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THE HYPERREAL LIFE

While China's sci-fi authors are elevated to the status of New Age prophets, Chen Qiufan's career—like his genre's place in society—has gone through the looking glass.

by Yi-Ling Liu

**P.34 DEAR BIRTH MOTHER**

As adoption migrates to Facebook, regretful adoptees and birth mothers are confronting prospective parents with their personal pain—and anger.

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Security cameras. License plate readers. Phone trackers. Drones. We're being watched 24/7. All of those eyes could become one.

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A DISASTER WITHOUT BEING SHATTERED BY IT

Margaret McKinnon survived a midair catastrophe, then became a researcher of trauma. Now she's studying how the pandemic will haunt us.

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The secret history of the first microprocessor, the F-14, and me.

by Sarah Fallon

ELECTRIC WORD

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ON THE COVER

Illustration by Lisa Congdon

It's a tradition in computer science, dating back to the days of the earliest microprocessors, for rookie coders to pass a simple test. They must write a program, no more than a few lines long, that outputs the phrase "Hello, world!" As we look ahead to the coming months—to the end, we hope, of isolation and the start of new growth—we can't think of a better message than that. So we asked Lisa Congdon, an artist based in Portland, Oregon, to put it on our April cover. The program isn't ready to run quite yet; there's still the vaccine rollout to worry about, and the emerging variants, and plenty else. But one day soon, the world is coming back, and you'll want to say hello.



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by Cade Metz



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by WIRED readers



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RANTS AND RAVES



In March, Rachel Monroe explored the booming tactical training industry; Steven Levy revisited a 25-year-old bet on the fate of the world between neo-Luddite Kirkpatrick Sale and WIRED cofounder Kevin Kelly; and Vince Beiser investigated a screwball case about clean-energy fraudsters in Utah. Over on WIRED.com, we published Sarah Fallon's personal essay about an engineer and the F-14 fighter jet (which we are printing in this issue).



Readers share their forecasts, skepticism, and reminiscences.

RE: "THE BET"

I don't know if it has destroyed society, but the unintended consequences of technology are jarring. The optimist in me sees these as "growing pains" in the effort to institute tech for the greater good. The pessimist thinks it could lead to our downfall. —Thinh Quoc Dang, via Facebook

The only flaw was putting a time limit on the bet. Neither Sale nor Kelly could see the impact Covid-19 will have on the next 30 years. A tip of the hat to Thomas Malthus: Famine, war, and pestilence are thriving as the world enters the 21st century. With the aid of technology, a world of 4 billion people might have been sustainable. But today's world has a population of over 7.5 billion, which is unsustainable even with technology. —D. Holmes, via mail@WIRED.com

RE: "THIS IS WHAT WE TRAINED FOR"

The problem with teaching an ordinary citizen these skills is

RE: "THE LION, THE POLYGAMIST, AND THE BIOFUEL SCAM"

that they don't come with the months or years of discipline that being in the military teaches, and there's likely zero vetting when it comes to the intent and background of the trainees. I'm fine with people learning how to handle firearms and how to protect themselves, but a two-day or one-week class may do more harm than good. —Brian Walsh, via Facebook

This seems like a self-fulfilling prophecy. You fear civilization will collapse because there are dangerous people out there with guns that want to kill you. So you take up arms and become a dangerous person. —John Cargo, via Facebook

RE: "THE LION, THE POLYGAMIST, AND THE BIOFUEL SCAM"

I worked at the Washakie Renewable Energy plant for six months in 2012. I know what I did, and I know what the purpose of the refinery was. Your article doesn't do justice to the community that the plant supported. Rather, it steps on the community involved while painting a pretty picture of justice served for the complicated few who strung the rest of the community along with the fraud and lies. It pains me to know how many of my family members will be impacted by the lies of Jacob and Isaiah. —Andrew Johnson, via mail@WIRED.com

I can still hear radio hosts and Utah Jazz game announcers proclaiming that they were "sponsored by Washakie Renewable Energy." As disturbing as this incredible story is, "we the people" (through tax credit programs) made this scam possible. If we think

it's not still happening, we're not paying attention. —Ryan Wilcox, via Facebook

RE: "FLIGHT PATHS"

I was one of hundreds of Grumman personnel who toiled to produce the finest warfighter airplane the world has seen (professional opinion). I was a systems engineer for Grumman, and I got to work on both the F-111 and the F-14. Your story was very emotional for me. —Richard Reid, via email

I flew over 1,000 hours and almost 300 trips in the F-14 from 1984 to 1988. I had no idea that our Central Air Data Computer was so cutting-edge. But after reading this article, I agree that box was absolutely amazing. —Steve Johnson, via Facebook

I am now a senior range control officer at White Sands Missile Range. It was because of my work on the Tomcat in the early '80s that I learned all about aviation. Now I get to talk to pilots who come in with all the newest toys (F-22s, F-35s, etc.) at the range. Thank you for reviving a smoldering love affair with the gift that Ray and Bill helped build. —Patrick Wilson, via email

To read "Flight Paths," turn to page 68.

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Learn something new about the federal RFS every day! (Like how handy a tax fraud accomplice it can be.)

—@GinaHadam, via Twitter

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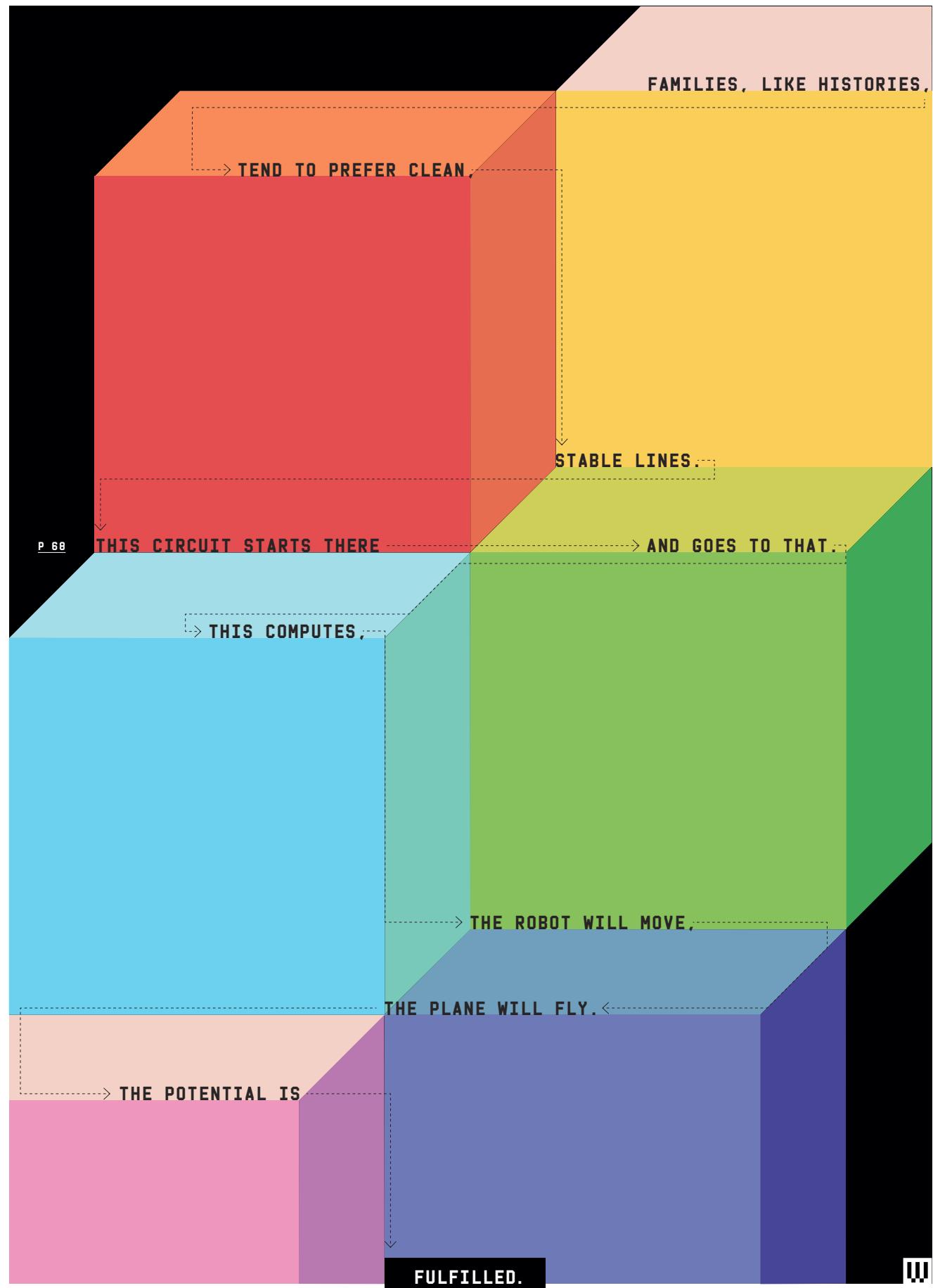


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Catfishing, the Hidden History

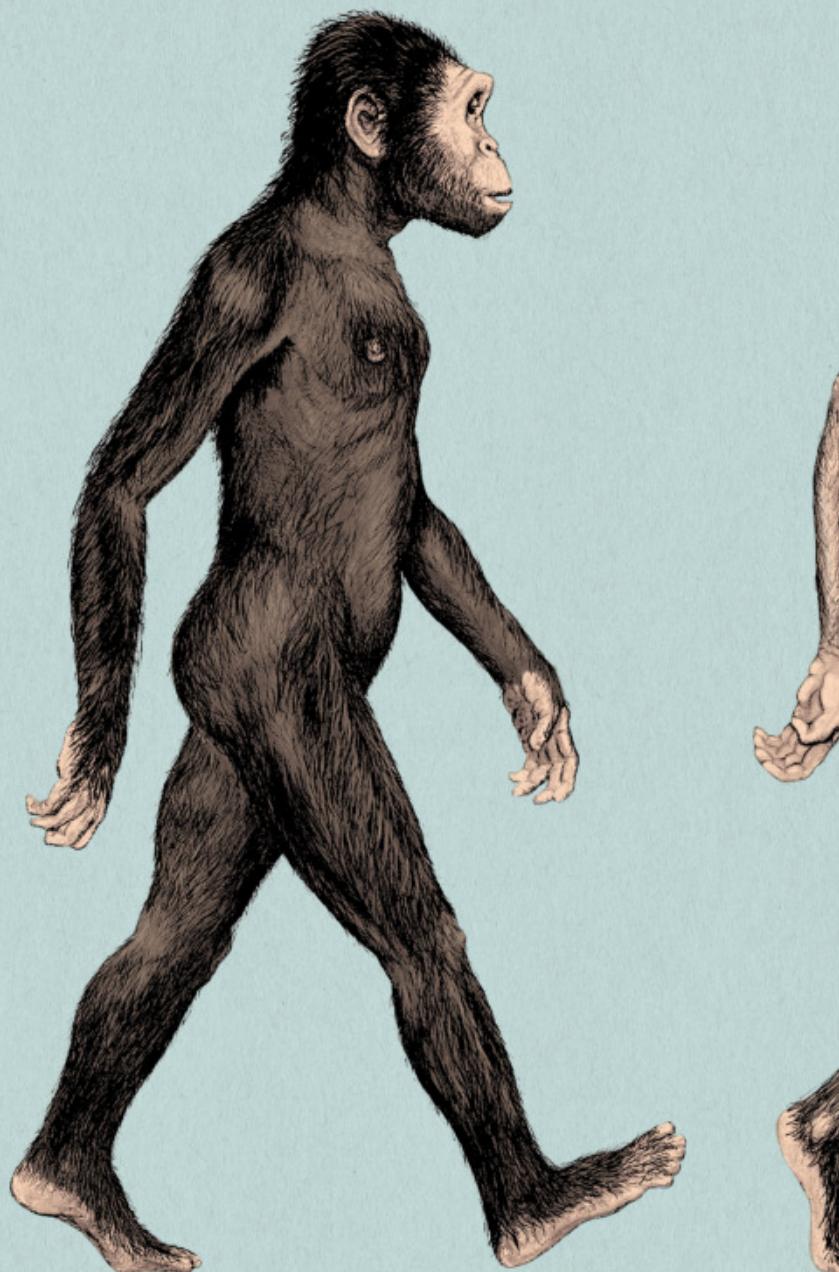
How the online troublemakers can sometimes—sometimes—set us free.

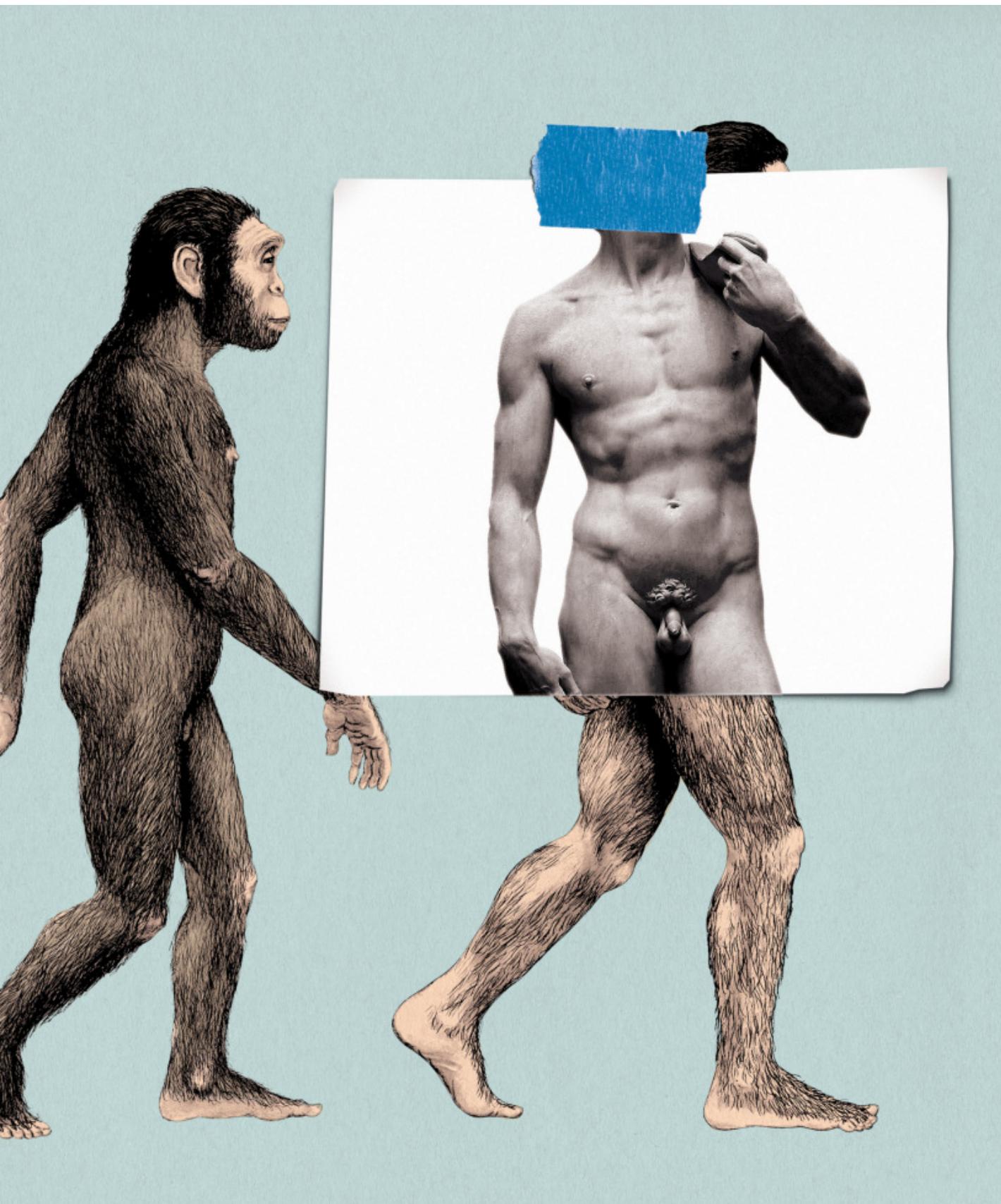
"**QUITE EARLY IN LIFE** George Tracy discovered that if he were to be reasonably happy and prosperous he must pretend." So begins a mesmerizing psychological novel by Charles Marriott, published in 1913. The tale of George's lifelong obsession with an elusive frenemy named Mary, who has "the key to the side door of his nature," has long been out of print. It's remembered chiefly for its title: *The Catfish*.

Yes, this century-old book gives us the figure of the modern-day catfish, the shrewd machinator who breaks hearts and passwords with nothing but Wi-Fi, cunning, and yottabytes of imagination. This conceit was reprised in the 2010 documentary by Ariel Schulman and Henry Joost, *Catfish*, which tells the story of a Michigan artist, Angela Wesselman, who used fake Facebook profiles and other online trickery to deceive Schulman's brother, Nev.

If you're confused, you're where you should be. The numberless catfish who now course through social media, the ones who devastate lives with sophisticated online masquerades, exist to beguile and disturb. Catfish like the fictional Mary or the real-life Angela are foxy and artistic. Others are in it for money or the lulz. But in all catfishing cases, the happiness of the catfish requires your disequilibrium—and your obsession with them.

The contemporary 2021 catfish leverages everything from Hinge ➔





to Photoshop to WhatsApp. But the catfish dynamic long predates the internet, and even Marriott's novel. In the 1660s, the dauntless Mary Carleton concocted letters and official certificates to steal hearts and monies from rich chumps, using a deck of beguiling identities, from a principled virgin heiress to an orphaned German princess.

Around 1700, George Psalmanazar, a fraudster, probably French but posing as a Taiwanese adventurer, published a book describing his pretend homeland as a polygamous bacchanalia where men, naked except for gold and silver genital plates, sacrificed children and ate their wives. The dubious shtick won him admirers for his heroic escape from paganism to Christianity. One of his admirers paid his living expenses.

Shakespeare's characters, of course, can catfish as dexterously as any Finsta phantom, and they gender-bend and trans-humanize their way through exquisite courtship chicanery. A "bed trick," a favorite device of Shakespeare, happens when one person subs for another in the *midst of a sexual act*. Take that, ye online catfish pikers.

I recently spoke by phone to Nev Schulman, the original catfish victim who is now famous as the host of MTV's reality show *Catfish*. He called my attention to *A Midsummer Night's Dream* as an ace catfishing precedent. Otherwise, he said, he isn't big on literary allusions, and formal education doesn't suit him. (Indeed, he was kicked out of college for beating up a woman whom he says he took for a man.) But his grandmother, Marlene Strauss, is a distinguished art historian. In 2016 she appeared on a Manhattan stage with Nev, for an intergenerational discussion of love and lies. While Strauss infused the evening with erudition, citing proto-catfishing in works from *Cyrano de Bergerac* to *Some Like It Hot*, Schulman talked about latter-day digital catfishing, a darker affair, which too often ends "in courtrooms and restraining orders."

Though he did cite Genesis. "Jacob had to stand before his father—though his eyesight was failing—and physically pretend to be someone else," Schulman said. "Of course,

now we've removed the human element." With human bodies out of the way, catfishing can finally happen at scale.

In Marriott's novel, the catfish Mary is less a liar than an agitator. She meets George in childhood and nips at the edges of his life into late middle age; she gets him to question everything; he can't tell if he loves or despises her. She also goads him to a more engaged and ecstatic existence. In this way, she is akin to Nev's catfish, Angela, who turned him from a defeated dropout to a man with a purpose.

Angela introduced Nev online to an 8-year-old prodigy painter, a 19-year-old seductress, and a whole cast of supporting characters composed of MP3 fragments, online video, photographs, text messages, and nearly a dozen Facebook profiles. Schulman at 24 had his worldview blown open when he fell hard for the seductress, who in pictures looked like Jennifer Lawrence. Only when he and his brother's film crew, suspecting something was up, drove to Michigan's Upper Peninsula to door-stop Angela did the scales truly fall. Angela, who does not look like Jennifer Lawrence, was

playing all the characters. Nev was first annoyed, then impressed, then grateful. He told me that Angela is still the greatest catfish he has ever encountered.

Ultimately, Marriott uses "catfish" to describe "anything or anybody that introduced into life ... the queer, unpleasant, disturbing touch of the Kingdom of Heaven." Angela's husband, Vince, who likely came to the catfish allegory by way of the popular Christian writer Joel Osteen, puts his own spin on it. "They used to tank cod from Alaska all the way to China," he says, mixing up the geography. "By the time the codfish reached China, the flesh was mush and tasteless. So this guy came up with the idea that if you put these cods in these big vats, put some catfish in with them and the catfish will keep the cod agile. And there are those people who are catfish in life. They keep you on your toes. They keep you guessing, they keep you thinking, they keep you fresh."

Thus is the catfish brought full circle. The person of Angela recalls the fictional Mary: Each is an intriguing and maddening woman who shakes up the existence of another.

Not long ago, Schulman's MTV show became a podcast. Schulman and a cohort help a range of young lonelyhearts, who fear they've fallen for digital specters, determine fact from fiction. Over and over the show features catfish victims who have been daydreaming into their phones, shoring up fragmentary missives from outer space to create alternate lives.

"Privacy has become so unbelievably rare," Schulman told me. "There's been a pendulum swing. Young people are desperately looking for something private in their life—just for them." The people who appear on *Catfish* don't want to be relieved, right away, of their illusions of intimacy; they want to live in the fantasia a while, juice it for self-knowledge. But by the time they contact Schulman, it's because, as he told me, "something isn't quite right. It's grown and grown as a pit in their stomach."

The love objects are almost always a mirage. The catfish almost never look like their profile pics. Sometimes they're of another gender or race. Generally they're

Catfish makes obvious what most adults know: Romantic love is shot through with projection. Our phones mirror to us our fondest hopes; into the text bubble we pour our yearnings.

less successful, less rich, more lost, more incarcerated.

Schulman on the podcast shows something like admiration for anyone sweetly naive enough to end up in the catfished seat, *his* seat. At the same time, he's surprised that many guests don't know he was once nabbed. They never saw his movie. "People in this situation are people who don't do their research," he told me. Right on.

Catfish makes obvious what most adults know: Romantic love is shot through with projection. Our phones mirror back to us our fondest hopes, and into the text bubble we pour all our yearnings. "I can't wait to fill my fingers with your hair," Schulman once texted his catfish. "My body is craving your touch tonight," wrote Angela. It's cringe-hyperworthy now. But it's what infatuation sounds like. You're always writing to a half-imagined other. Every sexter is a poet.

But *Catfish* never fails to end in disappointment. "Inevitably, the second they see them they have an instantaneous drain of affection," Schulman said.

Back to *The Catfish*, 1913. Though George and Mary are both married to other people by the end of the book, George discovers in a flash that he and Mary have something "beyond love," as only his catfish can keep him honest. "Before he could be straight with himself he had to have it out with her—and all his life he had shirked it." The catfish is not the pretender. Quite the contrary, she's the spur to drop all pretense. In talking to Mary, George is finally talking to himself, the self he's been suppressing. He's liberated. Some of the participants on MTV's *Catfish* find the same thing: that once they have it out with their catfish, they are, in Marriott's words, "free to love elsewhere."

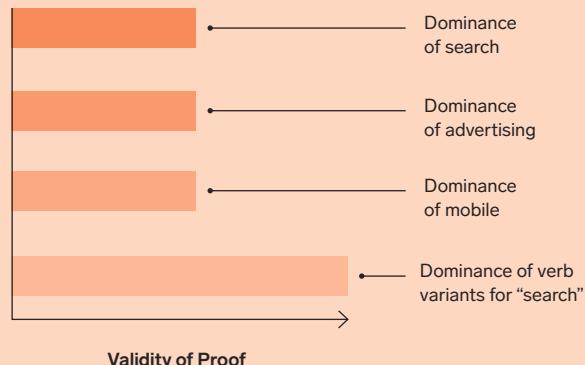
In profound gratitude, George turns back to his beloved wife with renewed passion. The provocations of the catfish have been enlightening, but real love is serene. And sometimes all you want is a person who, in not looking like their ravishing selfie, looks better. ■

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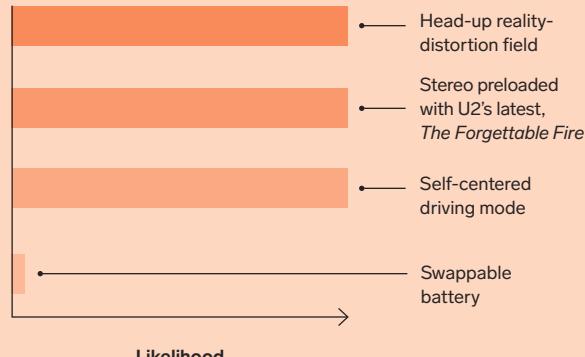
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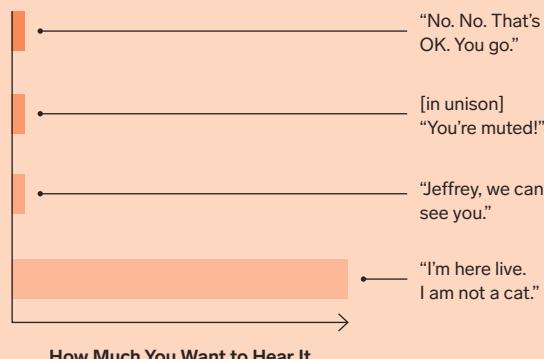
Why Google Is a Monopoly



Apple EV Potential Features



What You Hear on Zoom



The Preppie Handbook

If you're readying for doomsday, I'd be happy to share my methods.

Caveat: No gear included.



THE PREPPERS HAVE the best stuff. It's because they operate under such constraints: You have to pack your whole society—money, tinctures, food powders—in a lone bag. Then, when the big bug-out comes, you slip on your paracord bracelets and shemagh scarf and vanish into the woods, to an already-scouted redoubt obscured by trees. There, beside your tent, you gnaw jerky and sip bleached snow-melt out of 5-gallon bags, wrapped in a 26-micron bivy that reflects 90 percent of body heat. A society of one.

By day you carefully inventory the dozens of curated objects in your bag, rifling through sub-pockets, enumerating ibuprofen, contemplating seed packets, calculating caloric yields. *Portable hand-*

cranked flashlight. Clove oil for toothache. At night, with darkness yielding to bright gray inside your night-vision goggles, you patrol, hand hovering near your CZ-75 P-01. Far off down the mountain you hear the cracks, groans, whistles, and shots of a splintering society. A week ago you administered an Oracle database. Now your job is to survive.

And you dream: One day, after the smoke of civilization has drifted away, you'll link up with others exactly like you. A new world will rise out of your duffel bag. You'll hang up solar-powered mesh networks from trees and make your own internet. You'll transact for potatoes and penicillin on the blockchain under the watch of vigilant owls. But now, jerky.

