in the back. Vardakostas started working the grill, sneaking free food to friends from his private middle school between shifts. Some of the kids took to calling him Varda-Cheeseburger, a taunting twist on his last name. "My parents would come to the school dirty from work," Vardakostas says. "I had a chip on my shoulder." He got in a few fistfights, but never dared to tell his parents.

When Vardakostas reached high school, he says, his father started taking the boys on weekly trips to the local bookstore. "We'd drink frappuccinos," George recalls, "and everyone would pick their own book." While Angelo flipped through *The Wall Street Journal*, Vardakostas paged through books on science and physics. After graduating from Capistrano Valley High School with middling grades, Vardakostas headed to nearby Saddleback College. He washed and detailed cars to make extra money, eating for free twice a day at A's. In 2006, Vardakostas transferred to UC Santa Barbara to study physics. A classmate and friend, Steffanie Hughes, remembers him as a preppy kid, typically clad in a pink polo and Jack Purcells. She was impressed by his intelligence and intrigued by his unusual living arrangement. For his first few months in Santa Barbara, Vardakostas was staying at a Motel 6. He would spend hours studying in the driver's seat of his used Mercedes—a gift from his dad when he transferred to UCSB—which he liked to park at the beach. Though he loved his classes on quantum mechanics and electromagnetics, he says, his thoughts would often return to his parents and their longtime employees passing years in the A's kitchen, cooking burger after burger. An idea came to him his junior year, as he lay awake at 4 am in a bout of insomnia: "What if I could create a robotic kitchen?" The idea excited him. "Once you have a vision about how things could be better, it grows like a weed," he says. A couple of weeks before graduation, he told Hughes about his burger bot scheme. Her reaction was one he'd hear repeatedly in the ensuing decade. "You're going to displace workers," she told him.

After graduating in 2007, Vardakostas got a job automating data at a semiconductor company. Still, he says, he was fixated on the idea of a burger bot. "I was thinking, why the hell isn't anybody doing this?" He installed design software on his laptop and started studying robotics after work. Within two years, he quit his job and began building crude burger-making robot prototypes in his parents' garage. First up: the tomato slicer, pieced together for $25 using an Allen key set, PVC piping, and some balsa wood he bought at Home Depot.

Maheen urged him to get out of the burger business. His brother was baffled by his garage tinkering. "I mean, why don't you want a sexier job? Make the next iPhone," George told him. One night, a guy overheard Vardakostas talking about his burger bot at an Orange County bar and blurted out, "If my kid did that, I would shoot him." Vardakostas stopped telling people about his plan.



Momentum Machines CEO Alex Vardakostas samples robot-made burgers at Creator, his San Francisco restaurant.

By 2010, Vardakostas' robot was starting to show promise, but he knew he'd need heavy machinery to build a working prototype. He joined TechShop, a DIY makerspace in Menlo Park, and couch-crashed with Hughes, who had landed a job at Apple and was living in San Jose. Intimidated by the CNC tools, he introduced himself to a twenty-something guy in work boots he'd noticed expertly working the milling machine. The guy, Steven Frehn, was a mechanical engineer and recent Stanford grad—"one of these genius kids," Vardakostas thought. Frehn grew up in a dusty stretch of Southern California making sketches of electric cars and cities crowned with solar panels. In high school, he landed an internship working for NASA, automating sensors at an Air Force base. Now he was building his own solar panels and sweeping TechShop's floor in exchange for free use of the equipment. When Frehn asked what he was working on, Vardakostas was cagey. "A machine to cut vegetables," he replied.

The two struck up an unlikely friendship. Vardakostas is charismatic and creative, Hughes says, while Frehn is grounded and practical. Eventually, Vardakostas revealed his concept for the burger bot. "I immediately thought it was amazing," Frehn says, "but it sounded like a lot of work."

Vardakostas returned to his machine—and his parents' garage—in Orange County. When he didn't want to make the six-hour drive to San Jose, he would occasionally send Frehn robotic components via same-day delivery for quick alterations; Frehn would use TechShop's tools and rush-mail the part back. After about seven months, Vardakostas' makeshift vegetable slicer was functional.

Encouraged, Vardakostas moved on to building the conveyor belt that would move the burger down an automated assembly line, the bun slicer and toaster, and the electric grill. In the fall of 2011, after two years, a burger emerged from his machine. The robot was viable.

Now Vardakostas needed money. Hughes arranged a meeting with Lemnos Labs, one of Silicon Valley's first hardware incubators, and in November of 2011, two Lemnos partners flew to the Vardakostas home in San Juan Capistrano to visit the entrepreneur-in-waiting. Vardakostas delivered his pitch in his childhood bedroom; Lemnos partner Helen Boniske remembers that physics books were strewn on the floor.

Then he led the partners to his parents' three-car garage, now dominated by a 6-foot-tall burger beast. Vardakostas clicked Place Order on his laptop, and the machine sprang into action. A presliced bun ran through a toaster on a squeaky conveyor belt. The bottom half slid down a chute beneath the vegetable slicers, where robotic blades cut pickles, tomatoes, and onions. The patty traveled through a charbroiler on a separate conveyor belt, then glided down a chute onto the bottom bun. The top bun dropped onto the sandwich and a mechanical arm pushed the entire burger into a white paper bag. "For one dude to build this thing in a garage," Boniske says, "it was an incredible feat of engineering." Lemnos offered Vardakostas about $50,000 in seed money and invited him to join their ranks.

Two months later, Vardakostas moved to San Francisco and set up his workshop in Lemnos' SoMa district headquarters. He posted an ad on Craigslist seeking machining engineers and hired two recent college grads: Jack McDonald, a mechanical engineer from UC Berkeley, and Lucas Lincoln, a roboticist from the University of Utah. Frehn soon joined the group full-time.

The foursome set to work building a new, improved burger bot prototype, sometimes pulling days so long, Vardakostas says, that he slept in a sleeping bag under his desk. But because he wasn't looking to sell his machine to fast-food chains, venture capital firms were wary of investing. By now, Vardakostas had become convinced that his company could transform not only the repetitive act of burger making but also the entire fast-food business model, from the ingredients used to the wage structure. His dream, he says, is to open a chain of Creator restaurants across the country, delivering high-quality, inexpensive food to the masses. "It was right on the edge, man," McDonald recalls. "We believed in the idea, but it's a lot harder to convince other people that it's the future." To stretch their seed money, they often ate their machine's own imperfect trial-run burgers for lunch.

One day that fall, Avidan Ross, a roboticist turned venture capitalist, visited Lemnos Labs and spotted the burger bot across the room. "I said 'What is that?!' " he remembers. "I have to meet these people." Whereas other investors at the time were "caught up in iPhone apps, trying to find the next Snapchat," he says, his newly launched VC firm, now called Root Ventures, was focused on hardware. In a stroke of luck for Vardakostas, Ross was a kindred tinkerer: He had built his own pizza oven and several barbecue contraptions in his backyard, one of which tweeted its temperature every five minutes. Ross had also given a lot of thought to how robotics might be used to automate costly cooking techniques. Early in 2013, he wrote Momentum Machines a check for about $300,000. Google Ventures and Khosla Ventures soon followed.

Momentum Machines isn't the first to attempt to automate restaurant kitchens. In the 1960s, the American Machine & Foundry Company unveiled a fast-food device that churned out burgers, hot dogs, fries, and milkshakes at a Long Island drive-in. An attendant punched in the orders on a push-button dashboard that controlled the machinery. Though the contraption saved roughly $1,900 in cook's wages each month, it also cost $1,500 to lease. It never caught on. More recently, fast-food chains have been taking small steps toward automation, especially in ordering, but also in the more complicated process of making food. McDonald's has been installing self-service kiosks as part of its "Experience of the Future" campaign. Chains from Taco Bell to Burger King have adopted ordering apps. This spring, Little Caesars received a patent for a pizza-making robot. Over the past two years, Miso Robotics in Pasadena, California, has been developing Flippy, a burger-flipping robotic arm that works with





HOW TO WORK

1 –
Ordering
Diners customize their meals through Creator's app, which sends the information to the bot. The offerings include specialty burgers by chefs with James Beard Foundation awards and Michelin stars, such as Kyle Connaughton and Nick Balla.

2 –
Toasted bun
Employees load brioche buns into three tubes at the top of the machine. Air pressure pushes each bun into the starting position and through a blade that slices it in half. Then it travels down a vertical toaster before dropping into a compostable container.

3 –
Produce
Workers pile tomatoes, onions, pickles, and shredded lettuce into a series of refrigerated tubes each morning. As the bun moves below the chutes on a caterpillar-like conveyor belt, the robot cleaves a fresh portion from each of the vegetables.

4 –
Beef
Hunks of brisket and chuck are tumbled in a vacuum chamber with a mix of seasonings. When an order is received, the bot grinds 5 ounces of meat and shapes it into a loosely packed puck. A mechanized arm deposits the patty between two griddles, which cook it more quickly and evenly than a standard flat-top grill.

5 –
Grill
The patty is cooked at 350 degrees until medium rare. (If the meat falls below a food-safe temperature range, the machine automatically shuts down.) When it's done, a mechanized spatula slides under the patty and places it onto the open bun.

6 –
Condiments
Convection heat melts shredded cheese. Requested sauces and seasonings—including coffee-flavored salt, chipotle powder, and curry ketchup—are deposited from various dispensers.

7 –
Quality control
The burger emerges from the robot, where it's checked by a human worker.
A burger is completed every 35 seconds, on average. —L.S.

A BURGER BOT

most restaurants' preexisting grills. Flippy was slated to be deployed at CaliBurger restaurants around the country this year, but its March debut was inauspicious: After a couple of hours at the chain's Pasadena location, it fell behind on orders and was decommissioned for improvements.

The technical complexities, coupled with the cost of building a kitchen bot, mean that it will take time before robotics transforms the fast-food industry. Still, chains continue to pursue automation because they think it will boost their profits; labor costs typically make up around 30 percent of restaurant expenses. "The fact of the matter is businesses will automate when it's cost-effective," says Teofilo Reyes, a policy expert at Restaurant Opportunities United, a nonprofit that advocates better conditions for fast-food workers. Replacing multiple salaries with the one-time cost of a robot is an enticing business strategy, especially in an industry with a high turnover rate. Martin Ford, author of *Rise of the Robots: Technology and the Threat of a Jobless Future*, predicts that within the next five to 10 years, major fast-food chains will be able to reduce staff by 30 to 40 percent due to automation.

The impact of such cuts on overall employment rates is unknown, says Sylvia Allegretto, a labor economist at UC Berkeley. "The big mistake everyone makes is they can't foresee the new jobs that will come online because of the technology," she





Momentum Machines engineers receive real-time obstruction alerts from the burger bot during testing.

Vardakostas loads stacks of pickles, tomatoes, and onions into his machine. Each topping is sliced to order.

argues. The car may have put blacksmiths out of business, but it also created assembly-line jobs. Of course, automation in manufacturing has now put assembly-line workers at risk. They're being replaced by robots, overseen by a small group of humans with the expertise to manage them.

Vardakostas won't share his financial projections, but his business model makes some ambitious assumptions in its path to success. He says that the robot will eventually make burgers more efficiently than a typical fast-food restaurant, though at its current rate—about 100 burgers per machine, per hour—a McDonald's-style restaurant could keep up. App-based ordering means that Creator will be able to serve more customers, faster. The restaurant may also shore up its bottom line by serving beer, wine, and fries, items with a high profit margin. Vardakostas says he plans to spend around 45 percent of his revenue on burger ingredients, which include pasture-raised beef and organic vegetables. Most restaurants spend roughly half that on total food costs.

To Erik Brynjolfsson, coauthor of *The Second Machine Age*, it makes sense that Momentum Machines is opening its own restaurant rather than shopping its bot around to existing chains. "You can't just pop the robot into a restaurant and leave the whole rest of the business the same," he says. "You have to reinvent the roles of the people, the types of ingredients, your price points. Replacing a human burger-flipper with a machine isn't the big payoff—the payoff is inventing a totally new kind of restaurant."

While robots will serve as Creator's chefs and cashless cashiers, they won't be without human support. This spring, Momentum Machines hired its first restaurant employees, including a general manager, a host to explain how the smartphone ordering process works, and "burger buffs" trained to maintain the machine and deliver meals to tables. Up to nine employees will work during Creator's peak hours—on par with a standard fast-food restaurant—and Vardakostas says he'll pay them $16 an hour, $1 above San Francisco's minimum wage.

All this raises the question: Can Creator actually make money, or will it become another overhyped gimmick propped up by VC funding? "It's to be determined," says Aaron Noveshen, founder of the restaurant consultancy the Culinary Edge and an early Momentum Machines adviser. "If it doesn't take five people to stand next to the robot to make it work, then they can reach profitability." Helen Boniske believes Alex could charge more than his proposed price of $6 to $7 per burger, with an eye to Creator's eventual expansion.

While Creator is a contained testing ground, for now, the idea of robotic kitchens catching on throughout the restaurant industry is unsettling to many. "For some reason, with our burger bot, people have a visceral reaction: This machine is doing exactly what you see a human doing," acknowledges McDonald, one of Momentum's original engineers. There is something especially troubling about fast-food workers being tossed aside—perhaps because those jobs are viewed as a place for people who have limited options. The median income for a fast-food worker is around $21,000, and more than half receive some public assistance. "The reality is that many people who work in fast food may be well suited for routine jobs," Ford says.

Alex balks at such sentiments. He sees burger flippers as trapped by their jobs, not clinging to them. "You don't grow up next to fast-food workers without realizing these people are capable of so much more—it becomes this sort of haunting thing," he says. "People say, oh, flipping burgers is the only thing they can do. That's fucking bigoted. Dude, no, we can do a lot more than flip burgers. We just haven't had a chance."

For a line cook who just lost his job, though, Vardakostas' vision may offer little consolation.

A

At Creator in San Francisco, Vardakostas walks over to inspect his machine's latest burger. For the past year, the restaurant's unfinished dining area has been his second office, his 50 employees gliding between the two buildings on scooters and skateboards. At the moment, the restaurant windows are frosted over to thwart oglers, and the rare visitor is required to sign a nondisclosure agreement and cover their phone's camera lens with a sticker. It's mid-April, and the team is customizing burger orders from Creator's smartphone app for the first time, requesting extra cheese or chipotle powder instead of jalapeño salt. Half a dozen developers and software engineers are seated at the dining tables with their laptops, obsessively tracking the real-time progress of the two identical robots across the room.

Amid the bustle of machinery, finishing touches are being put in place to make the space feel more like a homey café than, say, a dystopian factory. One wall is painted with yellow Fibonacci spirals. Burger ingredients chill in glass-front refrigerators alongside meticulously written explanations of their provenance. Customers will be invited to browse books while they wait for their orders, from design tomes to Eric Schlosser's *Fast Food Nation*.

After nearly a decade of R&D, Vardakostas says, "we had our pick" of VC firms during last year's fund-raising round. He recently received investments from Root Ventures, Zynga cofounder Justin Waldron, Great Oaks Venture Capital in New York, and K5 Ventures in Orange County. According to its 2017 SEC filings, Momentum Machines raised $18.4 million in funds.

Despite his insistence that he's not selling his robot, Vardakostas claims his company has heard from fast-food chains and sports stadiums that are interested in purchasing it. "We were able to get them an introduction to Burger King really early on," Boniske says. "It was just too early to have a substantial discussion. Burger King's reps said 'I don't believe it's possible.' " It's hard to know if Vardakostas will sell in the end, but it's easy to imagine. Maybe Creator's opening will be an inflection point, like the day in 1948 when two McDonald brothers decided to make their customers walk up to the counter to collect their burgers, rather than hiring servers to deliver them to cars. Maybe nothing much will change at all.

In Dana Point, Maheen says she awaits the day she can install one of her son's burger robots at A's. She says she sees his machines as the next chapter in their family's American success story, payoff for all those years she and her husband spent in the kitchen. "You know who wants to lose their jobs?" Maheen asks wryly, slouched in a booth at A's during a weekend lull. "It's the managers." Once her son's long-promised burger bot arrives, she says, she may even consider retiring.





The Wall

President Trump wants a big, beautiful barrier on the US-Mexico border. Oculus founder Palmer Luckey has a plan to make it happen, with a human-targeting panopticon.

By Steven Levy

Photographs by Benjamin Rasmussen



We're standing on the edge of a cliff on a remote Texas ranch, a long patch of rocky desert stretching out below to the verdant banks of the Rio Grande, a silver ribbon 2 miles distant. On the horizon, a light haze shrouds the mountains of northern Mexico. The whistle of a stiff and constant wind cuts through a silence that gives no hint of the hostilities, both physical and political, that animate these borderlands.

Palmer Luckey—yes, that Palmer Luckey, the 25-year-old entrepreneur who founded the virtual reality company Oculus, sold it to Facebook, and then left Facebook in a haze of political controversy—hands me a Samsung Gear VR headset. Slipping it over my eyes, I am instantly immersed in a digital world that simulates the exact view I had just been enjoying in real life. In the virtual valley below is a glowing green square with text that reads PERSON 98%. Luckey directs me to tilt my head downward, toward the box, and suddenly an image pops up over the VR rendering. A human is making his way through the rugged sagebrush, a scene captured by cameras on a tower behind me. To his right I see another green box, this one labeled ANIMAL 86%. Zooming in on it brings up a photo of a calf, grazing a bit outside its usual range.

The system I'm trying out is Luckey's solution to how the US should detect unauthorized border crossings. It merges VR with surveillance tools to create a digital wall that is not a barrier so much as a web of all-seeing eyes, with intelligence to know what it sees. Luckey's company, Anduril Industries, is pitching its technology to the Department of Homeland Security as a complement to—or substitute for—much of President Trump's promised physical wall along the border with Mexico.