What the preppers do is fully acknowledge their fears and turn them into a particular aesthetic. Like goths. They make their anxieties perfectly legible. I get it. I read *My Side of the Mountain* when I was a kid. But while prepper gear is awesome, I keep thinking: *We should be trying to avoid a civil war, not packing for one.*

THE AESTHETICS WIKI has hundreds of different entries—Preppy and Punk, of course, but also more modern aesthetics like Dark Academia (Eurocentricity, Whit Stillman, sweaters), Vaporwave (synths, VHS boxes, teal), or Cottagecore (shortalls, Hozier). Many of the aesthetics have left- and right-wing offshoots: Vaporwave has produced Laborwave and Fashwave;

Tradwifery (patriarchy, heteronormativity, childbirth) can be understood as reactionary Cottagecoreism.

I would have told you I don't have an aesthetic. But a few months ago my family moved to an old house, not far from our old apartment. This house has a yard, and asbestos, and a plaque on the front that says: 1913. Multiple generations of telephone wiring run along and inside the walls, and jacks abound: Bell System four-pin 404A jacks and modular 6P4C jacks, too, all useless in 2021. I like them. They suggest critical infrastructure come and gone. The people who lived in the house before us sent a kind, slightly melancholy note, wishing us the best, but we never met them. Pandemic transaction.

When we moved in, we immediately started to plan for an apocalypse. (My spouse's elementary school overlooked Donner Lake, in California, so worst-case scenarios come easily to her; she has a disaster-preparedness Pinterest board.) I figured out where we could put the tilapia tanks and pondered a new fence. We could store barrels of powdered food in the basement. Following decades of living within the collective fortress of an apartment building, a house—just sitting there by the street—feels extremely vulnerable. After a few days, a nice older neighbor dropped off a box of candy. Hardly the Purge.

Oddly, we keep not buying furniture. We did find a dining room table, cut out

of a lane in a decommissioned bowling alley, with little inlaid arrows to guide your throw. Cheap and heavy. We bought some chairs, eBayed out of a university library in Georgia. Each chair carries the shadow of thousands of college butts. We like things that remind us of people gathering, playing, or working. Not shabby-chic, but institutional-heavy. Things that have been rubbed down to a shine.

My kids are doing ballet and tae kwon do on Zoom, I am sending Slack messages in a half-empty house, and my spouse is in the kitchen calling strangers to offer them help navigating the state vaccination website. This is the pandemic aesthetic: Everything is connected but you can't connect. I lull myself to sleep listening to FDR speeches. In one, he spoke sadly of a Boy Scout jamboree canceled for an outbreak of polio. This is my aesthetic. In this way I achieve safety and control. It's a little silly, really, but I'm Infracore.

MY THERAPIST [COGNITIVE-BEHAVIORAL], Thursday 2 pm, takes Venmo) tells me that one becomes angry when expectations aren't met. Thus, to remain calm, you have to adjust your expectations. The kicker: Behaviors tend to stay the same over time, so don't expect other people to change. Your only real choice, the only thing you can control, is whether to calm down—or not.

This advice has made me think differ-

ently about social media. Perhaps social media is not, as people say, a machine for the transmission of viral outrage, but rather an aggregator of shared expectations. In fact, people online are constantly talking about what they expect. They expect political victories, total respect for Taylor Swift, resolution of HR issues, financial aid, and apologies—and they expect it all right now. People online say, *We will never adjust our expectations, so you must adjust your behavior*. Twitter is the exact opposite of therapy.

Personally, I expect the apocalypse will come slowly, with episodic spikes (panemics, terrorism, superstorms, buildings collapsing in space or value). There's no shortage of warnings, feature articles about human climate migration and wet-bulb temperatures, or op-eds asking us to stop buying fridges.

At least for now the infrastructure we have keeps finding ways to route around the crises. When a train tunnel floods, you run a bus. You dump sand on a damaged beach, and one might always use public funds to construct a fine berm. And when that berm is submerged you can build a bigger berm. We are expecting that we can find *solutions*, ways to preserve the order of things. Just a little science, and some elbow grease, maybe a colony on Mars, and society can be good as new.

What else are we going to do? The therapeutic suggestion is: Broaden your expectations, so that when bad things happen you are ready. For some, this means being ready to grab your stuff, slipping into warm, gray clothes, and vanishing from civilization. For me, the only thing that calms fear is the idea that we'll keep helping until we need help. Doctors at the hospital, National Guard members at the vaccine center, neighbors dropping by with food. Lest you think me too much a fool, we do have a go bag. We just keep raiding it for cash and ibuprofen. And every morning I wake up and prep, by thinking: Expect everything to change but people. ■

We bought some chairs from a university library. Each one carries the shadow of thousands of college butts. This is my aesthetic. It's a little silly, really, but I'm Infracore.

PAUL FORD (@ftrain) is a programmer, essayist, and cofounder of Postlight, a digital product studio.



“Hey, Watcha Working On?”

There are ways to make remote work feel not-so-remote—and they’re not Zoom or Slack. Enter the chatty new world of copresence apps.

ONE YEAR INTO our all-remote existence, executives at white-collar companies are realizing two things. One is that they’re pleased (stunned, even) by how productive employees have been. They’d worried that “work from home” would turn into “Netflix and chill.” Instead, their people are killing it: Deliverables are being delivered, milestones milestone.

But companies have run into a serious problem. They have lost serendipity. Sure, colleagues are connecting on video chat. But it’s all very planned and formal; there are no *how’s-it-going* encounters at the coffee station. This is a shame, because those chance run-ins help cement a sense of togetherness, and they can engender new ideas too—like when the VP of HR eats lunch next to a salesperson and casually mentions a new market that winds up being worth millions.

So now people are wondering: Could software replicate some of that office magic?

Various startups are giving it a shot. One is Teamflow, a browser-based app that lets you set up a virtual office that you view from above, in 2D, sort of like a cartoony Ikea floor plan. You can set up different rooms and fill them with furniture icons (or even weird memey images, if you want a MySpace vibe). When employees log in, their faces appear in tiny round video streams. You drag your icon around the virtual office to hang out “near” others, and voice-talk to them too; the closer your icon is to a colleague, the louder they sound. Move farther away for peace and quiet.

It sounds kooky. Frankly, it *looks* kooky. But early users tell me it replicates many of the dynamics of in-person hanging out. “This really streamlined my life,” says Rafael Sanches, the cofounder of Anycart, a food-shopping service. We met recently inside his company’s Teamflow space. The little video icons for Sanches and me were perched at his virtual desk; three engineers were clustered together, chatting, in the corner of the office. Sanches dragged his icon over to say hello to them, then zipped back over to me.

“I do this all the time,” he says. He’ll plant himself near groups of employees, where they’ll work together, sometimes in silence, other times chitchatting. Sanches will also frequently invite an employee to wander off to a corner to talk one on one. He likes the fact that other employees can see that he’s meeting with someone individually; it replicates some of the quasi-public nature of conversation in a real office. “Socially, the engineers know I’m still there, like I’m *around*,” he notes. He’s not vanishing into private Zoom calls with people.

The whole thing felt oddly gamelike. That makes sense, because video games pioneered the art of letting far-flung people hang out online. Some workers have even playfully used games as meeting places during the pandemic. When the author and artist Viviane Schwarz was

working on a project last year, she met her team inside *Red Dead Redemption 2*, a cowboy fighting game. They’d sit around a virtual campfire and talk shop (while also watching out for danger: “Was that gunshots?”). Some new copresence apps, like Bonfire and Remotely, riff explicitly off game aesthetics and let you hang out with workmates as avatars in a 3D environment.

One thing you can see, in all these remote experiments, is that audio beats video. Zoom-staring into a webcam is wearying. So most of these apps actively downplay full-screen video, and users seem to like that. Pragli, another virtual-meeting startup, gives users a choice to connect with audio or video, and its cofounder, Doug Safreno, estimates that people use the audio-only method twice as often as video. Consider this the revenge of the old-school telephone call: Turns out we just want to talk.

And, more subtly, to listen. Many of these apps allow for a bit of the ambient eavesdropping that happens in an office, where you can look across the room and see that two colleagues are talking—maybe even get a sense what they’re discussing—without fully tuning in. This semiprivate, semi-public nature of office chat helps give a team a proprioceptive sense of itself, one that’s too often missing in our remote world of one-on-one calls.

An office has power dynamics, for good and for ill; part of how we navigate a job involves keeping tabs on how others interact. Is your manager talking to the boss a lot? Maybe it means your team is in trouble? Or that you’re *impressing* the head honcho? We gather intelligence, chew it over with colleagues, become more connected.

One benefit of the physical office, in other words, is that it lets us low-key *creep* on each other. It turns out we might want some of that even in our software. ▀

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READOUT

The world, quantified.

20%

Amount by which the value of bitcoin surged in just one hour after Elon Musk added “#bitcoin” to his Twitter bio.

1,300

Number of companies that lost IP and other data to ransomware attacks worldwide in 2020, according to cybersecurity firm Emsisoft.

7.7%

Proportion of Amazon warehouse workers who suffered a serious injury on the job in 2019—nearly double the industry average, according to Reveal.

24K

Number of g’s produced when the tiny, shrimplike amphipod snaps its massive claw in defense—so violent the critter could nearly explode itself.

Deploy the Carbon Eaters

Facilities that suck CO₂ out of the air could be powerful weapons for fighting climate change. But rolling them out quickly enough would require a massive wartime-scale effort.

THE CLIMATE EMERGENCY demands that we dramatically and rapidly cut emissions. There's no substitute for that, full stop. But it also demands a technological revolution to *reverse* emissions. The UN's Intergovernmental Panel on Climate Change says that if we want to meet the Paris climate accord's most optimistic goal of limiting warming to 1.5 degrees Celsius above preindustrial levels, we *have* to find a way of scrubbing the atmosphere of CO₂.

One promising way of doing this is with a technique known as direct air capture. Facilities equipped with giant fans suck in the carbon-laden air, which then passes over special plastic surfaces, where it reacts with a chemical solution that binds to the CO₂. The air goes out the other side, but the carbon stays behind.

What might the wide-scale deployment of direct air capture look like? Typically, climate scientists run big, complicated models to calculate the most economically optimal ways to decarbonize. "That

envisioned this very technocratic, manicured, highly granular transition, which doesn't really reflect the way transitions actually occur in reality," says Ryan Hanna, an energy systems researcher at UC San Diego. So Hanna and his colleagues sketched out an alternative vision: Imagine what would happen if humanity invested in direct air capture like we'd invest in another world war. "We think there's sort of a dearth of conversation generally, but also in the academic literature, around emergency responses to the climate crisis," he says.

In a recent paper in the journal *Nature Communications*, Hanna's team crunched

the numbers. They broke their modeling into three parts. First they estimated how much governments would need to pay for each new direct air capture plant, factoring in construction and CO₂ storage costs. Next they looked at how quickly the roll-out could scale if the plants ran on existing renewable energy sources like hydropower. (You wouldn't want to power them with fossil fuels, obviously.) Finally, Hanna and his colleagues simulated how a mass deployment of such facilities would affect the entire Earth system.

The researchers found that with an annual investment of between 1 and 2 percent of the global gross domestic product,





“It’s nice to approach things about climate change as if they’re just technological problems. But they are inherently *political* problems, and we’ve got to solve that.”

Getty Images

humanity could build a network of around 800 direct air capture facilities, capable of removing roughly 2.3 gigatons of CO₂ annually by the year 2050. That’s about 400 times the amount of CO₂ humanity currently sequesters, so we’re talking about a massive scale-up.

Still, Hanna says, “relative to what the integrated assessment models tell us we should do by 2050, it’s actually quite small.” Total global emissions are currently around 40 gigatons a year. To meet the 1.5-degree Paris goal, we’d have to remove something like 5 to 9 gigatons of CO₂ per year by 2050.

To truly make a dent in skyrocketing carbon levels, we’ll need between 4,000 and 9,000 plants by 2075, and more than 10,000 by the end of the century, at which point we could theoretically be sequestering up to 27 gigatons of carbon a year. Once the industry gets big enough, Hanna says, it becomes “really easy to add a lot of plants quickly, because you have this huge industrial base.”

Of course, global politics could make a mess of the rollout of direct air capture: All humans share the same atmosphere, so why should one country pay to research and deploy the technology if its neighbor doesn’t contribute a penny? “It’s nice to approach things about climate change as if they’re just technological problems—if we get the cost right, if we get the technology right,” says Louisiana State University environmental scientist Brian Snyder, who wasn’t involved in Hanna’s study. “But they are inherently *political* problems, and we’ve got to solve that simultaneously.”

Another outstanding question: What do you do with all that carbon once you’ve captured it? One option is to pump it underground, sealing it away forever. Economically, that’s a bit fraught, because you’re spending money to run your facility but then throwing away your product instead of selling it. That means direct air capture will require government subsidies to be economically feasible.

Researchers are also working on turning captured carbon into new fuels. That sounds, well, counterproductive, since we’d be burning the fuel and putting the

carbon right back into the atmosphere. But the idea is to use such a fuel to make hard-to-decarbonize industries carbon-*neutral*. Airliners and cargo ships, for instance, can’t run on current solar technologies. Making them essentially reburn fuel that’s on its second life means there’s less demand for fossil fuels pulled out of the ground.

Direct air capture is not a miraculous cure for climate change. Hanna’s team found that even with a massive buildup of this technology, the world will warm by 2.5 degrees Celsius by the year 2100 if we don’t take other aggressive action. “We still have to vigorously pursue emission reductions,” says Janos Pasztor, executive director of the Carnegie Climate Governance Initiative, who wasn’t involved in Hanna’s study. “Otherwise, the amount of direct air capture we’re going to have to do is going to be huge. And it’s going to be forever before we reach our temperature goals.”

Negative-emissions technologies carry a moral hazard. The temptation, says Zeke Hausfather, director of climate and energy at the Breakthrough Institute, is to keep emitting CO₂ as usual and to use direct air capture as a crutch. “The problem with that, of course,” he explains, “is that if you say, ‘OK, we’re going to have very slow emission reductions today, because we’re going to assume we’ll have all this cool technology 60 years from now that’ll solve the problem for us’—we might not *have* this cool technology 60 years from now that’ll solve the problem for us.”

A wartime-like deployment of direct air capture infrastructure would cost a lot of money, especially for a technology that we can’t yet say for sure will actually be feasible at a global scale. “In the long run, over the century, if we’re going to address the climate, we’re going to invest just incredible amounts of dollars into solving the problem,” Hanna says. “That’s a different mindset than, I think, conventionally what we’re used to.” A climate emergency, in other words, demands an emergency response. ■

Staff writer MATT SIMON (@mrMattSimon) covers biology, robotics, cannabis, and the environment.

Our Natural Networks

SOMETIMES, MATURE DOUGLAS FIRS SEND sugar to saplings via miles of underground, gossamer-thin mycorrhizal fungi. Through these same passageways (the “Wood Wide Web”) birches can loan carbon to fir trees in the summer, while firs pay it back in fall. And trees of different species might share nitrogen leached out of salmon carcasses left over from a bear’s lunch.

When the pandemic hit, photographer Andres Gonzalez retreated to his home in Vallejo, north of the San Francisco Bay. He started devouring novels, including Richard Powers’ climate epic *The Overstory*, which was inspired partly by the forest ecologist Suzanne Simard’s research on mycorrhizal networks. On long walks, Gonzalez began photographing redwoods in his neighborhood. To him, the trees, standing alone outside the braided forest, looked sick and isolated. But he knew that even these suburbanite *Sequoia sempervirens* survived in part thanks to the prodigious webs between them, some directly connected across adjoining lawns, and others, blocks apart, likely using the root systems of maples, laurels, yews—even ferns and herbs—as links, lifelines beneath our made world.

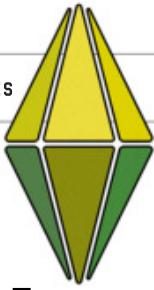
In January, Gonzalez’s 90-year-old grandmother tested positive for Covid. She was soon hospitalized, and the doctor recommended that the family prepare to say their goodbyes. Thirty of his grandmother’s saplings from Mexico to Sunnyvale gathered on Zoom, atoning, joking, praying. A nurse’s “blue latex fingers occasionally floated into the frame to touch her, the surrogate for all of us,” Gonzalez says. His grandmother survived. And now when Gonzalez thinks of the way they all pooled into her room via buried fiber optic, he also thinks of the way isolated trees aren’t really isolated. ■





BY SAIRA MUELLER

GAMES



Our Sims, Ourselves

Sometimes a game isn't just a game. It can make you see clearly what you want IRL, and not only in San Myshuno.

JUST AFTER THANKSGIVING—on Cyber Monday, to be exact—I impulsively dropped \$60.52 on four expansion packs for *The Sims 4*, despite not having played the game for two years. Why did I do this? Who knows. Let's blame the food coma. Or the pandemic. Take your pick.

I've been playing *The Sims* off and on since the original game was released 21 years ago. Most of my playthroughs involve building an alternate or idyllic version of my own life. (Shout-out to the versions of me in other dimensions who made better choices and are chilling on a boat in the Mediterranean right now!) “Who am I?” is always the question as I pick my avatar’s interests and outfits in Create a Sim.

This time, I went with realism: My Sim wanted to be a writer and was nerdy, adventurous, and liked reading books. Less true to life, my Sim was rocking the latest fashions, swimsuit to ball gown, while I have rotated the same four outfits for the past year—when I can be bothered to change out of my pajamas, that is. Then I created my cat, Gatsby, because I can’t live without him even in the digital world.

I decked out my Sim’s apartment in San Myshuno to resemble my current home (thanks goes to the money cheat codes) and signed her up for a career in writing. Then I did something I don’t usually do—I saved my game and went back to Create a Sim to build myself a partner. I moved him into the same city and then spent more time than I care to mention running the Sim version of me around, trying to “randomly” bump into him. (There are no dating apps in *The Sims*.) And that’s when it hit me: I’m ready, *actually* ready, for a lifelong partner and kids.

That day, I resolved to be more honest

with my dates to be sure we are on the same page early on. It worked; dating got much less stressful. When a guy I had just started seeing told me he never wants kids, all I could think was, “Crisis averted! And now I have a new good friend.”

Sometimes it’s hard to see the bigger picture, especially when the days run together and the best parts of life seem to be on hold until “things go back to normal again.” But what if gamifying your life could help? My thesis: If we were all a little more mindful of our actions in *The Sims*, we’d be much better off in our real lives.

Vincent Minichiello, 27, was in a limbo state when he picked up his PlayStation 4 controller and booted up *The Sims* in February 2020. He was spending a few weeks at his dad’s house in Elmira, New York, before moving to Seattle for a new job producing esports events. He says he was “extremely bored,” and *The Sims 4* happened to be one of PlayStation’s free games of the month. He started playing. “It was basically all I did for about a week before my move,” he told me via email.

Minichiello started his Sim off with a day job. “I think it was something like a telemarketer! My first job out of college was essentially a sports team telemarketer, so I wanted to see where my Sims character could go from there,” he says. The only “activities” Minichiello’s Sim had were the items the tutorial house came with: a bench press and a computer. He moved the bench press into the computer room and spent all of his Sim’s free time building his tech and fitness skills with the aim of transitioning into a career in gaming or fitness.

The game tracks your character’s basic human needs, with meters showing your Sim getting progressively more hungry,

“The Sims made happiness easy to comprehend. All I had to do was gamify my life and pretend I also had energy meters and progress bars in my daily life.”

tired, filthy, or lonely. Minichiello scrupulously cared for his Sim, making sure its “needs” meters stayed in the green and didn’t dip into the hazardous red zone.

Then, Minichiello went to Seattle. After moving into a studio apartment, he stalled. “It was really hard for me to find the motivation to furnish it and get my life started,” Minichiello says. Being locked down for the pandemic didn’t help. “I was procrastinating like crazy. I was overwhelmed. I didn’t know where to start. So, rather than get my life situated, I went right back to *The Sims*.“

That’s when he had his light-bulb moment.

“It was there, sitting in my unfurnished studio apartment with no pots, pans, plates, silverware, or furniture, that I realized how much time I was wasting trying to re-create the ‘ideal’ life within my Sim’s world, when I should start treating my real life like a game,” Minichiello says.

“The Sims made ‘happiness’ easy for me to comprehend,” he says. “All I had to do was gamify my life and pretend that I also had energy meters and progress bars in my daily life. As long as I continue to read and study, while making sure all my stats are in the green, then good things are bound to happen.”

And, sure enough, they did. Minichiello says his mood changed. He furnished his apartment and bought cookware and utensils. He made healthy meals instead of ordering Chipotle from Uber Eats every day. He got up earlier and started going for runs to explore the city. “I was starting to feel inspired,” he says. “It was an awesome domino effect that I had never really felt before.”

Minichiello is a wonderful example of how transfer of knowledge can happen between our in-game play and IRL lives, according to Rachel Kowert, research director at Take This, a nonprofit organization that provides mental health resources for the gaming community. Kowert, who also studies the relationship between games and cultural and social norms, likens players’ use of *The Sims* to a personality test in which their response to ambiguous stimuli reveals hidden desires and emotions.

A lot of work goes on behind the scenes to reveal those desires and make in-game actions as similar to real-life experiences as

possible for the game’s 10 million monthly active users. Lyndsay Pearson, general manager of *The Sims*, says that the dev team does everything from watching YouTube videos and looking at Instagram to interviewing people before trying to replicate actions in-game. For the Cats & Dogs expansion pack, for example, the dev team tried to create moments that would make people say “Oh, my cat always does that!”

In *The Sims 4*, players can choose among tens of thousands of actions—knitting a scarf, baking a cake, snorkeling on a reef, having your first kiss. And modding, a feature available since the start, allows players to do even more (lines of cocaine, live on a houseboat, online learning). This allows players to dig into what their life could look like with a few changes.

Kowert likens *The Sims* to a virtual dollhouse. Research on avatars and game-playing more broadly, she says, shows that half of players like to play as an idealized version of themselves while the other half play to test the boundaries, try on a new identity, or see what it feels like to be bad “in a space in which there’s no repercussions.”

Teens, especially, Pearson told me, use the game to try on different identities.

When I told Pearson my own *Sims* revelation, she wasn’t surprised. “I’ve heard flavors of that in different ways over the years, and I think it makes sense,” she says. “It’s a place without a lot of pressure, and I think that leaves that opening to say, ‘Oh, maybe I should think about this a little differently for me too,’ or ‘Maybe I don’t really want to be that kind of person,’ or ‘I don’t want that kind of skill or personality.’”

“I’m always amazed at the insights and experiences people can get from this,” she continued. “People have these really deep connections ... and have shared stories about how it’s helped them come to terms with who they really were and be able to express themselves. That’s just kind of incredible.”

I would have to agree. ▀

Games editor SAIRA MUELLER

(@SairaMueller) loves MMOs and RPGs and doesn’t discriminate between platforms, although PC will always be her favorite.

ANGRY NERD

BY JASON KEHE

A Very Nasty Remaster

Look, I see why Peter Jackson did it. Why he rereleased his *Lord of the Rings* trilogy, along with *The Nasty Hobbitses* movies—as I like to call them—in 4K Ultra HD. It’s a very 21st-century-filmmaker thing to do, this remastering business. Enrich the colors, sharpen the blurry old images, and your films hold up at least until the next upgrade. It’s practically a moral obligation, a question of clarity, and if you can clarify Legolas by pumping an extra 10 million pixels into his perfect Elven pores, which comes out to something like 100 billion photons, all twinkling immortally through the cosmic sweep of space-time, why then, shouldn’t you? Let me be clear: You should not. Cosmically speaking, things are supposed to get less clear over time. They’re supposed to blur, as the quantum gravity guru Carlo Rovelli says in *The Order of Time*, and “the difference between past and future is deeply linked to this blurring.” Translation: When disorder increases, you know time is passing. (If you saw Christopher Nolan’s latest VFX showcase, *Tenet*, you might follow. Or not—that empty excuse for a film won’t make sense in any era, at any time.) In the original Middle English, the word *clarity* meant “glory, divine splendor.” It’s the domain of gods, not humans, and certainly not Peter Jackson, a director of dreams. When he de-flickers and color-corrects his *LotR* and *The Nasty Hobbitses*, he violates nature, the very order of time. Besides, do you dream in high resolution? I most definitely do not. I wake up, the dragons fade, and a crisp new day dawns. To watch old fantasies in crystal-clear clarity is to remember a dream as if it were real and happening now. Sounds like my worst possible nightmare.



The Right Stuff

Tread lightly on the planet with shoes, clothes, and other gear made from upcycled and recycled materials.

MAKING ECO-FRIENDLY decisions can be tricky. We each need to do our part to reduce greenhouse gas emissions, but we also need to wear shoes and clothes and maybe brush our teeth. Luckily, more and more companies are putting sustainability first—or at least not last—making some of our purchasing decisions a little easier. Here are a few of our favorite products that deliver performance without too much pollution.



Cariuma Catiba Pro Sneaker



Whenever I scooter, skateboard, bike, or walk my dog, I pretty much always wear Vans, so I was excited to see Cariuma come out with a great-looking, low-profile, and sustainable skate shoe. The company uses natural rubber, cork, and mamona oil, an organic alternative to petroleum, to reduce its reliance on virgin plastics. The Catiba Pros are remarkably sturdy and stable on a board, with extra stitching on the outsole to reinforce weak points and stabilize the padding around the ankle. \$89



Patagonia Nano Puff



Patagonia has been recycling plastic soda bottles into fleece since 1993. Today, most of its Capilene base layers, shell jackets, board shorts, and fleece 1/4-zips incorporate recycled polyester. The iconic Nano Puff—a.k.a. the most useful jacket you will ever own—has a 100 percent recycled polyester shell, with insulation made from 55 percent recycled materials. When you're ready for a new color, you can trade it in at any Patagonia location, where it will be sold through its Worn Wear program. \$199



Everywhere 100% Recycled T-Shirt



Everywhere's unisex shirt is made of 50 percent recycled plastic—four or five single-use plastic bottles each—and 50 percent recycled cotton, saving 650 gallons of water compared to standard tees. (Some estimates say it can take about 713 gallons of water to produce enough cotton for one T-shirt.) Unlike many unisex T-shirts, which are cut for men's bodies, the Everywhere looks good on myriad body types; it's comfy, slimming, and keeps its shape. The white version could stand to be a bit thicker—you can see a slight outline of a bra underneath—but it's better than most women's white tees. \$24

Bureau Ahi

→
Discarded plastic fishing nets are a big threat to ocean wildlife. California- and Chile-based Bureau takes those nets out of circulation by turning them into recycled products like sunglasses, clothes, and skateboards. The Ahi is its performance cruiser, designed in collaboration with Carver Skateboards. Carver's patented trucks let you pump the skateboard and feel like you're surfing on land. \$195



Noho Move chair



Noho's Move is a surprisingly comfortable chair made from end-of-life carpets and fishing nets recovered from the ocean. It looks rigid, but the chair flexes so you can bend, stretch, and lean back. In other words, it lets you move. Mimicking the classic shape of Eero Saarinen's Tulip Chair, the design is understated and elegant. It's also the lightest and easiest piece of furniture I've ever put together, with legs that click right in—no tools required. \$375



Mafia Bags Deep Blue Bag

→ San Francisco-based Mafia Bags makes its backpacks, duffels, and totes out of light and durable recycled sailcloth. Industrial designer (and surfer) Yves Béhar designed the Deep Blue bag, which incorporates old climbing ropes, seat belts, and wet suit neoprene, and it has fun, hidden details like a loop at the bottom of the bag so you can hang it upside down to dry. All profits from the bag go to the nonprofit Sustainable Surf—specifically its Waste to Waves program, which focuses on recycling styrofoam packaging. \$195



Preserve Toothbrush

→ The handle of this toothbrush is made from 100 percent recycled plastic, like yogurt cups—sans fruit on the bottom. The extreme backbend of the head seemed a bit bizarre until I used the brush; it feels surprisingly natural compared to typical straight models. The Preserve comes in ultrasoft, soft, and medium, in a full spectrum of colors. Plus, you can mail in your worn-out brush for recycling. \$3



WIRED RECOMMENDS

The latest picks from our reviews team.

Apple AirPods Max Wireless Headphones

→ RATING: 8/10

\$549



WIRED

Noticeably higher build quality than Sony and Bose rivals. Excellent controls, with a physical volume knob. Very comfortable. They work seamlessly with iOS devices. Industry-leading fidelity. Actually repairable—even iFixit is impressed.

TIRED

Expensive! 20-hour battery life is good, but it's 10 hours shy of the competition. The case is silly and useless. And you can't power them down completely?!

—Parker Hall

DJI Mini 2 Quadcopter

→ RATING: 8/10

\$449



WIRED

Lightweight, compact, and very portable. New, more ergonomic controller. Light enough that you don't have to register with the FAA. 4K video (30 fps) and RAW images. In-camera video trimming and new panorama modes. More powerful motors deliver better performance in windy conditions.

TIRED

No obstacle-avoidance features—challenging for beginners. Lacks automated flight modes.

—Scott Gilbertson

Priority Apollo Gravel Bike

→ RATING: 8/10

\$1,699



WIRED

Reasonable price. Tons of commuter-friendly features, like a belt drive and an 11-speed internal gear hub. Light at 24 pounds. Zoolander-level good looks. Fun to ride on roads, gravel, and trails. Easy to clean and maintain.

TIRED

I'm a little afraid of changing the rear tire—dealing with the internal hub and belt drive can be intimidating, but at least it's less greasy than a chain and derailleur.

—Adrienne So

DEAR CLOUD SUPPORT:

Help! I Can't Stop Staring at My Own Face



I don't think I'm a particularly vain person, but whenever I'm on a Zoom call, I'm constantly looking at my own face instead of focusing on the other people. I'm not really admiring myself or scrutinizing my appearance. I'm just ... looking. What is this doing to my self-image? Should I turn off the self-view to avoid becoming a total narcissist? -SEEN

Dear Seen—

Turning off the self-view would seem to be the easiest solution, but it's not one I would recommend—in fact, I'd strongly advise against it. From what I've heard, the sight of one's image disappearing from the gallery inspires, almost universally, anguish, terror, and in some cases profound existential despair of the sort that Vladimir Nabokov claims to have felt when he came across family photos taken before he was born. It feels, in other words, as though you no longer exist.

Your larger query—about the possible side effects of staring at yourself all day—is more complex and extends beyond the question of whether you're a narcissist, which I will venture is unlikely. (Fear of narcissism, at least in the clinical sense, is self-disqualifying: Only those who don't fit the definition worry that they do.) It's not as though you're alone in this fixation, in any event. People who would never dream of looking at a photo of themselves for more than a few seconds nevertheless report, like you, an inability to look away from their own face floating on the screen during virtual classes or PTA meetings, a preoccupation so intense that vanity remains, for me at least, an unconvincing explanation. Perhaps the more relevant question is not what the platform is doing to your self-image but, rather, what has already happened to it such that you—like so many others—are unable to stop staring at your pixelated reflection.

Cloud Support: Spiritual Troubleshooting for the Digital Age
For philosophical guidance on encounters with technology, write to cloudsupport@WIRED.com.

Zoom, of course, is not an ordinary mirror, or even an ordinary digital mirror. The self that confronts you on these platforms is not the static, poised image you're accustomed to seeing in the bathroom vanity or the selfie view of your phone camera—a blank slate onto which you can project your fantasies and self-delusions—but the self who speaks and laughs, gestures and reacts. It's strange to recall how rare this view of the self-in-action was until recently. In your former life, you may have occasionally caught a glimpse of yourself laughing in a bar mirror or momentarily become distracted by the sight of yourself speaking to the salesperson standing behind you in the department store mirror. But it wasn't until a year ago that we were constantly, relentlessly, obliged to watch ourselves in real time as we interacted with others, to see our looks of dismay, our empathetic nods, our impassioned gestures, all of which appeared so different from how we'd imagined them, if we imagined them at all.

"Oh, would some Power give us the gift to see ourselves as others see us!" wrote the poet Robert Burns in 1786, a virtuous plea for the objective self-knowledge that most of us remain more conflicted about. The technological "powers" of our age have, by and large, given us the inverse capacity: to make others see us as we see ourselves. We're used to having complete control over our image—the angle, the filter, the carefully selected shot among hundreds—and yet despite this, or perhaps because of it, there remains something fascinating about the unfiltered spontaneity of Zoom. The person you are seeing there is not the compliant reflection of your ego, but that most elusive of all entities: the self you become in the emergency of a social encounter, when all your premeditations fall away; the self who has always been familiar to your friends, family, and acquaintances while remaining largely invisible to you, its owner.

This desire—to see oneself as others

do—is not in any way self-indulgent, but is crucial to forming and sustaining a viable sense of identity. Without getting too bogged down in theory and unnecessary references to Lacan, I'll briefly mention that mirrors have a social function, in that they reveal the self as an other, serving as a portal to the third-person point of view. The ability to pass the mirror test—the moment when infants stop seeing themselves as fragmented collections of body parts and recognize their image, whole, in the mirror—is a crucial rite of passage, marking the child's entrance into the social realm. The self is a fragile illusion that needs constant reinforcing, and this reinforcement happens most often through the gaze of other people, a process known in sociology as the "looking-glass self." We form our identities in large part by imagining how we appear to others and speculating about their judgments of us.

One aspect of your former life you probably took for granted were the thousands of gestures and reactions, most of them small and registered unconsciously, that contributed to your sense of a solid, continuous self: the curt thank-you from a person squeezing past you on the subway, the brief eye contact from a coworker passing your desk, the laughter in response to a joke you made at a party. Although you weren't forced to literally watch yourself interact with others, you were seeing yourself mirrored back through these intersubjective moments, all of which served, in a very real sense, as proof that you still existed—not merely as an ambient consciousness but as a real, embodied presence in the world.

It seems not coincidental that the most common complaints about social isolation—feeling scattered and fragmented, the inability to remember what one did from one day to the next—are recognizable symptoms of the social self breaking down. After spending the better part of the day alone, in front of various screens, it becomes all too easy to believe that you

are simply a pair of hands moving across a keypad, a pair of eyes scanning a newsfeed, a mind whose boundaries increasingly blur with the virtual world you inhabit. The self-view on Zoom is, unexpectedly, anchoring, and to remove it is to confirm our worst fear—that we have, in fact, dissolved into the ether.

All of which is to say, your obsession with your image likely stems from an impulse that is entirely natural and, at root, prosocial. You are trying to retain an identity that has been gradually eroded throughout the recent disruptions to public life. Far from being an exercise in vanity, the sustenance of this identity, I'd argue, is crucial. Seeing oneself mirrored back by others is bound up in complex ways with the ability to feel empathy and with the construction of consensus reality—the shared belief that there exist objective truths outside the solipsism of our individual minds. This is why, in cases of extreme isolation, people often lose the ability to determine what is real and what is imagined and can no longer identify a clear line between the self and external objects.

I'm not saying, exactly, that you should spend even more time staring at yourself on calls. But the impulse could serve as a reminder of the collective need for mutual recognition—a need likely felt by all the other faces tiled alongside yours in the gallery. It might prompt you to remember that others on the call are similarly experiencing a tenuous sense of identity, that the standard technical queries that accompany each logon (Can you see me? Can you hear me?) might express a deeper longing. The great thing about Zoom is that the mirror is two-sided. Every nod, every responsive gesture, serves to remind the person speaking that they exist for other people, that they remain a vital presence in the world that all of us—still, together—inhabit.

Faithfully, Cloud

MEGHAN O'GIEBLYN (@megogieblyn)
will publish her book God, Human, Animal, Machine with Doubleday in 2021.



THE MAN WHO SOLD THE FUTURE

How the shape of artificial intelligence—and the fate of the tech industry—went up for auction in a Lake Tahoe hotel room.

BY CADE METZ

By the time he stepped onto a bus in downtown Toronto for the first leg of a trip to Lake Tahoe in December 2012, Geoff Hinton hadn't taken a seat for seven years. "I last sat down in 2005," he often said, "and it was a mistake."

He first injured his back as a teenager, while lifting a space heater for his mother. As he reached his late fifties, he couldn't sit down without risking a slipped disk, and if it slipped the pain could put him in bed for weeks. So he stopped sitting down. He used a standing desk inside his office at the University of Toronto. When eating meals, he put a small foam pad on the floor and knelt at the table, poised like a monk at the altar.

He lay down when riding in cars, stretching across the back seat. When traveling longer distances, he took the train or went by ship. He couldn't fly, at least not with the commercial airlines, because they made him sit during takeoff and landing. "It got to the point where I thought I might be crippled—that I wouldn't be able to make it through the day—so I took it seriously," he says. "If you let it completely control your life," he adds dryly, "it doesn't give you any problems."

That fall—before lying down in the back of the bus from Toronto to New York, taking the train 2,700 miles to Truckee, California, at the crest of the Sierra Nevadas, and then stretching across the back seat of a taxi for the hour-long drive to South Lake

Tahoe—Hinton had created a new company. It included only two other people, both young graduate students in his lab at the university. It made no products. It had no plans to make a product. And its website offered nothing but a name, DNN-research, which was even less inviting than the sparse page. The 64-year-old Hinton—who seemed so at home in academia, with his tousled gray hair, wool sweaters, and two-steps-ahead-of-you sense of humor—wasn't even sure he wanted to start a company until his two students talked him into it. But as he arrived in South Lake Tahoe, some of the biggest tech companies in the world were gearing up for a contest to acquire his newborn startup.

He was headed for Harrah's and Harveys, the two huge casinos at the foot of the mountains near the shore of the lake. Rising up over the Nevada pines, these twin slabs of glass, steel, and stone also serve as convention centers, offering hundreds of hotel rooms, dozens of meeting spaces, and a wide variety of (second-rate) restaurants. That December, they hosted an annual gathering of computer scientists then called NIPS. Short for Neural Information Processing Systems—a name that looked deep into the future of computing—NIPS was a conference dedicated to artificial intelligence. A London-born academic who had explored the frontiers of AI at universities in Britain, the United States, and Canada since the early 1970s, Hinton made the trip to NIPS nearly every year. But this time was different. To his mind, this year's conference seemed like the ideal venue for a high-stakes auction.

Two months earlier, Hinton and his students had changed the way machines saw the world. They built what was called a neural network, a mathematical system modeled on the web of neurons in the brain, and it could identify common objects—like flowers, dogs, and cars—with an accuracy that had previously seemed impossible. As Hinton and his students showed, a neural network could learn this very human skill by analyzing vast amounts of data. He called this “deep learning,” and its potential was enormous. It promised to transform not just computer vision but everything from talking digital assistants to driverless cars to drug discovery.

The idea of a neural network dated back to the 1950s, but the early pioneers

had never gotten it working as well as they'd hoped. By the new millennium, most researchers had given up on the idea, convinced it was a technological dead end and bewildered by the 50-year-old conceit that these mathematical systems somehow mimicked the human brain. When submitting research papers to academic journals, those who still explored the technology would often disguise it as something else, replacing the words “neural network” with language less likely to offend their fellow scientists.

Hinton remained one of the few who believed it would one day fulfill its promise, delivering machines that could not only recognize objects but identify spoken words, understand natural language, carry on a conversation, and maybe even solve problems humans couldn't solve on their own, providing new and more incisive ways of exploring the mysteries of biology, medicine, geology, and other sciences. It was an eccentric stance even inside his own university, which spent years denying his standing request to hire another professor who could work alongside him in this long and winding struggle to build machines that learned on their own. “One crazy person working on this was enough,” he imagined their thinking went. But with a nine-page paper that Hinton and his students unveiled in the fall of 2012, detailing their breakthrough, they announced to the world that neural networks were indeed as powerful as Hinton had long claimed they would be.

Days after the paper was published, Hinton received an email from a fellow AI researcher named Kai Yu, who worked for Baidu, the Chinese tech giant. On the surface, Hinton and Yu had little in common. Born in postwar Britain to an upper-crust family of scientists whose influence was matched only by their eccentricity, Hinton had studied at Cambridge, earned a PhD in artificial intelligence from the University of Edinburgh, and spent most of the next four decades as a professor of computer science. Yu was 30 years younger than Hinton and grew up in Communist China, the son of an automobile engineer, and studied in Nanjing and then Munich before moving to Silicon Valley for a job in a corporate research lab. The two were separated by class, age, culture, language, and geography, but they shared a faith in neural networks. They had originally met in Canada at an academic workshop, part of a grass-

roots effort to revive this nearly dormant area of research across the scientific community and rebrand the idea as “deep learning.” Yu, a small, bespectacled, round-faced man, was among those who helped spread the gospel. When that nine-page paper emerged from the University of Toronto, Yu told the Baidu brain trust they should recruit Hinton as quickly as possible. With his email, Yu introduced Hinton to a Baidu vice president, who promptly offered \$12 million to hire Hinton and his students for just a few years of work.

For a moment, it seemed like Hinton and his suitors in Beijing were on the verge of sealing an agreement. But Hinton paused. In recent months, he'd cultivated relationships inside several other companies, both small and large, including two of Baidu's big American rivals, and they, too, were calling his office in Toronto, asking what it would take to hire him and his students.

Seeing a much wider opportunity, he asked Baidu if he could solicit other offers before accepting the \$12 million, and when Baidu agreed, he flipped the situation upside down. Spurred on by his students and realizing that Baidu and its rivals were much more likely to pay enormous sums of money to acquire a company than they were to shell out the same dollars for a few new hires from the world of academia, he created his tiny startup. He called it DNN-research in a nod to the “deep neural networks” they specialized in, and he asked a Toronto lawyer how he could maximize the price of a startup with three employees, no products, and virtually no history.

As the lawyer saw it, he had two options: He could hire a professional negotiator and risk angering the companies he hoped would acquire his tiny venture, or he could set up an auction. Hinton chose an auction. In the end, four names joined the bidding: Baidu, Google, Microsoft, and a two-year-old London startup called Deep-Mind, cofounded by a young neuroscientist named Demis Hassabis, that most of the world had never heard of.

The week of the auction, Alan Eustace, Google's head of engineering, flew his own twin-engine plane into the airport near the south shore of Lake Tahoe. He and Jeff Dean, Google's most revered engineer, had dinner with Hinton and his students in the restaurant on the top floor of Harrah's,

Every time Yu dropped in for a chat, Hinton asked his students to disassemble and hide the mattress, the ironing board, and the wet towels.

a steak house decorated with a thousand wine bottles. It was Hinton's 65th birthday. As he stood at a bar table and the others sat on high stools, they discussed Google's ambitions, the auction, and the latest research under way at his lab in Toronto. For the Googlers, the dinner was mostly a way of running the rule over Hinton's two students, whom they had never met. Baidu, Microsoft, and DeepMind also sent representatives to Lake Tahoe for the conference. Kai Yu, the Baidu researcher who'd kicked off the race, held his own meeting with the Toronto researchers before the bidding began. But none of the bidders ever gathered in the same place at the same time. The auction itself played out over email, with most bids arriving from corporate executives elsewhere in the world, from California to London to Beijing. Hinton hid the identity of each bidder from all the rest.

He ran the auction from his hotel room, number 731 in the Harrah's tower, which looked out over the Nevada pines and onto the snowy mountain peaks. Each day he set a time for the next round of bidding, and at the designated hour, he and his two students would gather in his room to watch the bids arrive on his laptop. The laptop sat on a trash can turned upside down on a table at the end of the room's two queen-size beds, so that Hinton could type while standing up.

The bids arrived via Gmail, just because that was where he kept an email account. But according to Hinton, Microsoft didn't like the arrangement. In the days before the auction, the company complained that Google, its biggest rival and likeliest competitor in the auction, could eavesdrop on private messages and somehow game the bids. Hinton had raised the same possibility with his students, though he was less expressing a serious concern than making an arch comment on the vast and growing power of Google. In the end, both Hinton and Microsoft set their concerns aside—"We were fairly confident Google wouldn't read our Gmail," he says.

The auction rules were simple: After each bid, the four companies had an hour to raise the buying price by at least a million dollars. This hour-long countdown started at the time stamped on the email holding the latest bid, and at the end of the hour, if no one lodged a new bid, the auction was over. DeepMind bid with company shares, not cash, but it couldn't compete with the giants

One evening, close to midnight, as the price hit \$44 million, Hinton suspended the bidding. He needed some sleep.

and soon dropped out. That left Baidu, Google, and Microsoft. As the bids continued to climb, first to \$15 million and then to \$20 million, Microsoft dropped out too, but then returned. Each increment felt heavy with meaning as Hinton and his students debated which company they'd rather join. Late one afternoon, as they looked out the window, two airplanes flew past from opposite directions, leaving contrails that crossed in the sky like a giant X right above a set of mountain peaks. Punchy with excitement, they mused about what this might mean, before remembering that Google was headquartered in a place called Mountain View. "Does that mean we should join Google?" Hinton asked. "Or does it mean we shouldn't?"

At about \$22 million, Hinton temporarily suspended the auction to hold a discussion with one of the bidders, and half an hour later Microsoft dropped out again. That left Baidu and Google, and as the hours passed, the two companies took the price still higher. Kai Yu handled the initial Baidu bids, but when the price reached \$24 million, a Baidu executive took over from Beijing.

From time to time, Yu would stop by, hoping to glean at least a small sense of where the auction was headed. Unbeknownst to Yu, these visits prompted a bit of a farce inside room 731. Hinton often got sick when he traveled to places like Lake Tahoe, where the air was cold, thin, and dry. He was worried he might get sick again, and he didn't want any tech industry people to see him that way. "I didn't want them thinking I was old and decrepit," he says. To keep illness at bay, he had removed the mattress from the pullout couch against the wall, laid it on the floor between the two beds, stretched an ironing board and a few other long, sturdy objects across the gulf between the beds, then dampened several towels with water and draped them across the gaps. He slept each night in the wet air under this makeshift canopy. But Hinton didn't want Yu to see his personal humidifying chamber, so every time Yu dropped in for a chat, Hinton turned to his two students, the only other people in his three-person company, and asked them to disassemble and hide the mattress and the ironing board and the wet towels. "This is what vice presidents do," he told them.

After one visit, Yu left the room without his backpack, and when Hinton and his students noticed it sitting on a chair, they

wondered if they should open it to see if anything inside would tell them how high Baidu was willing to bid. But knowing it wasn't the right thing to do, they didn't. In any case, they soon discovered Baidu was willing to go much higher: \$25 million, \$30 million, \$35 million. Inevitably, the next bid wouldn't arrive until a minute or two before the top of the hour, extending the auction just as it was on the verge of ending. The price climbed so high, Hinton shortened the bidding window from an hour to 30 minutes. The bids quickly climbed to \$40 million, \$41 million, \$42 million, \$43 million. "It feels like we're in a movie," he said. One evening, close to midnight, as the price hit \$44 million, he suspended the bidding again. He needed some sleep.

The next day, about 30 minutes before the bidding was set to resume, Hinton sent an email saying the start would be delayed. About an hour later, he sent another. The auction was over. At some point during the night, Hinton had decided to sell his company to Google—without pushing the price any higher. His email to Baidu said that any other messages the company sent would be forwarded to his new employer, though he didn't say who that was.

This, he later admitted, was what he had wanted all along. Even Kai Yu had guessed that Hinton would end up at Google, or at least another American company. His bad back, after all, would keep him from traveling to China. As it was, Yu was content that Baidu had taken its place among the bidders. The experience, he believed, had helped his superiors see the world the way he saw it. By pushing Baidu's American rivals to the limit, the company's brain trust had come to realize for themselves how important deep learning would be in the years ahead.

Hinton stopped the auction because finding the right home for his research was ultimately more important to him than commanding the maximum price. When he told the bidders at Google he was stopping the auction at \$44 million, they thought he was joking—that he couldn't possibly give up the dollars that were still coming. He wasn't joking, and his students saw the situation much as he did. They were academics, not entrepreneurs, more loyal to their idea than to anything else.

Hinton didn't realize just how valuable

their idea would prove to be. No one did. The rise of deep learning marked a fundamental shift in the way digital technology was built. Rather than carefully defining how a machine was supposed to behave, one rule at a time, one line of code at a time, engineers were beginning to build machines that could learn and apply lessons from such enormous amounts of data that no human could ever wrap their head around it all. The result was a new breed of computing that was not only more powerful than anything that came before but also more mysterious and unpredictable. Its superhuman capacities, it turned out, were also shot through with human failings. As Google and other tech giants adopted the technology, no one quite realized it was learning the biases of the researchers who built it.

After Hinton's auction played out at Lake Tahoe and the NIPS conference came to an end, Kai Yu boarded a plane for Beijing. There, he ran into another Chinese-born researcher named Li Deng, who had played his own role in the auction as an employee of Microsoft. Yu and Deng knew each other from years of AI conferences and workshops, and they arranged for adjacent seats on the long flight to Asia. Because the bidders had remained anonymous, neither was quite sure which companies were involved in the auction. They spent hours standing in the back of the cabin, discussing the rise of deep learning. But they also felt bound by their employers not to reveal their own involvement in the auction. So they danced around the issue, trying to understand what the other knew without giving their own secrets away. Though they didn't say it, both knew that a new competition was on—that the auction had been like a starting gun. Their companies would have to answer Google's big move. It was the beginning of a global arms race, and this race would quickly escalate in ways that would have seemed absurd a few years before.

At first, the contest would engage just a small group of scientists—spread mainly across the four companies that made bids in Hinton's auction—and would thrust their work into the tech industry's center spotlight. DeepMind, the obscure London startup, would grow to become the most celebrated and influential AI lab of the decade, fueled by the boundless ambition of cofounder Demis Hassabis to build machines capable of attaining what's called

artificial general intelligence: omnivorous, adaptable, humanlike thought. Hinton and Hassabis would come to disagree with each other about the validity of that goal, but starting in 2014 they did so under the umbrella of the same parent company—as Google acquired DeepMind that January.

Eventually Facebook and a startup called OpenAI would also join the race, with the latter becoming tied to Microsoft via major investments. The competition between all these players would dramatically accelerate the progress of artificial intelligence, sparking enormous advances in talking digital assistants, driverless cars, smart robotics, automated health care, and—stretching well past the intentions of Hinton and his students—automated warfare and surveillance.

After he checked out of room 731, Hinton boarded a train for the long trip back to Toronto—and he still hasn't sat down. Years later, in 2017, when he was asked to reveal the companies that bid for his startup, he answered in his own way. "I signed contracts saying I would never reveal who we talked to. I signed one with Microsoft and one with Baidu and one with Google," he said. He declined to mention DeepMind, which meant that some participants in the auction never had a full picture of who they had bid against for the future of computing—until now.



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AS ADOPTION SEARCHES MIGRATE ONLINE, REGRETFUL ADOPTEES AND BIOLOGICAL MOMS ARE CONFRONTING PROSPECTIVE PARENTS WITH THEIR PERSONAL PAIN.

THE INTERACTIONS CAN BE BITTER, NASTY, AND ENLIGHTENING.

DEAR BIRTH MOTHER

BY

SAMANTHA M. SHAPIRO

ART BY AMBER LEE WILLIAMS

PHOTOGRAPHS BY JUAN DIEGO REYES

**WHEN ERIN AND JUSTIN
DECIDED TO**

ADOPT A CHILD

at the beginning of 2016, they paid \$25,000 to sign on with one of the largest, most reputable adoption agencies in the United States. They imagined an orderly process, facilitated by lawyers and social workers.

They didn't foresee the internet trolls who would call them cunts and psychopaths. Nor did they imagine they'd be filing a police report, or pleading with Facebook to delete posts that called them human traffickers. They didn't expect the internet to be involved in the process at all.

Erin and Justin (not their real names) met in Chicago in 2010 on a dating site. Erin was 37 with blond, beachy waves and a Michigan accent. She was divorced at the time and approached the dating market pragmatically, uninterested in wasting time with men who were not serious prospects. When she met Justin, she knew she'd found what she was looking for. "He was so kind, different from anyone I'd dated, and I knew he'd be a good dad," she told me. They married in 2011 and planned to have children, but when Erin got a job offer that took them to New York City, they decided to wait until they were settled. Then, when they were ready to start trying, Erin learned that she had gone into premature menopause. "I wasn't devastated, because I knew I wanted to be a mom, and it didn't matter to me how my child came to me," she said. They forged ahead, excited to adopt.

But several months after they signed with the adoption agency, it filed for bankruptcy. Erin and Justin contacted an attorney, who advised them to move their search online.

The adoption industry has never been very well regulated, and there is a history of certain firms engaging in unethical practices. But when agencies were the primary facilitators of adoption, they could at least perform basic vetting of birth mothers and adoptive parents and manage complex legal processes. The open marketplace of the web removed that layer of oversight. A

2012 report on adoption and the internet, by the now defunct Donaldson Adoption Institute, found, among other things, that online adoptions create opportunities for fraud and for financial incentives that might push expectant mothers to give up their children. Online, prospective adoptive parents negotiate with birth mothers directly via Craigslist ads. People who adopt children, often from overseas, and then change their minds find new homes for them in Facebook "adoption disruption" groups, without any supervision from child welfare agencies. "One thing that is true about adoption and the internet is that no one is paying attention," says Adam Pertman, who was the executive director of the Donaldson Adoption Institute. "Whatever is happening is happening because it can, and it's having enormous impact—some good, some bad, and some unknowable—without any repercussions."