Anduril is barely a year old, and the trespassing I'd witnessed was part of an informal test on a rancher's private land. The company has installed three portable, 32-foot towers packed with radar, communications antennae, and a laser-enhanced camera—the first implementation of a system Anduril is calling Lattice. It can detect and identify motion within about a 2-mile radius. The person I saw in my headset was an Anduril technician dispatched to the valley via ATV to demonstrate how the system works; he was about a mile away.

As Luckey and his team see it, Lattice will become not just a system for securing the border but a general platform for geographic near-omniscience. With the aid of artificial intelligence, it aims to synthesize data from potentially thousands of sensors and local databases, displaying the most relevant data in phone apps, on laptop screens, and in mixed-reality headsets. Anduril's goal is to become a major tech startup that builds hardware and software specifically for the defense industry, a venture-capital-infused outsider challenging the likes of Lockheed Martin and Northrop Grumman with their multibillion-dollar government contracts and strong establishment ties.

The idea of the nimble maverick overthrowing lead-footed incumbents is, of course, the favorite startup narrative. But the people behind Anduril are not untested newbies; they have significant experience in tech and politics. Besides Luckey, who gave money to an alt-right group and donated to Trump's inaugural committee, the team includes former executives from the secretive data-crunching company Palantir, whose

↗ At Anduril's headquarters in Orange County, Palmer Luckey has been hands-on in building the company's technology.



work for many government agencies has raised alarms about intrusive surveillance. And Anduril's lead investor is Founders Fund, the VC firm headed by Peter Thiel, a prominent Trump supporter and the guy who shut down Gawker.

The politics of Anduril's founders may not be popular in liberal Silicon Valley, but they need to please a different audience: members of Congress and government bureaucrats. To win big border contracts, Anduril must beat out other companies peddling visions of an electronic border wall, including an Israeli firm called Elbit Systems, as well as traditional defense giants. Its advantages are operating cheaply and moving quickly. In a little over a year the company not only built and deployed its prototype in Texas, it has also launched a government-funded evaluation project under way outside of San Diego. It promises a system that would cost a small fraction of a physical wall and is cheaper than its digital competitors.

Of course, Anduril still has to prove its technology works in a more extensive test. But early signs look good. According to US Customs and Border Protection, in a 10-week period, Lattice's test in Texas helped customs agents catch 55 unauthorized border crossers, a notable figure for a system still in development. If Luckey has his way, the border wall of the future will be Anduril's.

LUCKEY

grew up in Long Beach, California; his dad was a car salesman, and his mother homeschooled him and his three sisters. "I was a PC gamer," he told me in 2015, "and I was always upgrading my PC, getting the best monitors, the newest graphics cards." He wanted to feel as if he were "actually in the game, like the game is actually real." By collecting and sublimely tweaking the technology available, Luckey created a homegrown VR system. He called his system Oculus and described it on a Kickstarter page in August 2012 as "designed by gamers, for gamers." But when Mark Zuckerberg tried it out in 2014, the Facebook CEO saw it as the social computing platform of the future. Facebook bought Luckey's company for $2 billion.

In June of that year, a newly enriched Luckey attended a retreat hosted by Founders Fund, which had been an early Oculus investor, on Sonora Island in British Columbia. There he met an employee at the fund named Trae Stephens, then age 30. Earlier in his career, Stephens had worked at a government intelligence agency that he will not publicly identify; in 2008, he joined Palantir. In 2014, Thiel convinced Stephens to join Founders Fund and specialize in investments



involving the government. Stephens found it ridiculous that almost no venture-backed companies worked closely with the government, with its billions of dollars to spend. "After Palantir and SpaceX, there's nothing," he says. Founders Fund also was an early SpaceX investor, and Stephens' goal was to fund a company to join that duo. He was coming up empty. The Valley, it seemed, didn't do government.

Over meals at the Canadian eco-resort, Luckey and Stephens bonded over a shared passion for defense tech. Luckey had once worked on a program that used VR to treat PTSD, which led him to think about how military tech worked—and how it didn't. During his Oculus years, he had read up on projects like the troubled F-35 fighter, which had a problematic head-up display, and realized that applying lessons from the consumer world could improve its design and lower costs.

After the Sonora Island trip, Luckey and Stephens kept in touch, and in 2016 the pair began speculating about starting a company together. They threw around a lot of ideas, some of them straight out of comic books—*What if we built a force field?* As that year ended, Stephens was making regular trips to Washington, DC, from San Francisco. Donald Trump was the president-elect, and Thiel, who was on the presidential transition team, brought Stephens on to focus on the Department of Defense. It was a useful post for someone thinking about a defense business.

Meanwhile, Luckey's political activities had made him the object of tech-press scorn. News reports claimed that Luckey was involved in an alt-right group called Nimble America, paying for billboards ripping Hillary Clinton as "TOO BIG TO JAIL" and allegedly penning vicious Reddit posts for the group. On his public Facebook page, he denied many of the allegations but confirmed that he donated $10,000 to Nimble America because he "thought the organization had fresh ideas on how to communicate with young voters." He apologized for "negatively impacting the perception of Oculus and its partners." When asked about this now, the normally buoyant Luckey drops his smile and chooses his words carefully, claiming that his politics are misunderstood. "The alt-right, as it exists, as it's defined, I do not support, never have," he says. He describes himself as "fiscally conservative, pro-freedom, little-*L* libertarian, and big-*R* Republican."

On the last day of March 2017, Luckey was ousted from Facebook. Neither party is sharing the details of his exit. (The

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STEVEN LEVY *(@stevenlevy) wrote about cryptographic back doors in issue 26.05.*

issue even came up at Zuckerberg's April 2018 Senate hearing, when Republican senator Ted Cruz, who has received $5,400 in political donations from Luckey, demanded, "Why was Palmer Luckey fired?" Zuckerberg said only that it wasn't because of his politics.) And what did Luckey learn from his experience at Facebook and Oculus? "Be careful who you trust," he says. "Be careful who has control."

On his first day as a free agent, Luckey connected with Stephens, ready to start building the company they'd discussed. Stephens didn't hesitate. Their guiding vision was something like Stark Industries—the mind-blowing font of matériel in the *Iron Man* movies. (Luckey is a voracious consumer of popcorn flicks; one of his favorites is *Pacific Rim*.) And it would probably involve VR.

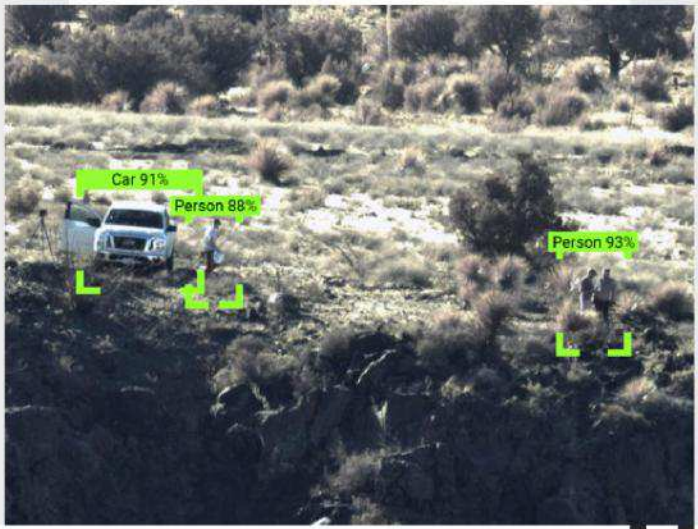
They began recruiting a team. Stephens suggested Matt Grimm, a former Palantir colleague. Luckey proposed a fourth cofounder, Joe Chen, an engineer who had worked at Oculus before joining a Hollywood VR startup. Chen had also served in the National Guard. Both men signed on. "I'd been an end user on some very, very bad VR military simulation



← The camera mounted on Anduril's surveillance towers takes still images in quick succession.

→ Screens show information about Anduril's towers.

↓ Artificial intelligence identifies whether it has spotted a moving person, vehicle, animal, or tumbleweed.



COURTESY OF ANDURIL

systems," Chen says. "Once Palmer said 'Hey, we gotta fix this,' I was like, 'All right, cool.' "

On April 7, exactly a week after Luckey left Facebook, the four invited around half a dozen potential recruits to Luckey's Orange County home. As the guests ate Chick-fil-A, the founders presented a pitch deck. By attracting "disruptive talent with a Silicon Valley vision, Anduril will be the next great defense company," it promised. They would need "crazy mad scientists," political connections, and lots of capital. "Almost every single person that was at that initial dinner is here right now," Stephens says.

Luckey secured warehouse space in an industrial area of Orange County. When the team approached Founders Fund, Brian Singerman, a partner who was also the first Oculus investor, agreed to lead the fund's $17.5 million seed round. "Palmer is an insanely brilliant technologist," he says. "A little bit ... out there. But most brilliant people are." (This May, Founders Fund led a $41 million Series A round.)

Luckey, Stephens, and Grimm also made their pitch to Palantir's directors. In attendance was Brian Schimpf, Palantir's head of engineering. After the session, Schimpf told them he wanted in. He became the fifth cofounder and CEO, with Grimm as COO and Luckey as CTO. Stephens chairs the board (he never left Founders Fund).

The company's name also has a Palantir connection. Middle-earth buffs will recognize Anduril as the enchanted blade that was Aragorn's go-to lethal weapon; a palantir is a magical crystal ball from

the same Tolkien universe. "All of us are *Lord of the Rings* fans, so it was a pretty fun name," Luckey says. "Also, I have Anduril the sword hanging on my wall." (Luckey procured a collector's version, not the original movie prop.)

They had a name and an executive team. But what was the product? "The DOD has been asking for what some people describe as *Call of Duty* goggles," Luckey says. "Like, you put on the glasses, and the headset display tells you where the good guys are, where the bad guys are, where your air support is, where you're going, where you were." (Pause to consider this Escher-esque scenario of soldiers clamoring for gear inspired by a game that mimics their combat experience.) But tiny Anduril—with no experience or history—couldn't just barge into the Pentagon and demand to build battlefield tech. "We needed a quick win," Schimpf says.

Anduril's pitch deck offered a sci-fi fantasia, including autonomous long-range bombers, attack-drone swarms, and something they called "perimeter security on a pole." The team zeroed in on this last notion. They figured they could build a surveillance tower using off-the-shelf sensors and cameras, connect them in a network, and make something in the spirit of Google Maps and *Pokémon Go*. By using AI, the system would identify what data was important. Stephens thought the Pentagon might see its value in securing forward operating bases—outposts in hostile territory. But Luckey had another idea: border security. A system to monitor America's southern perimeter would require components similar to those in a combat awareness platform. What's more, it was clear Mexico wasn't paying for that big, beautiful wall that Trump had promised. The government, they realized, might be receptive to their budget-friendly pitch.

Silicon Valley, meet the US-Mexico border.



→ *MythBusters* cohost Jamie Hyneman is building an autonomous firefighting tank for Anduril.



↘ The border towers include radar, communications antennae, and a camera enhanced by a laser from a hair-removal device.

↓ Anduril is trying out small, cheap helicopter-style drones.

TO

find their way to the border, Anduril executives started by approaching a California office of the Department of Homeland Security in June 2017. "They said they could provide broader border security for a lower cost. We were intrigued by that," says Melissa Ho, managing director of Silicon Valley's DHS

office. The DHS introduced Anduril's executives to border patrol officials, and a border patrol team near San Diego was happy to brief them. "They saw us as their own SpaceX," Schimpf says—that is, a nimble private entity that could provide specialized technology. Later, when the San Diego office of Customs and Border Protection was setting up tests of new border systems, it selected Anduril for a pilot project.

Anduril is suggesting a new way to secure the border electronically, but it is far from the first. Hundreds of millions of dollars have been spent on comically ineffective systems (in one of them the radars would get activated by rain). In the mid-2000s, Homeland Security initiated a competition to create SBInet, a comprehensive virtual wall. In September 2006, Boeing won a contract to start building a system that was estimated to cost $7.6 billion. It began constructing 80-foot-high towers loaded with equipment. In January 2011, after a series of cost overruns, late deliveries, and a basic failure to catch people crossing the border, then Homeland Security chief Janet Napolitano pulled the plug. With massive understatement, a DHS report said that SBInet "does not meet current standards for viability and cost effectiveness."

SBInet was a case of government contracting run amok. "You learn lessons from failure," says CBP commissioner Kevin McAleenan. Anduril, like both Palantir and SpaceX, seeks to avoid some common pitfalls. Instead of selling technology to the government for a huge up-front fee, it plans to own the system and lease it, with the data it collects belonging to whatever agency issues the contract. This arrangement, Stephens says, creates an incentive to keep development costs low.

Part of SBInet's failure was that it came too early. Sensors that cost a few bucks today were thousands of dollars a decade ago. Artificial intelligence is no longer an aspiration but a tool that delivers results. But technological attempts to secure the border have also tended to rely on complicated technologies, such as Predator drones, that aren't cost-effective for long stretches of the border. A much simpler surveillance system could work fine, as long as agents received useful alerts from it. "The key was just finding a way to get information in the hands of agents," Schimpf says.

Its competitors in the smart-wall business were pitching taller towers with exotic microwave transmitters and other bespoke gadgetry. For Anduril, the key to making consumer tech work was to combine it with AI. The company taught its software to identify the patterns of a person on the move, allowing it to avoid the expensive zoom lenses and thermal sensors used in competing systems, Schimpf says. "The sophistication of Nest-level technology isn't bad," he says, referring to the smart thermostats and motion detectors designed to automate a home. "And no one has used AI for this purpose yet. If you can identify objects with AI, you don't need to see as far."

Within a couple of months, Anduril had a prototype. Schimpf and his colleagues took it to a test range in Apple Valley, a two-hour drive from their Orange County office. "We lived out of the trailer there," Schimpf says. Using open source machine-learning training data, they taught the software how to tell humans from animals or tumbleweeds, and unearthed some glitches. In a certain light, for example, the system can mistake the rear end of a horse for a person.

What they didn't find in affordable parts was a way to capture distant moving objects at night. Thermal cameras cost hundreds of thousands of dollars and fare poorly in the wind and dirt of the Texas border. But Luckey had an idea: Sync a laser beam to a virtual shutter, similar to flash photography. "We shoot a flash beam way, way, way out to where you are," Luckey says. "It lights up you and the area around you, and then we're able to pick that up with our electro-optical sensor." Anduril discovered it could cheaply repurpose the laser, which it bought in bulk, originally meant for a 600-watt cosmetic hair-removal device.

To test their prototype, Stephens called Will Hurd, a Republican congressperson whose district includes the nation's longest stretch of land bordering Mexico. Hurd has long argued for a digital approach to border security, so when he heard Stephens' pitch, he perked up. "A lot of contractors say 'Oh yeah, I can do this,' but the federal government's going to have to pay for the prototypes and all that kind of stuff," he says. "When Anduril representatives explained their approach, I was like, 'This is pretty cool.' " Hurd introduced Stephens and Luckey to a rancher on the border who agreed to host three test towers.

In mid-April, Luckey, Stephens, Schimpf, and I are sailing down Highway 90 in southwest Texas in a rented SUV heading to that ranch, a road trip that started with a pit stop at an El Paso Whataburger (Luckey's choice). It's a long drive through the sagebrush-covered desert, with Schimpf at the wheel. "This is a place where machines are supposed to live," Luckey says, "not people." Luckey has a cold, but he chatters between sniffles about movies and technology, and he tells a story about hanging out in VR with *Ready Player One* author Ernest Cline. He's wearing his trademark Tommy Bahama aloha shirt, shorts, and flip-flops; the others are in the Silicon Valley cool-weather uniform of puffy jackets and jeans.

Schimpf takes a right at an unmarked intersection. We travel over roughly 30 miles of an unpaved road populated mostly by rabbits to



reach a gate with a faded sign that designates the ranch as a member of the Texas and Southwestern Cattle Raisers Association. Beyond it, inside a comfortable farmhouse, waits Ed, the fifth-generation owner of the property. (WIRED is changing his name to spare him the attention of drug cartels operating in his area.)

With a sagging mustache and a wide drawl, Ed has the air of a canny retired sheriff in a Sam Peckinpah movie. Over coffee, he explains that for decades his land has been an unpatrolled gateway to the United States. Past trials of new technologies hadn't worked out, but on Hurd's urging he gave the Californians a chance. To his astonishment, their system seems to be performing well.

Take what happened on March 5. At 7:41 am local time, the system noticed activity in the valley. An alert popped up a thousand miles away, on Matt Grimm's phone. "New person track near tower e1," it read. Grimm, who was at his home in Orange County, opened Anduril's app—and saw a dozen people making their way across the gullies and hills of the Texas frontier.

In an official installation, such alerts would go straight to Customs and Border Protection agents. But in this case, Grimm notified Ed. Ed called the nearest patrol station and settled into his living room couch with his laptop. Launching Anduril's software, a wide shot of his land filled the screen. Blinking green rectangles highlighted the trespassers; zooming in, he could make out the group of figures more clearly. Between sips of his morning coffee, he watched the boxes inch across the screen as the people traversed his ranchland. "I can hardly operate a cell phone," he later recalls. "This is beyond cool."

Later that morning, Grimm could see that a DHS helicopter was headed toward the scene. By then the visitors had traveled northeast of the towers' range, so he couldn't watch as border agents apprehended 12 people. In a 10-week span since the towers were installed, Lattice helped agents catch 55 people and seize 982 pounds of marijuana. (For 39 of those individuals, drugs were not involved, suggesting they were just looking for a better life.) The official test outside San Diego, ongoing at press time, led to 10 interceptions in its first 12 days.

Last July, Hurd introduced the Secure Miles with All Resources and Technology (SMART) Act, which would direct DHS to deploy technologies for "situational awareness and operational control of the border." His nine cosponsors include two Democrats. The bill is awaiting a vote, but some of its key ideas found their way into the 2018 federal budget, which provides funds for border-security technology.