Erin and Justin signed up for a platform called Adoptimist ("We're a technology company devoted to family-building. We are not an adoption agency or law firm") and set up a Facebook page about their "adoption journey." They filled their profiles



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with personal information, describing their love of basketball, football, and triathlons. Erin wrote that she came from a large Italian family and hoped to raise her children speaking Italian and English. They shared a picture of the two of them goofing around with a young nephew, another of them eating ice cream.

When they posted their profile to Adoptimist in 2017, Justin and Erin were approached by a woman from Las Vegas. She said she was pregnant with twins and had been diagnosed with cancer, and that she wanted the couple to raise the babies. After many texts and updates about the babies' heart rates, and an invitation to come meet the twins in the hospital, they discovered the woman had never been pregnant.

She was what Erin described as an "emotional scammer," someone seemingly uninterested in money who torments prospective adoptive parents for reasons known only to them. Erin said another woman on Adoptimist who claimed to be pregnant sent her a message saying she was hungry and asking her to order a pizza. This was, Erin said, how most of the couple's interactions on the site went. (Philip Acosta, the president and cofounder of Adoptimist, said that the company has in recent years focused on combating scammers. The site now offers to review the IP addresses of anyone who contacts a prospective adoptive parent, and also alerts users to different types of scams on a "scam blog.")

Justin and Erin joined a support group for parents seeking to adopt. Several of the couples in their group who had already adopted children passed along advice about using Facebook's advertising analytics to hone their search. So Justin and Erin paid the social media company between \$25 and \$150 a month to promote their adoption page in the feeds of women age 15 to 65 in college towns around the US. This range, they reasoned, might reach a grandparent or a friend of a pregnant woman.

Soon after they started buying targeted Facebook ads, Erin's mother became seriously ill. Erin flew to the suburbs of Detroit, where she was raised, to help. For a hectic few weeks, she and her sister took turns staying in the hospital with their mother and watching Erin's five nieces and nephews.

One night, Justin called Erin and, sounding stricken, asked if she'd seen their adoption page. She hadn't had time to check it. "Oh my God," he told her. "You have to go look now."

THAT NIGHT IN MICHIGAN,

WHEN ERIN LOGGED

ON TO FACEBOOK,

she saw, interspersed with encouraging messages, a torrent of abuse. Perhaps because of the increased exposure Facebook analytics offered, their adoption profile had come to the attention of anti-adoption blogs and Facebook groups. Now their profile had been screenshotted and tagged and mocked on many other pages. "How will you have time for a baby while you're resting your facelift, and getting all that work done?" one poster asked. Another proclaimed, "Get a dog, you stupid cunts." "No child deserves her ... even the 'man upstairs' saw that."

In the guest bedroom in her sister's house, Erin stayed up late into the night deleting the comments on their adoption profile and trying to report the users who posted them. "I was trying to plug the dam, but there wasn't enough time. It was a 20-person job," she said. "There was no one to talk to

HOPEFUL PARENTS WERE CALLED "VULTURES TROLLING THE NET FOR

at Facebook." (A Facebook spokesperson said, "We continue to improve the technology we use to find bullying and harassing content" and that it had "removed the content that violates our policies.")

As she jumped from one anti-adoption page to another, Erin saw that she and Justin were far from the only targets. Other prospective adoptive parents were called "vultures trolling the net for babies." One group had shared the Adoptimist profile of a gay male couple, asking sardonically, "Which one will be listed on the birth certificate as the woman who gave birth to the child?"

Erin was dumbfounded. "I didn't even know anti-adoption was a thing," she told me.

The anti-adoption movement lives in Facebook groups and on blogs with names like the Wounded Adoptee, Changing the Adoption Narrative, and Adopted Ball of Hate, and it is comprised of people who wouldn't have found each other elsewhere: older women who, as "unwed mothers" in the 1950s and '60s, were forced to give babies up for adoption; women whose churches still pressure them to give up children born outside of marriage; adoptees who want to overturn laws in 40 states that deny them unrestricted access to their original birth certificates.

The people in this movement come to it from a wide range of perspectives. Some

recognize the value of adoption in certain circumstances and have specific goals, like improving federal oversight, eliminating practices that are coercive to birth mothers, or giving them more time to reverse a decision to give up a child. Others see adoption as wrong in all cases, as an assault on some transcendent natural bond only possible between a biological mother and child. Some are finding community and expressing feelings of anger and pain for the first time; birth mothers describe pressure, regret, and lifelong mourning for the children they gave up, while adoptees talk about their sense of estrangement and about not knowing their medical history.

Members of these groups run an informal counter-messaging campaign to standard adoption narratives, one which incorporates their trauma and the role that poverty plays in adoption. When the economic devastation from Covid-19 shutdowns became apparent in April, Lifetime Adoption, an agency based in Florida, put up a blog post assuring prospective adoptive parents that the pandemic would open new opportunities. "Difficult times bring a greater need for adoptive parents," the post read. "Lifetime Adoption has found that phone calls from potential birth mothers are three times what they normally are." Anti-adoption groups took screenshots and critiqued the post, highlighting the more troubling issues underlying its assumptions, until the agency took it down.

The tactics that Erin encountered—targeting adoptive parents online, mocking their profiles, and calling them names like "womb wet baby snatcher"—are not the standard in the anti-adoption movement. The people who engage in those behaviors make up a small minority, but a vocal one.

For a while, one of the more aggressive anti-adoption posters and commenters was a woman whose online moniker is Julie Gray. She has been removed and blocked from many groups because of her use of harsh language to both birth mothers, whom she calls "relinquishers," and adoptive parents. Gray was adopted, and she told me that one of her goals in trolling adoptive parents' profiles was "to scare the crap out of them so they change their mind altogether. I want to stop other children from going through what I went through."

When Erin told her adoption support group about the response to her profile, other couples acknowledged that they'd been trolled too. They told her, "Delete, block, and don't engage," Erin recalled.

But Erin wasn't the type to back down. "I'm an attorney. I always advocate for my client, and now I felt I had to advocate for my family. I was not going to shut up and ignore it and walk away. I'm Italian, I'm hot-blooded. If I see something that's wrong for me or someone else, I am not going to be silent."

Whenever she saw adoptive parents being harassed, she reported it to Facebook. It seemed to Erin that Facebook removed a post only if a significant number of people reported it. (The company says one report is enough if a post violates its policies.) So in September 2017 she started a small Facebook group whose sole purpose was to monitor and report anti-adoption harassment. She sometimes commented acerbically on those posts she reported, and she quickly became known in the anti-adoption community. One commenter wrote an ominous post saying she had eaten dinner at the restaurant on the ground floor of Erin's Manhattan apartment building. Another post named the law firm where Erin worked and discussed strategies for getting her disbarred. At that point, Erin says, she filed a police report about the woman who claimed to have been in her building.

Although she was in frequent battle with the anti-adoption movement, Erin shared some of their concerns. She found that the inconsistency of laws from state to state created confusion and believed all adoptees should have access to their original birth certificates. At some point Erin had signed up for a newsletter from an adoption facilitator who connected prospective parents with birth parents for a fee. The emails included what the facilitator called "situations":

R BABIES."



brief descriptions of children available for adoption along with a price, usually in the tens of thousands of dollars. The idea of putting a “price” on a child above basic expenses incurred by the birth mother disturbed Erin. She thought it might encourage birth mothers to place their babies for adoption. She was especially horrified to see enormous race-based discrepancies: In one situation a white child was \$45,000, while in another a Black child was \$20,000.

Then, in the fall of 2017, a pregnant woman from the South reached out to Erin and Justin through Facebook. The woman was in a long-term relationship, was raising three other children, and had previously placed another child for adoption. Erin tried not to get her hopes up, but she had a good feeling as the months passed and the woman kept in regular contact. New York state has strict rules on payments to birth mothers: It permits prospective adoptive parents to give money only for certain expenses and in the final months of pregnancy and just after childbirth. The expectant mother was on Medicaid and didn’t need help with medical expenses, but Justin and Erin paid her \$1,450 a month for three months because she said her doctor ordered her to stop working toward the end of her pregnancy.

As the baby’s due date neared, Justin and Erin drove south to meet the family. They all went out for dinner, and Erin gave the birth mother a spa package.

When the baby girl was born, Erin and Justin were in the hospital. They held her soon after she was delivered. Erin cut the umbilical cord. They were overjoyed. Erin and Justin stayed with her in the neonatal intensive care unit for several weeks—she had breathing problems—before returning to New York City.

ERIN TOOK DOWN HER

ADOPTION PAGE, BUT SHE CONTINUED CHALLENGING

the harassment she saw on Facebook. For a while, she settled into a kind of routine. She’d tell the trollers to get a hobby, or worse. Sometimes, she’d threaten legal action. There was an anti-adoption Facebook group called Ask a Birth, First, Natural Mom, which Erin had taken to calling Ask a Moron in her posts encouraging her group to report it. She saw the heated exchanges as mutual sport. “They know who I am and know that I troll those pages. They don’t block me. They like the engagement,” she told me. “It was a cat-and-mouse game.”

Then, in August 2019, something happened that changed the tone for Erin. The previous January, when her daughter’s adoption was finalized in court, Erin had posted an album on Facebook that she hashtagged #familyday and #gotchaday, a phrase sometimes used by adoptive parents. In addition to taking photos at court, Erin had made a poster with her daughter’s full name and stylized numbers showing her birthday and the date “you were forever ours.” Erin put a bow in the toddler’s blond curls and took pictures of their little family posed on a white leather couch in front of the framed poster.

Erin believed her personal Facebook page’s privacy settings allowed only friends to see posts. But months after she posted the celebratory picture, she received notifications that it had been shared on two anti-adoption sites: Ask a Birth, First, Natural Mom and a group Erin hadn’t heard of: America’s Taken.

SAMANTHA M. SHAPIRO is a contributing writer to The New York Times Magazine.



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On America's Taken, which has more than 14,000 followers, the picture, with Erin's daughter's full name in view, was posted with Erin's name along with hashtags about kidnapping and trafficking. Soon others shared the link, and the mocking comments began.

That was nothing new, but now Erin's name and her daughter's were spreading with those hashtags. "The last thing I want is for her picture and mine to be on a dark web, as if we were available for trafficking," Erin told me.

Erin mobilized her group to report America's Taken and emailed Facebook repeatedly. Eventually Facebook removed the picture from pages that posted it.

Pfeiffer started America's Taken because of her own experience with child protective services. In 2009, one of Pfeiffer's sons—who was 19 at the time—learned that he had become a father. Neither her son nor the mother was prepared to raise a child, Pfeiffer told me, so Pfeiffer took over caring for the baby. "I just held him that whole first year," she remembered. "His skin was paper thin." She had the boy baptized in a white tuxedo. When her grandson was old enough, she enrolled him in preschool through Head Start.

Then, when he was 4, everything fell apart. On Halloween morning in 2013, a witness said she saw Pfeiffer swinging her purse at the boy in front of his preschool, "with such force causing the child to be knocked approximately 10 feet down a concrete ramp causing scrapes to his left and right forearms and face and head," according to court records. When we spoke, Pfeiffer denied that this happened; in a court record she had said "he was spanked outside of school grounds."

When the Halloween report was filed, Pfeiffer was on probation for an incident of assault and battery. (In an official statement, she said a woman she knew attacked her with a tire iron, and "I fought off the blows with a rake. I ran to her truck and put it in neutral, and it ran down the hill and into a tree.") Her grandson went into foster care.

Both Pfeiffer and her son say they tried to get the boy back. Pfeiffer completed an anger management course. Meanwhile her grandson bounced from one foster placement to another. Records from family court are sealed, so it is not possible to know the full details of this case.

Eventually one of the boy's foster families filed adoption papers. The last time Pfeiffer saw her grandson was at their final visit in the county Department of Human Services building.

Afterward, Pfeiffer fell into a sleepless depression. She shut the door to her grandson's room and didn't open it for two years. She finally cleaned it out when her teenage granddaughter asked to take it over. Her granddaughter hung up a tapestry with an elephant on it, and Pfeiffer moved the boy's belongings into storage containers. During my visit, she unpacked one that held the preemie outfit the baby wore the day she

AMERICA'S TAKEN IS RUN BY GERI PFEIFFER.

who lives in a trailer heated by a wood-burning stove in central Oklahoma, near the end of a narrow dead-end road. Pfeiffer, who is 61 and stands 6'2", has a big laugh and wears clear Coke-bottle-thick bifocals. She identifies herself on social media as a "hell raiser," "memaw," and "activist," and in her spare time she knits prayer shawls for a local church.

On the America's Taken Facebook page, Pfeiffer posts pictures of children who have been removed from their homes by child protective services, placed in foster care, and then adopted by new families. There are 135,000 adoptions every year in the US, and about 40 percent are from foster care. The birth parents in those cases no longer have the right to visit their children. The children's names are often changed, and many states still seal a child's original birth certificate.

Pfeiffer logs long hours advising birth parents all over the country on how to find their children. She can be relentless. She once sent Facebook messages to nearly every business owner in a small northwestern Washington town, asking if anyone knew the whereabouts of a child who'd been in foster care there. (It worked.) The tougher cases she brings to the online network of amateur detectives who are known in the adoption community as search angels. Many of them are former adoptees or birth parents, but some are just genealogy buffs with time on their hands. Most use online consumer tools like Ancestry.com or data-mining sites like Beenverified or Spokeo.

A typical post on America's Taken might show a photo of a child (who a relative has asked Pfeiffer to locate) along with a message:

As soon as you hit that 18th Birthday ... your grandma and great grandma ... will be waiting.
You weren't hard to find.
They love you. They miss you. They have waited a long time.

When she saw Erin's "forever ours" post, Pfeiffer had thought nothing of sharing a few choice words about it; she frequently compares adoption to kidnapping and trafficking. But Erin fought back. That week, Erin and Pfeiffer—and their respective followers—got into increasingly heated exchanges. On her Facebook group page, Erin posted, "Looks like the tables have turned. How does it feel, Geri Pfeiffer?" When Pfeiffer got online again, she composed a message to her followers with Erin's name: "To think that this attorney has adopted a child is another adoption horror story in the making. A child that was adopted to satisfy the narcissistic need of a psychopath attorney to be a 'mother.'"

"THE GRIEF IS NOT EVEN ACKNOWLEDGED."

first met him, the small white tuxedo from his baptism, a plastic octopus he used to fall asleep with, his Spider-Man wallet, and a lock of dirty-blond hair from his first haircut.

"Precious memories from a boy that doesn't exist anymore," Pfeiffer said sadly.

She still occasionally feels something embedded in the corner of her quilt and discovers a crayon or Lego sword lodged in the fabric. "Right now the grief is not even acknowledged once your rights are terminated," she said. "You're just relegated to the trash heap of life."

THE TERMINATION OF PARENTAL RIGHTS

has been called the "civil death penalty," because of its severity and finality. It is overwhelmingly levied against poor families. Some children are taken away from parents who abuse them horribly—and others who should be removed are not and die at the hands of abusers. Nationally, the majority of children are removed from their homes by child protective services not for abuse but neglect, which can be a more subjective state. Neglect can mean a child was left in a hot car for hours or that a child's parent is an addict. Or it can mean that a child was alone at home while their mother worked an overnight shift or went to the store, or that there's not enough food in the fridge. In other words, poverty can create conditions that lead to neglect, and the exigencies of poverty can also be interpreted as neglect.

Many anti-adoption advocates, as well as some experts in child-welfare reform, argue that helping families get what they need—rehab, food stamps, child care subsidies—should be prioritized over permanently removing children from their parents. In a 2019 paper, "A Cure Worse Than the Disease? The Impact of Removal on Children and Their Families," Vivek San-karan, a professor at the University of Michigan Law School, and his coauthors note that removing children from their homes is traumatic for both parents and children, and that standards for removal vary from state to state. In some states there must be

evidence that a child is in immediate danger; in others, suspicion of neglect is sufficient cause. Some states allow a parent to appeal the removal within 24 hours; in others a parent may have to wait 10 days. As a result, the authors note, states and even individual counties have widely varying rates of removing children. In 2017, West Virginia removed 10 times as many children from their homes as neighboring Virginia did. In Oklahoma, where Pfeiffer lives, the number of children who are adopted from foster care is far higher than the national average.

Other child advocates, however, point out that, whatever its cause, neglect can be profoundly damaging to children. Elizabeth Bartholet, director of the Child Advocacy Program at Harvard Law School, agrees that "if we eliminated poverty in this country, that would be the best abuse- and neglect-prevention program." But protecting the welfare of children, she says, has to take priority over parental rights.

In some cases, a judge will rule that a birth parent poses a danger to a child and will prohibit the parent from making contact. But many avenues exist for a birth parent to reconnect with a child unsupervised. The internet, along with widely available genetic testing, has dismantled the possibility of a truly closed adoption. "Judges' strictures mean nothing if a child can search for his birth mother without [adoptive] parents knowing," says Pertman, now the president and CEO of the National Center of Adoption Permanency. "But that doesn't mean an 11-year-old should be forming relationships with people he doesn't know without parents' knowledge."

Martin Guggenheim, an advocate for parental rights and a professor at NYU School of Law, who believes many removals are unjust, is not surprised that birth parents and relatives attempt DIY reunions through the web. When he saw the America's Taken Facebook page, he told me, "When you think about it, how do you not create this website?"

Other online groups have emerged where there are gaps in adoption processes. Adoption-disruption groups on Facebook, where adopted children are "re-homed," emerged at least partly because there is little post-adoption



support and monitoring; some families know almost nothing about the issues their overseas-adopted children faced or how to cope with their medical or behavioral challenges. In private adoptions, the lawyer who represents a birth mother is often paid for by the adoptive family, and some adoption agencies fund flashy public relations campaigns that paint the experience in sunny tones. There are no major organizations that share with expectant mothers potential downsides or that help them with their rights.

Renee Gelin started an organization and Facebook group that plays that role by crowdsourcing assistance and advice that birth mothers might not have access to. As a single parent, Gelin gave up her second child for adoption 10 years ago because she was under crushing financial pressure at the time. Her job as a contractor in IT offered no maternity leave, and her health insurance would not cover her high-risk pregnancy. She was paid too much to qualify for Medicaid.

Just weeks before her son was born, Gelin agreed to place him with a family in another state. As soon as he was on the plane, she regretted the choice. Although she had arranged an open adoption for her son, she says that the adoptive family ended the relationship when they found critical blog posts she had written expressing grief about the process. Gelin felt she hadn't understood that open adoptions exist at the discretion of the adopting family. In fact, they are not legally enforceable in all states, and where they are enforceable the cost of a lawyer can be prohibitive for a birth mother.

Gelin's organization, called Saving Our Sisters, tries to persuade birth mothers that financial strain shouldn't prevent them from keeping their children. When a woman who is having second thoughts reaches out to SOS online, the

group tries to find a "sister on the ground" nearby to bring her diapers, a month's rent, or a baby swing. Gelin says SOS has had around 90 "saves"—adoptions in process that the group helped reverse—in the past six years. Gelin transferred the blog about her adopted son to a public Facebook page years ago and still posts letters and updates to him, often signed "Mom."

THE WOMAN WHO ADOPTED PFEIFFER'S GRANDSON

once gave her a framed image of the boy's handprint. Pfeiffer took the handprint, painted it red, and made it the bloody-looking logo of America's Taken. She printed up T-shirts and signs and stood outside the family court in Guthrie in front of her truck, which had a decal that read "MY GRANDSON IS A VICTIM OF FORCED ADOPTION IN LOGAN COUNTY." She handed out pamphlets and told her version of the story to anyone who would listen. At the time, her message did not get much further than the Guthrie courthouse steps.

But in 2013, Pfeiffer enrolled in a University of Oklahoma Medical Center study on congestive heart failure. The hospital gave her an iPhone 4 so she could access a medical app she needed for the study. She had never used a smartphone, or even a computer. "I ran a laundromat," she told me, "and you don't need computers to clean people's underwear."

One day, as she entered her health data in the iPhone app, her brother asked her if she knew she could use it for other stuff. She didn't know. He showed her how to text and then helped her set up a Facebook account. Pfeiffer immediately saw the possibilities. Here she could hold up her sign 24 hours a day, all over the country. The first post she wrote was about her grandson. Within minutes, other people were posting stories to her page of children they were looking for. "It just snowballed," she told me. "The first person replied within a minute, and it just kept climbing and climbing."

As Pfeiffer got more familiar with the phone, she started tracking her grandson's

adoptive family. Pfeiffer has liver disease as well as advanced heart failure, and she told me it's unlikely she will live long enough to see her grandson turn 18, the age at which she could seek him out. She leaves messages for him on the internet. "I want him to know how hard we searched for him," she says. "And I'm going to spend every minute I have left searching for other taken kids, teaching other parents to leave clues in cyberspace."

**IN JUNE 2019,
ERIN GOT A NEW MESSAGE

FROM HER
DAUGHTER'S BIRTH MOTHER.**

The woman thought she might be pregnant again and wasn't sure what she wanted to do. She eventually asked if Erin and Justin wanted to adopt the new baby.

Erin had loved becoming a mother. She and Justin had recently put their adoption journey Facebook page back up, hoping to add to their family. The prospect of a biological sibling for their daughter was more than they had dreamed of.

I spoke to Erin when the birth mother was six months pregnant. At the time, Erin saw her adoption story as a rebuke to the ones she often saw on anti-adoption websites. The birth mother had reconnected unprompted, which confirmed to Erin that she had never felt bullied or coerced. Erin said she had made a book of pictures of her daughter's birth family that she read to her, and she shared pictures of the girl with the birth mother.

But when we talked again a few months later, Erin's view had changed. In February, the birth mother had abruptly stopped returning her messages. Erin grew increasingly frantic and eventually learned that the baby—a boy—had already been born and was in the NICU, along with another couple who also believed they were the baby's adoptive parents.

It turned out that, some months earlier, the birth mother had posted anonymously

on a Facebook adoption group and had connected with the other family. Justin and Erin rushed south with their daughter. When the boy was ready to leave the NICU, they were given temporary custody. They brought him to a townhouse they had rented, where their daughter was thrilled to meet her brother. They nested for almost four months.

The custody case became baroque. The birth mother was indicted for unlawful exchange of money in an adoption, a charge she said she was fighting as of early March. A judge ruled that the boy should be placed in foster care until custody was decided, with both couples granted an hour per week to visit him. The birth mother and her aunt also filed for custody. The birth mother and Erin described a scenario in which all four families visited the baby once a week in the midst of the pandemic. Eventually the second couple dropped their custody claim, and the baby was sent home with his birth mother, where he has lived for months. Erin and Justin are still pursuing custody.

Erin told me about this turn of events in June 2020. At the time, she was hunkered down in the rental, awaiting the final custody decision. She was sad and seething. But for the first time since we initially spoke nearly two years earlier, her target had changed. "The anti-adoption folks? Honestly, I get it now. I get why they say some of the things they say. A lot of their concerns are legitimate," she told me. "There's a dark side to adoption."

In the months she and her husband had spent with their daughter and her brother, she felt they had bonded. Then the boy was put in foster care. In her years of monitoring anti-adoption groups, Erin had read again and again about the trauma a child suffers when removed from his family. Now she was haunted by the rupture and the baby's experience of losing the "only home he ever knew."

"It tore me up inside," she said. "I can't imagine what he must be thinking and feeling."

The experience confirmed to her the need for federal adoption reform. Maybe, she said, it made sense to have 50 different sets of state adoption laws when adoptions were done locally. But in a world where a child's future may be mediated on various digital platforms with little accountability, one set of rules is needed. For starters, "there needs to be a federal register of hopeful adoptive parents and birth moms," Erin said. "There should be a registry to see if someone is matched or not matched."

When I reached the birth mother in February, she told me that she had decided on adoption for her daughter, another child, and initially planned on it for her son, because she was raising three other children and is against abortion. She thought the kids would have a better life. But it was not easy. In the hospital, she told me, she asked for the baby to be put in a separate room with the adoptive parents. "After giving birth knowing the baby was going with someone else," she said. "That's a lot to endure." She got very quiet on the phone. "I step away because it gets harder and harder to say, 'Well, yes, this is what I want to do.'"

She had liked the idea of getting to know a family directly through Facebook. But the bitter fight over her son had convinced her she had not really known the people who adopted her children. She told me, "Never again would I choose adoption." The baby is now a year old.

When we spoke in June, Erin said she had mostly stopped following anti-adoption groups on Facebook. But the activists were on her mind as she navigated a chaotic custody case born out of unverified Facebook threads. In a vacuum of oversight, the anti-adoption groups seemed to be the only ones tracking, however imperfectly, the adoption industry. More than once when we spoke that day, she said, almost wistfully, "I would be really curious to hear what they would say about this." ▀

GOD VIEW

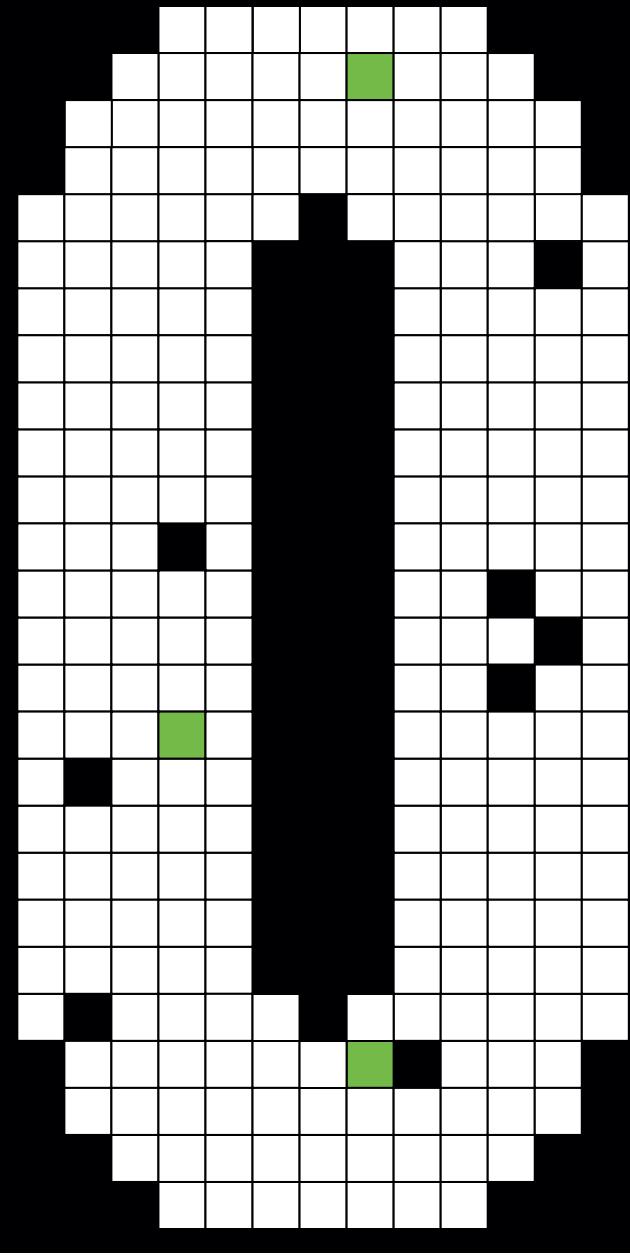
BY Arthur
Holland Michel

SECURITY CAMERAS.
LICENSE PLATE READERS.
SMARTPHONE TRACKERS.
DRONES.
WE'RE BEING WATCHED 24/7.

ILLUSTRATIONS BY Yoshi Sodeoka

SOON ALL OF
THOSE EYES COULD
BECOME ONE.





ONE AFTERNOON IN THE FALL OF 2019, IN A GRAND OLD office building near the Arc de Triomphe, I was buzzed through an unmarked door into a showroom for the future of surveillance. The space on the other side was dark and sleek, with a look somewhere between an Apple Store and a doomsday bunker. Along one wall, a grid of electronic devices glinted in the moody downlighting—automated license plate readers, Wi-Fi-enabled locks, boxy data processing units. I was here to meet Giovanni Gaccione, who runs the public safety division of a security technology company called Genetec. Headquartered in Montreal, the firm operates four of these “Experience Centers” around the world, where it peddles intelligence products to government officials. Genetec’s main sell here was software, and Gaccione had agreed to show me how it worked.

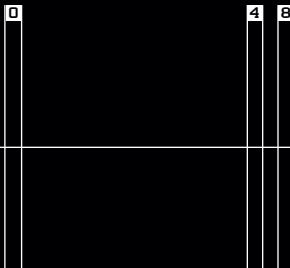
He led me first to a large monitor running a demo version of Citigraf, his division’s flagship product. The screen displayed a map of the East Side of Chicago. Around the edges were thumbnail-size

videostreams from neighborhood CCTV cameras. In one feed, a woman appeared to be unloading luggage from a car to the sidewalk. An alert popped up above her head: ILLEGAL PARKING. The map itself was scattered with color-coded icons—a house on fire, a gun, a pair of wrestling stick figures—each of which, Gaccione explained, corresponded to an unfolding emergency. He selected the stick figures, which denoted an assault, and a readout appeared onscreen with a few scant details drawn from the 911 dispatch center. At the bottom was a button marked INVESTIGATE, just begging to be clicked.

Citigraf was conceived in 2016, when the Chicago Police Department hired Genetec to solve a surveillance conundrum. Like other large law enforcement organizations around the country, the department had built up such an impressive arsenal of technologies for keeping tabs on citizens that it had reached the point of surveillance overload. To get a clear picture of an emergency in progress, officers often had to bushwhack through dozens of byzantine databases and feeds from far-flung sensors, including gunshot detectors, license plate readers, and public and private security cameras.

This process of braiding together strands of information—“multi-intelligence fusion” is the technical term—was becoming too difficult. As one Chicago official put it, echoing a well-worn aphorism in surveillance circles, the city was “data-rich but information-poor.” What investigators needed was a tool that could cut a clean line through the labyrinth. What they needed was automated fusion.

Gaccione now demonstrated the concept in practice. He clicked Investigate, and Citigraf got to work on the reported assault. The software runs on what Genetec calls



"TO THE
EXTENT THAT
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a "correlation engine," a suite of algorithms that trawl through a city's historical police records and live sensor feeds, looking for patterns and connections. Seconds later, a long list of possible leads appeared onscreen, including a lineup of individuals previously arrested in the neighborhood for violent crimes, the home addresses of parolees living nearby, a catalog of similar recent 911 calls, photographs and license plate numbers of vehicles that had been detected speeding away from the scene, and videofeeds from any cameras that might have picked up evidence of the crime itself, including those mounted on passing buses and trains. More than enough information, in other words, for an officer to respond to that original 911 call with a nearly telepathic sense of what has just unfolded.

Gaccione turned to a second console, this one loaded with a program called Valcri. Where Citigraf is designed for relaying early leads to patrol officers rushing to the scene of a crime, Valcri is for the detectives working long cases at the precinct. Originally developed to root out sex-trafficking rings, its fusion algorithms hunt for subtler, more elaborate patterns that might stretch

across years of unstructured data. Gaccione told me about one counterterrorism unit, which he wouldn't name, that had used the system to build a detailed profile of "a middle-aged unemployed individual with signs of radicalization," using "various databases, CCTV, phone records, banking transactions, and other surveillance methods." If done manually, he estimated, this kind of investigatory grunt work would take a couple of weeks. In this instance, it took "less than a day."

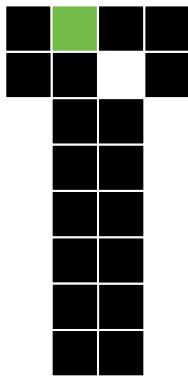
The market for fusion technology has been enjoying a quiet boom in recent years. Genetec says that Citigraf is deployed in "many cities." A growing number of established tech giants, including Cisco, Microsoft, and Motorola, sell fusion systems globally, often in the guise of "smart city" modernization packages. (Cisco sometimes even sweetens the pot with no-interest financing.) Palantir, which bills itself as a "data integration" firm, reportedly counts among its clients the Central Intelligence Agency, Immigration and Customs Enforcement, and the Centers for Disease Control and Prevention. Anduril has built a "virtual wall" along parts of the border with Mexico, using fusion software to link together a network of surveillance towers. Last fall, the four-year-old company won a flexible contract, capped at \$950 million, to contribute elements of the technology to the US military's Advanced Battle Management System.

For all these customers, a central appeal of fusion is that it can scale to new sources of data. You can add fuel to your "correlation engine" by, say, hooking up a new network of sensors or acquiring a privately owned library of smartphone location data. (The Pentagon's Special Operations Command was recently revealed to be a buyer of many such libraries, including those from a Muslim prayer

app with tens of millions of users.) Organizations with their own coders can develop capabilities in-house. In New York, for instance, the police department's analytics division created a custom plug-in for its fusion system. The feature, called Patternizr, draws on more than a decade's worth of departmental data to match property crimes that could be related to each other. When a new report comes in, all the investigator has to do is click "Patternize," and the system will return a list of previous incidents, scored and ranked by similarity.

Mind-bending new breakthroughs in sensor technology get a lot of buzzed press: A laser that can covertly identify you from two football fields away by measuring your heartbeat. A hack that makes your smartphone spy on anything nearby with a Bluetooth connection, from your Fitbit to your smart refrigerator. A computer vision system that will let the authorities know if you suddenly break into a run within sight of a CCTV camera. But it's a mistake to focus our dread on each of these tools individually. In many places across the world, they're all inputs for a system that, with each new plug-in, reaches a little closer to omniscience.

That idea—an ever expanding, all-knowing surveillance platform—used to be a technologist's fantasy, like the hoverbike or the jetpack. To understand how this particular hoverbike will finally be built, I began by calling up the people who designed the prototype.



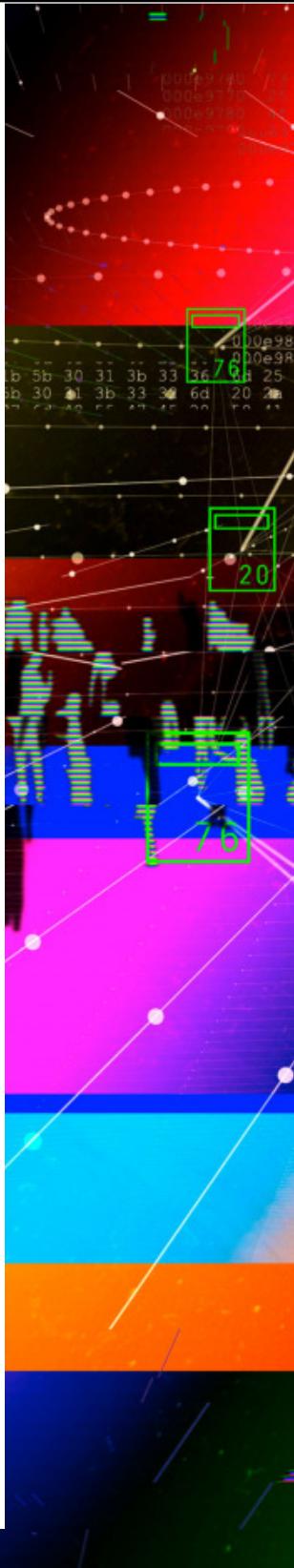
THE DEPARTMENT OF DEFENSE WAS AMONG THE FIRST organizations to face large-scale surveillance overload. By the decade after September 11, its arsenal of spy technologies had grown to galactic proportions. The department had experimented with computerized fusion since at least the 1970s, but the most advanced systems still couldn't handle more than two or three data inputs. A modern intelligence unit had to contend with hundreds. According to Erik Lin-Greenberg, who ran an elite fusion team for the Air Force from 2010 to 2013, the old ways still ruled. Each human analyst was typically responsible for a single datastream. They compared their findings in chats and phone calls, or sometimes by yelling to one another across the room. In one case, Lin-Greenberg said, another team in his squadron identified an IED just in time to halt a convoy less than 500 feet up the road.

One of the people who were supposed to help fix intractable problems like this was Dan Kaufman, the director of informa-

tion innovation at the Defense Advanced Research Projects Agency, the Pentagon's storied R&D hub. With his sunny manner and bowl of shimmering silver hair, Kaufman wasn't cut from the camo-speckled cloth of the typical military-industrial denizen. In his previous life, he had run the video game developer DreamWorks Interactive, where he helped launch what would become the *Medal of Honor* series. Later, as a consultant, he had worked with the CIA's venture capital fund, In-Q-Tel. At Darpa, Kaufman was known for championing complex computing projects with a distinct commercial flavor. He felt that the Pentagon's fusion efforts were due for a shake-up.

In the winter of 2010, Kaufman was introduced to Ben Cutler, an experienced engineer and tech entrepreneur who was considering a tour of duty in government. Over the phone, Kaufman explained the problem to Cutler and outlined his vision for what to do about it: He wanted a software platform that could integrate all available intelligence in a single, consolidated interface and grow as new capabilities came online. For Cutler, who had spent the previous year working on a new operating system at Microsoft, the idea clicked right away. What the Pentagon needed, he realized, was an OS for surveillance.

Cutler was intrigued enough to write a pitch. The document, which he completed in a day, opens with a theatrical flourish: "A patrolling group of soldiers pursues a pickup into a village; it stops at a mosque." At this point, in real life, the soldiers might have to wait for an old-fashioned fusion team to deliver its assessment. But in Cutler's scenario, they would simply log their geographic coordinates and the pickup's license plate number into a tablet. The operating system would then return a description of the neighborhood around the mosque ("known insurgent meeting area"), a profile of the imam ("has worked well with friendly forces"), and any records connecting the vehicle with known terrorist groups.





need to be capable of processing thousands of gigabytes at a time.

That was just the first step. Next, Cutler's engineers would have to find a way of hardwiring the accumulated knowledge of decades of spycraft into algorithms that could interpret, like a seasoned analyst, the subtle cues that give away the enemy's intent. These algorithms would track targets across sensor feeds and databases, tracing their every move in digital and physical space, assembling what Michael Pagels, an engineer who participated in the project's drafting, called "life histories."

And still the Darpa team wouldn't be done. Cutler wanted the system to display the assembled case file for every fighter and vehicle on a "grand chessboard"—a digital template of the physical battle space with thousands of moving pieces. Analysts would be able to click on any single one and know exactly what it was and where it had been, then take a best guess of what it might do next. And because the dynamics of battle were always shifting, the software would need a programming interface simple enough to let analysts code in new algorithms as needed.

Finally, to run simulated tests of the platform, someone would have to create a millimetrically accurate virtual battlefield populated with thousands of realistic avatars. Will McBurnett, an engineer for one of Insight's contractors, described this to me as "*Sim City* for adults." (Here, at least, the team had a head start: One of Kaufman's earlier Darpa ventures was a made-for-the-military video game called *RealWorld*, in which soldiers could rehearse missions in a detailed virtual battlefield before heading out for the real thing. Insight drew on the same code.)

Cutler threw himself into the program, he told me, as if it were any other startup taking an idea "from inception to early market

introduction." He set tight deadlines. He constantly reminded outside vendors that they were spending taxpayer dollars. To keep the focus on substance, he banned overdesigned PowerPoint presentations. By 2013 he had secured a deal to transfer the technology to the Army, which in Darpa terms was like receiving a buyout offer from Facebook. That year, an agency press release declared that Insight would "dispel the fog of war."

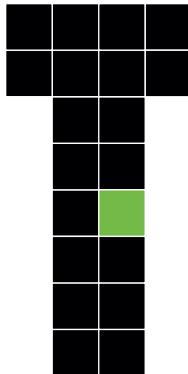
Darpa tested the platform repeatedly at Fort Irwin National Training Center, a vast mock battlefield in Southern California. In each weeklong exercise, "red teams" of highly trained soldiers would hide out among thousands of actors, like insurgents blending into a civilian population. Insight's job was to find them. Analysts would run the fusion system 24 hours a day, searching for the red teams in radar and lidar sweeps, drone footage, cell phone and internet data, and encyclopedic intelligence records that, as Cutler put it, "no analyst can possibly read." The system might, for instance, alert its operators whenever a vehicle from an enemy watch list entered a certain neighborhood. It could also generate a "normalcy model" of the observed areas so that it could alert analysts to anomalies, like a car driving errat-

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ically. (The more complex patterns remain secret; many are still used to identify targets in counterterrorism operations today.)

By the time of Insight's final disclosed test, in September 2015, the Army had pivoted the program to what McBurnett called "1980s-style, full-on, armored-brigades-on-armored-brigades kind of action." I obtained a short video of one of these later iterations of the software from BAE Systems, the prime contractor for Insight. It shows Fort Irwin in "grand chessboard" mode, with an enemy artillery unit moving across the terrain. Each vehicle, tracked relentlessly through multiple data feeds, is marked with a "likely identity" and a detailed tactical life history. In the video, analysts use the software to figure out whether the red teams will come at their forces head-on from the north or attempt a flanking maneuver from the south. As new intelligence streams in, Insight recalculates the relative likelihood of each eventuality. Soon, an alert appears in the corner of the screen: Insight predicts an 82 percent chance of an attack from the north.



THIS VIDEO CLIP IS THE OUTSIDE
world's first close look at Insight, and maybe also its last. In 2016, after BAE issued a short press release declaring that it was "on track to deliver" Insight to the

military, the program disappeared from view. By that point, both Kaufman and Cutler had returned to the private sector; they now run blue-sky research labs at Google and Microsoft, respectively. Their successors at Darpa declined to be interviewed for this story.

Public disclosures and interviews reveal a patchy story of what happened next. According to Brian Pierce, a former senior Darpa official, the Army may have been forced to put Insight on ice because of a lawsuit that Palantir brought in 2016. The Army wanted a new surveillance platform, built in part on the foundation that Insight had laid, and Palantir protested that its off-the-shelf tools hadn't received fair consideration. (Three years later, it was awarded the replacement contract.) But elements of the Insight system did find their way to the battlefield. Its vehicle-tracking tool, for instance, was adopted by an Air Force aerial surveillance program in Afghanistan called Blue Devil, which assisted in the capture or killing of at least 1,200 people between 2011 and 2014. Dave Logan, a vice president at BAE who manages its intelligence and surveillance programs, confirmed that Insight lives on in some form: The company recently received a contract from the Air Force Research Laboratory to continue development, he said, "with the goal to market the product to Department of Defense end user communities in the future."

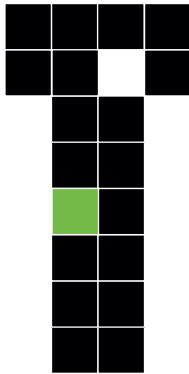
Insight's most enduring legacy, Pierce said, is philosophical. He likened it to the agency's work on driverless vehicles. Although Darpa never succeeded in building a fully autonomous car, he argued, it cleared a path for others by declaring—if not quite proving—that the pipe dream was within reach.

Automated fusion now stands at the center of how the Pentagon plans to wage any future war. "It's kind of seeped into our psyche," Michael Kanaan, an intelligence officer who runs a joint Air Force and MIT AI accelerator, told me. He gave credit to Insight's "trailblazing efforts" for, among other things, inspiring an automated fusion program that he oversaw at the Office of the Director of National Intelligence. Developed for the campaign against ISIS, that system condensed 24 databases into three and collapsed a 170-step investigative checklist for every tip the analysts received into a simple five-minute click-through. Kanaan said that rather than scrambling to respond to new threats as they emerged—bringing the convoy to a halt 500 feet from the IED—his team was able to "piece together the puzzle" days or weeks in advance.

Eventually, the Department of Defense hopes to link every plane, satellite, ship, tank, and soldier into a huge, mostly automated Internet of Wartime Things. Cloud-connected sensors and weapons will correlate among themselves while commanders direct the action on a rich, continuously updated digital chessboard that senior leaders hope will look like Waze. As part of the effort, the Air Force and the Army have earmarked billions of dollars for fusion networks from dozens of defense and technology companies, including Amazon, BAE, and Anduril.

The early results of these new efforts have been striking. In one exercise in late 2019, a Pentagon fusion system found and identified an enemy ship by linking intelligence from several airplanes and a satellite. Then it passed the information to the bridge of a nearby destroyer, where all the commanding officer had to do was decide whether to launch an attack. A more recent Army experiment condensed what was traditionally a 20-minute manual process for targeting decisions into a largely automated cycle that took just 20 seconds.

Ten years after the telephone call that kicked Insight into gear, developments like these spark a sense of validation among its creators. But their pride is tinged with something a little darker. “The vision works,” Kaufman told me over the phone. “Whether you want it to work in a civilian situation or not is”—he paused—“a debatable question.” Cutler was firmer. “I would not undertake something like Insight in a civilian context,” he said.



THE FIRST TIME I WAS GIVEN THE KEYS TO A CORRELATION engine, I was standing not in Genetec’s flashy Experience Center but in a grubby Irish pub in midtown Manhattan. On the edges of a social gathering, an NYPD official pulled me aside, said he had something to show me, and took an iPhone out of his pocket.

The phone, he explained, was loaded with a mobile version of the Domain Awareness System, the NYPD’s multi-intelligence fusion network. The network was launched in 2009 as a relatively modest attempt by the NYPD’s Counterterrorism Bureau to process CCTV footage from around Ground Zero in a central command hub. Microsoft got the main contract, and Genetec and other companies chipped in. Over the years, the system’s mandate expanded from counterterrorism to general police work, and the NYPD extended the dragnet from Lower Manhattan to all five boroughs. (In a profit-sharing agreement with the city, Microsoft has also sold the system to several US federal security agencies, along with the governments of Bulgaria, Rio de Janeiro, and Singapore, among others.) The software, which draws on many of the same sources as Citigraf, is available to all 36,000 officers on the force.

The NYPD official showed me how he could pull up any city resident’s rap sheet, lists of their known associates, cases in which they were named as a victim of a crime or as a witness, and, if

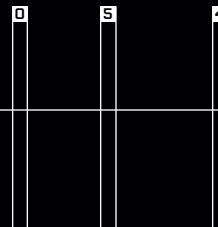
they had a car, a heat map of where they tended to drive and a full history of their parking violations. Then he handed me the phone. Go ahead, he said, search a name.

A flurry of people came to mind: Friends. Lovers. *Enemies*. In the end, I chose the victim of a shooting I’d witnessed in Brooklyn a couple of years earlier. He popped right up, along with what felt like more personal information than I, or even perhaps a curious officer, had any right to know without a court order. Feeling a little dizzy, I gave the phone back.

A couple of months later, I met up with Christian Schnedler, a hulking computer engineer with wraparound Oakleys and a tribal shoulder tattoo that peeked out from one arm of his tight khaki tee. Schnedler had his first encounter with the Domain Awareness System in 2011, as a Genetec employee, and he’d found the experience dizzying too. Far from being spooked, though, he thought the whole concept of fusion was “genius.” The following year he joined IBM, another NYPD contractor, and was posted to Dubai to help drive sales of the company’s “city management” products in the Middle East and North Africa. He set out on the job thoroughly convinced of the technology’s unmitigated potential for good, even in a civilian context. But that soon changed.

One of Schnedler’s first sales meetings was with the Egyptian Ministry of the Interior, not long after the Muslim Brotherhood swept to power in the wake of the Arab Spring. In Schnedler’s retelling, ministry officials said that they wanted software to pick out the networks of “terrorists,” “protesters,” and “agitators” threatening the country’s newfound peace.

Schnedler knew that this was technically feasible. But he also imagined that “protesters, terrorists, and agitators” in this context probably also referred to various political and religious minority groups,



including Egypt's long marginalized Coptic community. A devout Christian, Schnedler realized that the same technology that had so thoroughly persuaded him in New York could be turned into a sharp instrument of algorithmic authoritarianism, just as useful for rounding up networks of congregants as it was for mapping criminal organizations. He was relieved when the Egyptian government ultimately failed to follow through with a formal solicitation.

The following year, Schnedler was invited to Turkey, where police at Ankara's central surveillance center proudly showed him a system that seemed directly inspired by New York's. In a back room, a chain-smoking senior officer asked Schnedler whether he could build software that would identify masked protesters by correlating the tattoos on their forearms—which they'd often expose momentarily when throwing rocks—with a database of such markings that his government had been assembling. Again, Schnedler knew that this was technically feasible. Again, he worried about how it might be used against Turkey's Christian population. (The officer didn't follow up in the remaining time that Schnedler was at IBM.)

The final straw for Schnedler came in the spring of 2015, when he was invited back to Cairo. A new government greeted him this time—the Muslim Brotherhood had been ousted in 2013—and a new set of Interior Ministry officials wanted to stamp out threats to the country's security. Threats, Schnedler noted with a tinge of amusement, that would now also include members of the very party that had tried to enlist his services before. (To his knowledge, no deal materialized.) He returned to the United States that fall having learned an important lesson: "To the extent that you do not trust your government, you do not want your government to build these systems."

Such encounters are common in the fusion industry. Genetec's Gaccione says he often has to tell prospective customers, "That's not what we do." Particularly with the computing power and analytics tools readily available through the cloud, fusion could enable "a lot of crazy stuff," he said. One government, which he refused to name, issued a solicitation for a tool that would mesh facial recognition cameras and

mobile phone networks to track citizens wherever they went. "I didn't get through like eight pages before we threw it out," he said.

In the US there are no specific national rules governing fusion technology. Absent a legal challenge to test its constitutional integrity, there's little to say that you can't blend data sets together, even if doing so might generate information that investigators would otherwise have needed a court order to obtain. In the absence of stricter regulations, Genetec has developed a series of safeguards for its software. One feature, which is optional, automatically blurs all faces in CCTV footage. And if an analyst wants to see where a vehicle has been, he needs to enter a case number to activate the search; that way, he can't snoop on his girlfriend.

But the uncomfortable truth is that fusion's more dystopian incarnations are already out in the world. Dahlia Peterson, a research analyst at Georgetown's Center for Security and Emerging Technology, told me that fusion architectures are central to the Chinese government's campaign against dissidents and minority citizens, particularly the Uighur Muslim group. One such system, the Integrated Joint Operations Platform, fuses together facial recognition scans from CCTV cameras; financial, medical, and criminal records; hardware identifiers from smartphones and computers; even mandatory questionnaires that ask residents, among other things, how many times they pray each day. According to reporting by *The New York Times*, a cloud computing center in Xinjiang, powered in part by chips from Nvidia, can comb through hundreds of millions of photos and reports from the area's many checkpoints while applying real-time analytics to up to 1,000 CCTV cameras simultaneously. Authorities use the life histories generated by these systems to determine who is "trustworthy." Those who aren't often risk being sent to prison or a reeducation camp.

In modern life, we're rarely *not* in the crosshairs of some spying device or other. We rush by a license plate reader on our way to work, a few blocks from a burglary that's being patterned. As we walk from the parking lot to the gym, or the mosque, we're picked up on a dozen CCTVs. We attend a protest under the watchful eye of a drone. Our smartphones log our every move, our every click, and our every like. But no single one of these machines, when used in isolation, is omniscient. The fact that intelligence can be difficult and tedious to correlate was perhaps the last natural rampart standing between us and total surveillance. The little privacy we have left exists in the spaces between data points.

Fusion technology eviscerates those spaces. With the click of an Investigate button, our digital footprints, once scattered, become a single uninterrupted life history, leaving not only our enemies, but also our friends and our lovers, with nowhere to hide. ■

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HOW TO
REMEMBER
A DISASTER
WITHOUT
BEING

SHATTERED

BY IT

BY *Erika Hayasaki*



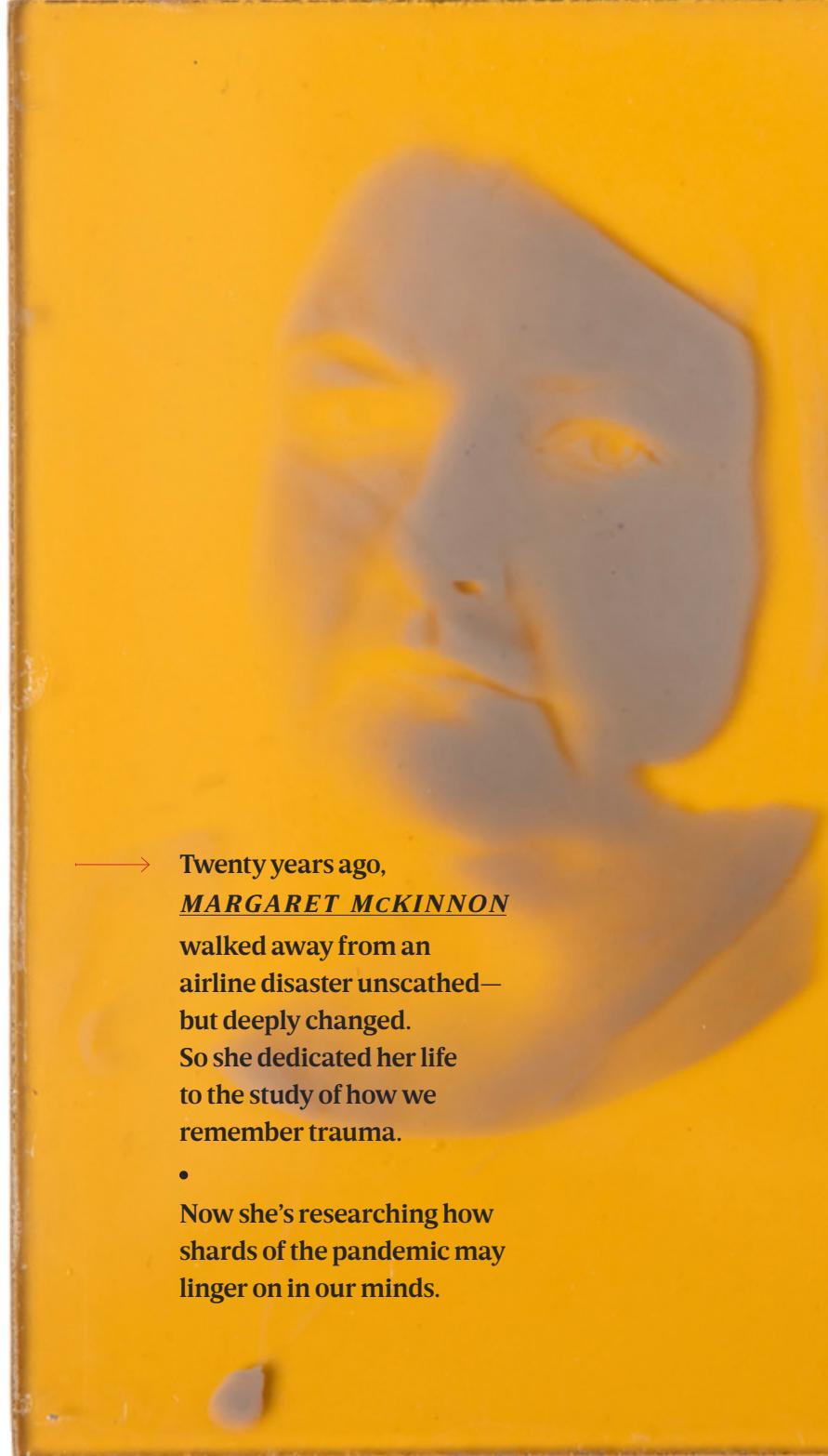
PHOTOGRAPHS BY *Driely S. Carter*



→ Twenty years ago,
MARGARET MCKINNON
walked away from an
airline disaster unscathed—
but deeply changed.
So she dedicated her life
to the study of how we
remember trauma.