"Nobody is disagreeing with the smart wall," says Hurd, a former CIA agent who is one of the few members of Congress with a computer science degree. The economics are an obvi-



↓ Anduril's founders come from Oculus, Founders Fund, and Palantir.

ous factor. “A concrete structure 30 feet high that takes four hours to penetrate costs $24.5 million a mile,” he says. “A smart wall, a system like what Anduril is proposing, is about a half a million a mile.”

The prototype towers on Ed’s ranch are the epitome of cheapskate. A plain metal pole juts from the ground, propped up by a tripod and anchored by cinder blocks. Solar panels hang off its lower portion, and the top is a cobbled-together cluster of radar antennae, cameras, and more. The finished version will look more polished, but its bones will be the same. Unassembled, it can fit into a pickup truck and be installed in less than an hour. Anduril has since added small drones to the system. If the company wins a contract for the hundreds of miles of rural borderlands, where its tech is best suited, these towers will watch the movements of all who cross their line of sight—drug smugglers, job seekers, families, as well as Americans going about their business.

Staring down from our bluff toward the Rio Grande, Schimpf reflects on Anduril’s long-term goals, which include protecting private sites like oil pipelines and monitoring the battlefield of the future. “Looking at this helps you conceptualize what it would be like in Afghanistan, if you had a forward-operating base on top of this hill. It’s the same problem.”

ANDURIL

is unusual among today’s startups for embracing the defense business. In the Valley, many believe that “if you do defense you must be an evil person,” says Joe Lonsdale, an Anduril investor and Palantir cofounder. But that wasn’t always the case. California’s tech sector was once a virtual branch of the military. “Literally 100 percent of the early microchips went to defense use,” says Leslie Berlin, project historian for Stanford’s Silicon Valley archives.

In the 1950s and ’60s, “working for the defense effort meant working for the good guys,” Berlin says. After Vietnam, that changed. “Many people in Silicon Valley today don’t feel that way.” The most recent evidence came in April, when *The New York Times* reported that more than 3,100 Google employees had protested the company’s work on a Pentagon-backed AI effort called Project Maven.

Lonsdale and Luckey argue that building cheaper, more efficient systems is a virtuous pursuit, saving taxpayer dollars. Anduril’s Palantir pedigree may have prepared it for criticism. As that company grew to a private valuation of $20 billion, its technology has been portrayed as Big Brother–style surveillance tools. Anduril’s leaders tread lightly on the subject of deadly force—traditionally the purview of defense companies—and have a ready answer when I ask whether the company will ever build systems that kill people.

“We’re really focused on the intelligence and surveillance piece right now,” Schimpf says. But in the next beat: Not that there’s anything wrong with building weapons. “I wouldn’t say that’s a line we’re drawing.”

Stephens jumps in to clarify. “Part of the unintended shiftiness of our answer is that no one even knows what that means. In 20 years, are we still going to be filling bullets with gunpowder? Or is this electronic warfare? Is it like sending a pulse out that takes drones out of the sky?”

Put that way, warfare sounds a bit like a videogame, an echo of the drone pilots who execute deadly missions from behind computer screens many miles away.

IN

a steampunkish workshop in an industrial area of Oakland, California, Anduril houses a project called Sentry that brings this parallel to life. Sentry is a fleet of autonomous firefighting machines meant to battle blazes on California’s hills, among other applications. The idea is to hollow out armored troop carriers to hold more than a thousand gallons of water. With crinkled aluminum skin, a Sentry vehicle looks something like a battlebot tank. That’s no coincidence—Anduril’s subcontractor for the project is Jamie Hyneman, the special effects expert and former cohost of *MythBusters* who built one of the fiercest battlebots in *Robot Wars* history.

Luckey passes me an Oculus Rift headset and a handheld controller to try driving a simulation of a Sentry vehicle. On my headset I see a stand of burning trees. I set the tank on autonomous mode and use the index-finger trigger, familiar to anyone who has used an Xbox, to shoot its water cannons at the blazes. It is exactly like playing a videogame. As the flames spread, I concentrate hard to rule over the conflagration, wanting to put in a strong performance for the Anduril team.

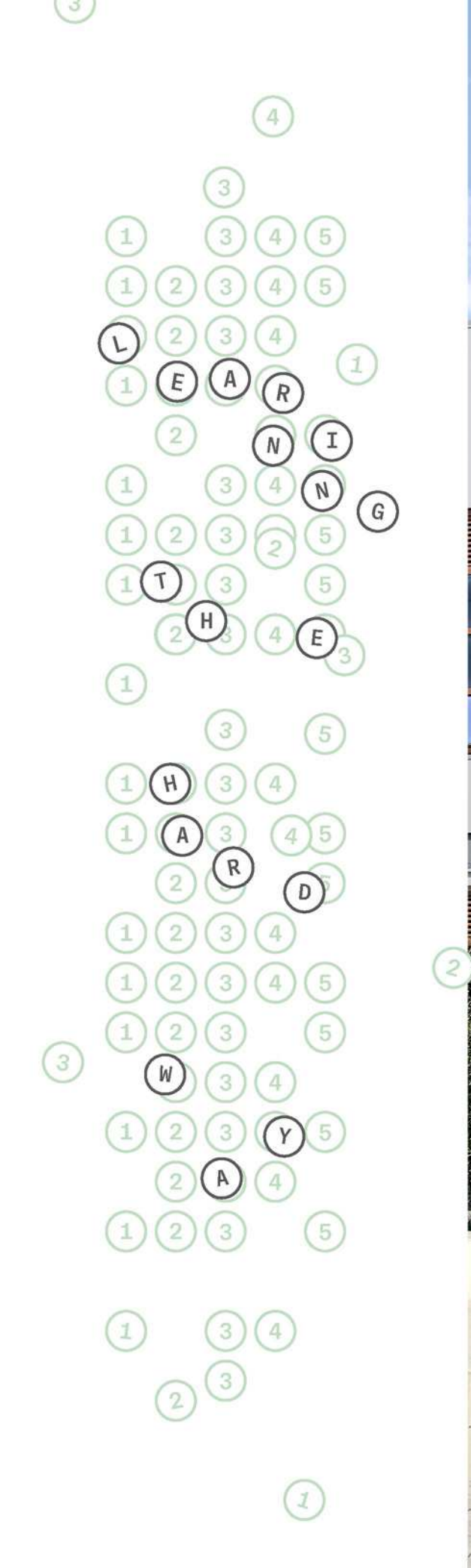
I leave the Oakland workshop pumped from the excitement of saving the homes of imaginary Californians. But as I steer my car through the battered chain-link gate, past graffiti-covered buildings, the lingering adrenaline from my digital immersion turns to a funny aftertaste. The California fires last summer were devastatingly real. So is warfare. Anduril is on a quest to build awesome tech, the stuff of comics and action films. But it will be deployed in situations of human desperation, a vast remove from the land of fun. Transforming consumer tech’s plowshares into swords is ultimately a dark pursuit.

It struck me after I’d wrapped up my visits with Anduril that, aside from the drug smugglers they helped intercept on the border, I had not heard the founders mention the people who might get caught in their omniscient zone. What is the right way to treat those individuals? What of the children and parents who are now being torn apart while crossing? Those are social and political questions, not technical specifications. But it is increasingly the case that the people who build new technologies trigger political consequences.

Though tech companies have been taking their knocks lately, even the ones now under the most scrutiny were launched in a glow of idealism. We once dreamed that an era of ultraconnected and infinitely empowering tech would solve the kinds of problems that lead people to flee their own countries or that propel terrorists or nations to attack. Those problems didn’t end. It now seems obvious that tech was never going to make us better human beings; we are still our flawed selves. Instead, those same technologies that once seemed full of promise are finding their way into all-too-human clashes—led by a company named after an avenging sword.

IT COST $54 MILLION FOR SAN FRANCISCO TO BUILD.

IT CAME WITH HU CONTRIBUTIONS F TITANS, A STEM- CURRICULUM, A R GADGETS EVERYWH



GE
ROM TECH
PACKED
OBOT LAB,
ERE.

WILLIE BROWN MIDDLE SCHOOL WAS SUPPOSED TO BE A SHOWCASE FOR HOW SILICON VALLEY–STYLE INNOVATION CAN HACK EDUCATION.

THEN IT OPENED.

BY DANIEL DUANE
PHOTOGRAPHS
BY PRESTON GANNAWAY





WINDY AFTERNOON OF MARCH 17, 2017, I opened my mailbox and saw a white envelope from the San Francisco Unified School District. The envelope contained a letter assigning my younger daughter to a middle school. This letter was a big deal; San Francisco's public schools range from excellent to among the worst in the state, and kids are assigned to them through a lottery. The last time we put her name into the lottery, for kindergarten, she was assigned to one of the lowest-performing schools in California. Then we got a break: A private school offered a big discount on tuition. But now our discount was gone, so we entered her in the public-school lottery again.

Ripping open that envelope, I found that she had been assigned to Willie L. Brown Jr. Middle School. I knew who Willie Brown was—Speaker of the California State Assembly for 15 years and two-term mayor of San Francisco from 1996 to 2004. The school, however, was new to me. So I grabbed a laptop, poked around on Google, and pieced together an astonishing story.

Willie Brown Middle School was the most expensive new public school in San Francisco history. It cost $54 million to build and equip, and opened less than two years earlier. It was located less than a mile from my house, in the city's Bayview district, where a lot of the city's public housing sits and 20 percent of residents live below the federal poverty level. This new school was to be focused on science, technology, engineering, and math—STEM, for short. There were laboratories for robotics and digital media, Apple TVs for every classroom, and Google Chromebooks for students. A "cafetorium" offered sweeping views of the San Francisco Bay, flatscreen menu displays, and free breakfast and lunch. An on-campus wellness center was to provide free dentistry, optometry, and medical care to all students. Publicity materials promised that "every student will begin the sixth grade enrolled in a STEM lab that will teach him or her coding, robotics, graphic/website design, and foundations of mechanical engineering." The district had created a rigorous new curriculum around what it called "design thinking" and a "one-to-one tech model," with 80-minute class periods that would allow for immersion in complex subjects.

The money for Brown came from a voter-approved bond, as well as local philanthropists. District fund-raising materials proudly announced that, through their foundation, Twitter cofounder Evan Williams and his wife, Sara, had given a total of $400,000 for "STEM-focus" and "health and wellness." (The foundation says that figure is incorrect.) Salesforce founder Marc Benioff, who has given nearly $35 million to Bay Area public schools in the past five years alone, contributed $100,000 through his charities. The Summit Public Schools network, an organization that runs charter schools in California and Washington state and has a board of directors filled with current and former tech heavy hitters (including Meg Whitman), made a $500,000 in-kind donation of its personalized learning platform. That online tool, built to help students learn at their own pace and track their progress, was created in partnership with Priscilla Chan and Mark Zuckerberg's funding organization.

As the school's first principal, the district hired a charismatic man named Demetrius Hobson who was educated at Morehouse and Harvard and had been a principal in Chicago's public schools. Students from four of the Bayview's elementary schools, where more than 75 percent of kids are socioeconomically disadvantaged, were given preference to enter Willie Brown Middle. To ensure that the place would also be diverse, the district lured families from other parts of town with a "golden ticket" that would make it easier for graduates from Brown to attend their first choice of public high school.

The message worked. Parents from all over the city—as well as parents from the Bayview who would otherwise have sent their kids to school elsewhere—put their kids' names in for spots at the new school. Shawn Whalen, who was then the chief of staff at San Francisco State University, and Xander Shapiro, the chief marketing officer for a startup, had children in public elementary schools that fed into well-regarded middle schools. But, liking what they heard, both listed Brown as a top choice in the lottery. Kandace Landake—a Bayview resident and Uber driver who wanted her children to have a better education than she'd received, and whose children were in good public schools outside the neighborhood—likewise took a chance on Brown. One third-generation Bayview resident, whom I'll call Lisa Green, works at a large biotech company and had been sending her daughter to private school. But she too was so enticed that she marked Brown as her first choice in the lottery, and her daughter got in.

On opening day in August of 2015, around two dozen staff members greeted the very first class. That's when the story took an alarming turn. Newspapers reported chaos on campus. Landake was later quoted in the *San Francisco Examiner*: "The first day of school there were, like, multiple incidents of physical violence." After just a month, Principal Hobson quit, and an interim took charge. In mid-October, less than two months into the first school year, a third principal came on board. According to a local newspaper, in these first few months, six other faculty mem-

DANIEL DUANE *is the author of six books; he's at work on the next, about California.*

ROBOTICS TEACHER
JAMES ROBERTSON AND A STUDENT.



bers resigned. (The district disputes this figure.) In a school survey, only 16 percent of the Brown staff described the campus as safe. Parents began to pull their kids out.

By August of 2016, as Brown's second year started, only 70 students were enrolled for 100 sixth-grade seats; few wanted to send their kids there. The school was in an enrollment death spiral.

It was hard to imagine sending our daughter to a place in such chaos. But I was also unsettled that so many people spent so much money and goodwill to do the right thing for middle schoolers, with such disastrous results. I wanted to know what had happened.

AFTER JUST A MONTH, THE FIRST PRINCIPAL QUIT AND AN INTERIM TOOK CHARGE. IN MID-OCTOBER, LESS THAN TWO MONTHS INTO THE FIRST SCHOOL YEAR, A THIRD PRINCIPAL CAME ON BOARD.

WILLIE BROWN'S FOURTH PRINCIPAL, CHARLESTON BROWN.

L. BROWN JR., THE MAN HIMSELF, NOW occupies a penthouse office with a spectacular view of the west span of the San Francisco–Oakland Bay Bridge, which happens to be named after him. As mayor, he famously gilded San Francisco City Hall's dome with $400,000 worth of real gold. Brown's best-known political achievements were in real estate development. He helped spur the rise of live-work lofts during the original dot-com boom and helped to turn San Francisco's tawdry South of Market neighborhood into a booming tech startup district. After leaving office, Brown became a lobbyist; his clients included some of the biggest developers involved in transforming San Francisco into a corporate tech hub.

Small and compact at age 84, with a genial face, Brown greeted me in his office wearing an elegant purple suit. He explained that Willie L. Brown Jr. Middle School was the second iteration of a school formerly called Willie L. Brown Jr. College Preparatory Academy—"part of a group of schools called the Dream Schools," he said, "that were going to try to afford equal educational opportunity on almost a boutique, as-needed basis."

To make sense of this remark, it helps to understand that San Francisco has been trying, and mostly failing, for half a century to give African American and Latino students an education comparable to that provided to white and Asian students in the city. Those efforts started in the 1970s after the success of lawsuits accusing the city of maintaining racially isolated schools in the Bayview. Attempted remedies over the years included busing and racial quotas for school assignment, but both approaches foundered, partly due to opposition from families, often white and Asian, who argued they didn't want to send their kids across town to school. In 1978, California voters passed the state's most infamous law: Proposition 13 severely restricted raising property taxes, and required a two-thirds majority to pass many tax measures. This gutted California's education funding so severely that the state's public schools, which had been ranked best in the nation in the 1950s, fell to among the worst in a few decades. (They now hover around 35th.) California currently spends less per student on public education than many low-tax states. Belying its progressive image, San Francisco spends roughly half the amount per public school student than New York City, where the cost of living is comparable.

By the early 2000s, the district's next campaign for change was aimed at improving its most underperforming schools, aided in part by a $135,000 pledge from the Bill and Melinda Gates Foundation. The district designated some of these new schools as Dream Schools. This plan involved requiring existing teachers to reapply for their jobs, sprucing up their buildings, offering foreign-language and art classes,



and requiring kids to wear uniforms. The Dream School that was eventually renamed Willie Brown College Preparatory Academy—Brown 1.0, if you will, in the Bayview—opened in 2004 (the same year Facebook was founded and Google and Salesforce held their IPOs). Six years later, Brown 1.0 had only 160 kids enrolled for 500 slots, and its standardized test scores were among the worst in the state.

"We tried to make it work," Brown insisted as we sat in his office. "We put kids in uniform, we did everything." He shook his head as if astonished by the outcome. "I used my connections. I had Spike Lee teach out there! Every friend I had in the celebrity world I took to that godforsaken place for an hour. I shattered my resources in that effort. It was clear it wasn't going to work." It was eventually decided, Brown told me, that the school would only succeed if it had a new building.

This, it turns out, was actually kind of easy to obtain. San Francisco has plenty of money for school construction, because asking San Francisco voters for permission to borrow money to build better schools is an easy win: Voters approved four such initiatives from 2003 to 2016, raising a cumulative $2 billion. Money to raise teacher salaries, by contrast, can require lengthy union negotiations and raising taxes. (As I write this, residents are voting on a proposition that would tax property owners to raise teacher pay.) The money for the new Willie Brown Middle School was a mere line item in a 2011 bond issue that raised $531 million.

When those funds came through for Brown 2.0, the school district was facing an existential crisis. Over the previous four decades, enrollment in SF public schools had fallen by nearly 40 percent, from 83,000 to 53,000, even as the city's population grew by almost 100,000. Part of that loss was due to the skyrocketing cost of local living, which drove middle-class families to the suburbs and left San Francisco with the lowest number of children per capita of any of the nation's 100 largest cities. As San Francisco's population became more affluent, parents started to send their kids to private schools in droves. Around 30 percent of the city's school-age children now attend private school—one of the highest rates in the nation. More shocking, in a city that is 54 percent white, just 13 percent of school-district kids are white. Starting in about 2010 and driven by this new, wealthy tech workforce, the city likewise became a laboratory for tech-driven innovation in private education. Nine new secular private schools, many of them with a science and math focus, opened in San Francisco between 2010 and 2015.

This all made what looked to me like the basic premise of Brown 2.0 eminently sensible: Emulate the new tech-driven private schools, court their funders, and help kids in one of the poorest parts of town. Perhaps the district could even start to reverse a decades-long decline in enrollment.



SHEER NUMBER OF MISHAPS AT BROWN, RIGHT FROM THE START, DEFIES EASY explanation. According to the district, Principal Hobson, who declined to comment for this story, tried to quit as early as June of 2015, two months before the school opened. The superintendent talked him into staying but, a district official told me, his heart seems not to have been in it.

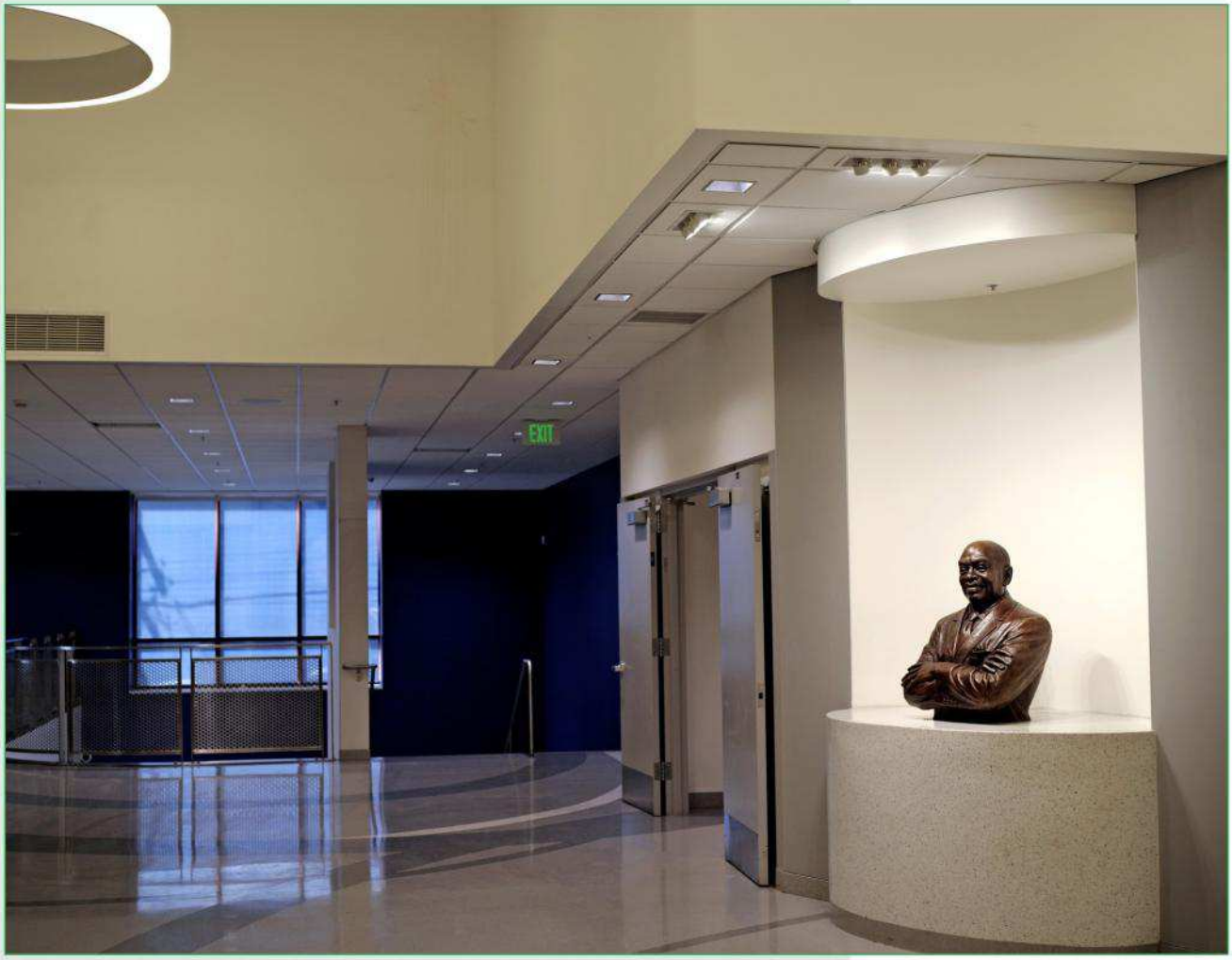
The summer before the kids showed up for class should have been a time when Hobson and the staff trained and planned, and built a functioning community that knew how to care for 11- and 12-year-old kids and all their messy humanity. Instead, according to one former teacher, the primary teacher training was a two-week boot camp offered by Summit Public Schools meant to help teachers with the personalized learning platform. Teachers who attended that boot camp told me that as opening day inched closer, they worried that Hobson had yet to announce even basic policies on tardiness, attendance, and misbehavior. When they asked him how to handle such matters, according to one teacher who preferred not to be identified, "Hobson's response was always like, 'Positive, productive, and professional.' We were like, 'OK, those are three words. We need procedures.' " When families showed up for an orientation on campus, according to the teacher, Hobson structured the event around "far-off stuff like the 3-D printer." That orientation got cut short when the fire marshal declared Brown unsafe because of active construction.

After the school opened, Lisa Green took time off work to volunteer there. "When I stepped into that door, it was utter chaos," she told me. According to parents and staff who were there, textbooks were still in boxes, student laptops had not arrived, there was no fabrication equipment in the makerspace or robotics equipment ready to use. According to records provided by the district, parts of the campus were unfinished. Teachers say workers were still jackhammering and pouring hot asphalt as students went from class to class. The kids came from elementary schools where they had only one or two teachers, so Brown's college-like course schedule, with different classes on different days, turned out to be overwhelming. When Hobson quit, district bureaucrats sent out letters explaining that he had left for personal reasons and was being replaced by an interim principal.

Shawn Whalen, the former San Francisco State chief of staff, says that pretty early on, "kids were throwing things at teachers. Teachers couldn't leave their rooms and had nobody to call, or if they did nobody was coming. My daughter's English teacher walked up in front of the students and said 'I can't do this' and quit. There was no consistent instructional activity going on."

Teachers also became disgusted by the gulf between what was happening on the

A BUST OF FORMER SAN FRANCISCO MAYOR WILLIE BROWN, IN THE SCHOOL FOYER.



inside and the pretty picture still being sold to outsiders. "I used to have to watch when the wife of a Twitter exec would come surrounded by a gaggle of district people," said another former teacher at the school. "We had a lovely building, but it was like someone bought you a Ferrari and you popped the hood and there was no engine."

Early in the school year, another disaster struck—this time, according to district documents, over Summit's desire to gather students' personally identifiable information. The district refused to compel parents to sign waivers giving up privacy rights. Contract negotiations stalled. When the two sides failed to reach a resolution, the district terminated the school's use of the platform. (Summit says it has since changed this aspect of its model.) This left teachers with 80-minute class periods and without the curriculum tools they were using to teach. "Teachers started walking away from their positions because this is not what they signed up for," said Bill Kappenhagen, who took over as Brown's third principal. "It was just a total disaster."

The adults had failed to lead, and things fell apart. "The children came in and were very excited," says another former teacher. "They were very positive until they realized the school was a sham. Once they realized that, you could just see the damage it did, and their mind frame shifting, and that's when the bad behavior started."

Hoping to establish order, Kappenhagen, a warm and focused man with long experience in public school leadership, simplified the class schedule and made class periods shorter. "I got pushback from parents who truly signed their kid up for the STEM school," he said. "I told them, 'We're going to do middle school well, then the rest will come.' "

Xander Shapiro's son felt so overwhelmed by the chaos that he stopped going to class. "There was an exodus of people who could advocate for themselves," Shapiro said. "Eventually I realized it was actually hurting my son to be at school, so I pulled him out and said, 'I'm homeschooling.' "

Green made a similar choice after a boy began throwing things at her daughter in English class and she says no one did anything about it. "I don't think any kid was learning in that school," she says. "I felt like my daughter lost an entire semester." Her daughter was back in private school before winter break.

THE

FIRST YEAR OF ANY SCHOOL IS FULL OF glitches and missteps, but what happened at Willie Brown seemed extreme. To learn more, I submitted a public records request to the district, seeking any and all documentation from the school's planning phase and its first year. Among other things, I got notes from meetings conducted years earlier, as the district gathered ideas for Brown 2.0. It all sounded terrific: solar panels, sustainable materials, flatscreen televisions in the counseling room, gardens to "support future careers like organic urban farming." Absent, though, was any effort to overcome some of the primary weaknesses in San Francisco public education: teacher and principal retention issues, and salaries dead last among the state's 10 largest districts.

Eric Hanushek, a Stanford professor of economics who studies education, points out that among all the countless reforms tried over the years—smaller schools, smaller class sizes, beautiful new buildings—the one that correlates most reliably with good student outcomes is the presence of good teachers and principals who stick around. When Willie Brown opened, some teachers were making around $43,000 a year, which works out to about the same per month as the city's average rent of about $3,400 for a one-bedroom apartment. After a decade of service, a teacher can now earn about $77,000 a year, and that's under a union contract. (By comparison, a midcareer teacher who moves 40 miles south, to the Mountain View Los Altos District, can make around $120,000 a year.)

The tech-driven population boom over the past 15 years has meant clogged freeways with such intractable traffic that moving to a more affordable town can burden a teacher with an hours-long commute. According to a 2016 *San Francisco Chronicle* investigation of 10 California school districts, "San Francisco Unified had the highest resignation rate." That year, the article found, "368 teachers announced they would leave the district come summertime, the largest sum in more than a decade and nearly double the amount from five years ago." Heading into the 2016–17 school year, the school district had 664 vacancies.

Proposition 13 takes a measure of blame for low teacher salaries, but San Francisco also allocates a curiously small percentage of its education budget to teacher salaries and other instructional expenses—43 percent, compared with 61 percent statewide, according to the Education Data Partnership. Gentle Blythe, chief communications officer for the SFUSD, points out that San Francisco is both a city and a county, and it is therefore burdened with administrative functions typically performed by county education departments. Blythe also says that well-intentioned reforms such as smaller class sizes and smaller schools spread the budget among more teachers and maintenance workers. It is also true, however, that the district's central-office salaries are among the state's highest, as they should be given the cost of living in San Francisco. The superintendent makes $310,000 a year; the chief communications officer, about $154,000, according to the database Transparent California.

District records show that at least 10 full-time staff members of Brown's original faculty earned less than $55,000 a year. The Transparent California database also shows that Principal Hobson earned $129,000, a $4,000 increase from his Chicago salary. That sounds generous until you consider that Chicago's median home price is one-fourth that of San Francisco's.

ON

MONDAY, MAY 15, AT THE BLOCKLIKE CONCRETE HEADQUARTERS OF THE SAN Francisco Unified School District near City Hall and the opera house, I took a drab old elevator up to the third floor. Walking down a short hallway, I entered a tidy, small office and shook hands with Blythe and three other administrators: Joya Balk, a director of special projects who supervised planning for Brown; Tony Payne, the interim assistant superintendent for principals, who served as interim principal after Hobson quit; and Enikia Ford Morthel, the assistant superintendent for the Bayview. They all told me that the Brown disaster narrative was unfair and overblown.

Payne dismissed the notion that Brown saw unusual levels of violence. "No kids were seriously hurt," he said. "So, you know, a kid throwing a pen in a classroom, that's middle school." He pointed to the fact that violence in predominantly African American schools is depicted differently than in predominantly white schools. "I saw worse behaviors at Presidio," he said, referring to a middle school in a more affluent part of town where he was principal for three years. "A fight happens at Presidio, and the narrative is 'Oh, how do we help that student? What's going on with that student?' A fight happens at Willie Brown: 'Oh, that's because it's a terrible school.'"

Payne struck a similar note on the teachers leaving Brown. "Looking back," he said, "you could easily say, you know, of course we're going to lose teachers the first year. Right? This is hard work."

In Payne's view, Brown was a "super-good-faith effort to build a state-of-the-art school that is still ongoing. The startup metaphor is a really good one," he said, "where you have to iterate. You can't expect everything to run perfectly on the first day. And I think, you know, that process of storming and norming and developing a community is going to be challenging under the best of circumstances."

To be sure, Brown was the most ambitious new-school launch ever undertaken by the district, and is still populated by children and teachers who deserve encourage-

ment and every chance to succeed. The allure of the startup metaphor is likewise understandable—except tech startups are launched by entrepreneurs backed by investors who understand the risks they are taking, while Brown was started by government employees with little personal stake in the outcome.

Those government employees, says Hanushek, the Stanford economist, "are not idiots, and they're not against kids. It's just that when push comes to shove, the interest of the kids isn't ahead of the interests of the institutions."

Hanushek suggests another reason for bureaucrats' temptation to believe that their innovations will make a difference: Unable to solve deep systemic problems like improving teacher salaries, those tasked with improving specific schools do what they can and hope for the best.

Something similar might be said about the philanthropic efforts of local CEOs. Salesforce's Benioff recently gave $250,000 to support the June effort to levy a parcel tax to raise teacher salaries. His charities also give an impressive $100,000 each year to every middle school principal in San Francisco—for them to use as they wish—as part of what he calls a Principals Innovation Fund. Partly thanks to Benioff's fund, all of San Francisco's middle schoolers now have access to computer science courses.

But a lot of philanthropic efforts have focused on gifts that generate good press while mostly avoiding the diseased elephant lumbering around the room: Critically low school funding combined with the Bay Area's tech-money boom have made living in San Francisco untenable for teachers.

Even some uses of Benioff's Innovation Fund can feel less on point in the face of high teacher turnover—like a teachers' lounge that looks like a cool coffee shop or student work tables that fit together like puzzle pieces to "look like Google and Facebook and Salesforce," as one school principal told a reporter.

The Sara and Evan Williams Foundation paid design company Ideo and the school district to collaborate on a sweeping redesign of the school lunch experience, including, according to a foundation spokesperson, "a minor investment in technology to support the rollout of vending machines and mobile carts." The foundation also donated to a district-wide initiative that targeted students who are eligible for free or reduced-price lunches. The spokesperson told me via email that the foundation did consider "all aspects of the public school system, including low teacher salaries. We've chosen to focus on the connection between hungry kids and learning because it reaches the most vulnerable students. When addressing a system, there are many points for intervention and no one funder can take on the entire entity." (She also clarified that the organization's contribution to Willie Brown was dramatically lower than the district claimed—$48,000, not $400,000.) None of the foundations that donated money to Brown would discuss what went wrong at the school. Neither Salesforce nor the Williams Foundation made anyone available for an interview.

IN THE END, WE SENT OUR YOUNGER DAUGHTER BACK TO PRIVATE SCHOOL—because Landake and Green told me not to send her to Brown and our efforts to place her in a different public school failed. Our private school discount was gone, and the cost was painful, but I was grateful to have the option. Still, I hated the way it felt. Our older daughter is getting a great education at a public high school, all public schools need community support, and I could not convince myself that I'd made the right decision. It is entirely possible that our daughter could have thrived at Brown.

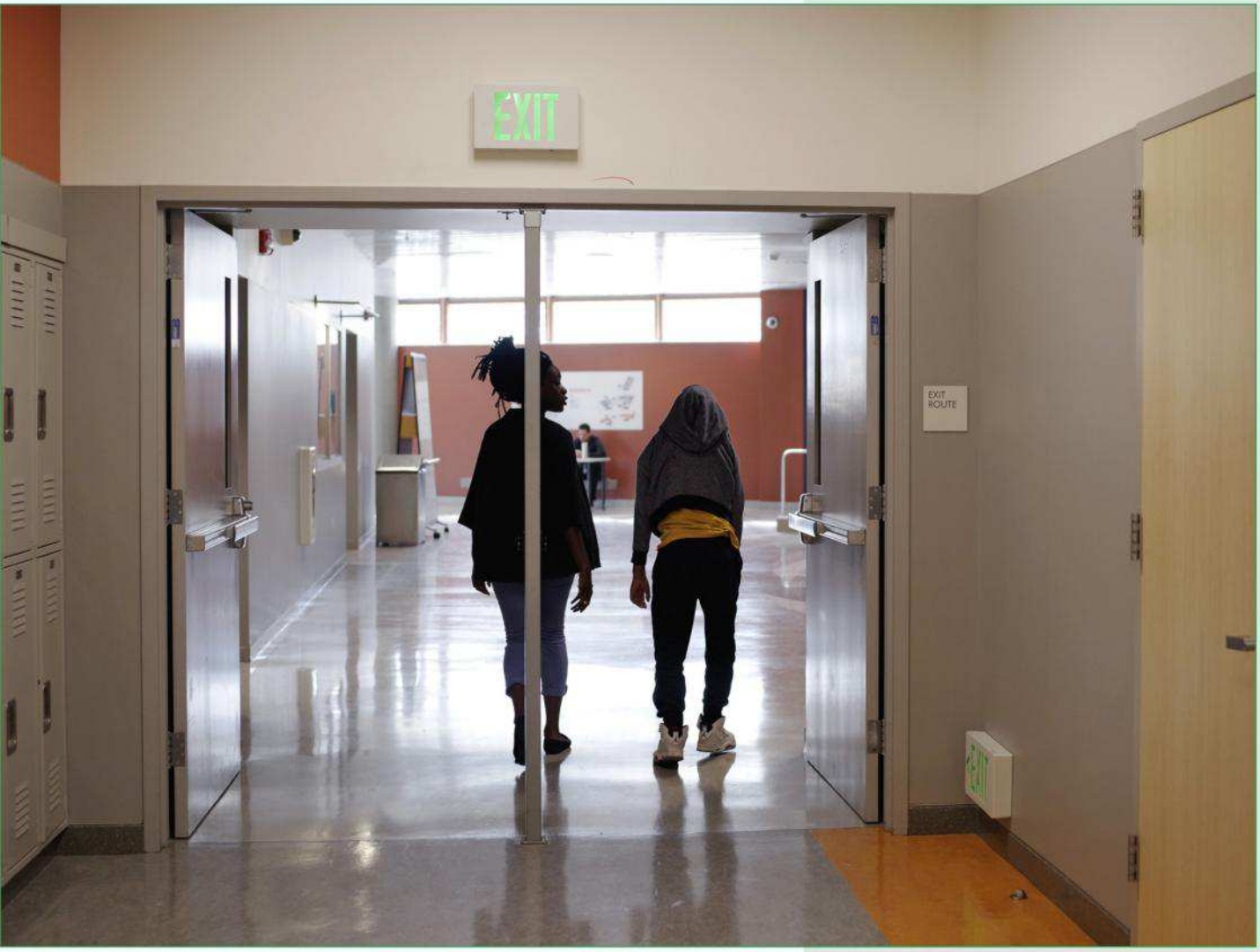
Last August, as the school year began, I set up another meeting to take a look at the school. I drove there one morning and found the principal—the school's fourth in two years—greeting kids outside. His name was Charleston Brown, and he seemed terrific. Raised in South Central Los Angeles, a Division 1 football player at Alcorn State in Mississippi, he was charming with a gentle humility. Kids got out of their parents' cars and shook Brown's hand as they walked onto campus. He led me on a tour, accompanied by Blythe and Ford Morthel.