•

Now she's researching how
shards of the pandemic may
linger on in our minds.





INSIDE THE NARROW'

AIRPLANE BATHROOM AT 39,000 FEET, MARGARET McKinnon tried to turn on the faucet, but she couldn't get any water to come out. It was just past 5:45 am, Greenwich Mean Time, on August 24, 2001, and McKinnon was somewhere high above the mid-Atlantic.

Her husband of less than one week, John Baljkas, was asleep where she had left him in a center block of coach seats. The Toronto newlyweds were on their way to a honeymoon in Portugal. With a little less than two hours to go, McKinnon was hoping to get back and nap a bit before landing, but no matter how much she fiddled with the sink she couldn't get it to work. She had no idea that the bathroom's plumbing relied on air pressure generated by the plane's jet engines, and that a faulty tap can be a sign of a much deeper failure. So she thought little of it and gave up.

As McKinnon made her way down the dark aisle to her spot next to Baljkas, she noticed that passengers were beginning to stir. The retractable television monitors above the aisles had just finished playing the movie *Chocolat* and were a few minutes into an episode of *Seinfeld* when the show suddenly cut off. The cabin lights flickered. →

She sat down next to Baljkas, who had just woken up. A voice came over the speaker, first in Portuguese: “Atenção passageiros ...” The couple couldn’t understand the message, but they noticed passengers around them becoming alarmed and crying out. Then came English: “The pilot is experiencing difficulties.”

McKinnon and Baljkas heard the word “ditch,” but its meaning didn’t instantly register. The crew fanned out and directed passengers to pull their life jackets from beneath their seats. They told everyone to take off their shoes. They repeated the directions in three languages. A flight attendant began to speak, but broke down in tears before she could finish. Then the meaning of “ditch” came clear: “We’re going to land in the water,” said another flight attendant.

The intercom died. From the middle of the aircraft, McKinnon heard a noise. A click. Like part of the plane had shut off. Then the soft growl of engine noise fell silent, and suddenly they were surrounded by the whistling sound of air against the fuselage. A stillness.

At 6:26 am, McKinnon heard: “The engine has gone out.”

Now the powerless 338,000-pound machine—with nothing left to propel it—was floating swiftly downward from 34,000 feet, like a paper airplane drifting in the wind.

“We’re going to die,” a passenger cried.



MCKINNON HAD GROWN UP LISTENING TO POLICE AND fire scanners. Her father was a deputy fire marshal, and her mother was a nurse. From their living room, McKinnon heard about car crashes, people trapped inside of homes,

or victims escaping from burning buildings, dragging themselves outside for help.

Overhearing these life-or-death intrusions into an otherwise ordinary childhood, she started out thinking she wanted to be a writer, drawn to stories of resilience in the face of trauma. “That was absolutely my dream,” she says. But in college her interests cut a new channel, and she majored in psychology.

By the time she got engaged to Baljkas, McKinnon was a PhD student studying memory and its pathways in the brain at the University of Toronto. Baljkas was a graduate student in graphic design, and they had met through McKinnon’s best friend from high school. He was logical and cool-headed. She was empathetic, probing. “It will be fine,” Baljkas told her as the plane bucked back and forth underneath them.

On board, a couple tried to wrap a life vest around their young child. People near McKinnon and Baljkas were praying, whispering, and weeping, calling out the

name of Our Lady of Fatima in Portuguese. Pleading for their lives. Saying goodbye to daughters and sons. McKinnon, who had long suffered from asthma, struggled to inhale.

From her seat, she felt the aircraft swerve and rock as it glided. Oxygen masks tumbled from above, but some of them didn’t work. “Please just make this end right now, God,” someone aboard prayed. “Make it quick.”

McKinnon remembers thinking in those moments: *You know, my life, it's been a good life. My husband, I love him.* As she grew more distraught and terrified, and the plane descended faster, she surrendered to the inevitable. She thought of a video she’d once seen that

showed a hijacked Ethiopian Airlines flight in 1996. The pilot had attempted to land in the Indian Ocean after running out of fuel. The plane in the grainy footage broke apart immediately upon hitting the water. McKinnon knew the chances of surviving a water crash were slim.

But as McKinnon accepted the end, Baljkas rejected the possibility completely. He believed they would survive, no matter what. He planned how their escape would go: They would crash into the ocean, climb out of an exit, make their way to shore. He knew they were both good swimmers, and he rationalized that they would not get hypothermia in the warmer Atlantic waters.

"We'll need our shoes," he told her as the wide-body Airbus 330 continued to drop.

She gripped his hand.

"We're going to be OK," he told her.

The disaster went on like that for 30 minutes. Earthquake survivors often say that a tremor seems to last an eternity, when its actual duration is a matter of seconds. To believe that you are about to die for half an hour—to jostle inside a metal tube as you imagine yourself careening into the ocean, killed by either the impact

or by drowning—is to endure at least a few eternities.

At some point, the copilot announced that they were going to attempt a landing on an island called Terceira, in the Azores, within the next five to seven minutes. The pilot turned the gliding airliner around in a giant, hideous corkscrew, banking hard and turning everyone sideways, before leveling out and picking up speed. McKinnon's thoughts jumped from imagining what it would feel like to die in a water landing to envisioning a crash on land. She pictured them plowing into a neighborhood of people, killing all of them too.

Outside the windows in the predawn dark, it was hard to see anything, but McKinnon caught a glimpse of the ground—then water again. Until the last second, it was unclear what lay beneath them.

Then, finally, the plane's landing gear slammed into a hard surface. McKinnon's body pitched forward and her ears filled with the sound of scraping and grinding until the plane came to a stop. Passengers began to cheer and applaud, until the crew began rushing them toward the exit slides for fear that the aircraft would explode on the ground. Baljkas figured they would need cash and IDs, so he grabbed their wallets.

After everyone was out, buses arrived and took the shaken, bruised survivors to a small terminal. And somehow, in that moment of relief and horror, McKinnon's scientific curiosities kicked in. How would all these people remember this event? She recalls looking around at her fellow passengers, these walking ghosts. McKinnon saw people still in their life jackets sprawled on the ground. The smell of vomit was everywhere. "Terrible," she would remember. "Brutal." Yet she also thought in that moment about what the world might be able to learn from them. Just hours after the crash landing, she thought: *We should really do a study on this.*

ERIKA HAYASAKI

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LESS THAN THREE WEEKS LATER, MCKINNON AND BALJKAS were back in Canada, sitting down for a set of interviews with the American TV host Chris Hansen, who was preparing a special segment on the miraculous crash landing of Air Transat Flight 236 for the prime-time newsmagazine *Dateline NBC*. The day after their interview, a pair of airliners flew into the World Trade Center in New York City, another crashed into the Pentagon, and a fourth plowed into a field in Pennsylvania.

As the entire world processed the shock of 9/11, McKinnon found herself identifying strongly with the passengers on the hijacked aircraft—with the feeling of “knowing you’re on a doomed plane,” as she describes it, “and that the end is near.” She had nightmares about the Air Transat plane hitting the Twin Towers. But for Baljkas, the terrorist attack felt completely disconnected from his own near-death experience. Their divergence left McKinnon wondering how the rest of their fellow survivors experienced the attacks.

NBC finally aired its segment on Air Transat Flight 236, called “A Wing and a Prayer,” on April 2, 2002. The show dramatically reconstructed the plane’s descent from the passengers’ point of view, minute by excruciating minute; it also added in certain God’s-eye-view contextual details that had only become clear in the days, weeks, and months after the emergency landing: How, four days before the flight, Air Transat mechanics had accidentally installed mismatched parts during an engine replacement; how those parts had rubbed and chafed against a fuel line, causing a large leak to open up inside the plane’s

tank a few hours into the flight; how the lack of fuel had disabled first one engine, then the other; how the captain, a 30-year flying veteran, had set a course for Terceira when the island was still hundreds of miles away; how there were a total of 293 passengers and 13 crew members aboard the plane; how the radio operators down on the island didn’t really expect any of them to survive.

McKinnon and Baljkas watched the *Dateline* special together at home. By then, it was becoming clear how much McKinnon’s life and career had been transformed by her experience over the mid-Atlantic. She was still an ambitious young scientist—she was now serving out a prestigious postdoctoral fellowship at the Rotman Research Institute in Toronto—but she moved through the world on high alert for danger. She suffered from nightmares and anxiety-inducing flashbacks that sent her back into that seat on the plane. She startled easily. It was a little like living with the police and fire scanners of her childhood—only this time the life-or-death intrusions into her consciousness were her own memories, and she couldn’t turn them off or get away from them.

Her research had begun to change course too. Before the crash, she had worked on studies about music and cognition, and then on memory in Alzheimer’s patients. But now she was increasingly drawn to study memory and post-traumatic stress disorder. McKinnon had been trained in a tradition of Canadian neuropsychology that was built on the study of unusual brains—ones changed by injury or surgery or illness—and the particular behaviors and mental states that resulted from them. Now she was curious about her own brain. She wanted to know why she suffered from anxiety-inducing flashbacks while other people who survived the exact same events, including her own husband, did not. Baljkas didn’t have nightmares and did not feel changed or haunted by the event. He was just happy to be alive.

McKinnon never forgot about the idea she’d had that day in the Azores for a study of Flight 236. When she came back to Canada, she discussed the notion with one of her advisers at the Rotman Institute, a neuropsychologist named Brian Levine, who had independently considered the same thought. After all, it wasn’t every day that you could expose a bunch of human test subjects to the experience of impending death

for 30 minutes, under conditions “approaching that of a laboratory experiment,” as the two scientists later wrote. A study of such a near-fatal incident, both scientists realized, would be unprecedented. They agreed to work on it together. But McKinnon would not only be one of the study’s authors; she would also help hone their methodology as a test subject in a pilot study.

It took them years to track down enough passengers willing to participate in a study. Ultimately, 19 came forward. Half of them, like McKinnon, lived with the symptoms of post-traumatic stress disorder. The other half, like Baljkas, did not. The research would involve two major components: a set of brain scans and a set of structured interviews with the survivors that Levine and McKinnon would analyze.

Psychologists have long distinguished between two kinds of long-term, autobiographical memory, which are each stored in different parts of the human brain. There are episodic memories, which are linked to a subject’s first-person, emotional, embodied point of view (like McKinnon’s memory of struggling to breathe in her seat during the descent of Flight 236), and then there are non-episodic memories, which are more factual and detached from one’s subjective experience (like McKinnon’s knowledge of the flight number). The scientists wanted to see how many memories of each kind the survivors retained, and to check those memories for accuracy. And in the brain scans, they wanted to see how the survivors responded neurologically to a vivid video re-creation of the accident—which came courtesy of the NBC News archive.

And so it was that, in 2004, as a guinea pig in her own research, McKinnon found herself lying face-up inside a magnetic resonance imaging machine, staring up at a mirror reflecting a projection of B-roll from *Dateline NBC*: A plane taking off from a runway. A map of the flight route. Clips from *Chocolate* interspersed between plane animations. McKinnon’s own younger face flashed before her eyes too—her barely-there makeup, blue eyes, and bob haircut.

For McKinnon, viewing the *Dateline* footage felt like being flung back in time. “Boom, my body is right over the top of the island again,” she recalls. It was as if she were trapped inside her episodic memories: inside of the aircraft again, trying to breathe, utterly possessed by the awareness of impending death. It was not just a memory but an all-encompassing physical sensation. Waves of confusion and fear.

McKinnon hadn’t realized how emotionally taxing her participation in the pilot study would be. And it wasn’t just the exposure to the *Dateline* episode that was grueling. So was reading through the interviews with other survivors—some of whose memories she would eventually

This period of MASS DEATH, McKinnon knows, will reside with us long after the pandemic ends.

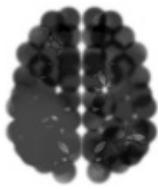
stitch into her own timeline. The other research participants would recall details that McKinnon hadn't: The smell of something burning. Darkness. The flight attendant's shaky voice. The pilot shouting: "When I say 'Brace! Brace!' lean forward and put your hands behind your head."

Some remembered the pilot counting down minutes to impact. Others spoke about the silence and the wind. They recalled the airplane making violent turns. A loud swoosh coming from inside the plane, followed by cries for help. Some participants recalled the pilot saying, "About to go into the water." Then the feeling of coming down too fast. Screams. They remembered the pilot suddenly shouting, "We have a runway! We have a runway!"

Published in the journal *Clinical Psychological Science* as two studies in 2014 and 2015, the research on Flight 236 found, not surprisingly, that the emotional memory centers of survivors' brains—the amygdala, hippocampus, and midline frontal and posterior regions—showed increased blood flow when the passengers were exposed to video footage of the crash landing. Many of the passengers' brains also exhibited remarkably similar heightened activity when the scientists showed them news footage of 9/11. Control subjects showed far more neutral responses to both disasters. For survivors, it was as if the trauma of Flight 236 had bled outside memories of the event itself.

But probably the most surprising finding was that all the passengers of Flight 236—those who'd developed PTSD and those who hadn't—exhibited what the psychologists called "robust mnemonic enhancement." Both groups remembered the incident in unusually rich, episodic, first-person detail. PTSD has long been connected to harboring vivid memories. But apparently, the study found, just because an individual retains lucid traumatic memories does not mean those memories will exert an intrusive hold on them.

To McKinnon and her colleagues, this indicated that PTSD is not necessarily driven by the storage of such an emotional memory. There was something else about the people holding those memories that made them susceptible to being haunted by them.



BY THE TIME THOSE FINDINGS BECAME PUBLIC, MCKINNON was well established in her career as a researcher of traumatic memory. And in her research, she now often joined forces with a neuroscientist and psychiatry professor named Ruth Lanius, a powerhouse who had published more than 150 papers and chapters on traumatic stress. The two women were drawn to each other, in part because they shared an interest in the untold varieties of ways people respond to traumatic events.

While McKinnon was gearing up for her study on Flight 236, for instance, Lanius had published a study about a married couple who had been traumatized in starkly different ways by the same incident. They had been driving along a highway when their car became involved in a violent 100-vehicle pileup; trapped inside their own car, they could hear a child begging for help in a burning vehicle nearby. They listened, helpless, as the child's screams came to an end. In interviews with Lanius' team, the husband recalled feeling intensely anxious throughout the ordeal, frantically trying to free them from the car. But his wife described being "in shock, frozen, and numb." She was incapable of moving, much less figuring out how to escape.

For her study, Lanius put the couple through an fMRI machine as they listened to scripted audio narrations of their accident experiences—much the way McKinnon's subjects reexperienced the crash of Flight 236 via *Dateline* footage. The couple's neurological and physiological responses in the machine mirrored those they described experiencing during the actual event. The husband's heart rate increased. His blood oxygen levels rose

in specific regions of his brain. In contrast, the wife's heart rate remained at a baseline, and she exhibited a "shutdown response" in specific brain regions.

The couple both showed symptoms of post-traumatic stress, but the wife's symptoms seemed unusual. Follow-up studies by Lanius and colleagues found that, in fact, 30 percent of individuals with PTSD experience such a "numbing effect." For one trauma victim, a memory might bring all of the bodily senses and fear online, like receiving an electrifying jolt; the person becomes "hyper-aroused." For another it might switch the senses off, deadening them to the world. Neither response is a healthy way to live—and indeed, Lanius' research was instrumental in the addition of a "dissociative" form of PTSD to psychiatry's diagnostic bible, the *Diagnostic and Statistical Manual*.

Today, McKinnon and Lanius are part of an emerging school of researchers and clinicians who believe that the field of trauma therapy needs an overhaul. PTSD, they say, is too often used as a blanket diagnosis for people suffering from complex and varied kinds of trauma, and the remedies that the field offers are likewise far too broad-brushed. For years, the predominant treatments for post-traumatic stress have essentially been forms of talk therapy: There's exposure therapy, a course of treatment in which patients revisit fearful memories and situations in hopes of becoming desensitized; and there's cognitive behavioral therapy, a "solution-oriented" dialog meant to identify and root out unhelpful beliefs about one's trauma.

But in the minds of many researchers like McKinnon and Lanius, the stark variations in people's response to trauma don't primarily point to faulty beliefs on the part of the victims; they point to real differences in their brains, bodies, backgrounds, and environments. The job of trauma researchers, in turn, is to home in on an understanding of those differences and come up with therapies informed by them.

The two women, along with others in their field, have helped bolster the case for some treatments that go beyond talking through tough memories. One of them is called Eye Movement Desensitization and Reprocessing, or EMDR. In a session, the patient is asked to hold a traumatic memory in their mind while a therapist prompts them to rhythmically swing their gaze back and forth from side to side. It sounds bizarre, but the approach has gained increasing acceptance in the medical mainstream for its efficacy. Scientists don't know precisely why it works—some argue that the technique mimics how the brain integrates and processes memories during REM sleep—but the effect is often that a patient can shift from reliving a traumatic memory in first-person terror to simply remembering it.

Another approach is a more controversial technique called neurofeedback, which involves strapping patients into an electroencephalogram cap, putting them in front of a screen that is reflecting their own brain waves, and then asking them to figure out how to change those waves a certain way, sometimes through a video game interface. Lanius has performed studies of neurofeedback as a way of treating PTSD.

McKinnon, who is now an associate professor of psychiatry at McMaster University and a senior professor at the Homewood Research Institute in Ontario, has researched some of these alternative therapies; she has also tried some, like EMDR, herself. The stakes of her work are still personal. Propelled by a sense of kinship with other survivors of trauma, McKinnon's research career has taken her into the minds and memories of soldiers, paramedics, veterans, police officers, and rape victims, as well as accident survivors. And in recent months, she has been paying particularly close attention to a new and growing group of people struggling with trauma: In April, the Canadian Institutes of Health Research gave McKinnon and Lanius \$1 million to study frontline health care workers in the nation's Covid wards.



YOU MIGHT SAY WE'VE EXPERIENCED A COLLECTIVE period of trauma in the age of Covid-19. The pandemic has stolen away loved ones, cut off social contact, forced people to lose their jobs, heightened the fear of death, and left many of us feeling lonely, helpless, or in a state of grief. And there are stark variations in how we have reacted to this shared trauma. Some of us are prone to ride out this reality with quiet acceptance, despite feelings of anger, sad-

ness, and frustration. Others are driven into states of severe depression or anxiety and ongoing fear of the unknown, exacerbated by that loss of control. Some live in denial.

Even within families and households, people can react entirely differently. One partner in a marriage might live in day-to-day fear of contagious droplets or mysterious coughs, panicking over the loss of control. Their partner might take an approach far more accepting of fate, problem-solving with a measure of patience or a calmer submission to the threat of the virus.

These drastic differences in coping with stress, anxiety, and trauma appear to have both biological and environmental bases. For most people, a sudden car accident, an imminent plane crash, a life-threatening attack, or a brush with someone who might be infected with a novel virus can kick up the fight-or-flight response, releasing hormones like cortisol and epinephrine that propel energy to muscles. Neurotransmitters like norepinephrine, adrenaline, and dopamine filter into the amygdala, stimulating the brain to tell the heart and lungs to beat and breathe faster. Emotions and acuity go on high alert.

For the majority of people who are *not* susceptible to PTSD, those symptoms may arise but then subside after several months, especially if the person receives immediate therapeutic treatment. But for someone prone to the disorder, a traumatic event can cause those same stress hormones to go into overdrive. The brain might get stuck in a constant state of fight-or-flight—the kind of chronic

stress that impedes the development of stem cells, brain connections, and neurons, and makes someone more vulnerable to chronic health problems like heart disease, stroke, diabetes, and cancer.

One day in May, over Zoom, a doctor named Will Harper from a Covid-19 unit at McMaster University Medical Center told McKinnon about a harrowing scene from one of his shifts: His patient, suffering from both dementia and coronavirus, had ripped out her IVs and yanked off her oxygen mask. She would not eat or drink. She pushed away medicine and thrashed. "We all knew she was dying of Covid, and there was nothing that could be done," explained Harper. But he looked over at a nurse on the shift with him—normally a cool-headed health care worker—and saw that she was visibly shaken and distraught.

As the situation deteriorated, the nurse went into her own emotional tailspin; she sat on the patient's bed and began tugging at her own protective gear in agitation. Now the nurse's safety

glove was off, her wrist exposed. Now she was lurching toward the door, trying to run away. Distraught, she was not thinking about stopping to properly sanitize or remove her gown, mask, goggles, or gloves. Like the patient, it seemed the nurse only wanted to be anywhere but there. It was “like a scuba diver trying to get to the surface too quickly,” Harper said.

He knew she might harm herself, that she was putting herself at risk of contracting Covid-19. He pulled his coworker aside. “Breathe,” Harper said, trying to get her to snap back into the moment. “Breathe.” For Harper, the memory was upsetting; but for the nurse, the event seemed to have been traumatizing.

This period of mass death, McKinnon knows, will reside within us long after the pandemic ends. And it’s not clear who will keep carrying fearful memories of it around for years—who will be like Baljka walking away from Flight 236, and who will be like McKinnon.

It is still largely a mystery what makes someone susceptible to PTSD. “We know what some of the risk factors are,” McKinnon says. “But we don’t really have a precise way of predicting whether or not they will go on to develop PTSD.” Individuals with a history of trauma may be more vulnerable, she added, along with those of us who belong to a group that has been marginalized by society—people who’ve been bullied, taunted, subjected to discrimination, or raised in an environment of toxic stress. McKinnon says she had a history of depression before she boarded Flight 236; scientists believe that depression can also be a risk factor for PTSD.

But she and Lanius hope that, by studying frontline workers like Harper and the nurse on his shift, they might one day be able to help those who emerge with PTSD improve their symptoms and everyday functioning. In therapy sessions, the patients learn skills to regulate their emotions and become more aware of sensations within their bodies. Are they hyper-aroused or emotionally offline? Do they relive memories or shut down in the face of them? Patients are given methods to tolerate their own distress and strengthen their sense of self.

Of a few things, Lanius and McKinnon are confident: Treating trauma, they believe, is not merely about examining or erasing a bad memory. Instead, the key is to recognize that there are memories that you recount at a distance—in third person—almost as if telling a story about someone else. And then there are the visceral, episodic ones, like the ones McKinnon formed on Flight 236, which send her traveling back in time, reexperiencing scenes as if her body were stuck inside the past.

The duo have devised techniques to help trauma survivors work toward a goal of moving away from reexperiencing a disturbing memory in first person. With awareness, practice, therapy, and sometimes interventions like EMDR and neurofeedback, patients focus on what they can control—in the hope that they can eventually hover outside of the memory instead, confidently and fearlessly, like an omniscient narrator.

“I can just tell the story,” McKinnon said recently, of her experience aboard Flight 236. She is now able to go over the details without feeling the pang of each one inside her body, the heart palpitations, the overwhelming feeling of impending doom. The PTSD from that day has dampened. The nightmares come less often. She can offer the sequence of events and recount her thoughts from back then, as if reading a script.

“I’m just listing out the facts,” McKinnon explained. “I have the cognitive control to do that now.”

After years of therapy and two decades of her own research into the nature of trauma, she has the measure of mental and physical mastery that she hopes her patients can achieve. She can recall the day of the crash, how the smell of jet fuel filled the air—and the moment, just after the pilot’s miraculous landing, when everyone realized the plane might explode. The landing gear was on fire. Passengers slid down escape slides and ran for their lives. McKinnon’s dress flew up as she slid. She gripped her asthma inhaler, puffing. They stumbled through a field of tall, wet grass. It was foggy and cold.