"The headache of being a new school, even three years in," Brown said, "is that you have to build the traditions, build the culture." He had implemented college T-shirt Thursdays and school T-shirt Fridays. He walked me down hallways newly decorated—by Principal Brown himself—with college pennants. We stopped to observe a sunny science classroom where students sat quietly at desks and paid attention while the teacher handed out a worksheet with the questions "What does it mean to be 'On task'?" and "Why is it important to be 'On task'?" Next, Brown took me to see a robotics elective in another sunny room, where a dynamic teacher named James Robertson zigzagged among tables while bright-eyed kids diligently built little machines.

It all felt promising. Test scores from Brown's second year, the most recent available, did find the student body losing ground: The portion of Brown students testing at or above grade level in English fell about five points, to 21 percent; in math, about three points to near 10 percent. It is too early to expect Brown's scores to rise, but those numbers doubtless played a role in depressing enrollment—with only 111 kids in the incoming sixth grade, and 382 overall, Brown is currently about half full.

On the upside, the number of families ranking Brown as a first choice has begun to rise, and I've heard that many families are encouraged by the nascent community forming there. In fact, Robertson, who has been teaching at the school from the start, told me a hopeful story: "I have kids who stay after school for hours, and I knew parents would have no idea what their kids were doing if they didn't see it. So we had a robotics night, and they gave presentations, and they programmed in C++ and set up all the sensors. The kids know 12 different mechanical systems of movement. They gave a formal presenta-

A STAFFER WALKS THE HALLS WITH A STUDENT IN SEPTEMBER.



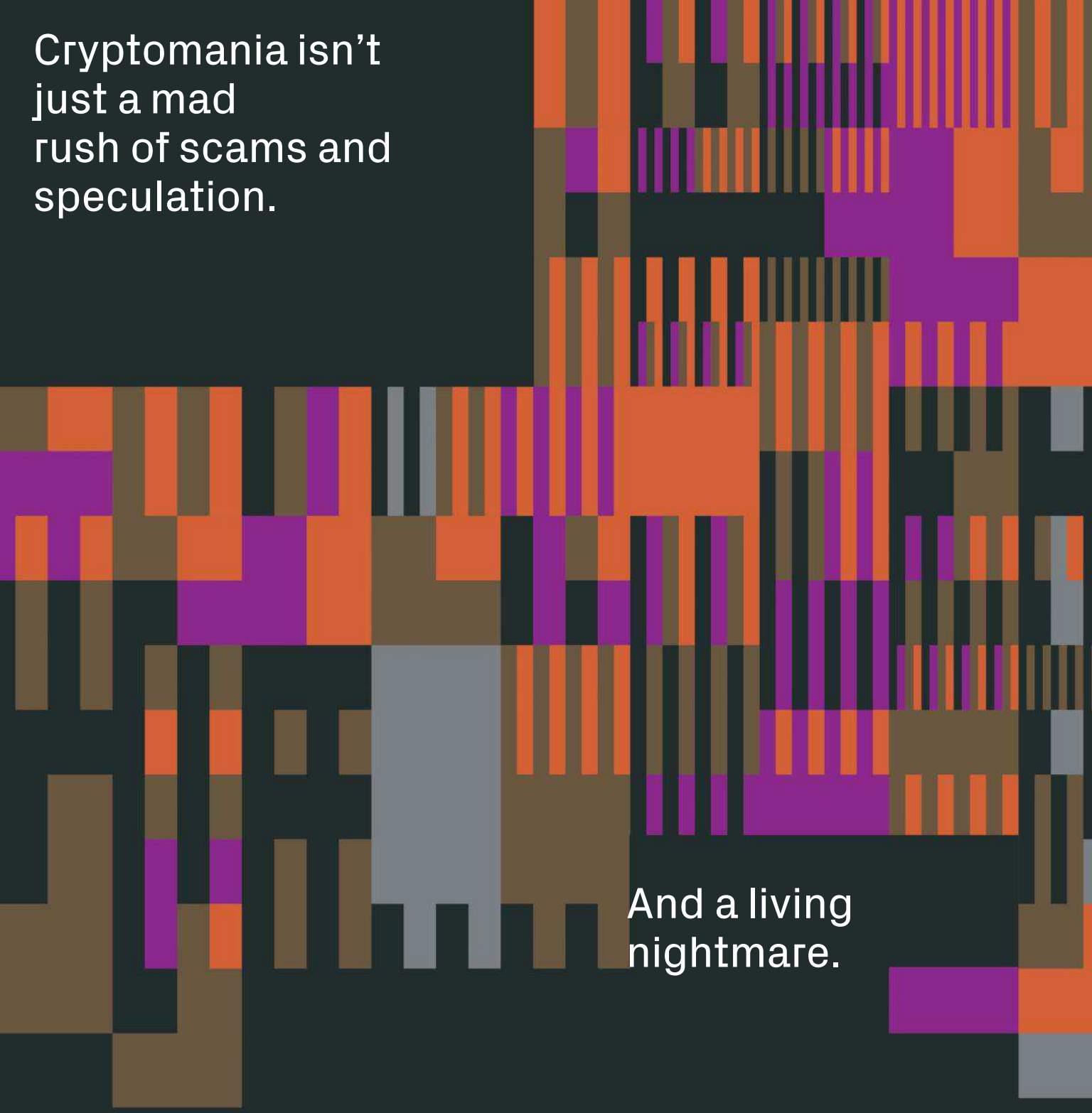
SOME TEACHERS WERE MAKING AROUND $43,000 A YEAR, ABOUT THE SAME PER MONTH AS THE CITY'S AVERAGE RENT OF $3,400 FOR A ONE-BEDROOM APARTMENT.

tion. I just watched parents crying." He added, "Ultimately, building a beautiful building is great, but community is the heart and reality of a school. And that takes time to build."

Principal Brown also struck me as a good leader. But I worried. The district's salary for a principal with his experience starts near $100,000. It looks like the district's strategy for turning around Brown 2.0 included paying Principal Number Four about $29,000 less per year than Principal Number One.

Brown lives in Fairfield—an hour's drive to work without traffic. The salaries for principals in that town start around $114,000 a year. If the Fairfield-Suisun Unified School District offered him a job, he could hardly be blamed for taking it.

Cryptomania isn't just a mad rush of scams and speculation.



And a living nightmare.

The Blockchain:

A Love Story



By
Gideon Lewis-Kraus
Photographs by Anna Huix
Illustration by Muir McNeil

The Blockchain:

A Horror Story

ACT I

One day in the spring of 2010, Kathleen McCaffrey, a sophomore at New York University, received an invitation from a stranger named Arthur Breitman. On the basis of what Breitman had been told about her political persuasion by a mutual acquaintance, he thought she might want to join his monthly luncheon for classical liberals. (Breitman had also seen a photograph of McCaffrey and thought she was pretty.) McCaffrey, the curious type, accepted. ¶ Breitman was not typically one to overextend himself socially, but he made a "beeline" for McCaffrey, she recalls, when she walked in the door. The luncheon, it turned out, was actually for anarcho-capitalists—people who believe that an absolutely free, self-regulating market will allow individuals, bound to one another by contract alone, to flourish in radical harmony. But by the time McCaffrey discovered she'd been misled, they'd already hit it off. She told Breitman she admired Milton Friedman. Breitman was pleased to report that he was friends with Friedman's grandson, Patri, and offered to lend her a book about freedom by Patri's father. ¶ To keep McCaffrey nearby, Breitman threw an impromptu party at his disorderly financial-district apartment after lunch. The next morning he texted her to say he'd reserved a table for two for that evening. Everything from that point forward felt like a fait accompli. ¶ The match, despite their vast differences in temperament and background, was an inspired one. Kathleen is relentlessly animated and quick-witted, with thick tangerine hair, steely eyes, and an endearing personal idiolect that suggests both an autodidactic reading in philosophy and economics and the gusty crudity of the merchant marine. Arthur is by turns retiring and pointed, with a soft, cublike appearance and a tight, parsimonious grin. Kathleen had grown up in northern New Jersey, the daughter of a Bronx-raised contractor and an Irish elementary-school teacher; she read *The Wall Street Journal* and played on the golf team at her all-girls Catholic high school. Arthur had been raised just outside Paris by a well-known playwright/television impresario and a civil servant; at 18 he'd won France's first-ever medal, a bronze, in the International Olympiad in Informatics, and he'd gone on to take his degree in applied math and computer science at the extremely selective École Polytechnique. Now, at 28, he worked as a quant in Goldman Sachs' high-frequency trading shop.

Arthur only discovered that Kathleen was eight years his junior sometime later, when he remarked that her academic work, in epistemology and mathematics, frankly seemed pretty easy for a grad student. Kathleen was insulted, but she got over it. Arthur was unfazed by her youth; what mattered was that *Kassleen* had a mind that could keep pace with his own. They admired in each other a brusque self-assurance and artless candor that others often perceived as arrogant.

When Kathleen transferred to Cornell University that autumn, she optimized her schedule to spend time in the city with Arthur, who was infinitely more interesting than her classes. If in the middle of the night Arthur read about a rare kind of suspension-bridge support, he'd immediately want to try his hand at the application of its principles. The two of them once passed two very happy weekends of courtship in attempts to reconstruct an ancient catapult called an onager. He expected precision and rigor in her thinking, but remained blunderingly sentimental in his attachment to Kathleen, who had reserves of strength and conviviality that far exceeded his own.

The weekend Kathleen graduated from college, she and Arthur traveled to France for a wedding. Following a drink at the storied Harry's Bar, he brought her to a bench in the Place de la Concorde and produced a box. Kathleen opened it to discover the ring was upside-down. "It was," as she remembers it, "the most Arthur thing ever. So much effort to go through, and such a small detail to screw up in the end."

Given his background in mathematics, computer science, and economics, it was natural that alongside bridge supports and primitive catapults Arthur was bound to fixate on Bitcoin. He bought his first bitcoins at a time when few people had even heard of them, and he badgered Kathleen about cryptocurrency until she could parry to his satisfaction. Arthur spent countless hours poring over Bitcoin's documentation. It clearly offered a terrific way to hold value, and to move value from one place to another, without paying for the services of a trusted intermediary. But it was clunky and limited, and it eventually became apparent to Arthur and Kathleen—"pedants by hobby," Kathleen likes to say—that Bitcoin's underlying technology, the blockchain, was capable of doing a lot more.

There is great confusion and debate about what a blockchain even is—some people argue it's become a meaningless buzzword—but the standard definition describes a shared, decen-

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tralized, cryptographically secure, immutable digital ledger. In the broadest terms, a blockchain allows a group of strangers to agree on a state of affairs and to proceed together on the basis of that covenant. Bitcoin's blockchain is meant to supplant the powerful middlemen called banks, but in theory a blockchain could replace any kind of institution—a credit agency, a social media service—that exists to safeguard a changing set of historical records. We pay these centralized entities handsomely for their custodial services, not only in the form of the rents they charge but in the control they exert over our lives. The blockchain, in theory, affords us new opportunities to solve complex coordination problems without letting the incumbent coordinators extract so much value in the process.

This had, of course, been the initial premise of the internet itself. Its great collaborative potential, however, had been funneled into the leviathans of Amazon, Facebook, and Google—a new and massively powerful set of trusted third parties. The blockchain pointed the way to the sunlit uplands of a genuinely decentralized world. A loose culture of entrepreneurs and cypherpunks came together in what felt like a special moment of experimental ferment, and the Breitmans looked on with interest. Most of these early blockchain innovators just took the original cryptocurrency's source code, made their preferred changes, and launched their alternative versions as distinct cryptocurrencies; it was as if they'd modified the DNA of an existing species to create a new, reproductively isolated branch of the family tree. To Arthur and Kathleen, this "Cambrian explosion" of disparate currencies was a tremendous waste. Far preferable would be to have some machinery to organize and streamline this evolutionary process, to integrate its most successful adaptations into one grand, unified project. But this was never going to happen with Bitcoin. Its pseudonymous inventor, Satoshi Nakamoto, was a god in whose absence Bitcoin evangelists could only argue and dither. Bitcoin could only move forward by schism rather than reformation.

While Arthur and Kathleen continued to discuss what the blockchain augured—taking a break to marry, in a ceremony in France in the late summer of 2013—Bitcoin's first major competitor appeared on the horizon. In January 2014, a 19-year-old Canadian-Russian prodigy named Vitalik Buterin released a white paper that outlined his vision for something he called Ethereum. It would be not merely a decentralized bank but a decentralized world computer; Ethereum allowed for the automatic execution of programs called "smart contracts," which went beyond the simple movement of money from one place to another. A group of people could run their own insurance company, say, which would accept premiums, automate the actuaries, and pay out claims without skimming a house take off the top.

Arthur printed out the entire Ethereum codebase to bring along on their honeymoon that spring. He inhaled it on safari in Botswana's Okavango Delta, turning to it when he'd seen his fill of elephants. Ethereum was, Arthur saw, an awful lot like what he'd been imagining. But there remained a need for some system of participatory governance. Ethereum was more pliable than Bitcoin, but its updates were disseminated by a core development team overseen by Buterin. As with Bitcoin, if you didn't like those updates you only really had two choices: accept the revisions or "fork" the code and go your separate way. Arthur resolved to create a rival, one with formal provisions for genuinely decentralized administration—a community in which the entrenchments of power and control could at last give way to a new order that rewarded competence and merit. Kathleen was alternately skeptical and encouraging, but came around to rally him on. "The early bird might get the worm," she said, "but the second mouse gets the cheese."

In the summer of 2014, a few months after their honeymoon, Arthur wrote a pair of white papers, under the pseudonym LM Goodman, and posted them on the cryptography listserv famous for Bitcoin's quiet debut. (The pseudonym was a snide reference to Leah McGrath Goodman, the *Newsweek* journalist who notoriously misidentified the person behind Satoshi Nakamoto.) The papers outlined what Arthur saw as Bitcoin's flaws, and they accurately anticipated issues that would soon plague Ethereum; they also predicted, with stunning foresight, that the digital world would soon be awash in new fly-by-night currencies. As a way out of these traps, "Goodman" proposed a new platform called Tezos, the world's first "self-amending" cryptocurrency, one that could assimilate all the best newfangled ideas. "While the irony of preventing the fragmentation of cryptocurrencies by releasing a new one does not escape us," the second paper concluded, "Tezos truly aims to be the *last* cryptocurrency."

Arthur printed out the entire Ethereum codebase and inhaled it on safari in the Okavango Delta, turning to it when he'd seen his fill of elephants.

Nobody paid any attention. Arthur, by then an employee of Morgan Stanley, tried to explain the idea to the various corporate entities that had become interested in the blockchain, but he was by his own admission a miserable spokesperson for his own creation. Besides, the point of Tezos wasn't to help corporate middle managers impress their bosses with blockchain solutions, it was to support cooperative undertakings at a grand scale. But how was one supposed to build a critical mass of users? Bitcoin had slowly gathered its participants over years, but now the cryptocurrency field was chaotically large and competitive. If you built it, they did not necessarily come.

There was, however, one relatively new option. It was called an ICO, or initial coin offering, and it provided a way to jump-start a new decentralized platform via a crowdfunding model. It was as if an amusement-park operator, say, promoted the blueprints for innovative roller coasters, sold advance tokens at a discount for future rides, and then devoted the proceeds to the construction of a park—one that would eventually be overseen, maintained, and updated by its own visitors. An ICO, in which one central party collected money to support an ultimately centerless community, was a shortcut, if a slightly sinuous one, to arrive at a utopian political end. It also entailed the risk that an unsavory ICO might sell meaningless chips for a fake casino nobody ever planned to build. But Ethereum had doled out its own tokens via this method, and the $18 million it raised had become a lively and variegated mini economy worth, on its best day, $135 billion.

International libertarian circles had acquainted Arthur with one of the figures who'd helped orchestrate Ethereum's coin offering, a South African expat in Switzerland named Johann Gevers. On Gevers' recommendation, and with his support, Arthur and Kathleen decided to go down the same path. The Breitmans thought they'd be lucky if their enterprise could garner $20 million, and they hoped to have at least a modest impact. Tezos, to their surprise, went on to be the larg-

est ICO to date. That surprise quickly turned to dismay, as the project descended into rancor, litigation, and even the odd rumor of an international assassination plot. What began in utopian ambition would blow up into one of the crypto world's biggest scandals.

JOHANN GEVERS IS A VERY TALL, SLENDER, charismatic man in his early fifties, with a high forehead, short orange hair whitening at the temples, and cloudy gray-blue eyes. He grew up in South Africa, a descendant of German missionaries; his second language, he says, was Zulu. He studied psychology, logic, mathematics, and philosophy, and then accounting and auditing, before he turned to work as a business consultant and investment manager. In 1998, fed up with his country's "financial authoritarianism," he left South Africa to make his name, in Canada, as a libertarian entrepreneur and "visionary thought leader." He would find his vision in the twinned phenomena of the 2008 crisis and the rise of Bitcoin. Cryptocurrencies, he preached, created the opportunity to move away from "too big to fail" and set our international financial system on a more secure footing.

In 2012 Gevers cofounded a digital-payments startup called Monetas, an attempt to disrupt a financial system that left billions unbanked. The banks, however, along with the governments that protected their interests, jealously guarded their domains, so Gevers tarried for two years in search of an agreeable regulatory environment for his venture. He considered Singapore, which he called the "Switzerland of Asia," and Santiago, which he called the "Switzerland of South America," but his period of jurisdictional shopping halted with Zug, the Switzerland of Switzerland. In 2013, Gevers moved himself and his company to the nation's smallest canton, about half an hour uphill from Zurich.

Zug had been a province of poor dairy farmers until laws enacted in the 1940s reduced the effective corporate tax rate to zero. By 2010, the canton counted 115,000 people and 29,000 companies, almost all of them headquartered in post-office boxes. The human residents live in highland villas above the town proper, which itself is unremarkably Helvetic: a broom-swept lattice of modest shopping boulevards extending outward from a scrupulously restored medieval fishing warren. The only signs of uncommon opulence are the cars. Zug is reported to have the greatest horsepower per person of any canton, and the largest per-capita number of Porsches in the country. The Maserati dealership is next to the Ferrari dealership and across from the other Ferrari dealership.

In June of 2017, a local business-development concern arranged for me to meet with Gevers, holding him out as an example of the sort of luminary the region was trying to attract. Monetas' office, in a five-story building, occupied rooms on a floor beneath the canton's tax authorities and its government accountability office; the other tenants were dentists, and the corridors had a sharp antiseptic smell. The fourth-floor landing was empty when I arrived early. Monetas, through a glass partition, looked dark and uninhabited, as if nobody worked there. Gevers arrived a few minutes later to explain that he was in the middle of a relocation. We went to sit at the chain café downstairs.

Gevers has a lilting accent and speaks fluently in the modular capsules and rehearsed-casual delivery of someone wearing a wireless headset microphone in a theatrical round. The story he told me began with cavemen on the hunt, moved through the Republic of Venice and the rise of the American railroads, and concluded with the crowning success of Ethereum. History had taught him to place his faith in technology over the tug-of-war called politics, but he nevertheless liked the political climate in Zug. "If you want to get something done here," he said, "you pick up the phone, and you've got an appointment within 24 hours."

What he wanted to get done in Zug was not limited to the goals of his own startup; Gevers hoped to help lay the groundwork for the full efflorescence of blockchain-related technologies. In the year of his arrival, similarly minded Swiss actors had pioneered a new legal mechanism that offered a means to raise money for legitimate crypto enterprises and discourage scams. Chief among its proponents was a local law firm called MME, a specialist in technology, anti-money-laundering compliance, and arbitration. The basic insight was that the Swiss Civil Code allowed considerable latitude to foundations. An independent foundation could be established to support an open source software platform in the public interest; instead of asking people to *buy* a token that might never do anything, these entities could instead solicit donations; donors would subsequently receive their tokens as a thank-you gift. The foundation structure would ensure that all donations would go directly toward the platform's development costs rather than disappear to some Caribbean island; the foundation itself would, in a second layer of institutional security, be supervised by a federal authority. The best part: None of these novel instruments would technically constitute securities, and would thus lie outside the remit of US or EU regulatory bodies. The resulting form of economic alchemy was what came to be called an ICO. (Other regulatorily agreeable jurisdictions, like Gibraltar and Malta, would follow suit, with various adjustments to the original Swiss model.)

The success of Ethereum, and the steady fruitfulness of Swiss ICOs in its wake, gave aficionados like Gevers and MME increasing confidence that the method did in fact serve as a viable way to galvanize token economies—and generate a lot of local wealth in the process. Last spring, a consortium announced the official formation of the Crypto Valley Association, an "independent, government-supported association" that would spur local fintech initiatives. The blockchain seemed an especially promising way to make up for the economic losses expected as a result of recent rule changes that had put an abrupt end to Switzerland's long, lucrative tenure as a world capital of banking secrecy.

Such government support—Zug became perhaps the world's first municipality to accept taxes in cryptocurrency—soon drew all manner of blockchain proselytes to the canton. One afternoon, outside the local administrative building, I met a chain-smoking Dane who told me that the blockchain was going to transform the lives of the poor by giving them titles to their land. Today, he explained, if you're a peasant in Africa, the sheriff can come whenever he wants and claim your property. But imagine that you have a smartphone with a GPS device that can fix the coordinates of your land on the blockchain. The next time the sheriff shows up to take your plot, you just use your phone to demonstrate your title. The sheriff will nod and stroll off.

Visionary thought leaders like Gevers, who took Silicon Valley's monopoly on startup financing to be a more tractable menace than African sheriffs, seemed by comparison exceptionally reasonable.

There was, however, a hiccup on this passage to the blockchain's emancipation of the world spirit. In 2016, an outfit calling itself the DAO—the Decentralized Autonomous Organization—sold $150 million worth of tokens in an ICO, in this particular case as a kind of Ethereum subtoken. (One of the selling points of Ethereum is that it's easy to build your own rides with your own tokens—as if, more or less,

Arthur Breitman

Grooming by Corinne Fouet





Space Mountain had its own special wristband within Disney World.) After the token sale, a security flaw allowed hackers to claim more than $50 million worth of the "ether" tokens raised by the DAO. The need for redress provoked a profound rift within the Ethereum community. Worse, however, was the likelihood that the kerfuffle would draw the scrutiny of the US Securities and Exchange Commission to the whole ICO apparatus.

Still, the debacle with the DAO did little to stem the rising ICO mania. Last year ICOs raised $6.5 billion for various enterprises. One venture brought in $153 million in three hours. As the regulators in more cautious jurisdictions had warned, some turned out to be Ponzi schemes or other varieties of outright fraud. Everyone in Zug knew this. But they were certain that the problem was less with bad actors than flawed software. There was at last a technical solution—one that, Gevers told me on that June morning, would be unleashed upon the world in two weeks' time. It was called Tezos.



GEVERS AND ARTHUR HAD FIRST ENCOUNtered each other in 2011 as fellow travelers of Patri Friedman, who had employed Gevers on a project to build a libertarian-minded charter city in Honduras. Arthur followed the project closely, and Gevers had been awestruck by his intelligence. Over the following few years Gevers had been pleased to see how their philosophies dovetailed—with each other and, now, with history. In the late summer of 2016, Arthur reached out to Gevers, who offered to make the introductory rounds in the Crypto Valley.

Arthur could not have arranged for a better prelude to his arrival in Zug than the calamity of the DAO, and the particular nature of the problems that almost brought Ethereum down with it. The DAO had fallen prey to a gaping security flaw in its code; the subsequent attempts on the part of the decentralized Ethereum community to remediate the breach had, in turn, revealed the platform's foundational instability. The hackers who absconded with the $50 million worth of ether had not technically done anything wrong—they just found a bug and seized their bounty. Some Ethereum supporters believed that the theft was bound to spoil the public perception of the platform's security, and suggested that Ethereum's clock be rolled back. Others believed that the immutability of the blockchain was axiomatic; by that logic, the record—theft and all—should never be manipulated. The creator of Ethereum, Vitalik Buterin, consulted with the community and then emerged to proclaim that the money would be restored to its prelapsarian locations on the ledger. The blockchain's sanctity had been altered by fiat from above. The Ethereum community was promptly rent asunder by a "hard fork": Some users respected the adjusted ledger, and others continued, irreconcilably, to use the one uncontaminated by a human hand.

Gevers spoke about Tezos in explicitly redemptive terms. Unlike the sloppy software engineers at the DAO, Arthur had what Gevers called a "fanatical focus on security." Gevers, too, was "obsessed with security," he said, "having grown up in South Africa with security concerns." But Arthur's obsession went so much further than his own! "Arthur goes to extremes. It's strong enough for the world financial system to run on. Trillions of dollars—quadrillions!" That wasn't all, however. There was also Tezos' "governance" provision. Without such a structure, Gevers said almost sadly, the Bitcoin and Ethereum communities "have vicious fights with each other on the bulletin boards—they hate each other, and it's bad for the whole ecosystem."

Gevers, the Breitmans, and the MME lawyers agreed upon a Swiss foundation structure to support Arthur's masterpiece. The public mission of the new Tezos Foundation, enshrined in its bilingual deed, would be to benefit "the fields of new open and decentralized software architectures," with particular emphasis on the "so-called Tezos protocol" and related technologies. As steward of the money collected, it would set budgets and disburse funds toward that end. The Breitmans, as inventors of the technology, would play a crucial role in getting the platform off the ground, but their relationship to the foundation was drawn up as an arm's-length contractual arrangement. Otherwise the Tezos ICO might just look like a license for the Breitmans to print money. Kathleen hadn't met Gevers in person and didn't know much about Swiss foundation law, but by now she had business experience—at the hedge fund Bridgewater Associates and the consulting firm Accenture—and what she cared about was that the plan seemed to guarantee the sober dispensation of the funds. The Breitmans didn't want token holders to feel as though Tezos were taking their confidence for granted.

Gevers emerged as the logical choice for foundation president. He had all the right credentials—he was trained as an accountant, and his emails were returned by important figures, both locally and abroad. The Breitmans got the impression he was a pillar of the community, and no further due diligence struck them as especially necessary. Gevers said he was very busy with Monetas—he was, he said, about to close a large funding round—but nevertheless agreed to serve. The foundation council, a three-person board, was filled out by a technical candidate with connections to Arthur and a local German businessman, well known to MME, who served on dozens of similar councils.

Arthur happened to be in Zug on the day last June when I met Gevers, and Gevers booked us a table for dinner on the outdoor patio of a lakeside restaurant that operated as the unofficial hub of the local blockchain community. The Tezos ICO fund-raiser was just two weeks away, but Arthur had no apparent desire to discuss it, or the Crypto Valley, or any ICOs at all. (Just that day, an Israeli outfit had raised $150 million in its own coin offering.) As far as cryptocurrency was concerned, he was happy to talk about governance or not talk at all, eating with rapid impatience.

He did talk about his family. Arthur had just come from Paris, where he'd scattered the ashes of his father, Jean-Claude Deret, who'd passed away the year before at 95. Deret, Arthur told me, had spent his young adulthood in flight from the Nazis; his own father was sent to Buchenwald. In the 1960s, Deret became famous for the creation of a children's television show that crossed a Robin Hood story with a thinly veiled attack on French collaborators. As Arthur grew up, his family observed the standard pieties of postwar left-wing French intellectuals, but Arthur's collegiate encounters with computer science and economics had emboldened his self-image as a rationalist in the tradition of French positivism, and he took pleasure in the espousal of hard-headed heresies.

Arthur moved to Manhattan in 2005 to study at NYU under Nassim Nicholas Taleb, whose emphasis on life's randomness modulated Arthur's belief that life was a multidimensional optimization problem. (Taleb argued it was always good to go to a party because the opportunity cost is low and the return could be high; Arthur's marriage to Kathleen was arguably the result of that advice, but he later reverted to a personal mean of mostly standing in the corner at social gatherings.) While Arthur came to develop an affinity for anarcho-capitalism, he had little patience for its emphasis on the evils of central bankers. He liked banks, and thought that the fractional-reserve system had been a glorious inven-

Kathleen Breitman

tion; if anything, he thought there should be more banks to compete. Ever since he'd visited the New York Stock Exchange as a 7-year-old, he'd wanted to work on Wall Street.

Arthur has a sleepy, remote affect, and if a conversation isn't stimulating enough for him he sinks into a kind of hibernation. When conversation turns rigorous, his eyes fly open and he sputters to talk. But if he seemed especially intolerant of stupid or slovenly thinking at that pre-ICO meeting, it may have been because he had a lot on his mind.

The Breitmans had begun to have some preliminary concerns about Gevers. In public, Kathleen described him as a "mensch," but, as she told me later, she'd in fact been instantly put off by him, and she couldn't help but prick at him in her pedantic way. She pointed to his nearly empty office and asked him how his big financing round was going. She offered to help circulate his pitch deck to people in the (other) Valley, but he didn't respond. Arthur told Kathleen to stop being so hard on him. It wasn't long, however, before Arthur began to have his own misgivings. On June 2, according to notarial records available online, the foundation board approved a revision of the deed to give Gevers single-signature access to its bank accounts and safe-deposit boxes. A local American expat named Tom Gustinis, a former UBS controller who'd been in talks with Gevers to pitch in at Monetas, remembers pulling Arthur aside to ask if this seemed wise. "You do realize," Gustinis recalls saying, "that this puts a lot of power in Gevers' hands?"

Arthur hadn't thought it was such a bad idea; the intention was to make the foundation more nimble and efficient, and the Breitmans' major concern about Gevers was that his responsibilities at Monetas would leave little time for Tezos Foundation work. The decision, in any case, was up to the foundation's board; the Breitmans had no say. Besides, they had far bigger things to worry about—like the potential vulnerability of their ICO to hackers.

On the morning of July 1, 2017, the widely anticipated issuance of a new currency called the *tez* was set in motion. Blogs and online fora debated whether this was the birth of the new Ethereum. The initial retail price for 5,000 tezzies was arbitrarily floated at one bitcoin, or about 50 cents per tez—though a special discount structure incentivized early participation. For two weeks, there was no limit to the quantity of tezzies available for order. At the close of the business day on July 13, more than 607 million had been reserved for eventual distribution. In the end, the Tezos Foundation took in $232 million in alchemical exchange for a currency that did not yet exist, and, according to the fine print of the offering, might never.

It was by far the biggest ICO to date, and Gevers was ecstatic. "TEZOS RAISES RECORD-BREAKING $200 MILLION IN THREE DAYS," he tweeted, "giving it the resources to grow into one of the Big 3 blockchains."

ACT II

In the 1980s, a man named Frank Tortoriello wanted to relocate his deli, on Main Street in Great Barrington, Massachusetts, but was unable to secure the necessary bank loan. Instead, he issued his own Deli Dollars. A local artist provided a design and Frank signed all of the notes himself. Eight dollars purchased a $10 meal, redeemable in dated tranches. He raised $5,000 in a month. The pastor at a local church was a known breakfast regular at the deli, and he was given Deli Dollars in the collection plate; even the bankers who had turned him down for a loan lined up to buy Frank's Deli Dollars. The proprietors of other businesses accepted the currency at face value; they knew how hard Frank worked and trusted he would be good for sandwich repayment.

We value Deli Dollars, or euros or yen or francs, because we trust that other people, and the government, are going to accept them as payment; we also trust that the government won't wantonly print so many of them that their purchasing power gets inflated away. The novel thing about Bitcoin was that it created a way to move value around—a debit in my column would appear as a credit in yours—without having to trust anybody at all. There was, in theory, no way to tamper with the accounting, no possibility of counterfeit, and no threat of hyperinflation. (There will only ever be 21 million bitcoins.) All of the parties that had abused our trust could wither away in favor of incorruptible machines.

One of the things that differentiated the Breitmans from many others in the money-creation game was they never believed, as a meme once had it, that Bitcoin works "because math." Of course, Arthur thought, if you could depend only on math, that would be fantastic, but that was impossible; you invariably had to rely on people, and thus the kinds of leverage afforded by institutions. And there were, after all, plenty of credible people and credible institutions that had underscored thousands of years of humanity's joint efforts. Among the most auspicious of those joint efforts was the proliferation of money as a coordinating technology.

The blockchain could only properly be understood as a product of that history. Human commerce had seen lots of different kinds of money in circulation—money that was a good store of value but a bad means of exchange (like gold); money that was a good means of exchange but a bad store of value (like cacao beans); money that was a good means of exchange and a good store of value but a bad unit of account (like the early years of the euro)—but there weren't many good examples of money that could be reengineered midflight according to the preferences of the community. Entire social movements have arisen to protest the inflexibility of currency. A hard fork last year in the Bitcoin community was one example; another, memorialized in *The Wizard of Oz*, was a campaign for monetary expansion that gave rise to major American populist unrest. Tezos described its future tokens as programmable money that its bearers could hold to account.

Deli Dollars, for example, could be put onto Tezos. Everybody who bought a Deli Dollar would get to vote on how they would behave. They could decide, say, that if you help Frank sweep the floors for an hour, your account is credited with five Deli Dollars. Or that if you propose an imaginative new sandwich, Frank will put it on the menu, and you'll get 2 percent of the proceeds in the form of Deli Dollars. All of the accounting and the settlements would be automated and incorruptible, so there would be no question as to whether the books were kosher. If people rushed to sweep Frank's floors and invent his sandwiches, then there might

be too many Deli Dollars in circulation; the lines would extend around the block, and Frank might be forced to radically increase the price of a sandwich. But the platform itself could then automatically adjust both Deli Dollar "wages" and sandwich prices to allow for nominal inflation. That is: Relative to the total number of Deli Dollars in circulation, the price of the sandwich could stay the same. If this sounds like some hippie collective, or a hyperlocal Federal Reserve, that's because it is. The Breitmans believed that the blockchain didn't have to replace the kind of trust inspired by Frank; it could actually underwrite and extend it.

Tezos was designed at least in part for enterprises like Frank's that might want to operate on a larger scale, or for larger entities that might seek to generate public credibility by outsourcing their accounting to a clear, auditable blockchain. Imagine, for example, a videogame that runs an internal economy on a credit like digital gold; Tezos could prevent arbitrary changes to the game's money supply. Or take the example of airline miles, a form of private currency that is constantly debased by its issuers. It makes little sense to commit to an airline's loyalty program if one year a domestic flight is 35,000 miles and the next year it's 70,000. If these companies decided to put their rules and conditions into smart contracts on a public blockchain, the miles might be understood to be a better store of value, and loyalty programs would become more attractive.

That's all in theory, of course. As John Kenneth Galbraith put it, "A constant in the history of money is that every remedy is reliably a new source of abuse."