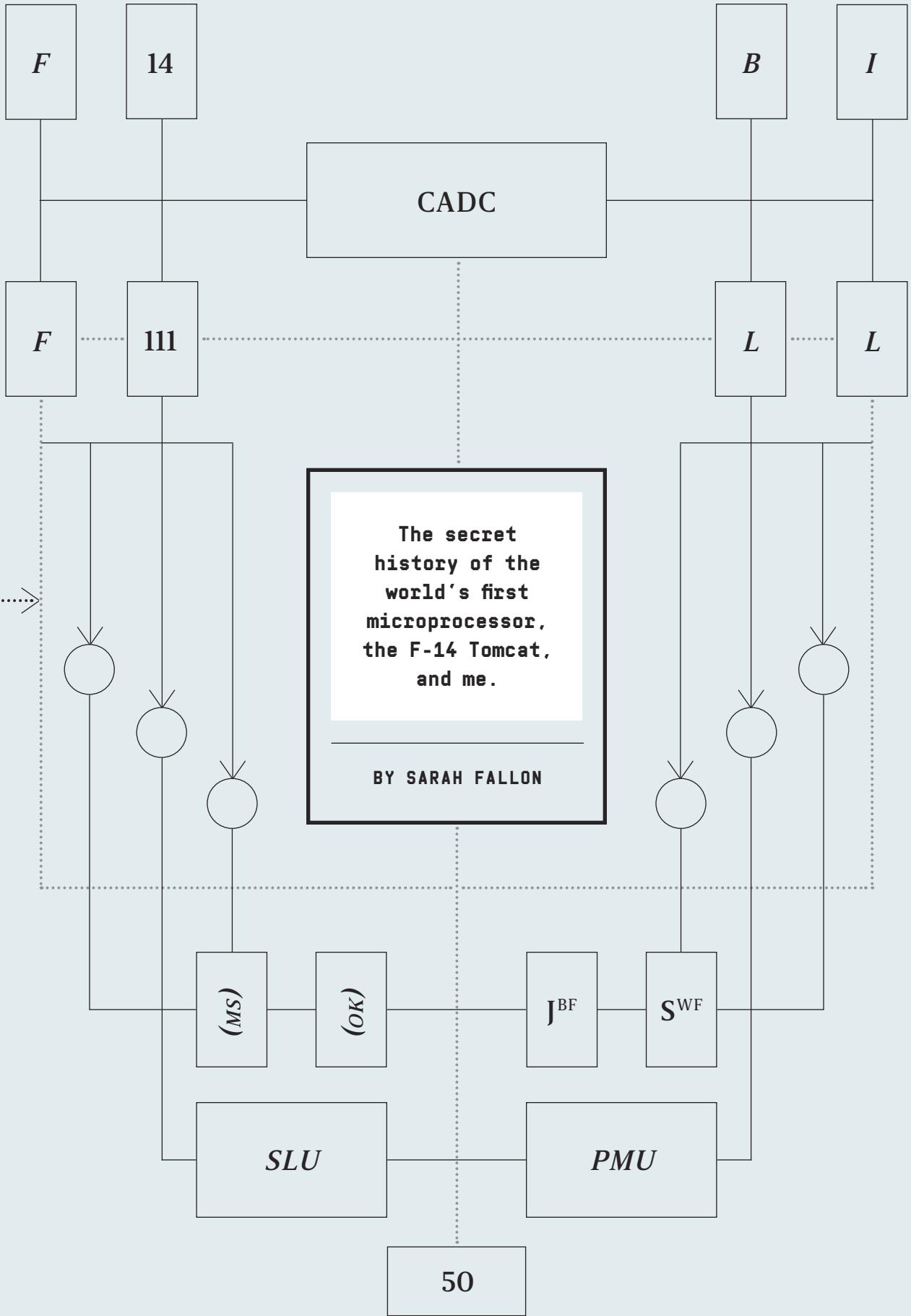
She recounts how passengers spent five hours in the terminal before loading onto a boat headed for another island, to another airport. They would face their own version of exposure therapy in the days after, each survivor boarding yet another plane to get home, and then just three weeks later, watching as terrorists flew airplanes full of passengers into the Twin Towers and the Pentagon.

Yet McKinnon says she is not terrified now. She recalls the events of August and September 2001 as if fulfilling an obligation, in service of a greater good. She has turned these memories over in her mind so many times it’s as if they are suspended outside of herself. They could be the details of someone else’s story, really. Drifting like a paper airplane, elsewhere and away. ▀



FLIGHT

PATHS



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The story of the first microprocessor, one you may have heard, goes something like this: The Intel 4004 was introduced in late 1971, for use in a calculator. It was a combination of four chips, and it could be programmed to do other things too, like run a cash register or a pinball game. Flexible and inexpensive, the 4004 propelled an entire industry forward; it was the conceptual forefather of the machines upon which you might easily read this very article.

That's the canonical sketch. But objects, events, people—they have alternate histories. Their stories can often be told a different way, from a different perspective, or a *what could have been*.

This is the story, then, of how *another* first microprocessor, a secret one, came to be—and of my own entwinement with it. The device was designed by a team at a company called Garrett AiResearch on a subcontract for Grumman, the aircraft manufacturer. It was larger, it was a combination of six chips, and it performed crucial functions for the F-14 Tomcat fighter jet, which celebrated the 50th anniversary of its first flight in December. It was called the Central Air Data Computer, and it calculated things like altitude and Mach number; it figured out the angle of attack, key to landing and missile targeting; and it controlled the wing sweep, allowing the craft to be both maneuverable when the wings were at about 50 degrees and very, very fast when they were swept all the way back.

Ray Holt was one of the engineers for the Central Air Data Computer. He is probably not someone you've heard of—how could you have? He worked on the

PHOTOGRAPHS BY WILLIAM WIDMER

project, one of two people doing what's called the logic design, for two years, between 1968 and 1970, with a team that included his younger brother, Bill. He couldn't tell anyone about what they had built, and the project was kept quiet by the Navy and by Garrett for decades as other engineers were awarded credit for inventing firsts. Later, when he was able to talk about the device, people were skeptical. Maybe they were uncomfortable with history being revised.

I wanted to know more about him. Ray has always been in the margins of my life, ghosting around the edges of my consciousness. I remember visiting his parents' house in Compton, California, when I was very young. His family came to our place once, and I have a memory of chasing one of his three sons up the stairs. One time, in my mid-twenties, I unknowingly sat next to him in the audience at a health food talk my mother was giving. She was surprised to see us sitting together when she came out afterward to say hello.

Ray Holt is 76 years old now. He lives in rural Mississippi, where he teaches high school STEM classes and runs a robotics nonprofit. Me, I live in the San Francisco Bay Area with my husband, a software engineer, and two sons; I've been an editor at WIRED for more than a decade. Ray and I reconnected over the summer, and after he told me his story, I wanted to learn more about the Central Air Data Computer and its place in history—and how his life might have branched around mine.

His career as an engineer almost didn't happen. Growing up in Compton, Ray made extra cash fixing bicycles and old tube radios; in high school he was class president and a great baseball player, but he was also a B student who had difficulty reading. His teachers sometimes discounted him. One once said to him, "I wish you were as good a student as Bill." Everybody loved Bill. Math genius, they said. When Ray took an aptitude test during his senior year, he was told that he had low mechanical ability. He was told, "Don't go into engineering."

He made his way to the University of Idaho; Bill was off to Stanford on a baseball scholarship. Ray was struggling until he took a course called Physics of Electricity. He aced it. He got an A in calculus, made the dean's list, and ultimately graduated with a degree in electronic engineering from Cal Poly Pomona, getting job offers from Bendix, Westinghouse, and Garrett AiResearch. Turns out, Bill was interviewing at Garrett too, for a job as a computer programmer. They both decided to work for Garrett, but maybe for Bill the decision was a little more layered: At the time, he was dating a young

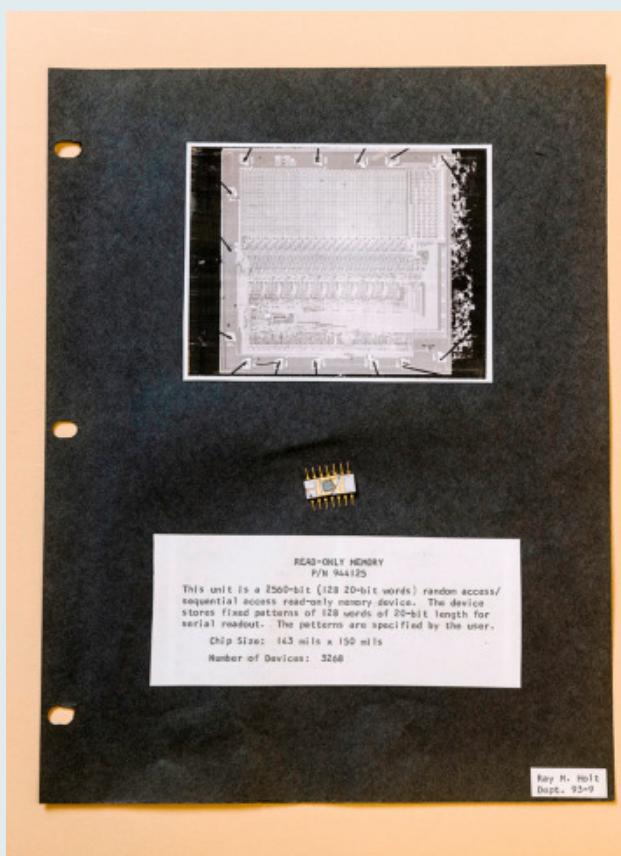


[1]

TODAY RAY TEACHES
ENGINEERING CLASSES AT
THE WILKINSON COUNTY
CHRISTIAN ACADEMY IN
MISSISSIPPI.

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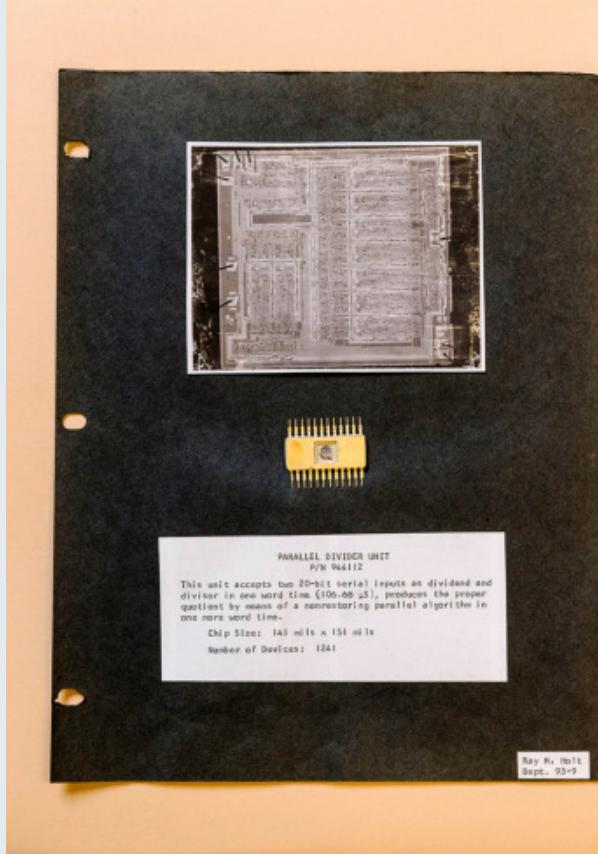




[2]

RAY KEPT SAMPLES OF
THE CHIPS AFTER THEY
WERE MANUFACTURED
AND COLLECTED THEM
INTO AN ALBUM.

[2]



woman he had met at Stanford named Sally Wetzel, who happened to be the daughter of the president of Garrett AiResearch. Later, she would be Sally Fallon—my mother.

The story of my mom and Bill is an alternate history, one lightly sketched in the mind and emotionally charged, a little trickle of current.

Bill met Sally when she went to a party for incoming freshmen. “We were together from the first day I was at college. We were an item,” Sally says. In addition to being smart, extremely athletic, good looking, and kind, “Bill was musical. He played the clarinet and had a beautiful voice. It was so much fun to harmonize with him in church.”

When I was young, I’d find Bill’s signature and inscriptions in books I idly plucked from shelves on bored afternoons. He had lovely cursive handwriting. Squirreled away in my possession is a book of e.e. cummings poetry that he gave Sally. This is the inscription:

To Sally on Christmas, 1967

Whatever distance lies between us (but cannot blind our eyes to the happiness we owe), howmuchever time separates us (but does not calm the fire of two minds and two hearts bound in one soul); we will always be “wonderful one times one”...

*I love you,
Bill*

A shadow relationship. A reminder, perhaps, that my mother existed before I did, had her own noncanonical life that stretched back beyond the one that had instantiated me.

I had always kind of known about Bill, and I had always been curious about him. He was so *handsome*. Poetic, too. When I got older, I’d sometimes Google around to see what else I could find out about him. I knew he had worked at Garrett, and I once found a list of people who worked on something to do with the F-14. His name was on it. A Ray Holt was on the list too—must be some other Holt, I thought. *Weird, though, right?* I said to my husband. Who could that be? I didn’t make the connection with the man who once visited my parents’ house, or the one sitting next to me at the conference. I could have asked Sally, of course, but I never did.

My husband did some Googling of his own—more directed, efficient, unromantic, logical Googling—and found that Ray Holt had a website. That led my husband to a slim autobiography Ray had self-published called *The Accidental Engineer*. He gave it to Sally, who was flabbergasted. She emailed Ray, and we all set up a Zoom call. She had known Bill had worked on some computations related to fighter planes, but she never knew Ray had been involved.

The F-14 Tomcat is arguably the star of *Top Gun*, and it doesn’t even chew gum or take its shirt off.

And what a plane to have been involved with. It is my personal truth that the F-14 is the most radical, hella gnarliest airplane in history. I was 13 when I first saw *Top Gun* in the theater; I had the soundtrack on cassette tape. Maybe the opening scene is etched into your neural network too, the ‘80s synth chords rising portentously as the Tomcats whine their way into position on the flight deck. Then the afterburners blast to life in the dawn’s early light, and the thing punches into the atmosphere. It is arguably the star of the movie, and it doesn’t even chew gum or take its shirt off. As Dave Baranek, a former Naval Flight Officer and Topgun instructor, who operated the radar from the back seat of F-14s starting in the early 1980s, puts it, “We felt like rocket men flying this thing.” The back seat is what made the F-14 an especially good vehicle for a movie: Maverick has a Goose, and you can have a friendship and a death and an emotional arc.

One of the things that made the plane so revolutionary was its wing sweep abilities. The Navy had wanted a plane that could go faster than Mach 2 but still be an agile dogfighter, easy (ish) to land on an aircraft carrier, and able, also, to fly relatively slowly so it could growl around the ocean on patrol. A wing that changes position enables this. Check out the scene in *Top Gun* where Maverick turns to head home after a dogfight. His wings are out and he’s kind of floating slow in the

air. Then the wings sweep back and he zooms to the aircraft carrier. When it's time to land on that harrowingly short runway, the wings swing out for a lower landing speed that gives the pilots a fraction more time to react. (I am an unabashed apologist for the Blue Angels' F-18 Hornets that buzz the San Francisco office every year before Fleet Week. Next-generation ultra-octane fighter jet, yes, but still.)

The F-14 wasn't the first plane to have wings that changed position. The long-snouted F-111, which started flying in the late '60s, allowed the pilot to shift its wings mid-flight, grasping a lever on his left-hand side and sloooowly sliding it back. The F-14 wings adjusted themselves automatically—largely thanks to the Central Air Data Computer designed by the Garrett AiResearch team of two dozen engineers, including Bill and Ray.

On Ray's first day of work at Garrett, in Torrance, California, the personnel manager walked him over to a box and took off its lid. Inside was what looked like a big heavy transmission. "It was quite pretty, gears and cams and gold and silver or chrome," Ray says. He was looking at a mechanical flight computer for an F-4 Phantom. You are the only person in your department to have taken a computer design class, the man said. Your job is to turn this into a 100 percent electronic computer for a new airplane.

It's fall 2020, and Ray is sitting in a workshop explaining to me how you design a microprocessor. Black metal-frame shelves to his right are filled with bins and boxes; wrenches dangle like piano keys from a wooden workbench behind him. Genial, kind, encouraging, supersmart, in wire-rimmed glasses, Ray often wears one of several Ole Miss baseball caps, but not today. He's at Wilkinson County Christian Academy, where he teaches subjects like computer science, electronics, and drafting. An array of orange tubs at the back of the room holds resistors, capacitors, wire, and other tinkerer's bits and pieces. "We are trying to find out what the kids are really interested in," he says. "Some like to build, some like to program, some like electricity."

He glances down from the Zoom screen and then holds up a sketch of what looks like a sideways family tree of ovals and lines connecting and branching out. Each of these logic gates represents a mathematical operation inside the computer, which takes information about air speed and temperature and altitude gathered by probes on the nose and belly of the plane, feeds it to quartz analog sensors inside the Central Air Data Computer box, and turns it into digital information.

Ray walks me through how he and the team developed the system. One guy would work out the math, another would do the big-picture system design. Ray focused on the detailed implementation, sketching it out on paper. They built a physical prototype that put all the

circuits in place. Bill programmed the Fortran simulator that helped check the team's work. Along the way, the manufacturer, a company called AMI, would assess the prototype. "They would say, well, we think the design will work, but the chips won't work because they're too big, or they're going to get too hot," he explains to me. "They're not going to be reliable. So you're gonna have to change this part." And the guys would go back and change the paper design and the prototyping. Bill would run the simulation again, and they'd iterate until AMI said they'd be able to manufacture it.

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he Central Air Data Computer allowed co-processing, which means you could shove math calculations off onto other chips. It ran, Ray told me, what is called pipeline execution of instructions—the next instruction could be started while the previous instruction was being completed. Plus, it could be configured with multiple CPUs, if you wanted, and it was fully self-contained. This all meant it was flexible and expandable, and it was powerful and reliable and there wasn't anything like it in the world at the time.

When they were kids, the boys "fought like brothers": Bill would hide around corners and jump out and scare Ray. Once Ray knocked Bill's teeth out with a broom. But of their time at Garrett, Ray says, "Those were our best years together. We had lots of time to share intellectually—and play flag football."

Ray served as best man when Bill and Sally got married in May 1970. The couple rented a little bungalow on 34th Street in Santa Monica for \$250 a month, and sometimes a Garrett colleague and friend of Bill's, another engineer named John, would stop by. Things were good.

Bill was in the office one Saturday in September, working on a parabolic reflector project with John, when he had a seizure and passed out. John found him on the floor. Bill was diagnosed with a brain tumor the size of a baseball. He died a week later, and the funeral service was held at the church where he and Sally had gotten married. The same people were there; the wedding party acted as pallbearers.

Sally had enrolled in a master's program at UCLA, and her first day of class was the day after Bill died. I cannot imagine the will it took to get in the car and drive there. She parked about a mile away from her classes and had to walk across campus, past the cheerleaders and the football field. "I thought to myself, well, the test is going to be if I can make this walk and hear all these things and smell the grass and not burst into tears," she says.

It took a while, but she made it.

I had known about Bill; I had known he died. But I hadn't known about this day, when Sally had to engineer her own way through awful sadness, until now. It's piercing: Writing a story for WIRED about Ray, this



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WHEN BILL [LEFT] AND SALLY GOT MARRIED IN MAY 1970, RAY SERVED AS BEST MAN.

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RAY SAYS HE LIKES TO FIND OUT "WHAT THE KIDS ARE REALLY INTERESTED IN. SOME LIKE TO BUILD, SOME LIKE TO PROGRAM, SOME LIKE ELECTRICITY."



[4]

low-key not-uncle, somehow revives this gleaming not-father who once stood with Sally in the doorway to a different life that never happened.

She and John got married in 1972, and in 1973 they had me.

When the first F-14 flew in December 1970, *Popular Mechanics* was rhapsodic:

It will be ... a fighter—a dogfighter in the old tradition. It will turn and roll with the best of them, even at supersonic speeds, keep up with most of them straight-and-level, and outshoot any of them with guns, rockets and missiles. It will fly fast and it will fly long. In short, the F-14 is an air-superiority fighter, designed to clear the skies of anything that might threaten the fleet.

And the Central Air Data Computer worked. Three years ago, Ray spoke to a noncommissioned officer who had been in charge of maintenance for the F-14s, and she told him that they never changed out the technology.

It was a terrific breakthrough, to have turned a mechanical thing into an electronic device, especially one that was so rugged and accurate and dependable and could perform at the extreme temperatures and stress levels required by the military. But Garrett then simply turned to the next contract; it made lots of aerospace systems, for lots of customers. NASA even.

Ray wrote a paper called “Architecture of a Microprocessor,” for *Computer Design* magazine, but the Navy and Garrett didn’t want it published. Security reasons. Indeed, one of the hardest things for Ray after Bill died was the fact that the F-14 project was secret. Which meant Bill’s part in it was secret. “I had no opportunity to brag about Bill’s contribution,” Ray says.

My mother stayed in touch with Bill and Ray’s parents over the years. Their father, Mark, would garden with Sally in the months after Bill died. Mark was part Cherokee, and he was very proud of that fact. “He would never say he was from Oklahoma,” Ray says. “He would say, ‘I’m from the Cherokee Nation.’” Before Oklahoma became a state, nation members were offered an allotment of land, typically between 80 and 160 acres, a large portion of which the government took back over the ensuing decades. Mark was part of a class action lawsuit against the government, and when Ray was in high school Mark got a check. A dollar an acre. He tore it up. “He never talked again about Oklahoma.”

Ray designed other microprocessors for other companies; in the early ’70s he and his business partner contracted with Intel to teach other engineers how to use the 4004 and the 8008—that was a little weird. And here’s a cool thing: He also designed a flexible and easy-to-program single-board computer called the Sym. Bart

What Ray is doing now is launching another set of little histories, individual ones, as he nudges hundreds of students down a different path, through a different set of logic gates.

Everett, who ultimately became the technical director for robotics at the Space and Naval Warfare Systems Center Pacific, used it inside two sentry robots he built called Robart I and Robart II. The next generation, Robart III, was “one of the most significant autonomous systems in the world,” he says. Kind of an early precursor to (if you squint your eyes and don’t trace the family tree too assiduously) much more famous and advanced machines, like the Boston Dynamics robots. Ray was a vice president at Honeywell for a while. He did some consulting. And when he retired, he went to Oklahoma to see his family’s land. He spent eight years there, occasionally visiting the houses his family had lived in, and when he found the deed to his family’s original plot, he went there too. It’s some kind of Army training center now, so he couldn’t go on it. He just looked over the fence to see the land that should have been his.

When Ray was about to leave Oklahoma, he got a call from an old friend, Dolphus Weary, a pastor and racial justice advocate. He asked if maybe Ray, who had founded a group called Christian Athletic Association back in 1977, would come down for a little while and help local Christian ministries build websites. (The way Weary tells it, Ray is the one who called him—history is told a number of different ways.)

So Ray moved to Mississippi. He was supposed to be there for a year; that was a decade ago. He got his master’s in education and established Mississippi Robotics,

which runs after-school programs for kids all over the state, holding robot competitions twice a year. He teaches engineering classes. Liz Patin, a teacher who often works with Ray, told me that Ray is most passionate about the underdogs and being sure kids don't get discounted and left behind. "Just finding something that a kid can do well, and promoting it, and making sure that the kid is aware of it. You think you can go conquer the world after you talk to him." She calls the kids "little Ray Holts." I love that.

Was the Central Air Data Computer the first microprocessor? Well, histories are complicated. In 1998, Ray finally got clearance from the Navy to tell people about it, and *The Wall Street Journal* published a piece titled "Yet Another 'Father' of the Microprocessor Wants Recognition From the Chip Industry." The Intel engineers who share the title told the paper that the Central Air Data Computer was bulky, it was expensive, it wasn't a general purpose device. One expert said it was not a microprocessor, because of how the processing was distributed among the chips. Another—Russell Fish—said it was, noting, "The company that had this technology could have become Intel. It could have accelerated the microprocessor industry at the time by five years." But other people also wanted to claim the title of father of the microprocessor; there were some big patent fights, and not everyone even agrees on the exact definition of a microprocessor in the first place.

"The discussion," says Fish, who today runs an IP licensing company called Venray, "is not a technical one, it is a philosophical one." At one point, he wrote that the 4-bit 4004 could "count to 16," while the 20-bit Central Air Data Computer "was evaluating sixth order polynomial expressions rapidly enough to move the control surfaces of a dogfighting swing-wing supersonic fighter." (And anyway, Ray notes that the Intel system actually required a number of external circuits for most applications.) When I spoke to Fish recently, he said he had gone back and read through the documentation. "What Ray Holt did was absolutely brilliant," he says. "Particularly given the timeframe. Ray was generations ahead, algorithmically and computationally."

Official histories have a way of hardening, but notice the very careful language on Intel's website today when it describes the 4004 (emphasis mine): "the first general-purpose programmable processor *on the market*."

The device Ray and the team had invented, this non-commercial, not-on-the-market microprocessor, was a stumped branch on a family tree. It flew a plane that could go fast and slow and fire missiles with unprecedented precision, but no next thing was born from it. A brilliant and beautiful secret butterfly that didn't beget other butterflies.

Except.

What Ray is doing now is launching another set of little histories, individual ones, as he nudges hundreds of

students down a different path, through a different set of logic gates. "As a robotics teacher, it's astronomical, really, what he does," says Skylar DiBenedetto, a former student of his. Ray and Liz helped Skylar discover VR and 3D printing, and now she's a freshman at Ole Miss, the first person in her immediate family to go to college, where she helps run the virtual reality lab.

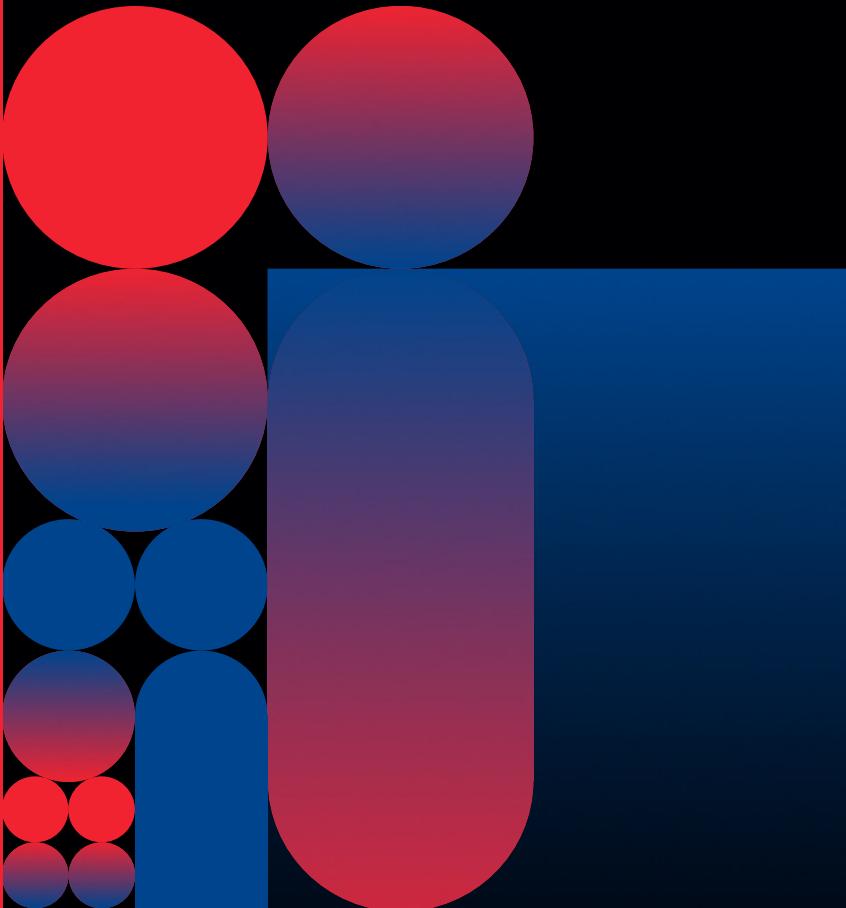
And he's not stopping. In our last conversation, just before Thanksgiving, he describes the after-school program for public school kids he and some other collaborators want to start after the new year. He is wearing a cap commemorating the last flight of the F-14, and a cross is affixed to the doorframe behind him. A friend of a friend has donated a big space, and he and Liz Patin and a few others are going to talk to local leaders and teachers and set it up. Maybe down the line he'll even raise enough money to execute on his idea for a Christian-based STEM high school—the sketches for it look amazing, with classrooms and labs arranged around a central robot-competition area. When I ask Ray if it's a stretch to say that his work to connect with kids is a little bit reminiscent of the way he was able to connect with Bill when they were working on the F-14 project, he says, "Not a stretch at all." Maybe they could have even started a company together. "I think we probably could have made some useful products."