WITH THE ICO SUCCESSFULLY COMPLETED, everything seemed to be in place for the final transformation of Tezos from idea to reality. The Breitmans held the project's intellectual property—the Tezos source code—through a Delaware corporation called Dynamic Ledger Solutions; now the foundation, according to both its contract with the Breitmans and its own public charter, was obligated to deliver a functional platform. The contract stipulated that it had a little less than nine months to do so; once the network was up and running for a specified interim, the foundation would acquire the original source code and the Tezos trademark from the Breitmans' company for 8.5 percent of the ICO funds raised, plus 10 percent of all tokens issued on the "genesis block." The foundation did not, one might reasonably have assumed, lack the necessary resources to get the work done; in fact, it was drowning in assets. They were still denominated in cryptocurrencies, so the foundation began to sell them off for regular fiat—hard currency was needed for rent and salaries—at the rate of approximately half a million dollars a day.

> The Tezos Foundation took in $232 million in alchemical exchange for a currency that did not exist, and according to the fine print, might never.

The first signs of discord appeared without delay. Just days after the close, Gevers messaged Arthur to propose that the foundation hire someone to serve as a joint COO of both the Tezos Foundation and Gevers' own company, Monetas. The candidate Gevers had in mind was Tom Gustinis, the American expat who only a month earlier had warned Arthur about Gevers' single-signature power. Arthur responded to say that he thought the foundation could probably afford its own full-time person but that Kathleen was a better judge of these things. Gevers continued undeterred. In his strategic vision, he wrote, Tezos and Monetas needed a dual executive. Together, the entities had "two technologies that serve the same mission, and are used as a 'portfolio' to build solutions for clients." Furthermore, Gevers claimed, Gustinis was willing to work for free—or, that is, for tokens. The proposal was peculiar. With a $232 million endowment, why did they need to go bargain hunting for a C-level executive on a time-share basis? But Gevers, as president of the foundation, was entitled to recruit whomever he wished for board approval. The question was deferred.

Small skirmishes followed one another in rapid succession. Arthur had developed Tezos in a functional programming language that had emerged from French academia, and had been working with software developers at OCamlPro, a specialized French contract shop. According to internal foundation emails I was able to review, Arthur got into a dispute with the contractor, which held that, in light of the Tezos ICO haul, a generous bonus was in order. Work on the protocol slowed, and Gevers suggested that the development could be done much more cheaply elsewhere. Arthur didn't bother to hide his disdain: This was not simply a matter of outsourced IT, it was *computer science*. Gevers was micromanagerially preoccupied with things like travel expenses: He questioned, for example, Arthur's decision to purchase a sandwich on a plane. Arthur responded with contempt, and Gevers grew defensive. Even minor quarrels took on emotional freight.

As the summer dragged on, Gevers proved hard to reach, always seemingly en route to or back from a blockchain conference. Arthur assumed that he was very busy with Monetas, which in August had moved into a new address—an office listed as a Tezos Foundation expense. Then Tom Gustinis told him that, to the contrary, Gevers was almost never there. Nobody seemed to know what he did all day.

According to foundation emails, Gevers called the other two board members on September 8, a Friday, and told them he wanted to hire Tom Gustinis, this time as CFO, the following Monday. Diego Olivier Fernandez Pons, the member of the three-person board with longstanding ties to Arthur, wrote the next day to question the rush. Gevers responded with a long message about his own perfectionism and the necessity of good faith: "We also need to remember that no amount of 'systems' will ever be able to replace trust. If we don't trust each other and our competence, all of this will not work, no matter how many systems we put in place." When he eventually returned to the Gustinis question, he argued that the hire would come cheap, as he would only be working half-time. Gevers did not, in that email, see fit to mention to the board that he already considered Gustinis to be COO of Monetas.

Four days later, Gevers wrote to demand in addition that the matter of his own contract be settled immediately, as he'd been working as "de facto executive director" of the Tezos Foundation for months. There were limitations on what he could be paid as president of the board, but he was free to propose himself for a salaried executive role, and the contract he attached included compensation in the hundreds of thousands of Swiss francs. He also asserted that he was still owed a quota

of tokens from his own ICO contribution, noting that a verbal agreement with Arthur had supposedly granted him a personal 50 percent discount for that period; on top of that, his draft contract included provisions for additional tokens in the form of annual bonuses. The Tezos network itself hadn't yet launched, of course, so any market value ascribed to these token allotments was almost entirely arbitrary. His proposed contract valued the allocations at a few hundred thousand dollars, but in a near-simultaneous private communication he expressed his belief that they were worth perhaps 10 times more. The cumulative contract value was potentially worth millions of dollars.

When Arthur found out that Gevers hadn't mentioned the potential conflict of interest with Gustinis, and then had proposed such a lavish contract for himself, he was livid. Arthur called Gevers incompetent, and threatened that if he did anything improper—like prevail upon the supervisory authority to nullify the foundation's contract with the Breitmans' company—he'd expose him to the press; according to Pons, Arthur began to harass the third board member as well. Gevers, in response, excoriated the Breitmans for their attempts to wield "undue influence" over the foundation, and called a halt to all foundation activity until the matter of his own contract was forthwith resolved. No one—neither the software developers nor the small team—was being paid. (Gevers declined multiple opportunities to discuss questions about Tezos.)

Pons emailed the board with a methodical summary of a situation he could only describe as "dire." The foundation, in his view, had accomplished almost nothing since the ICO and now ran the risk that federal authorities would revoke its charter. Unless they got down to real, productive work, they would find themselves in breach of their contractual obligation to the Breitmans to complete the protocol. Foundation balance sheets for the period from July through October show inflows from crypto sales of about $65 million—and business expenses of less than a million dollars. The foundation had hired only a handful of contract employees, one of whom had sent screenshots of an empty bank account in a plea for payment. It was time, Pons wrote, to appoint an outside executive director.

Gevers argued that the stasis hadn't been his fault. "I cannot handle all the operational tasks myself," he wrote to the board, "and in fact it's a waste of my time, as my skills lie in high-level leadership, vision, strategy, and evangelism. However, Arthur has rejected all my suggestions for candidates for operational roles, instead suggesting candidates that are personal friends of the Breitmans." The latter category, in Gevers' view, included Pons, whom he denounced as an agent of the couple, scornfully inquiring if he was on their payroll. In emails and texts, Gevers instructed the foundation's team to stop talking to the Breitmans.

Meanwhile, the value of the foundation's remaining crypto assets had passively doubled in value to more than $400 million. Within weeks, the entirety of the Tezos Foundation, as documents later revealed, would consist of three directors, zero employees, two HR complaints, and open hostilities with the people who owned the actual intellectual property.

O

ON OCTOBER 15, ONE OF THE BREITMANS' growing cadre of lawyers sent a 46-page letter, including exhibits, to Pons and the third board member, excluding Gevers. The document charged Gevers with "deception and self-dealing" in his attempt to award himself a "license to print money," as well as with the Swiss crime of "disloyal management." The Breitmans called for Gevers' prompt removal.

Within a very short time, word of the letter and the ensuing tumult reached reporters working for the news agency Reuters, which had been investigating Tezos. On October 18, Reuters published a 3,300-word investigative report on Tezos, alleging that it was "now in danger of falling apart because of a battle for control playing out behind the scenes." Gevers told Reuters that the letter's censure represented nothing but "attempted character assassination. It's a long laundry list of misleading statements and outright lies."

For the most part, the article seemed to treat the Gevers-Breitman quarrel as a case of dishonor among thieves. After duly noting that the cryptocurrency markets had become "magnets for fraud and deception," the Reuters journalists quoted a pre-ICO interview with Kathleen in which she described Switzerland as a place with "a regulatory authority that had a sufficient amount of oversight but not like anything too crazy." The article noted that a PR firm representing the Breitmans had exaggerated a variety of claims about the financial institutions they had advertised as early adopters of their platform. (Kathleen showed me emails in which she expressed discomfort with the firm's move beforehand.) In describing the terms of their contract with the Tezos Foundation, the story insinuated that, even if the Tezos tokens never amounted to anything, the Breitmans would still walk away with tens of millions of dollars.

But the parts of the Reuters article that would ultimately cause the Breitmans the greatest tribulation were the ones that all but openly identified the Tezos ICO as a sale of unregistered securities. The article quoted a handful of Tezos token purchasers who frankly admitted they were only in it for speculative gain. "For me and for a lot of people this is an investment. We are looking for a return," a cryptocurrency trader named Kevin Zhou told Reuters; he added that he "didn't really care about using the Tezos technology." Kathleen had on her end been intermittently nonchalant in the way she described the fund-raiser in public. She'd been unable to help talking about the "sale" of tokens, and when she was careful to talk instead about "donations" she could sound glib: She once referred to their tokens as akin to the "tote bag" one might receive as a thank-you gift from NPR.

The Breitmans would not comment on the securities question, but these statements were all the more problematic in the context of a recent SEC memorandum on the DAO; its upshot was that anybody who wanted to sell tokens was on notice to proceed with extreme caution. The DAO's tokens, the commission wrote, had clearly qualified as securities, and ill-disguised ones at that. The same might be true for everything coming out of Switzerland, "depending on the facts and circumstances of each individual ICO." Optimistic observers took this to mean that the SEC would ultimately permit the unregulated sale of so-called utility tokens—those that, like a digital Deli Dollar, actually did something. Ethereum, for instance, had grown from a founding group's project to a diffuse, participatory network, and its token had evolved from a passive investment to an item people were using to animate utility-management systems, censorship-proof media startups, and music-distribution services. Tezos saw its destiny in the same arc, and the network, if it ever launched, would presumably prove it. Any token purchase was in some sense *speculative*, but in the utopian rather than the rapacious sense of the word. Idealistic token buyers speculated that their contributions represented a down payment on a new world of unfettered interpersonal exchange, one free at last from banks and other rentiers.

More than a few American securities lawyers, however, thought there were fundamen-

tal flaws with the entire Swiss model. The use of the magic word "donation" was not enough to indemnify coin issuers against the charge of selling unregistered securities; if it was unfair that a coin issuer was to be judged by somebody else's expectation of a return, well, that was the law. The US allows individuals to sue in cases of potential securities fraud, and the assets of the foundation made Tezos a rich target for private litigation. A week after the Reuters article appeared, a class-action complaint against the Breitmans, Gevers, and various associates was filed in San Francisco. These first plaintiffs—token buyers—charged the Breitmans with the sale of $232 million in unregistered securities, securities fraud, false advertising, and unfair competition.

As the Breitmans and Tezos came under ever more intense scrutiny, the value of the foundation's crypto hoard escalated under their feet. By the time four more lawsuits had been filed, in Florida and California, the dramatic rally in crypto prices had driven the foundation's assets to more than $700 million. Dodgy crypto entrepreneurs had become figures of morbid public fascination, as their magical internet money turned into very real Lamborghinis—"Lambos" in their insufferable meme argot—and at-home stripper poles. Further suits piled up. By Christmas, when the price of bitcoin neared $20,000, the foundation's assets had more than quadrupled. At Bitcoin's height, the board had at its disposal approximately $1.2 billion.

If the SEC or the courts ultimately ruled that the Breitmans had been selling unregistered securities, they could face ruinous financial penalties. On the utility-token theory, their best defense would be the appearance of the platform. But relations with Gevers were deadlocked, and he still had single-signature access to the safe-deposit box in Zug that held the cold-storage laptop with the private keys to the crypto assets. He couldn't steal the money—that would require a second private key, held by an entity called Bitcoin Suisse—but if the foundation's keys were somehow disappeared or destroyed, the money would simply be gone.



AS THE FIASCO UNFOLDED, THE NAME "TEZOS" became crypto-world shorthand for ICO avarice. On one Ethereum-news site, a contributor wrote that Tezos was "a reminder for us all that the greed of the few could ruin great ideas and ventures for everyone." Redditors called Tezos "the worst scam since Mt Gox." Maybe Gevers was a bad actor, some allowed, but the Breitmans had installed him in the first place.

> By the winter, the Tezos Foundation consisted of three directors, zero employees, two HR complaints, and open hostilities with the Breitmans.

Arthur was viewed as a sullen genius with no ability to communicate with those he took to be beneath him. In reality, he was overwhelmed by anxiety; he tried to put his own situation in perspective, he told me, by reminding himself that the source of his father's youthful stress was Nazi pursuit. He liked to distract himself with thought experiments: If he could send his past self a message that was limited to only eight bits, what would it be? Kathleen got none of the begrudging charity doled out to her husband. She was frequently disparaged as a nontechnical interloper of overweening aspiration, a nerdy engineer's Lady Macbeth. "If you look at her profile at LinkedIn you won't find anything special about her," one Reddit thread began. "Of course, it is easy for Gevers to fool a young girl like her." If the agony of the situation turned Arthur inward, it made Kathleen furious.

Gevers was no longer speaking to the Breitmans or, according to Tom Gustinis, pretty much anyone else; he confided in Gustinis that he believed his phones had been tapped, and ordered regular bug sweeps. Gustinis, as one of the only people Gevers would listen to, involved himself as an avuncular ombudsman, breezily telling the Breitmans to sit tight and give him time to broker peace. Given Gustinis' ties to Gevers and Monetas, however, he hardly seemed to them a disinterested party.

The Breitmans did, however, have thousands of ICO patrons who wanted them to prevail. Some were true believers in the promised land; others just wanted their tezzies in hand so they could flip them before the cryptomania ran out of lesser fools. In either case, they carried on like zealots. This distributed cohort took matters into its own far-flung hands, with letter-writing campaigns and tweetstorms designed to pressure the Swiss authorities into action. One anonymous Redditor, part of a loosely organized online group that called itself the Tezos Community Organization, corralled resources in the United States, South Africa, Canada, and Europe to compile a 17-page, single-spaced report on Gevers' past. Where Gevers had mythologized himself as visionary thought leader, the report presented a long list of odd, dead-end projects. He was listed as the president of nebulous libertarian operations called Freedom Universal and Institute for Freedom, and had solicited donations to their cause, but it was difficult to find evidence of anything they had done. The dossier referred to multiple businesses he led that ostensibly ended in stagnation or insolvency, as well as to a personal bankruptcy filing in Vancouver in 2009. A Zurich newspaper reported that the bankruptcy proceedings listed Gevers' occupation as "massage/odd jobs."

In addition to the dossier, other former colleagues of Gevers came forth to describe corroborating experiences. James Hogan and Patri Friedman, who'd employed Gevers on the libertarian-city project, took to Medium to describe troubling patterns of evasive and unprofessional behavior. Gevers, they wrote, refused multiple requests to hand over a security token that granted access to the project's bank account; this was "so unusual and disturbing that we began to fear the possibility that Mr. Gevers intended to embezzle or otherwise misuse company funds." They added that no such crime occurred and attributed the situation to poor communication, but said that the company's board took emergency steps to relocate the funds, and fired Gevers. Hogan and Friedman now urged Gevers to remove himself from his role at Tezos. (Though Gevers declined to respond to WIRED's detailed list of questions, a crisis PR specialist supplied a general statement, contending that all allegations against his client "are patently and demonstrably false." He attached a screenshot of a now deleted LinkedIn endorsement from Hogan.) Multiple people told me that Gevers was far less interested in money for its own sake than he was in money as a vehicle for control. "He would never spend 10 francs inappropriately," Gustinis told me, "but he would hold up a billion-dollar project over 10 francs."

Monetas, for its part, appeared to be a ghost ship. In an investor update on Novem-

ber 30, Gevers reported a new commercial venture that, he projected, would make the company profitable by the second quarter of 2018; he described it as "the most important milestone since our founding five years ago." The company, however, had no employees except the unpaid executive Tom Gustinis, and its bankruptcy was announced 12 days later. According to testimony submitted to the foundation authorities in Bern by a former Monetas employee, the company had been on the verge of receivership since the previous spring, before the Tezos ICO. The office had been dark when I visited because Monetas was moving into Gevers' apartment, which served as its headquarters until he could relocate his company to the new Tezos Foundation office. The employee described him as a capricious figure who was quick to blame any problems on the "dark forces" arrayed against him.

When I spoke with the former Monetas employee on the phone, she told me that she had been incredibly impressed by Gevers when she first met him, but that he was unable to keep up the facade. "Do you know that moment when you get on a train and sit down next to someone, and then you try to inch away without upsetting him?" she said. "I had that moment." She sighed; she seemed to pity him, as did two other former Monetas employees I spoke with. "The things he does leave him worse off," she said. "It's not like ... he makes his money, rubs his hands, and goes off sailing to the South Pacific."

Still, the employee said, he was clearly so bright, and people were always trying to help him. This had certainly been the case in Switzerland. The anonymous Redditor's dossier drew a picture—with the sort of elaborate graphical aids that belong on a whiteboard in a caper movie—of a man propped up by a loose local confederation of mutual interest. The Monetas employee, in an email to Kathleen, described Gevers' problematic patterns of behavior as an "open secret" in Zug. Gustinis, for his part, told me that he'd spent the summer and fall trying to put together a salvage deal to save Monetas, in part because he expected to be installed as the CEO of the recapitalized firm.

The reality of the situation in Zug was almost certainly less archly conspiratorial than the dossier alleged, but the problem of business as usual was precisely the point. The specific charges were merely a vehicle for the Tezos token holders' grievances with the status quo. All of this was the opposite of what the blockchain was supposed to be. The Tezos community, however, proved itself exactly the sort of self-orchestrating effort

> Thinking of Gevers and the others in Zug, Kathleen paused to stare out at the hills. "They fucked with the wrong nerds, is my take."

the platform was designed to incubate, even without recourse to its actual blockchain. In December, aspiring tezzie holders posted an online petition requesting Gevers' immediate removal; it would gather more than 1,700 signatures, from a reported 95 countries.