On the weekend before this piece is due to publish, I find myself gazing idly at the bookshelf under the television and my eyes focus on a small volume called *The Portable James Joyce*. It looks old, and I can't remember ever actually opening it, but something scratches at my brain. I pull it out and turn to the front. It's inscribed. *William B. Holt 1/6/65*. I flip to the table of contents. A few stories are underlined lightly in pencil, including "Portrait of the Artist as a Young Man" and "The Dead." A young man, organizing his early days at university, five years before a death he could never have foreseen, reading a short story that ends with a man wondering about a boy his wife used to know, one who died.

Bill's death too seems so unfair, so premature. If he had lived, it would wink Ray and Sally onto different paths, maybe with more recognition, less heartbreak. But then I would vanish, becoming exchanged for another self, on another timeline, a branch of a different tree. Instead I have had the pleasure of getting to know Ray, this curious not-relative. Someone from my ... past? Present? Lineage? Not-family? Families, like histories, tend to prefer clean, stable lines. This circuit starts there and goes to that. This computes, the robot will move, the plane will fly. The potential is fulfilled.

But life is tangled, conditions change: The wing sweeps, the man dies, the innovation is lost to time. So we set a new course, we take a breath, we launch ourselves into the sky. ▀

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AS CHINA'S SCI-FI AUTHORS ARE ELEVATED TO THE STATUS OF NEW AGE PROPHETS, **CHEN QIUFAN'S** CAREER—LIKE HIS GENRE'S PLACE IN SOCIETY—HAS GONE THROUGH THE LOOKING GLASS.

Photographs by YILAN DENG



THE HYPERREAL LIFE

by
YI-LING LIU

WUHEN CHEN QIUFAN TOOK

A TRIP TO THE SOUTHWEST CHINESE PROVINCE

of Yunnan 15 years ago, he noticed that time seemed to slow down as he reached the city of Lijiang. Chen was a recent college graduate with a soul-sucking real estate job in the pressure-cooker metropolis of Shenzhen, and Lijiang was a backpacker's refuge. Wandering through the small city, he was enchanted by the serrated rows of snow-capped mountains on the horizon and the schools of fish swimming through meandering canals. But he was also unnerved by the throngs of city dwellers like himself—burned out, spiritually lost, adrift. He wove his observations together into a short story called "The Fish of Lijiang," about a depressed office worker who travels to a vacation town, only to discover that everything is artificially engineered—from the blue sky to the fish in the streams to the experience of time itself.

Chen has since gone on to pen many more stories, win virtually every sci-fi literary award in China, and establish himself as a leading voice among the country's growing roster of acclaimed writers in the genre. But unlike Liu Cixin, the lionized author of *The Three Body Problem*, who grapples with the faraway grandeur of outer space, Chen is drawn more to

the interior lives of characters struggling to anchor themselves in a moment of accelerated change—much the way nearly anyone in China struggles to anchor themselves today. His work is often described as “science fiction realism.”

At the beginning of his writing process, Chen says, he often tries to act like “an anthropologist conducting fieldwork.” Before writing his debut novel, *The Waste Tide*, a 2013 eco-thriller about a workers’ uprising in a futuristic dump called Silicon Isle, Chen spent time in the southeastern city of Guiyu, one of the world’s largest dumping grounds for electronic waste, observing migrant workers toil in the toxin-laden trash. Once he has a feel for a given landscape in the real world, he transports the scene into what he calls the imagined “hyperreal”—a zone where the fantastical and factual are so blurred it is unclear where one begins and one ends. (In the novel, one of his main characters transforms into a cyborg, having become subsumed into the world of waste.) He wants his writing to provoke a sense of both wonder and estrangement, like a “fun-house mirror, reflecting real light in a way that is more dazzling to the eyes.”

But in the past few years—a period that has seen China’s sci-fi authors elevated to the status of New Age prophets—Chen’s own career has become an object in the fun-house mirror. After *The Waste Tide* garnered widespread attention at home and abroad, reviewers began praising Chen as the “William Gibson of China,” and the tech industry has embraced him as a kind of oracle. An institute run by AI expert and venture capitalist Kai-Fu Lee’s company has even developed an algorithm capable of writing fiction in the author’s voice. (Chen’s recent short story “The State of Trance,” which includes passages generated by the AI, nabbed first prize in a Shanghai literary competition moderated by an artificially intelligent judge, beating an entry written by Nobel Prize in Literature winner Mo Yan.) In China, it is the place of science fiction itself—and the status of writers like Chen—that have taken a turn toward the hyperreal.

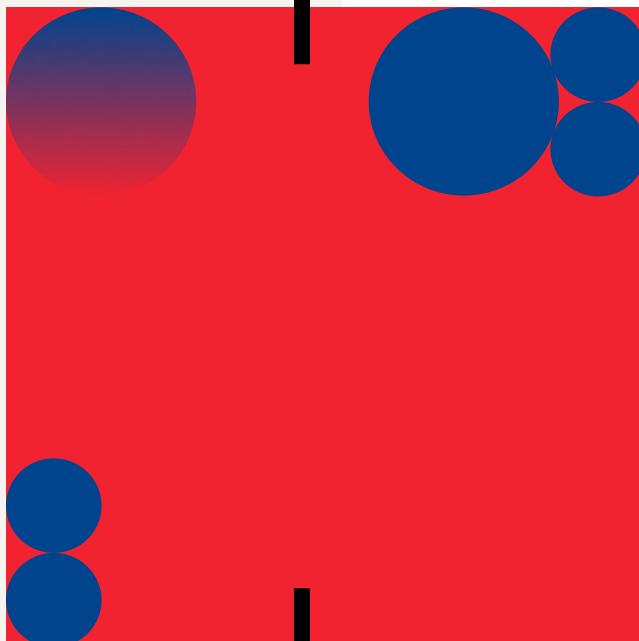
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BORN IN THE '80S, IN THE WAKE OF CHINA'S OPENING UP AND Reform movement, Chen grew up during a moment of exhilarating upheaval: The market economy was introduced, state control over culture loosened, and Western ideas flowed freely into the country—from McDonald’s to rock ‘n’ roll to *Star Wars*. He lived in the city of Shantou, in the culturally diverse, coastal region of Chaoshan, Guangdong, close to the Hong Kong border, with easy access to foreign entertainment. As a teen, he would devour golden-age sci-fi classics by Arthur C. Clarke and Isaac Asimov that his father, an engineer, brought home for him, and he would watch a movie a day, buying bootleg DVDs of *Blade Runner* and *2001: A Space Odyssey*. “I was a young boy who liked to ask, ‘Why?’ and so I turned to science for answers,” Chen says. “But when science couldn’t explain everything, I turned to science fiction.”

But the very reforms that brought intergalactic epics to China also ushered in the myth of capitalism—the belief that “to get rich is glorious.” Along with it came rampant corruption, pollution, and inequality. China transformed from a nation of communes and Mao jackets into a land of Gucci-wearing super-tycoons and migrant workers hustling in Nike sweatshops. While most people were dazzled by the bounty of China’s economic boom, Chen was ambivalent. In his first short story, “The Bait,” which he wrote as a precocious high schooler, aliens arrive on Earth, give humans an invaluable new technology, and eventually enslave them with it.

By the time Chen graduated from Peking University in 2004, China was perched on the edge of another revolution—the internet boom—and the Chinese people had bought into another myth: that technology had the power to change the world for good. After completing a dual degree in Chinese literature and film arts and enduring a brief and dispiriting stint in real estate, he left to work in the tech industry, first in advertising at Baidu, then in marketing at Google, all the while writing science fiction on the side.

In 2008, Chen emailed the Chinese American science fiction writer Ken Liu to express admiration for his work. The two became





A dark, grainy photograph of a ship docked at night. The ship's hull is visible, along with its superstructure and some equipment. The water in the foreground is choppy, reflecting the light from the ship and the surrounding area. The overall atmosphere is moody and atmospheric.

“ONE OF THE MOST IMPORTANT QUALITIES IN
A WRITER IS **SENSITIVITY**—THE ABILITY TO CAPTURE
THE **STRANGENESS** IN EVERYDAY LIFE.”

online friends, and in 2011, Liu offered to translate “The Fish of Lijiang” into English. That small, serendipitous idea would kick-start Liu’s role as the pre-eminent English translator of Chinese sci-fi, and in turn set the stage for the genre’s booming global popularity. (Liu went on to translate not only Liu Cixin’s *The Three Body Problem* but also a diverse range of new voices, from Hao Jingfang to Xia Jia to Ma Boyong.)

Chen, still moonlighting as an author, kept taking jobs in tech into the 2010s. In 2013 he returned to Baidu to work in product marketing and strategy, then joined the marketing team at a virtual-reality startup in Beijing two years later. He was enchanted by the tech world’s wide-eyed idealism and its central belief that a product, if scaled and optimized, could transform the lives of billions. But he also intuited that those ideals were “ultimately hollow at the core,” Chen says. In 2017 he quit his job in VR to write full-time.

By then, though, such a move didn’t exactly qualify as stepping off the treadmill. Indeed, in the past five years, China has become a nation obsessed with its own science fiction. What was once a niche subculture with a small circle of hardcore fans has blossomed into a full-fledged 66 billion yuan (\$10 billion) industry of films, books, video games, and theme parks. In 2015, Liu Cixin had become the first Chinese writer to win a Hugo Award, for *The Three Body Problem*. The next year, Hao Jingfang became the first Chinese woman to win a Hugo, for her novelette *Folding Beijing*. *The Wandering Earth*, a 2019 film adaptation of a story by Liu Cixin, earned more than \$300 million in its first week after release and would become China’s fourth-highest-grossing film ever. Once dismissed as frivolous children’s literature, science fiction now commands the attention of all kinds of enterprises hoping to profit from its popularity: film studios hungry for screenplay fodder, universities setting up sci-fi research institutions, talent agencies eager to jump on the bandwagon, tech companies keen to borrow the genre’s aura of profundity, and even government officials looking to ennable the national project of innovation.

In hindsight, the ascendancy of sci-fi in Chinese literature seems almost inevitable. After all, walking the streets of Beijing today can feel like inhabiting a cyberpunk fiction: Bright yellow shared bikes line the streets, facial recognition cameras hang on street lamps, robot servers deliver hot-pot dinners to your table. Liu Cixin has compared present-day China to the US after World War II, “when science and technology filled the future with wonder.” It’s also a time when science and technology have filled the present with a sense of estrangement, ennui, and anxiety, and a writer like Chen is a natural chronicler of that tension.

But for the people working in the genre, the sudden crush of attention and esteem has been vertiginous. “None of us had the goal of

“WITH SCIENCE FICTION, I CAN PROBE REAL-LIFE ISSUES THROUGH AN IMAGINARY NARRATIVE WITHOUT EXPLICITLY ARGUING WHO IS RIGHT OR WRONG, GOOD OR EVIL.”

taking over the world,” says Emily Jin, a translator and protégé of Ken Liu who has worked closely with Chen. “We’re just a bunch of nerds having fun together.” In China, where rapid technological change keeps transfiguring the world beyond recognition, “one of the most important qualities in a writer is sensitivity—the ability to capture the strangeness in everyday life,” Chen says. And it can be hard to maintain that sensitivity when you’re squinting under the spotlights.



CHEN TURNS 40 THIS YEAR, BUT AT FIRST glance—lithe and graceful, sporting candy-colored Adidas high-tops—he could easily pass as a man in his twenties. He is cerebral, wry, and soft-spoken. Chen lives in Shanghai but came to Beijing for two weeks in October, where I meet him at a café. He switches seamlessly between languages (English and Mandarin), dialects (Teochew and Cantonese), and names (Chen Qiufan and Stanley Chan). He moves with ease between conversation topics, from autonomous terrorism to his trip to Burning Man, and midway through our discussion of Taoist philosophy, he excuses himself to take a quick call from his investment adviser. He also reads voraciously—citing Aldous Huxley, the Chinese novelist Lao She, and a 10,000-word academic paper on asteroid mining.

When I see him next, he's standing on a neon-lit stage in the banquet hall of the Grand Millennium Hotel, a slab of glass and steel in Beijing's central business district, giving a speech titled "Mind Reset and Embracing the Unknown: The Way of Science Fiction" to an audience of suited-up professionals. The *Financial Times* organized the conference, inviting a lineup of modern-day oracles—the CEO of a health care startup, a professor of economics, a machine-learning expert, and Chen—to prognosticate about the near future. To dress up for the occasion, Chen put on a blazer but kept the high-tops.

His visit to Beijing in October was packed with similar engagements. Tencent, the tech monolith behind China's super app WeChat, had invited Chen—again, a literature major—to predict developments in genetic engineering alongside a panel of world-class biophysicists, because he once wrote a story about genetically modified Neo Rats. Kai-Fu Lee summoned him to the glassy offices of his company, Sinovation Ventures, to join a panel on AI-human cooperation in the creative arts and to demonstrate the algorithm that writes fiction like Chen.

It is no surprise that Lee tapped Chen to participate in the panel. The two are collaborating on a book, *AI 2041: Ten Visions for Our Future*, to be published this fall. Pairing Chen's speculative fiction with Lee's real-life technical perspective, the book explores how artificial intelligence will transform humankind and the global order in the next 20 years, in areas ranging from contactless dating to natural language processing to job displacement. "Computer scientists and science fiction writers don't speak the same language. If I describe how speech recognition works, it'll go right over people's heads," Lee tells me in a glass-walled conference room called Back to the Future (all the rooms at Sinovation are named after science fiction films: Total Recall, Cloud Atlas, Star Trek). "I needed a writing partner who understands the technology but can also tell a good story."

"I tend toward darker endings, and Kai-Fu toward the positive," Chen says. "He thinks of

the narrative as a step-by-step process, like a manual, and I prefer to preserve a story's ambiguity."

Given all the time he spent at tech companies, Chen is both insider and outsider in an environment like Lee's; he's fluent in the language of data and metrics and KPIs. But it's not just that he's at home in tech. I've noticed that in any new environment, Chen is observant and open-minded, careful to absorb its rules and rituals before synthesizing them as his own. Zipping from one engagement to the next, I watched him make a straight-laced professor feel at ease, charm a hippie Mongolian shaman over lunch, then pen an op-ed for a state-run newspaper at night.

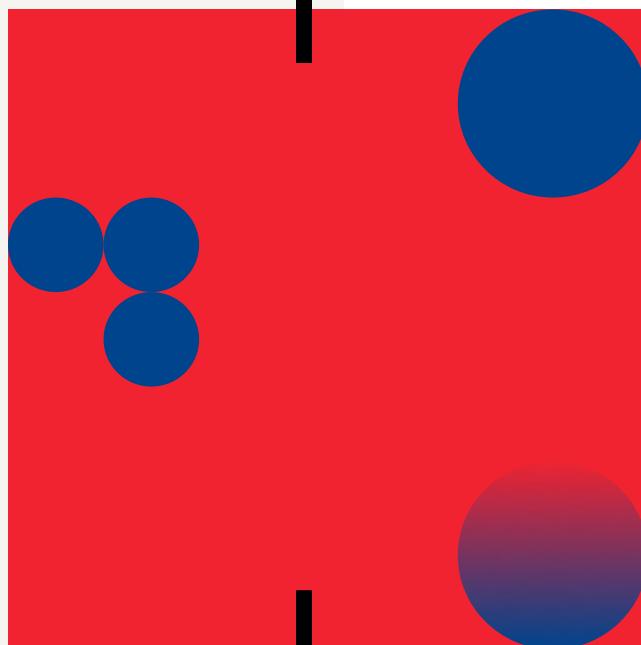
This ability to move between disparate worlds has proved useful for navigating more perilous waters: Chinese politics. In China, writers have to be sensitive not only to commercial pressures but also to shifting political winds, evading the ever watchful eyes of the censors. They have to gauge what the government is thinking, pay attention to developments on the international stage, and discern what to play up and play down, what is OK to write, what is not, and when. In addition to capturing the attention of profit seekers, science fiction's popularity has piqued the interest of the authorities, who are eager to use its skyrocketing profile to boost their own agendas. "If I'm speaking to the government, I emphasize the importance of sci-fi as a tool to strengthen innovation

and promote creativity. I fill my message with *zheng neng liang*," Chen says wryly, quoting a hackneyed catchphrase of officialdom. "How do you say that in English?"

"Positive energy," I respond.

Although Chen's *The Waste Tide* can be read as a dark and scathing critique of the government's failure to deal with ecological destruction, the novel can just as easily be interpreted as a criticism of American hypocrisy, a manifesto against global consumerism, or simply an apolitical exploration of post-human consciousness. "With science fiction, I can probe real-life issues through an imaginary narrative," Chen says, "without explicitly arguing who is right or wrong, good or evil."

Lately, though, the leeway afforded to cultural expression seems to be tightening even further. In recent years, authorities have scrubbed the internet clean of not only sensitive political content such as the Three T's—Tibet, Tiananmen, and Taiwan—but also anything the party deems immoral, from tattoos and one-night stands to hip hop. Last summer, film authorities issued a set of guidelines on how to make sci-fi films, urging filmmakers to "highlight Chinese values," "cultivate Chinese innovation," and "thoroughly study and implement Xi Jinping thought." These



measures have made writers and publishers more paranoid about making a misstep. (Last year, Chen wanted to write a story about Californian independence, but he was advised against it by his publishers for fear that it would not get past the censors. “It wasn’t even about China,” he exclaims, rolling his eyes.)

A broad, China’s science fiction writers find themselves caught in a tug-of-war between competing geopolitical agendas. The Western world has always perceived China as a monolith, reading Chinese literature through the lens of Western dreams and fears and viewing Chinese authors as either romantic dissidents clashing with the regime or soft-power tools parroting the Party’s agenda. Recent developments—the US-China trade war, conflicts with Huawei and ZTE, closed borders, and China’s aggressive posture as a technological superpower—have only exacerbated the situation. Hawkish academics pen reductive op-eds with subtitles such as “To Know What the Chinese Are Really Up To, Read the Futuristic Novels of Liu Cixin,” as if one novel could demystify a nation of a billion people. Whereas five years ago President Obama touted *The Three Body Problem* as a must-read, last September, Republican senators condemned its Netflix adaptation, criticizing Liu for his politics.

“We do the works a disservice when we focus on the geopolitics alone,” Ken Liu has written. But as much as China’s science fiction writers aspire to transcend the boundaries of nationalism, they find themselves swept into a whirlpool of forces outside of their control. According to Chen, the timing of *The Three Body Problem*’s publication was crucial. If it had come out today instead of in 2008—the days of bilateral relations, economic cooperation, and the Beijing Olympics—perhaps it would be censored by the Chinese government or condemned by the American one, targeted by both. “I stay away from politics, because—what do I know?” Chen says. “Sometimes I feel like I’m just being pulled along by the strings of history.”

Sunday evening, at the end of Chen’s jam-packed time in Beijing, we share a Didi ride from the Tencent headquarters back to the city center. I can tell he’s exhausted. “Nap a little?” I ask. He nods, and we both pull out our headphones. I listen to Bon Iver; he tunes in to a meditation app, carving out a rare period of stillness after a long day.

For a moment, I’m reminded of a passage toward the end of “The Fish of Lijiang,” when the protagonist discovers schools of fish swimming in the waterways. At first sight, they seem to be hovering calmly in the water, but as he looks closer he sees they are struggling to maintain their position. Once in a while, a fish gets pushed out of formation. “But soon,” the passage continues, “tails fluttering, they fight their way back into place.”



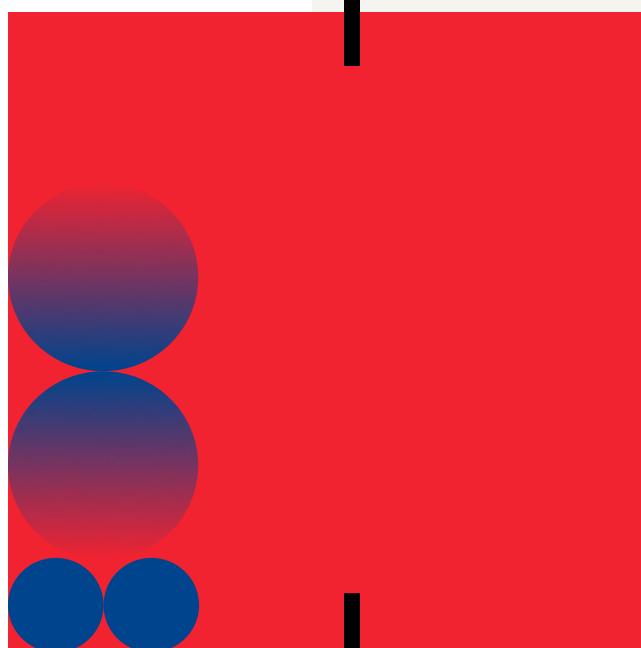
LATE LAST YEAR, 15 YEARS AFTER HIS FIRST visit, Chen returned to Lijiang to find that it had transformed. The city had morphed into the fictionalized Lijiang of his story—a digitized tourist hub where self-driving cars shuttle smartphone-toting visitors around town and local delicacies are served up by automated bots.

“Today we live in a world dominated by technology,” Chen says. “Where everything is driven by data, productivity, metrics.” In China, with a swipe of a touchscreen, you can order a Luckin coffee that appears wordlessly at your doorstep and hail a nameless Didi driver whenever you want to go somewhere. We turn to algorithms for all the answers: where to eat, what to watch, who to love. The tech industry has learned

how to monetize not only consumer goods but also experiences, attention, relationships. In many ways, we’ve become just like our devices—efficient, optimizable, operating faster than ever, caught in the endless churn of increasing productivity. But nobody knows to what end.

Of course, this is happening everywhere, but in China the transformation has been faster, vaster, and more bewildering. There’s even a word for this sense of sped-up purposelessness today—an arcane, academic term that has exploded on Chinese social media and popped up in Chen’s speeches: *involution*. The opposite of evolution, a process of involution spirals in on itself, trapping its participants.

Originally used by anthropologists to describe the dynamics that prevent agrarian societies from progressing, the term has become a shorthand used by people from all walks of life: tech workers clocking long hours at the office, delivery workers hustling from one gig to another, high school students toiling over college entrance exams. Technological progress has humanity caught in an inward-turning shell. Fifteen years after “The Fish of Lijiang,” everyone,



COLOPHON

Speculation that helped get this issue out:

What if, just maybe, I jumped into GameStop stock now? Is it possible to work long-term from an Airstream? Just hear me out: formal sweatpants. Will the baby birds nesting in my backyard survive this year? Is there a chance Indian food in Idaho is as good as we have here? Which of my beloved bars will survive? Booking a nonrefundable family vacation for August. How many days in a row is too many for microwave mac and cheese? Assuming my 3-month-old is quietly evaluating my every move and dad joke, to be tallied in a Final Judgment. What could possibly go wrong?

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like the story's burned-out wanderers, is lost, adrift and desperately looking for something to hold onto. "The times have changed," Chen says. "And the story needs to be renewed."

So Chen has returned to the drawing board, doing what he does best: going out into the world and observing, gathering material for his next project. Lately he's been interested in shamans. He's gone on several field trips, interviewing and shadowing shamans, in hopes of understanding the rites, rituals, and traditions of China's Buddhist and Taoist past. Last summer he met a shaman named Aodeng Toya through a WeChat group, and the two became fast friends. He stayed with her in Mongolia and spent a night at the foot of the sacred Bogd Khan mountain, where thousands of villagers gathered to pray to the mountain gods—drinking, eating, and dancing under the stars. For most of the year, Toya practices in Beijing, helping urbanites through all kinds of spiritual ailments. "Depression, overwork, bad luck with love, to ward off evil spirits, to commune with the dead," she tells Chen and me over lunch. "I'm booked up every day for the next month."

In our accelerated transition to a technological culture, Chen believes that we've lost so much—our relationship to our bodies, to nature, to our roots, to our faiths—and he has set out in search of them. "Shamans used to predict the weather, prevent disease, counsel leaders, show us how to coexist with the natural world," he says. "Today, technological tools have replaced those functions, but not all. Why do we still go to them? What are we looking for?" We thought we could divine, precisely and quantifiably, where we're headed, but instead find ourselves hurtling toward an increasingly precarious future: skyrocketing housing prices, soaring unemployment, deepening inequality, accelerating climate change, and a shattering global pandemic.

It's not surprising, then, that people are turning to shamans—and to science fiction. "They are treating sci-fi as an anchor to reality and science fiction writers as prophets, to help them make meaning of an unfolding future and navigate a treacherous world," says Emily Jin, Chen's translator. How do we reclaim meaning and purpose in the age of computers? What does spirituality look like when everything is mechanized and mass produced? When our lives are so deeply embedded in our devices, how do we preserve what makes us human? "As a result of all this attention, science fiction writers have been given a burden," says Jing Tsu, a professor of comparative literature at Yale. "To be the soothsayers of technological salvation."

But Chen is not a soothsayer, he's a writer. And writers need time to write. "With all these panels and talks and attention, Chinese science fiction writers could find themselves stretched thin, eviscerated of their creative energy," Tsu says. "If science fiction is to have a future in China, they need a space to create and keep maturing."

Chen has ambitious goals for 2021: to wrap up his collaboration with Kai-Fu Lee, continue his research on shamans, and write a sequel to *The Waste Tide*. But he also wants to go home to Shantou to visit his parents (he didn't get to see them much during the pandemic), find a few months of quiet in the Cangshan mountains, and maybe return to rock climbing. Like the rest of us, he has no idea where things are headed. What he does know is that he needs to slow down, find things to hold onto, and remember what makes him human: taking the time to swim against the current, fighting his way back into place. ■

YI-LING LIU (@yilingliu95) is a writer based in China. She is a 2021 ASU Future Security Fellow at New America and is working on a book about the Chinese internet.

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IAN SCHOEN, VIA FACEBOOK
WIFE REALIZED MY JOB IS EASY.
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HE CERTAINLY SHOULDN'T HAVE STOOD UP.
MAŁGORZATA KUŚ, VIA FACEBOOK

AS EVERYONE'S COMPUTER FROZE,
SHE LAUGHED.
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