At the same time, Gevers and Pons submitted their responses to a formal inquiry conducted by the foundation authorities. Gevers blamed the delays on the Breitmans and the media, but concluded that the foundation was now prepared to move forward with alacrity. Pons held a different view. Though supposedly an agent of the Breitmans, he did not spare Arthur; he understood why Gevers, hammered by Arthur for incompetence, had been offended. "But M. Breitman's lack of civility doesn't exonerate the board from its legal and technical shortcomings," he wrote. He presented an exhaustive inventory of the board's mismanagement, inactivity, and conflicts of interest, and finished with undisguised alarm. "As a member of the foundation council, I, once again, respectfully request your Authority to take immediate action to safeguard the interests of the foundation."



IN LATE FEBRUARY, GEVERS STILL REIGNED as foundation president. Kathleen had recently arrived in San Francisco from Paris via New York, and I drove with her to Los Angeles, where she was scheduled to appear at a blockchain conference at UCLA. She had recently received one more in a succession of Russian scam emails telling her that Johann Gevers had initiated a plot to hire assassins to murder her with poison, and that it could only be stopped if she transferred 10 bitcoin to the address included. She delivered an executive summary of the Tezos situation in a tone of hyperrational self-parody: "We overindexed on operational security risk, and underindexed on key-man risk."

By then, however, most of her resentment was reserved for the Crypto Valley. A prominent Zurich businessman called as we headed south, with a patronizing offer to broker a deal that would put the foundation in wholly safe Swiss hands. Kathleen's measured tone went out the window. "All these Swiss people calling me and telling me to shut the fuck up and do things the discreet way. If I got raped at a party, would you tell me it was my fault for wearing a skirt? Swiss business culture is a load of shit."

Gevers, the Breitmans' erstwhile key man, seemed to be doing fine. Kathleen described how she and Gevers had both recently been in St. Moritz to speak at a blockchain conference; Kathleen was allotted a "fireside chat," while Gevers had been invited to give his own talk—on ICO best practices. A friend of Kathleen's who had run security for Metallica paid for a German bodyguard to accompany her. At a white-tablecloth dinner, a prominent table companion brought up rumors that Kathleen had placed a bounty on Gevers' head. She had taken the comment to heart, and as she related the scene she looked at me with pleading humor. "Do I look like a violent person?"

Gevers had delivered his speech with a calm, commanding sense of impending victory. (On his PowerPoint slides, he quoted Warren Buffett, Elon Musk, and himself.) Immediately afterward he released a series of triumphalist tweets about the future of Tezos. "After months of incapacitating interference, obstruction, and attacks, the Tezos Foundation has regained the ability to act," he announced. "For those seeking to understand what happened at Tezos—both its successes and its failures: 'In a high-trust environment, the impossible becomes possible. In a low-trust environment, even the possible becomes impossible.'—Johann Gevers." Further tweets, later deleted, seemed to link, if implicitly, the future of Tezos to Monetas, for which Gustinis had found a buyer.

The Breitmans, Kathleen said, took Gevers' social media proclamations to indicate he was prepared to continue fighting a war of attrition. Though Tom Gustinis says he was personally paying Gevers' rent at this point, the founda-

Johann Gevers



tion had expensive lawyers on retainer; the Breitmans, meanwhile, were paying $250,000 a month in legal fees. As Kathleen put it, "It's not a corporate-governance matter anymore, it's a hostage negotiation." When I asked how it had possibly come to this—Gevers, it seemed, could have just cut the checks, celebrated the network launch, and emerged a wealthy man—Kathleen could only throw up her hands. "He's the world's stupidest scorpion, and Arthur is the world's most gullible frog."

Kathleen now felt as though they had one option: brinkmanship. This was no longer about the utopia to come but ascendancy in the here and now. "I feel like I'm in a hole, so fuck it, the game's afoot. I'm going to blow this fucking canton up. I'm going to play the hand I was dealt, and I've got a much better deck. I keep telling Arthur that the people on the other side are just going to play their game for a billion dollars. It's not about the morality of crypto. It's about shipping and winning the game. I've got 60,000 lines of code that will ship with or without those guys in Zug."

She paused to stare out at the hills near Santa Barbara, blackened and denuded by fire. "They fucked with the wrong nerds, is my take."

Their will had been renewed by the fact that they no longer felt so alone. Once it had become clear that the original board's efforts were at best nugatory, the Tezos community had formed its own parallel "T2" directorate. In partnership with this second foundation, she and Arthur would continue to fund the platform's development out of their own pockets; it had cost them $1.5 million so far, but they'd made a lot of money on their early personal investments in Bitcoin. She couldn't comment on anything that pertained to their legal entanglements, but an actual launch could conceivably change the juridical landscape: After all, it was the original billion-dollar foundation that had the contractual responsibility to roll out the platform and distribute the tokens. More than anything, though, they wanted to see Tezos live.

Exhausted, Kathleen looked out to the placid expanse of sea and wilted a little. "It's the 13th inning, and we're getting a little tired. Neither of us needs to be doing this. I'm doing it as an act of love for my husband, and he's doing it because he thinks he can do a good thing for the world. We're going to birth Tezos as an act of love and collaboration."

The next day, in front of a crowd at UCLA, she unveiled this strategy for the first time. "We're going rogue, and in the next few weeks we'll release the token. It's the software equivalent of carrying an ectopic pregnancy to term."

A few days after the UCLA panel, Kathleen sent me a strangely low-key message over Signal to report that Gevers had resigned from the Tezos Foundation. The leader of the T2 faction—a preternaturally tranquil and even-keeled Mormon named Ryan Jesperson—had sat in a room with Gevers and the lawyers for 10 hours of what he insisted was polite, amicable conversation. In the end Gevers had consented to his departure on the condition that the entire board be replaced. Gevers stepped down; an unsigned version of the final resolution of the first Tezos Foundation stipulated more than $400,000 in severance. Pons was ready to be rid of the whole travail, and he communicated, via Reddit, that he would be returning his own settlement to the foundation. He publicly invited Gevers to do the same, but according to Pons, no such donation had materialized. Jesperson moved, with his wife and three small children, from Utah to Zug to take over the new foundation. Twitter users taunted the foundation account: "When Lambo? When Lambo?"

ACT III

THE END OF THE STANDOFF DID NOT MEAN that everything for Tezos was looking bright. The lawsuits had been consolidated and a lead plaintiff selected. But the network had yet to appear, and, unfortunately, the long delay meant a lot of competition. When the original Tezos papers were released, in 2014, nobody was concerned with the need for governance. Now it was a stock talking point.

The other piece of bad news was that in late February the head of the SEC, Jay Clayton, declared that, as far as he was concerned, all ICOs constituted the sale of unregistered securities. He did not exclude Ethereum. The longstanding fantasy that a centralized entity could presell a token on the premise of delayed decentralization might have to be set aside once and for all. In the meantime, the total ICO market in the first quarter of 2018 had, by one measure, surpassed $6 billion. An MIT professor estimated that up to a quarter of that total was collected by scam artists.

Arthur was in Paris for the spring, passing long hours with a team of international software developers drawn from academia; they had the mellow, abstracted air of a postdoc colloquium. The platform, with any luck, would at last come to realization over the summer. Kathleen joined Arthur there between speaking engagements and business-development meetings in Singapore, Hong Kong, San Francisco, London, Berlin. The constant dread of the past year had only deepened the bluff tenderness of their interactions. Kathleen mocked Arthur for ordering a gin drink thick with melted marshmallows; Arthur made fun of Kathleen for her terrible French. Their small apartment had the underfurnished ambience of an Airbnb. The only remaining evidence of the conflict was a piece of ruled white paper with a ballpoint rendering of something that looked vaguely like Babar; it floated over Arthur's head in the video update he posted on Reddit, the elephant in the room.

In late March, Kathleen had yet another speaking engagement, this one in Zurich. Arthur wasn't crazy about the idea of Kathleen alone and unprotected there; other people might associate Switzerland with chocolate, watches, and neutrality, but the mountainous confederation hadn't been particularly kind to the Breitmans. I wanted to go to Switzerland anyway, to try to see Gevers and the lawyers at MME in Zug, so I went along. Gevers responded to my request to tell me that he was in "an intense work phase" but that I ought to try him in a month, then stopped replying, and I heard nothing from MME.

On the train to Zurich, Kathleen tried to concentrate on other things. But she couldn't help ruminating once more over how, exactly, a system she and Arthur had designed to underwrite and extend interpersonal trust at scale had foundered on their inability to rely upon one single individual. In certain moods, their interpretation of the events of the previous year had the ring of conspiratorial fancy—not because their thinking was muddled but because it was, if anything, too crystalline.

Conspiracies made sense. One of the things that drew the blockchain community together was a commitment to the idea that the whole of human behavior could be interpreted as the pursuit of rational self-interest, and there was something profoundly disturbing in the fact that their model remained unable to account for Gevers' motivations.

The conference was two stops outside Zurich's city center, at a hulking black venue called Samsung Hall. It looked like what you'd get if you gave an alien civilization's stodgiest corporation a written definition of a nightclub. Kathleen ducked and dodged her way through the lanyarded slicks who wanted to network or gossip.

Then she froze. "Well," she said, with a weak laugh. "There's Tom Gustinis now, Johann's flying monkey."

Gustinis flashed Kathleen a wide smile and approached her with an unhurried, deliberate gait. He was very tall and broad-shouldered, with graying blond hair gone shaggy over his ears, and he vibrated with pocket-jangling energy. He greeted her with affected warmth. Curtly polite, she returned the greeting, introduced us, and immediately excused herself. Gustinis looked a little hurt.

We stood at a high, rickety cocktail table and made small talk about our shared origins in New Jersey. When I asked him about Tezos, he assumed the frowning detachment of an elder statesman. In the ICO world, he said, there was now "Before Tezos and After Tezos, after everything that happened with the Stiffdong." It took me a moment to realize he must have meant *Stiftung*, the German word for "foundation." But he didn't think that ought to be the case, and his own postmortem was lax and mild. "The project was delayed—probably unnecessarily. The project could have done without the noise." He'd tried to mellow the fuss. "After Kathleen and Arthur hung up on me many, many times, I still say the same thing: It started as a misunderstanding, and then egos got involved. She gives me a cold welcome here, but I've never done anything against the Breitmans." He'd only gotten involved because the world of blockchain felt electrifying in a way banking no longer did.

His deflationary story, if slightly evasive, felt plausible. "Look, I'm a conservative guy who comes from accounting and worked my way up at UBS. I was astonished at how this anarcho-capitalist community was going to cannibalize themselves." He stopped to sum it all up. "It was a fundamental misunderstanding that started it—and I disagree with Johann. And for that I have a lot of empathy for the Breitmans. But maybe that's too boring a story for you."

Two people from one blockchain startup or another came over to network aggressively and I excused myself. Through the business scrum I could see Kathleen far across the room, her back to the wall, editing her talk. Maybe it all *had* been a boring misunderstanding. After all, there had been few apparent consequences for Gevers; the previous week he had been quoted as a coin-issuance expert in a *Financial Times* story. There would, however, be at least some formal repercussions for Arthur for promoting Tezos while employed at Morgan Stanley: In April, the Wall Street regulator Finra suspended him from trade with its members for two years.

A few minutes later, Gustinis materialized once more. Kathleen conceded a second hello without looking up. He chatted idly to nobody in particular—"Who will be the Elon Musk of the blockchain?"—while Kathleen ignored him until she left to watch a panel.

I made to follow Kathleen, but Gustinis, all of a sudden upset, turned to confront me. "So," he said, "I see what this is, from one Jersey boy to another." As he spoke, he slowly leaned closer, until his heavy frame was looming over me. (Gustinis disputes this account, claiming he is simply tall.) "You're here hanging around with her, huh? I get what's going on."

I said I had press accreditation for the conference, but Gustinis only smirked. "Well, I'm going to tell people what this looked like to me." He turned on his heels to saunter away. As I began to stutter in reply, he wheeled back around and placed his palms flat on the high rickety table. "Are you going to make me be more explicit with you, Jersey boy?"

And then he was gone. Gustinis kindly apologized later. There was something, we both tacitly acknowledged, about this troubled crypto utopia—the conditions of perpetual alarm and mistrust, as well as fear, uncertainty, and doubt—that, even now, drove otherwise sensible people to paranoid extremes.

I said I of course forgave him, but at the time I'd walked into the dark hall on the verge of panic. Onstage the conference organizer was interviewing a panel of four Swiss men in suits. Their faces were gigantic and fleshy on the screen mounted behind them. I texted Kathleen to say I thought Gustinis had just tried to scare me. When I found her at her seat she just nodded, and even seemed to smile.

A lawyer onstage in a fitted waistcoat was talking about the necessary role of the proper regulator. "We take the fear away," he said. It is our job to tell people, he continued, "Don't be afraid."

COLOPHON

GET-RICH-QUICK SCHEMES THAT HELPED GET THIS ISSUE OUT:

Charming the (possibly Russian) bot impersonating me on Twitter into sharing the cryptocurrency loot it claims to be giving away; my self-financing outerwear addiction; cutting a hole in the fence and bringing all my friends with me; moving to Crypto Castle; buying penny stocks for pot companies on a tip from a surfer in Puerto Rico; participating in a neurological study at UCSF for a hot $150; signing up to walk a dog and showing up to find a goose; flipping coffee tables on Craigslist; becoming a professional poker player like Maria Konnikova; getting $100 and a free cruise ticket for taking pictures at a stranger's bachelor party; *Gold Rush* TV series; selling plasma; producing "Yanny/Laurel" by Post Malone (featuring Migos)—it would be the jam of the summer; harnessing Twitter outrage to generate electricity for cryptocurrency transactions; working at a pop-up toy store so I could buy an engagement ring.

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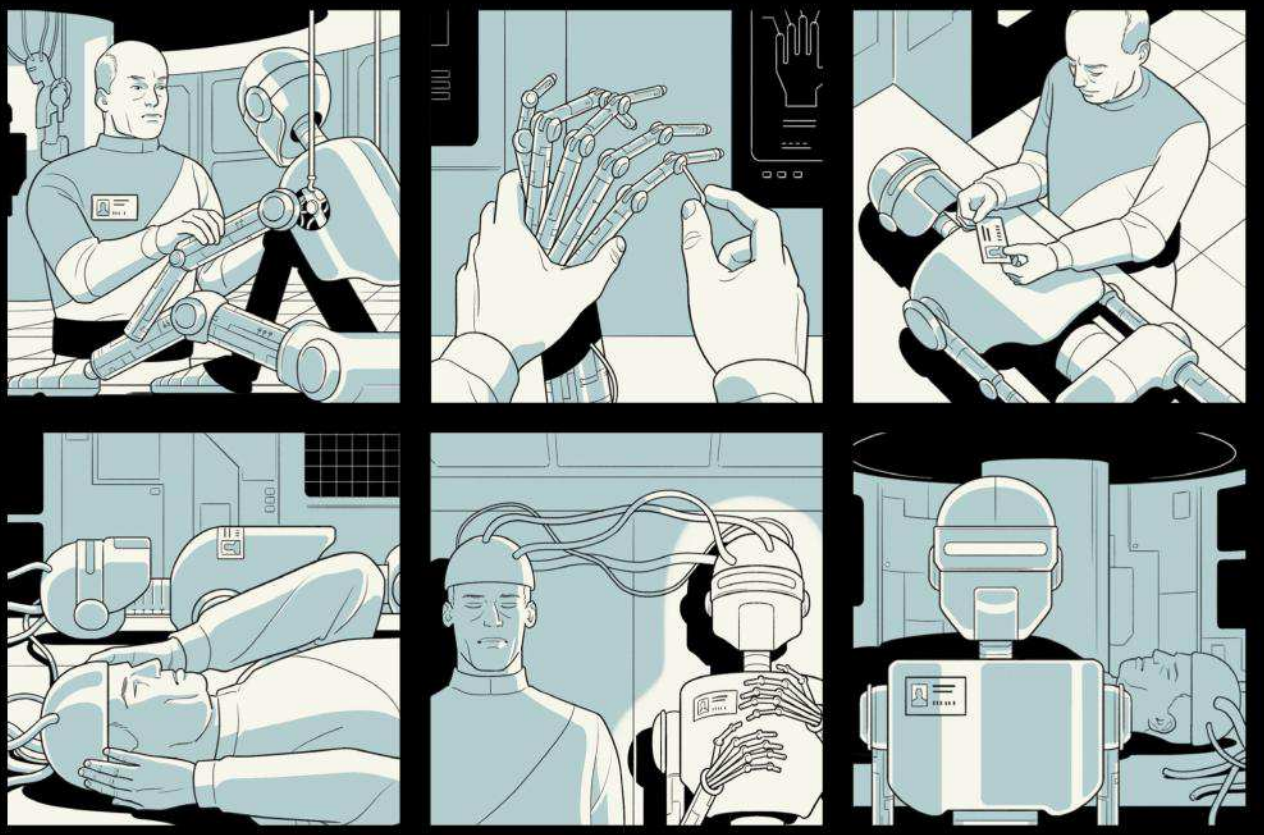
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I ASSEMBLED MY OWN REPLACEMENT TODAY.

BY CHRISTOPHER DORDA, VIA FACEBOOK

HONORABLE MENTIONS: TAKING NIGHT COURSES FOR DEEP LEARNING. (@ADAMAHARON, VIA INSTAGRAM) **// NOTHING BUT MALWEAR IN MY CLOSET.** (@AKUNZE, VIA INSTAGRAM) **// FINDING COURAGE TO REQUEST AN UPGRADE.** (KAREN JANTSCH, VIA FACEBOOK) **// WAS A LONG DAY. ELECTRIFY ME.** (@IAGSCH, VIA INSTAGRAM) **// NOTHING CERTAIN BUT RUST AND TAXES.** (@DJVJGRRL, VIA TWITTER) **// WHEN IN DOUBT, BLAME USER ERROR.** (@DANNYGRONER, VIA TWITTER) **// I FAILED THE CAPTCHA AGAIN TODAY.** (AJAN R PRABHU, VIA FACEBOOK)

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